SUCF Project No. 231020
Wicks and MacArthur Halls Mech/Elec Systems Study
State University of Technology at Canton
Building Systems Study

November 15, 2018

Mechanical/Electrical Engineer:
Pathfinder Engineers & Architects , LLP
134 South Fitzhugh Street
Rochester, NY 14608
(585) 325-6004

Hazardous Material Consultant:
Watts Architecture & Engineering
95 Perry Street, Suite 300
Buffalo, NY 14203
(716) 206-5100

Construction Cost Estimating:
Trophy Point, LLC
4588 South Park Avenue
Blasdell, NY 14219
(716) 823-0006

Prepared by:

Pathfinder
Engineers & Architects

134 South Fitzhugh Street
Rochester, NY 14608
585-325-6004

Woman Owned Business Enterprise
www.pathfinder-ea.com

1. EXECUTIVE SUMMARY

MacArthur Hall and Wicks Hall were built in 1971 and were occupied in 1972. MacArthur is a seven story, faculty office building and Wicks Hall is a three-story building that houses classrooms, class labs, lecture halls and additional administrative space. The buildings are in need of HVAC and electrical upgrades. Air handling systems, steam heating systems and chilled water systems including the chiller are in need of replacement. Because both of these buildings are fully occupied and there is no swing-space available to move students/faculty to another location on Campus, both buildings will have to be renovated in a 'phased-occupied' scenario. With limited infrastructure space available to run new systems the characteristics/components of the replacement HVAC system must allow for flexibility of construction phasing.

Remediating hazardous materials will compound the difficulty of replacing the mechanical systems in occupied buildings. Although there have been several past projects where abatement has taken place, hazardous materials have been identified mainly in the mechanical rooms.

The study considered six (6) possible HVAC system replacement options, weighing the pros and cons as well as the constructability/phasing of each system. A life cycle cost analysis (LCCA) was conducted to further investigate how each system would perform from an energy, first cost, and maintenance cost standpoint over the life of the mechanical system. These systems are:

System Option 1:	Four-pipe Variable Air Volume system with heat recovery and free-cooling outdoor air economizer cycle.
System Option 2:	Four-pipe Fan Coil Unit heating and cooling combined with decoupled dedicated outdoor air units (DOAS) with heat recovery.
System Option 3:	Ceiling mounted, 4-pipe Active Chilled Beam cooling & heating units with Perimeter finned tube radiation to supplement heating combined with decoupled dedicated outdoor air units (DOAS) with heat recovery.
System Option 4:	Geothermal ground-source heat pump (GSHP) heating and cooling combined with decoupled dedicated outdoor air units (DOAS) with heat recovery.
System Option 5:	Hybrid system with geothermal ground-source heat pump (GSHP) heating and cooling with decoupled dedicated outdoor air units (DOAS) with heat recovery and used in conjunction with conventional, high efficiency boilers and chillers.
System Option 6:	Two-pipe Variable Air Volume system with heat recovery and free cooling outdoor air economizer using water to water geothermal ground source heat pump (GSHP) to generate heating and chilled water.

The hybrid geothermal system was found to offer the Campus the best value from an operating standpoint over the life of the system, even though it is ranked #2 in the LCCA. It also has the least complex phasing/constructability requirements. Therefore, the hybrid GSHP System Option 5 is recommended.

A. Cost

Rough construction costs were estimated for each system option. These costs were used in the LCCA to help determine which system would be the most economical for the College over the lifetime of the mechanical system. A summary of life cycle costs for each option is shown in the figure below. First costs, equipment replacement costs and utility costs are shown based on a 25-year analysis. The system options are ranked according to net present value (NPV). Details of the project construction costs (first costs) are provided in Section IX of this report.

	One-Time Costs			Total Utility Costs		Total Costs	LCC
System Option	First Cost	Replacement	LCC NPV	First Year	LCC NPV	LCC NPV	Rank
4-Pipe VAV	$13,628,200	$1,460,000	$14,469,485	$53,045	$1,508,428	$15,977,913	**3**
4-Pipe FCU	$13,790,100	$1,265,000	$14,513,885	$52,125	$1,487,969	$16,001,855	**4**
Chilled Beam	$13,954,700	$1,376,000	$14,738,970	$50,539	$1,425,708	$16,164,678	**5**
GSHP	$14,065,400	$1,100,000	$14,688,033	$44,158	$1,216,860	$15,904,893	**1**
Hybrid GSHP	$13,987,200	$1,250,000	$14,697,190	$44,297	$1,220,507	$15,917,698	**2**
Heat Pump VAV	$15,012,800	$1,310,000	$15,766,728	$50,416	$1,439,421	$17,206,149	**6**

Life Cycle Costs of Wicks/MacArthur HVAC System Options

B. Constructability/Phasing

Phasing plans have been included in this report to allow for a better understanding on how the geothermal system would be implemented in both Wicks and MacArthur Halls. These plans should be used as a guideline for timeframe and construction sequencing for the removal of the existing systems and installation of the new mechanical and electrical system(s).

C. Energy Modeling and Analysis

Energy modeling was used both to capture the performance of the existing building conditions and to evaluate the system options. An energy model of the existing conditions for Wicks and MacArthur Halls was created with eQUEST software and calibrated to the utility bills for 2017. This model was revised for each of the six system options. The energy consumption and energy costs of each of these options was used to inform the life cycle cost analysis.

2.0 Mechanical Existing Conditions

2.1 HVAC Systems Summary

MacArthur Hall and Wicks Hall were built in 1971 and occupied in 1972. MacArthur is a seven-story, faculty office building and Wicks Hall is a three-story building that houses classrooms, class labs, lecture halls and additional administrative space.

Both MacArthur and Wicks Hall are served by the same heating and cooling plant with equipment housed in two separate mechanical rooms. The main electrical switchgear for the two buildings is also housed in the basement of Wicks Hall.

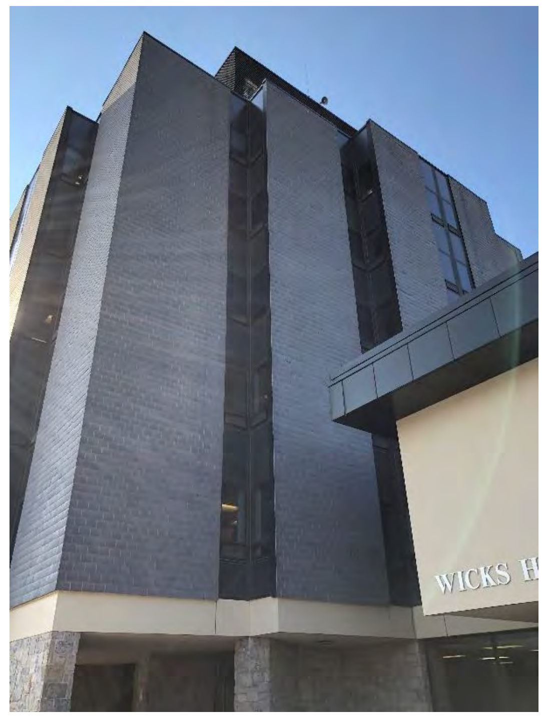


Figure 1: Wicks and MacArthur Halls

2.2 Central Heating System

A low pressure (5 psig) steam service is generated by the two 200 boiler-horsepower, natural-gas fired boilers located in the Wicks Hall basement mechanical room. The boiler manufacturer is Superior Boiler Works. Steam piping is distributed through the building and serves heating coils and humidifiers in the dual duct air handling units located in the Wicks and MacArthur basement and penthouse mechanical rooms, as well as numerous unit heaters located throughout the building. No heating hot water exists in the building.

The boilers are original to the building and are beyond their useful life expectancy. The boilers also have a rated efficiency of 78% which no longer complies with NYS energy codes and latest SUCF program directives.

Figure 2: Existing Steam Boiler

2.3 Cooling/Air Conditioning System

Both buildings share a common chilled water cooling plant located in the MacArthur Hall penthouse mechanical room. Chilled water is generated by a 325 ton, water-cooled centrifugal chiller manufactured by Carrier. A replacement cooling tower, manufactured by Evapco was installed in 2012, sized to match the chiller capacity and is located on the roof adjacent to the penthouse. A chilled water pump and a condenser water pump (with a shared standby) circulate water from the chiller to the cooling tower and from the chiller through MacArthur Hall to the basement mechanical room located Wicks Hall.

Chilled water systems are limited to serving cooling coils in the two dual duct air handling units that are located within the MacArthur Hall penthouse and Wicks Hall basement mechanical rooms. Chilled water is also piped to chilled water coils in Cook Hall.

Figure 3: 325 Ton Water-Cooled Chiller in Penthouse

Figure 4: Cooling Tower on Roof of MacArthur Hall

Pathfinder
Engineers & Architects

2.4 Air-Handling and Ventilation Equipment

Both Wicks Hall and MacArthur Hall are served by two original 'dual duct' type main air handling units. The unit serving MacArthur Hall is located within the building's penthouse mechanical room and the unit serving Wicks Hall is located within the facility's basement mechanical room. Space heating and cooling is achieved in conjunction with dual duct terminal mixing box units, located throughout both buildings within the ceiling space and floor mounted along the building perimeter wall.

2.5 MacArthur Hall Penthouse Equipment

AC-1 is a 38,100 cfm, 175-ton air handler and functions as the general building HVAC unit serving all six occupiable floors of mostly office space, and common areas on the first floor. This unit is a 'dual duct' type unit that is equipped with a common steam pre-heat coil, chilled water pre-cool coil, supply fan and return fan. After the supply fan, the ductwork splits into two separate duct systems, a 'cold deck' and 'warm deck'. The 'cold deck' duct system is equipped with a duct mounted chilled water cooling coil and the warm deck duct system is equipped with a duct mounted steam heating coil. Approximate age of the unit is 47 years.

Figure 5: AC-1 with remote return fan

Figure 6: Existing dual duct box

2.6 Wicks Hall Basement Mechanical Room Equipment

AC-2 is a 57,825 cfm, 225-ton air handler and functions as the general building HVAC unit serving all three floors of classroom, lab, lecture and office space. This unit is a ‘dual duct’ type unit that is equipped with a common steam pre-heat coil, chilled water pre-cool coil, supply fan and return fan. After the supply fan, the ductwork splits into two separate duct systems, a ‘cold deck’ and ‘warm deck’. The ‘cold deck’ duct system is equipped with a duct mounted chilled water cooling coil and the warm deck duct system is equipped with a duct mounted steam heating coil. Approximate age of the unit is 47 years.

Figure 7: AC-2 with remote return fan

Figure 8: Speed drive for AC-2

2.7 Ducted Heating and Cooling Distribution System

The building air from AC-1 is distributed via ducted supply. Both warm and cold air is delivered to floor-mounted terminal mixing box units located around the perimeter of each floor of MacArthur Hall via separate duct systems. One that is referred to as the ‘cold deck/duct’ and the other referred to as the ‘warm deck/duct’, thus the name of the mechanical system ‘dual duct’. To effectively heat and cool each space, the room’s terminal mixing box blends the cold and warm deck air from the two ducts to achieve a predetermined space heating or cooling setpoint and then delivers this blended air to the space. This ‘dual duct’ system offers good space control but is operationally inefficient. Return air is also ducted and captured throughout each floor level via a combination of linear and ceiling mounted grilles and is returned to AC-1 located in the penthouse mechanical room.

Similarly, building air for AC-2 serving Wicks Hall is designed much like AC-1. A dual duct system is employed for space heating and cooling with a combination of floor-mounted mixing boxes installed around the perimeter of the first and second floor levels as well as above ceiling horizontal mixing box units serving the basement and all interior spaces on the first and second floor levels. Return air is captured at each level and ducted to two return air masonry shafts that connect the basement, first and second level. These shafts terminate within a plenum that spans the length of the basement corridor and is utilized as the main pathway to get return air back to AC-2 which is in the basement mechanical room. At each level, a combination of linear and ceiling mounted grilles connected to return air ductwork is stubbed into the shafts above the ceiling.

2.8 Exhaust Fans

Exhaust for the building is minimal as a majority of the building, with the exception of general toilet room exhaust is recirculated through two main air handling units and relieved out large louvers at either the Wicks mechanical room or the MacArthur penthouse.

2.9 HVAC Control Systems

The building automation controls are accomplished through a combination of pneumatics which are original to the building and newer Siemens DDC controls that have been installed in both MacArthur Hall and Wicks as the buildings have been renovated. The control head end box is in the Wicks basement mechanical room and actuators and valves appear to be a combination of pneumatic or DDC electric, depending on their vintage. Pneumatics are provided by an air compressor located in the basement mechanical room. The compressor is an older vintage and the existing pneumatic piping throughout the building constantly leaks and is in poor condition.

Figure 9: Existing Building Controls

Figure 10: Control Air Compressor

3.0 Electrical Existing Conditions

3.1 Electrical Service Entrance

The existing underground electrical service enters the Electrical Substation Room located approximately in the center of the basement on the east side of the building.

Two 4160V circuits are connected to the service entrance switchgear, with a transfer switch upfront to select the circuit. However, the 1970 record drawing's One Line Diagram and Power Riser

Diagram indicate only a single incoming 4160V primary feeder. These record drawings show a single (fused) interrupter switch, not a transfer switch as illustrated on the current switchgear enclosure. (Refer to Figure 12, Service Entrance Transfer Switch.) The record drawing Site Plan indicates a single primary feeder tapped off of a 5kV loop at a manhole located north-east to the building. Later construction drawings have been studied, but the location of the second 4160V feeder has not been found on any of the documents provided. The building's Electrical Staff does not know the source of the second incoming 4160V feeder, and further investigation is required to determine.

The existing Electrical Service Entrance Switchgear consists of a:

- 4160V Kirk-Key Transfer Switch
- Primary Air Interrupter Switch with 150 Amp Fuses
- Transition Section
- 1000kVA Dry Ventilated Transformer, 4160V Delta – 480Y/277V, 3-Phase 4 Wire
- Secondary Air Circuit Breaker Set to Trip at 1200 Amp
- Circuit Breaker for Fire Pump Feeder
- Secondary Distribution Section with circuit breakers feeding McArthur Penthouse Motor Starters, Wick's Boiler Room Motor Starters, Elevator Panel and branch panelboards.

The switchgear is original to the building and is approaching 50 years. Life expectancy of service distribution equipment is 40 years. The ITE manufactured switchgear is obsolete and was completely abandoned in 1996, and only reconditioned parts are available. An emergency repair (231012-00) was recently performed.

The existing service size is adequate, and the capacity of the electrical system is not a concern. To determine the power consumption, a demand meter can be temporarily installed to provide electrical usage readings. It is suggested to install the meter over a two-week period when the building is at full occupancy during the month of January/early February. Peak electrical demand is not anticipated to increase in the future.

Figure 11:
Electrical Service Entrance Switchgear

Figure 12:
Service Entrance Transfer Switch

3.2 Electrical Distribution System / Branch Panelboards

Power is distributed throughout the building from the Electrical Service Entrance Switchgear to branch circuit panelboards on each floor of the buildings. Wicks Hall has two sets of risers of panelboards in stacked electrical closets on each floor. McArthur Hall has one riser of panelboards stacked in electrical rooms on each floor, with a Mechanical Room Penthouse on the top 7th floor. Each electrical closet has a lighting panel ("LP") and a power/utility panelboard ("UP"). Branch circuit panelboards appear original to the building also, and like the main switchgear, have a 40-year life expectancy.

Most of the panelboards are original to the building, and like the incoming switchgear, they are approaching 50 years while their life expectancy is 40 years. The ITE panelboards are obsolete. Siemens assumed ITE in 1983 and does manufacture some Siemens/ITE circuit breakers that can be used to maintain the UL Listing of the panelboard. Original reconditioned ITE circuit breakers are available on the market.

Figure 13:
Typical Branch Circuit Panelboard

Figure 14: Panelboard Nameplate

3.3 Central Emergency and Exit Lighting Inverters System

Two emergency lighting inverters provide Level 1 emergency power for exit and emergency lighting throughout the buildings. They are floor mounted cabinets which contain batteries and an integrated front panel with a keypad and display. The inverters appear to be relatively new, in good condition, and equipped with self-diagnostics and self-testing capabilities.

The emergency lighting inverters are in the fire pump room, which is adjacent to the basement electrical room. (Note: The Lighting Inverter System is not allowed to be installed within the same room as the Normal Power supply equipment in accordance with NFPA 111, Stored Electrical Energy Emergency and Standby Power Systems.)

Per NFPA 111, the SEPESS (Stored Emergency Power Supply System), "shall be located to minimize the possibility of damage from flooding, including flooding resulting from firefighting, sewer water backup, and similar disasters or occurrences." The fire suppression within the room must be fire-compatible with the battery such as a clean agent gaseous system or a pre-action system.

Although the Lighting Inverter System is installed in a separate room than the Normal Power Electrical System, the current location within a Pump Room is not code complaint. In addition, a Fire Protection Water Line is routed directly over the inverters, which is a clear violation of NEC

Article 110, Requirements for Electrical Installations. The current location also does not have a fire suppression system in the room that is fire-compatible with a battery system.

Further environmental evaluation is required to determine if the area's heating, cooling, ventilation, and humidity control meet NFPA requirements.

Figure 15: Emergency Lighting Inverters

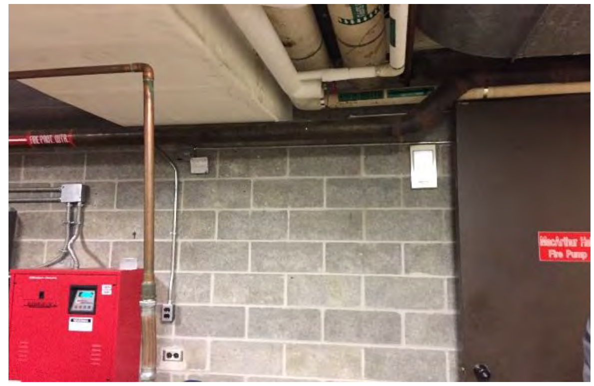


Figure 16: Water Line Over Inverters

3.4 Fire Alarm System

The fire alarm control panel is in a dedicated room on the first floor of McArthur Hall. It has been upgraded to the latest Simplex Addressable Technology (4100 ES) and is equipped with a microphone.

A remote annunciation panel for first emergency responders is located at the basement door of Wicks Hall, closest to the parking lot.

Smoke detection, manual pull stations and annunciation devices are located throughout the building and meet the requirements of the National Fire Protection Agency (NFPA).

Figure 17: Fire Alarm Control Panel

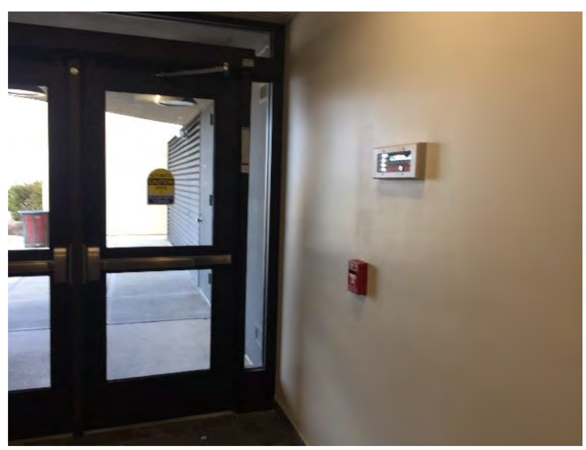


Figure 18: Fire Alarm Remote Annunciation Panel

Pathfinder
Engineers & Architects

3.5 Communication and Data Systems

The Telecommunications Equipment Room is located on the second floor in Wicks Hall. It is in good condition and has available capacity and room for potential future growth. The room is environmentally controlled and is sufficiently cooled.

A (HFC-277ea) Clean Extinguishing Agent System is installed in the Telecommunications Equipment Room. Upon detection of smoke within the room, this fire suppression system is activated, and an addressable notification signal is sent to the Fire Alarm Control Panel. A warning strobe annunciator, located in the corridor immediately outside the door, is also activated. Located under the waring strobe is an “Extinguishing System Release” red keyed-push bottom and an “Extinguishing System Abort” yellow push-and-hold button. Proper warning signage is provided.

An additional Telecommunication closet is located on the first floor, centralized to McArthur Hall.

Figure 19: Telecommunications Room

Figure 20: (HFC-277ea) Clean Extinguishing Agent System

3.6 WIFI Wireless Internet

Wireless access points (for wireless internet connection) were observed throughout the first floor lobby, in corridors, and in the Training Rooms and Lecture Halls.

Figure 21: Wireless Access Point in Corridor

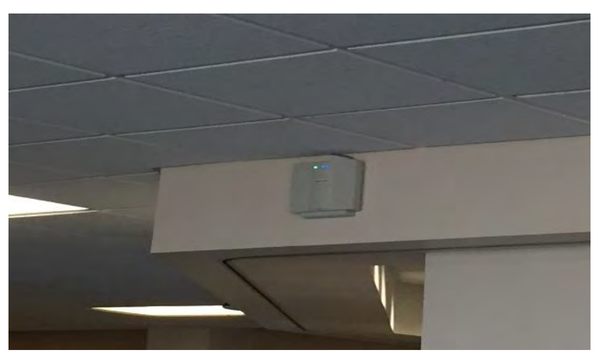


Figure 22: Wireless Access Point at Café/Lobby

3.7 Security / Access Control / Surveillance Systems

The University Police Office is in Wicks Hall on the basement floor. Card readers and cameras were observed at door entrances, and Stanley Best Security Panels in closets.

Yellow Emergency “University Help” push button stations are located next to card readers at the lobby entrances.

Figure 23: Stanley Best Security Panels

Figure 24: Security Camera

Figure 25: Card Reader & Emergency Station

3.8 Interior Luminaires:

Building interior luminaires appear to have been updated within the past 15 years. The majority of luminaires are fluorescent (type T8) lay-in-grid troffers. A variety of lenses were observed.

Newly renovated training rooms/labs have energy efficient LED type troffers. Several styles of exit lights were observed, but all are energy efficient LED type.

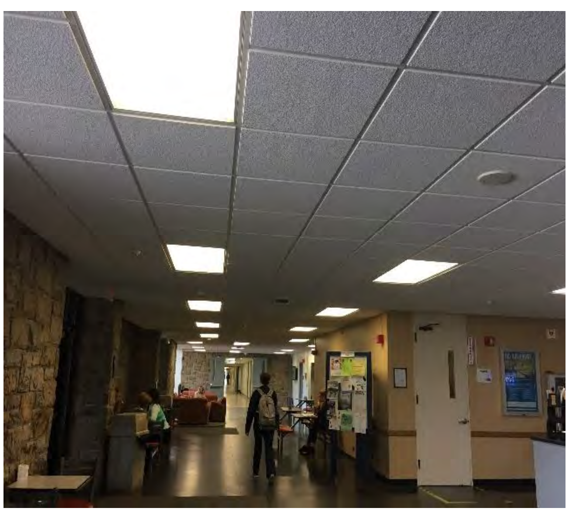


Figure 26: Lobby Fluorescent Troffer

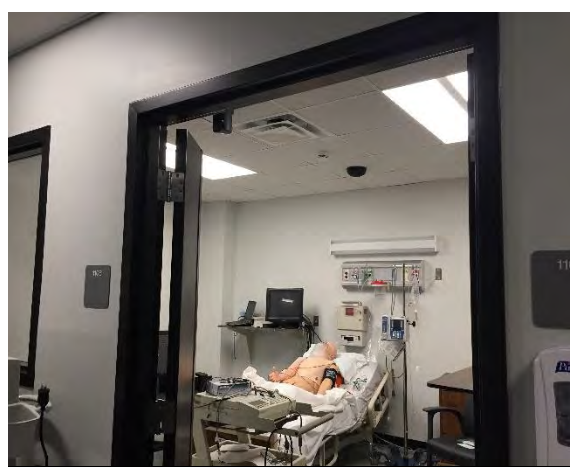


Figure 27: New Training Room with LED Lighting

3.9 MicroLite Lighting Controls

A MicroLite relay lighting control system is used for interior building lighting controls in Wicks Hall. The MicroLite Lighting Controls company was purchased over a decade ago by Musco. Musco still supports some MicroLite parts and repairs, however the MicroLite system has been discontinued. Retrofit kits are available, although updating the complete system is "expensive" by the company's website information.

From the panel directories, the MicroLite Panels currently serve Work Rooms, Locker Rooms, Treatment Rooms, Labs, Computer Station, Lecture Halls, Faculty, Storage and Offices.

Figure 28: MicroLite Lighting Control System

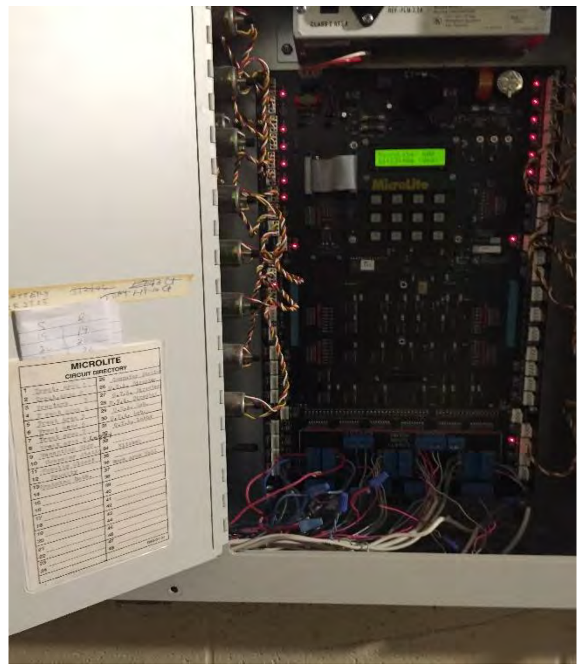


Figure 29: MicroLite Panel Interior

3.10 Exterior Building Mounted Luminaires:

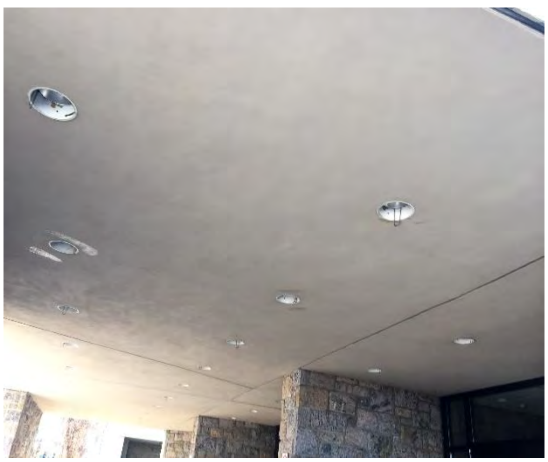
Two types of exterior building mounted luminaires are mounted around the perimeter of the building, under the roof overhangs. The original luminaires under the west side overhang of the Wicks Building were updated to HID type in 2008. The luminaires mounted under the overhang in the front of the MacArthur building have been swapped out to LED type luminaires.

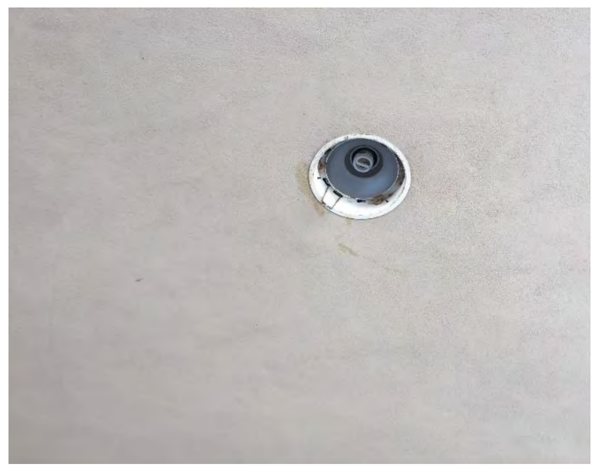
The canopy (recessed can type) luminaires at the building entrance appear to have been originally incandescent and have been retrofitted with compact fluorescent lamps. The lenses on these luminaires are missing. Other canopy luminaires at the side entrance appear to have been replaced with a surface mounted luminaire that may be LED type.

Astronomical Digital and Electrical/Mechanical time clocks/switches were observed in Wicks Hall electrical closets and are assumed to control the exterior lighting.

Figure 30: Wicks Building 2008 HID Luminaires Under West Roof Overhang

Figure 31: MacArthur Building LED Replacement Luminaires Under Front Roof Overhang





Figures 32: Original (Recessed Can Type) Canopy Luminaires at the Building Entrance

Figures 33: Side Entrance Canopy Luminaires Appear to be Replaced with LED Type

Figure 34: Exterior Lighting Time Clock

Figure 35: Exterior Lighting Time Clock

3.11 Elevator Equipment Rooms

Both McArthur and Wicks Hall have dedicated elevator machine rooms and meet current code requirements.

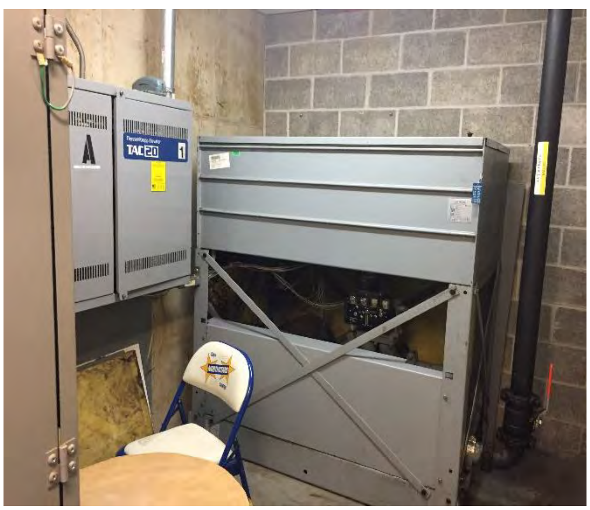


Figure 36: McArthur Elevator Machine Room

Figure 37: Wicks Elevator Machine Room

3.12 Lightning Protection System (LPS)

A lightning protection system is installed on the roof of McArthur Hall, and is consistent with the recommendations of NFPA 780, Standard for the Installation of Lightning Protection Systems. The LPS consists of air terminals around the building edge parapet (with additional terminals on metal equipment housings), roof conductors, and down conductors to a grounding electrode (ground rod). Roof top railings and drains are bonded to the system to prevent flash over.

Figure 38: LPS Air Terminals

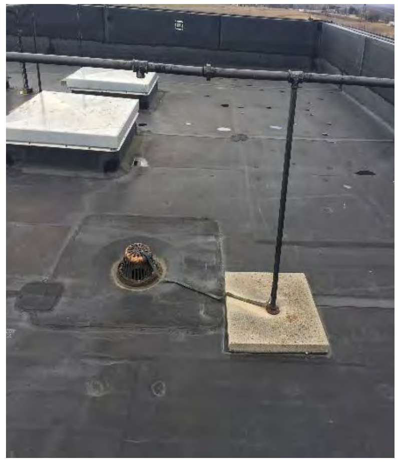


Figure 39: Metal Bonded to LPS

Figure 40: LPS Down Conductor

4.0 MEP Concept Design Considerations

4.1 HVAC Concept Design Considerations

The system issues and corresponding design challenges that will be important are:

Project HVAC Considerations	Design Challenges
Phasing/Constructability	Limited Swing Space
Project Cost	First Cost vs. Life Cycle Cost
Energy Efficiency (Low Cost)	Equipment and System Eff Meeting Campus Goals
Comfort Conditions	Existing building envelope/proper system zoning. Equipment to handle variability of occupancy and thermal loads
Indoor Air Quality	Ventilation without introducing excess humidity
Low Noise/Good Acoustical Isolation	Low ceilings and walls, lots of hard surfaces.

The building renovation will include all new HVAC systems and zoning within the existing shell. This involves working with limited space available for routing mechanical services. We recommend removing the existing steam and chilled water plants and updating the mechanical system to a high-performance air or hydronic system for better performance and control.

The HVAC and related Mechanical Systems shall not only be functional and responsive to the campus's needs, but shall be simple, reliable, durable, maintainable, and easily accessible. The HVAC System utilizes energy conservation techniques to the greatest extent possible, while maintaining comfortable control. All HVAC components shall be capable of a complete override from the Energy Management System.

Heating and cooling systems and their associated controls shall be designed and zoned to enable the building to operate at less than full capacity without conditioning the entire building.

The mechanical systems shall be designed to meet and/or exceed New York State Energy Code (with Supplements).

4.2 HVAC System Options

Programs planned for the building will necessitate at least two primary air handling systems delivering dedicated outdoor air to the occupied spaces: one system for Wicks educational program spaces and nursing suites, and another system for the MacArthur offices and administration tower.

Due to the complexity of phasing this project, and limited space in the existing penthouse and boiler room, new mechanical systems may not be able to be installed concurrently within these spaces. It should be noted that new air handling units may need to be located on the roof, in a penthouse enclosure where service and access for filter changes, and general maintenance would be improved as there would be no available space in the existing mechanical rooms to house new units.

Pathfinder has evaluated a combination of terminal system options, best suited for this building type and function, for the new HVAC system:

- Option1: Four-pipe Variable Air Volume system with heat recovery and free-cooling outdoor air economizer cycle.
- Option2: Four-pipe Fan Coil Unit heating and cooling combined with decoupled dedicated out-door air units (DOAS) with heat recovery.

- Option3: Ceiling mounted, 4-pipe Active Chilled Beam (induction) cooling & heating units with Perimeter finned tube radiation to supplement heating combined with decoupled DOAS with heat recovery.
- Option 4: Geothermal ground-source heat pump heating and cooling combined with decoupled DOAS with heat recovery.
- Option 5: Hybrid system with geothermal ground-source water to water heat pump heating with decoupled DOAS with heat recovery and used in conjunction with conventional, high efficiency boilers and chillers.
- Option 6: Two-pipe Variable Air Volume system with heat recovery and free cooling outdoor air economizer using water to water geothermal ground source heat pump (GSHP) to generate heating and chilled water

4.2.1. Option 1: Four-Pipe Variable Air Volume System

Heating System

The proposed heating system is hot water. The buildings will be heated by means of Hot Water Circulating System servicing hot water heating coils located in air handling units, room terminal control units, baseboard radiation, unit heaters, and convectors.

The boiler's fuel source will be natural gas.

Base-mounted vertical inline distribution pumps, located in a mechanical space, will circulate the required quantities of hot water, by piping systems, to air handling units, room terminal units (VAV boxes) and miscellaneous heating units. A redundant circulating pump will serve as a back-up to the lead circulating pump.

The heating water loop will be variable flow and provide the necessary low temperature (140°F maximum) hot water to air handling unit coils, unit heaters, terminal control units, baseboard radiation, and miscellaneous terminal heating units. The heating water pump will utilize a variable frequency drive to vary pump speed based on the system's differential pressure requirement. The system differential pressure operating setpoint will be automatically reset based on analyzing all control valve positions. The heating water loop supply temperature will be reset based on outside air temperature. Constant hot water circulation by means of high efficiency, ECM motor centrifugal in-line type circulating pumps will provide the necessary freeze protection of air handling unit preheat coils. A redundant circulating pump will serve as a back-up to the lead circulating pumps.

Heating water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges and flow meters.

Generation equipment will include three 1500 MBH, high efficiency (90%-95% efficiency) variable flow condensing type fire tube hot water boilers (i.e., AERCO Benchmark, Cleaver Brooks Clearfire or equal of Fulton) sized equally for the total heating capacity. These boilers will be in the Boiler Room.

Water expansion and air removal devices will be provided in the Heating Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements. All makeup water will be metered and monitored through the EMS.

Chemical Treatment Systems will be provided for the Hot Water Circulating System.

Hot Water Heating System piping will be Schedule 40 Black Steel and insulated in accordance with ASHRAE Standards.

The heating system will operate whenever the outside air temperatures are 65°F or less.

Cooling System

The building will be cooled by means of a Central Chiller Plant with chilled Water Circulating System serving chilled water cooling/dehumidification coils located in air handling units.

Chilled water will be generated by one base load, high efficiency, variable speed compressor, magnetic bearing water cooled centrifugal type chiller. A smaller capacity positive displacement chiller (scroll or screw type) will be used for low part load conditions (night, weekends, summer, early spring, late fall) and peak design conditions to supplement the base chiller. This smaller chiller will also be capable of rejecting heat (up to 140°F) to the heating system when the building requires both heating and cooling or when operating in a dehumidification mode. All chillers will use and environmentally safe refrigerant in accordance with The Clean Air Act.

Base-mounted vertical inline pumps (secondary) located in the Mechanical Room will circulate the required quantities of chilled water, by piping systems, to air handling unit cooling coils. A redundant circulating pump will serve as a back-up to the lead circulating pump. Independent base mounted, vertical inline pump(s) (primary pump) will be designed to circulate chilled water through each chiller. The pumps will be variable flow to track secondary flow rate requirements. The system differential pressure operating setpoint will be automatically reset based on analyzing all control valve positions.

The full load capacity performance and part load efficiency of the chillers will be selected to precisely and efficiently track the building load based on hour-by-hour building load requirements and will be capable of a high turn down ratio.

An induced air type cooling tower associated with each chiller will utilize a variable speed fan to reject heat to the atmospheric heat sink.

Base-mounted vertical inline pumps for condenser water will be located in the Mechanical Equipment Room.

Chilled water and condenser water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges, and flow meters.

Water expansion and air removal devices will be provided in the Chilled Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements for each system.

Independent Chemical Treatment Systems will be provided for the chilled water and condenser systems.

Makeup water for the chilled water and condenser water system will be metered and monitored through the EMS.

Chilled water piping will be welded Schedule 40 Black Steel and insulated in accordance with ASHRAE Requirements. Condenser water piping will be Schedule 40 Galvanized Steel with mechanical couplings. Condenser water piping will be insulated.

The Chiller System (i.e., mechanical cooling) shall operate automatically whenever outside air temperatures are above 50°F.

Air Distribution Systems

Multiple air handling units will provide the necessary ventilation and supply air to maintain the desired environmental conditions and make-up air requirements. Minimum ventilation air rates will be determined by the requirements set forth by the current ASHRAE Standard 62 and the International Mechanical Code.

All air handling unit systems will be provided with 100% outside air economizer cycles for free cooling. All air-moving equipment and ductwork will be installed in accordance with requirements of SMACNA and ASHRAE.

The proposed air handling unit(s) will be variable air volume, medium pressure air handling unit(s) with direct drive, plenum type airfoil supply fan, belt drive backward inclined airfoil return fan, economizer Section, mixing box, filter Section with 30% (MERV 8) prefilters and 85% (MERV 13) final filters (with differential pressure gauge across each filer bank), hot water preheat coil with circulating pump(s), and chilled water dehumidification/cooling/ dehumidification coil. Outside air, relief air, return air and supply air streams will be equipped with air flow measuring stations. Return air will volumetrically track supply air and relief air will volumetrically track outside air to maintain a slight positive building pressure. The proposed air handling units will be strategically located within penthouses near the area they serve.

All outside air will be preconditioned through the use of a heat recovery device so as to capture and reuse waste heat. A dedicated outdoor air system (DOAS) unit(s) will serve multiple adjacent air handling units or a heat recovery device shall be an integral component within an air handling unit.

Variable air volume type air handling units will distribute supply air (55°F) to room terminal control units through a medium pressure round/flat oval duct system. Each classroom and/or office will be provided with a room terminal control unit for independent space temperature control. The proposed room terminal control unit is a standard (i.e., non-fan powered) variable air volume terminal control unit equipped with hot water heating coil which will vary the amount of conditioned primary air to the space from the air handling unit. Low pressure sound lined rectangular supply air ductwork located at the outlet of room terminal control units will serve ceiling supply diffusers.

A low-pressure duct system will return air from room return air grilles to air handling units.

Advantages

The advantages of this system include a full air-side economizer for free cooling (i.e., no mechanical cooling). The cooling central plant refrigeration equipment is sized based on the building’s block load (which is less than the sum of individual space peak loads required by small compressor-based systems) and all central plant generating equipment is in the boiler/chiller room and not scattered throughout the building. VAV systems tend to be quiet since there is no radiated fan noise from the terminal units.

Disadvantages

The main disadvantage of a VAV system is that it is an ‘all air’ system. This means that all the building’s heating and cooling energy is transported through large ductwork, which in turn requires that more infrastructure (ceiling) space be available. Due to the current lack of space within the existing boiler room and penthouse, new AHUs may have to be located on the roof.

Constructability

For this project, the installation of a four-pipe VAV system would be challenging. Due to the need to keep the existing mechanical systems operational while new systems are being installed, there may not be enough room to fit all the associated components of this system above the ceiling. This includes new ductwork, piping, terminal control units and their associated valve packages. Additionally, new AHU zoning for the building while utilizing a VAV type system would be recommended. New locations within the building for new indoor AHUs does not appear to be available, therefore, units will most likely have to be installed on the roof of Wicks Hall.

Reuse of existing duct systems under this option would be difficult as most of the existing systems are up-fed from the floor below and not with overhead distribution on the floor that the units serve. This means that most new VAV boxes would need to be supplied with new ductwork that was tied into the central shafts located in both Wicks and MacArthur Halls at each floor level to be feasible.

System Performance

Under this option, the proposed first cost for installing a four pipe VAV system would be $13,628,200. The annual energy cost projection based on energy modeling is $53,045. For this study, it has been assumed that at year 20, the chillers, cooling tower, boilers, air handling units and all associated pumps would have to be replaced. Also starting at year 20, VAV boxes would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,460,000. Refer to the Energy Modeling and LCCA section of this report for additional information.

4.2.2. Option 2: Four-Pipe Fan Coil Unit System

Heating System

The proposed heating system is hot water. The building will be heated by means of hot water circulating system servicing hot water heating coils located in air handling units, room terminal control units, baseboard radiation, unit heaters, and convectors.

The boiler's fuel source will be natural gas.

Base-mounted vertical inline distribution pumps, located in a mechanical space, will circulate the required quantities of hot water, by piping systems, to air handling units, fan coil units, and miscellaneous heating units. A redundant circulating pump will serve as a back-up to the lead circulating pump.

The heating water loop will be variable flow and provide the necessary low temperature (140°F maximum) hot water to air handling unit coils, unit heaters, terminal control units, baseboard radiation, and miscellaneous terminal heating units. The heating water pump will utilize a variable frequency drive to vary pump speed based on the system's differential pressure requirement. The system differential pressure operating setpoint will be automatically reset based on analyzing all control valve positions. The heating water loop supply temperature will be reset based on outside air temperature. Constant hot water circulation by means of high efficiency, ECM motor centrifugal in-line type circulating pumps will provide the necessary freeze protection of air handling unit preheat coils. A redundant circulating pump will serve as a back-up to the lead circulating pumps.

Heating water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges and flow meters.

Generation equipment will include three high efficiency (90%-95% efficiency) variable flow condensing type fire tube hot water boilers (i.e., AERCO Benchmark, Cleaver Brooks Clearfire or equal of Fulton) sized equally for the total heating capacity. These boilers will be in the Boiler Room.

Water expansion and air removal devices will be provided in the Heating Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements. All makeup water will be metered and monitored through the EMS.

Chemical Treatment Systems will be provided for the Hot Water Circulating System.

Hot Water Heating System piping will be Schedule 40 Black Steel and insulated in accordance with ASHRAE Standards.

The Heating System will operate whenever the outside air temperatures are 65°F or less.

Cooling System

The building will be cooled by means of a Central Chiller Plant with chilled Water Circulating System serving chilled water cooling/dehumidification coils located in air handling units.

Chilled water will be generated by one base load, high efficiency, variable speed compressor, magnetic bearing water cooled centrifugal type chiller. A smaller capacity positive displacement chiller (scroll or screw type) will be used for low part load conditions (night, weekends, summer, early spring, late fall) and peak design conditions to supplement the base chiller. This smaller chiller will also be capable of rejecting heat (up to 140°F) to the heating system when the building requires both heating and cooling or when operating in a dehumidification mode. All chillers will use and environmentally safe refrigerant in accordance with The Clean Air Act.

Base-mounted vertical inline pumps (secondary) located in the Mechanical Room will circulate the required quantities of chilled water, by piping systems, to air handling unit cooling coils. A redundant circulating pump shall serve as a back-up to the lead circulating pump. Independent base mounted, vertical inline pump(s) (primary pump) will be designed to circulate chilled water through each chiller. The pumps sh will all be variable flow to track secondary flow rate requirements. The system differential pressure operating setpoint will be automatically reset based on analyzing all control valve positions.

The full load capacity performance and part load efficiency of the chillers will be selected to precisely and efficiently track the building load based on hour-by-hour building load requirements and shall be capable of a high turn down ratio.

An induced air type cooling tower associated with each chiller will utilize a variable speed fan to reject heat to the atmospheric heat sink.

Base-mounted vertical inline pumps for condenser water will be in the Mechanical Equipment Room.

Chilled water and condenser water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges, and flow meters.

Water expansion and air removal devices will be provided in the Chilled Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements for each system.

Independent chemical treatment systems will be provided for the chilled water and condenser systems.

Makeup water for the chilled water and condenser water system will be metered and monitored through the EMS.

Chilled water piping will be welded Schedule 40 Black Steel and be insulated in accordance with ASHRAE Requirements. Condenser water piping will be Schedule 40 Galvanized Steel with mechanical couplings. Condenser water piping will be insulated.

The chiller system (i.e., mechanical cooling) shall operate automatically whenever outside air temperatures are above 50°F.

Air Distribution Systems

A combination of individual console and horizontal type fan-coil units with ducted supply air system to ceiling supply air diffusers be provided for each room. These units will be 100% recirculating air type with heating and cooling coils (i.e. 4-pipe) controlled to maintain the desired indoor temperature conditions (i.e. sensible heating and cooling only).

Heat Recovery Ventilation Air Units (100% outside air) will be used as part of the Dedicated Outdoor Air System (DOAS) to dehumidify, temper and heat ventilation air to a neutral air temperature (70°F). These units will provide the minimum amount of outside air for ventilation as determined by the requirements set forth by ASHRAE Standard 62, The International Mechanical Code and the makeup air requirements to maintain a slight positive building pressure. This conditioned/tempered outside air will be directly injected into each room. Relief air (used outdoor air) s will hall be brought back to the heat recovery unit for energy reclamation via a ducted return air system, then discharged to the outside. Multiple heat recovery devices inside these units (heat wheels, flat plate heat exchangers) will be employed to provide the necessary preconditioning (sensible and latent energy) and free reheat (sensible energy) of outside air. Additionally, these units will be equipped with a supply fan, exhaust/relief fan, filters, cooling/dehumidification coil, and heating coil. The heating and cooling medium will be provided by the buildings central cooling and heating plant.

An extensive insulated condensate collection system will be required to connect all the terminal fan coil units.

To reduce energy usage, it is recommended to cycle the units fan based on the demand for heating and cooling in lieu of running these low efficiency fans continuously during the occupied mode. Additionally, it is recommended these fans utilize the higher efficiency ECM motors in lieu of PSC type.

Advantages

The advantages of this system include superior indoor air quality through use of dedicated ventilation air units, energy-conserving heat recovery to minimize central plant equipment and distribution system sizes, individual room control while providing simple operation. Fan coil units are relatively quiet and are readily available in a wide range of sizes and capacities. These units are easily and inexpensively serviced (fan motor and throwaway filter). This system also has the flexibility to be installed concurrently while keeping the existing dual duct system online and operational.

Disadvantages

This system does not allow for free-cooling through an air-cooled economizer cycle like a VAV system and many small fan coil units would be scattered throughout the building(s) that will have to be maintained (filter changes, etc.).

Constructability

The installation of a four-pipe fan coil unit system will be very flexible for the phasing requirements of this project. There are separate approaches that that we would recommend for each building:

For Wicks Hall, the existing dual duct system remains operational as the new heating water and chilled water piping is installed throughout the building. New console fan coil units will be installed along the exterior wall in each classroom/lab space behind the existing sheet metal cabinets/enclosures next to the existing floor mounted dual duct boxes. Where required, new low-profile horizontal FCUs will be roughed in above the existing ceilings. The new central heating water boiler plant will be installed in the Wicks Hall ground level storage room and gradually tie into the new FCUs. As new equipment comes on-line and spaces are completely converted to the new FCU system, one existing steam boiler will be removed freeing up floor space in the mechanical room for new equipment. Once the entire Wicks building is served by the FCU system, the existing dual duct air handling unit will be removed in its entirety. The sections of the existing hot deck ductwork will be reused as the ventilation air duct that is served by the new DOAS unit that located in the Wicks basement mechanical room. All other ductwork (existing cold deck, exhaust duct, etc.) will be removed in its entirety. New chilled water piping within the Wicks building will be tied into the new chilled water plant (in the Penthouse of MacArthur Hall) and be charged/energized.

For MacArthur Hall, it is recommended that one floor at a time be taken offline and renovated. Existing ductwork serving a floor will be cut and capped at the central shaft penetration, isolating the floor from the rest of the existing dual duct system and allowing the existing system to serve the remaining floors yet to be renovated. The floor-mounted dual duct mixing box located under the window sills around the building perimeter walls will be replaced with floor-mounted FCUs in the same locations. Where required, new low-profile horizontal FCUs will be roughed in above the existing ceilings to serve interior spaces. New heating water piping will be installed and tied into the new central heating water boiler plant located in the MacArthur Hall ground level storage room. New ventilation air ductwork, as well as new chilled water piping, will be roughed in and extended to the central shaft where it will be charged/energized in a later phase when the new DOAS unit and central cooling plant is installed and operational. Final tie-in to each floor from the central shaft will take place once each floor has been renovated and the existing chilled water plant and dual duct air handling unit located in the mechanical penthouse has been removed in its entirety.

System Performance

Under this option, the proposed first cost for installing a four-pipe fan coil unit system would be $13,632,600. The annual energy cost projection based on energy modeling is $52,125. For this study, it has been assumed that at year 20, the chillers, cooling tower, boilers, DOAS units and all associated pumps would have to be replaced. Also starting at year 20, individual fan-coil units would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,265,000. Refer to the Energy Modeling and LCCA section of this report for additional information

4.2.3. Option 3: Four-Pipe Active Chilled Beam System

Heating System

The proposed Heating System is hot water. The building will be heated by means of Hot Water Circulating System servicing hot water heating coils located in air handling units, room terminal control units, baseboard radiation, unit heaters, and convectors.

The boiler’s fuel source will be natural gas.

Base-mounted vertical inline distribution pumps, located in a mechanical space, will circulate the required quantities of hot water, by piping systems, to air handling units, room induction units (chilled beams) and miscellaneous heating units. A redundant circulating pump will serve as a back-up to the lead circulating pump.

The heating water loop shall will variable flow and provide the necessary low temperature (140°F maximum) hot water to air handling unit coils, unit heaters, baseboard radiation, and miscellaneous terminal heating units. The chilled beam induction units will be served by a separate piping loop receiving a maximum heating water temperature of 110°F maximum. The heating water pump will utilize a variable frequency drive to vary pump speed based on the system’s differential pressure requirement. The system differential pressure operating setpoint will be automatically reset based on analyzing all control valve positions. The heating water loop supply temperature will be reset based on outside air temperature. Constant hot water

Pathfinder
Engineers & Architects

circulation by means of high efficiency, ECM motor centrifugal in-line type circulating pumps will provide the necessary freeze protection of air handling unit preheat coils. A redundant circulating pump will serve as a back-up to the lead circulating pumps.

Heating water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges and flow meters.

Generation equipment will include three high efficiency (90%-95% efficiency) variable flow condensing type fire tube hot water boilers (i.e., AERCO Benchmark, Cleaver Brooks Clearfire or equal of Fulton) sized equally for the total heating capacity. These boilers will be in the Boiler Room.

Water expansion and air removal devices will be provided in the Heating Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements. All makeup water will be metered and monitored through the EMS.

Chemical treatment systems will be provided for the hot water circulating system.

Hot water heating system piping will be Schedule 40 Black Steel and insulated in accordance with ASHRAE Standards.

The heating system will operate whenever the outside air temperatures are 65°F or less.

Cooling System

The building will be cooled by means of a Central Chiller Plant with chilled Water Circulating System serving chilled water cooling/dehumidification coils located in air handling units.

Chilled water will be generated by one base load, high efficiency, variable speed compressor, magnetic bearing water cooled centrifugal type chiller. A smaller capacity positive displacement chiller (scroll or screw type) will be used for low part load conditions (night, weekends, summer, early spring, late fall) and peak design conditions to supplement the base chiller. This smaller chiller will also be capable of rejecting heat (up to 140°F) to the heating system when the building requires both heating and cooling or when operating in a dehumidification mode. All chillers will use and environmentally safe refrigerant in accordance with The Clean Air Act.

Base-mounted vertical inline pumps (secondary) located in the Mechanical Room will circulate the required quantities of chilled water, by piping systems, to air handling unit cooling coils and chilled beam induction units. A redundant circulating pump will serve as a back-up to the lead circulating pump. Independent base mounted, vertical inline pump(s) (primary pump) will be designed to circulate chilled water through each chiller. The pumps will be variable flow to track secondary flow rate requirements. The system differential pressure operating setpoint sh will all be automatically reset based on analyzing all control valve positions.

The full load capacity performance and part load efficiency of the chillers will be selected to precisely and efficiently track the building load based on hour-by-hour building load requirements and be capable of a high turn down ratio.

An induced air type cooling tower associated with each chiller will utilize a variable speed fan to reject heat to the atmospheric heat sink.

Base-mounted vertical inline pumps for condenser water will be in the Mechanical Equipment Room.

Chilled water and condenser water pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges, and flow meters.

Water expansion and air removal devices will be provided in the Chilled Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements for each system.

Independent chemical treatment systems will be provided for the chilled water and condenser systems.

Makeup water for the chilled water and condenser water system will be metered and monitored through the EMS.

Chilled water piping will be welded Schedule 40 Black Steel and will be insulated in accordance with ASHRAE Requirements. Condenser water piping will be Schedule 40 Galvanized Steel with mechanical couplings. Condenser water piping will be insulated.

The chiller system (i.e., mechanical cooling) will operate automatically whenever outside air temperatures are above 50°F.

Air Distribution Systems

An induction system consists of induction coil units, in the occupied space, integrated into the ceiling or floor mounted flush to a wall. This equipment provides localized heating and cooling utilizing ventilation air introduced in the equipment. Induction systems provide excellent temperature control, ensure proper ventilation is delivered to the occupants of the space, and require minimum fan energy. A combination of ceiling mounted and console (floor-mounted) type would be utilized in both the Wicks and MacArthur buildings. Where existing dual duct boxes are currently located along exterior walls in both buildings, new chilled beams would replace these in kind. Ceiling mounted units would be installed where above ceiling dual duct boxes once existed.

Heat Recovery Ventilation Air Units (100% outside air) will be used as part of the Dedicated Outdoor Air System (DOAS) to dehumidify, temper and heat ventilation air to a neutral air temperature (70°F). These units will provide the minimum amount of outside air for ventilation as determined by the requirements set forth by ASHRAE Standard 62, The International Mechanical Code and the makeup air requirements to maintain a slight positive building pressure. This conditioned/tempered outside air will be directly injected into each chilled beam terminal unit. Relief air (used outdoor air) will be brought back to the heat recovery unit for energy reclamation via a ducted return air system, then discharged to the outside. Multiple heat recovery devices inside these units (heat wheels, flat plate heat exchangers) will be employed to provide the necessary preconditioning (sensible and latent energy) and free reheat (sensible energy) of outside air. Additionally, these units will be equipped with a supply fan, exhaust/relief fan, filters, cooling/dehumidification coil, and heating coil. The heating and cooling medium will be provided by the buildings central cooling and heating plant.

An extensive condensate collection system will be required to connect all the terminal fan coil units.

Advantages

The advantages of a chilled beam system is that it has a lower operating cost than any of the other systems explored in this study. It also requires the least amount of infrastructure space above the ceilings as most of the energy is moved through smaller hydronic pipes and ductwork when compared to a VAV (all air) system. There is also minimal equipment to maintain throughout the building as the chilled beam units themselves have no moving parts.

Disadvantages

Chilled beam systems are extremely sensitive to the introduction of untreated outdoor air (open windows) and fluctuations with indoor humidity levels. Keeping the indoor environment at tight temperature and humidity ranges is critical for proper operation. For this project, trying to implement this system in a phased manner would be challenging due to the need for this.

Constructability

The installation of a chilled beam system will make for complicated phasing requirements of this project. While the chilled beam induction units and associated piping could feasibly be installed concurrently with existing dual duct system still active and operational, the new system would have to remain completely off until the old system (boilers, chiller, AHUs) where removed to make space for the new DOAS units that supply the induction units with conditioned air. The inherent nature of the induction process requires that the air delivered to the chilled beam be at precise temperatures and humidity levels or else the we lose control of the system and space relative humidity. The existing dual duct AHUs do not have the capability to provide these sorts of supply air conditions meaning that they cannot be used at any point during construction for spaces that are converted to chilled beam. If this system were to be installed for both Wicks and MacArthur, the new DOAS units would either have to be installed early on in the project with mostly new ductwork and be located on the roof.

System Performance

Under this option, the proposed first cost for installing a 4-pipe chilled beam system would be $13,887,900. The annual energy cost projection based on energy modeling is $50,539. For this study, it has been assumed that at year 20, the chillers, cooling tower, boilers, DOAS units and all associated pumps would have to be replaced. Also starting at year 20, individual chilled beam units would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,376,000. Refer to the Energy Modeling and LCCA section of this report for additional information.

4.2.4. Option 4: Geothermal Ground Source Heat Pump System

Water- source heat pumps are single packaged reverse- cycle heat pumps utilizing a closed recirculating water loop into which units absorb or reject heat. Typical condenser water flow rates are based on 3 GPM per ton of cooling (12,000 BTUH). Ground source heat pump components include a complete refrigeration system consisting of a compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion devices, and a refrigerant reversing valve.

Like fan-coil units, ground source heat pumps do not have the latent capacity to condition (dehumidify) outside air. Therefore, a separate decoupled dedicated outdoor air system (DOAS) using heat recovery ventilation air units needs to be used in conjunction with geothermal ground source heat pumps.

There are two main types of geothermal ground source heat pump units; water-to-air type and water-to-water type. As their name type implies water-to-air heat pumps use the geothermal water loop to exchange heat absorbed (cooling) or rejected (heating) from the air stream via the refrigeration system to the water loop. Similarly, water-to-water heat pumps utilize the refrigeration system to absorb heat from a re-circulating water system to create chilled water while rejecting this heat via the refrigeration cycle to the geothermal loop. During the heating mode the refrigeration system absorbs heat from the geothermal loop and coupled with the waste heat created by compressor inefficiency the combination of heat sources creates low temperature heating water, typically about 110°F.

The system concept is also like the fan-coil units, utilizing a combination of individual console and horizontal type water-to-air heat pump units with ducted supply air system to ceiling supply air diffusers shall be provided for each room.

Geothermal water-to-air heat pumps need to be used in conjunction with a decoupled dedicated outdoor air system. Water-to-air heat pumps shall be recirculating air type to provide sensible heating and cooling to the space where the DOAS will provide dehumidified, conditioned and tempered ventilation air to each space. The heat recovery units are the same as described for the fan coil unit option except they shall have a single dual-temperature coil (i.e. 2-pipe) in lieu of separate heating and cooling coils (i.e., 4-pipe).

It is recommended that all DOAS units be provided with a two-pipe/dual temperature coil and be served by a dual temperature system using geothermal water-to-water heat pumps. Water-to-water heat pumps or a geothermal chiller shall generate either chilled water (45°F supply) or low temperature heating water (110°F supply) which through a separate 2-pipe loop will provide heating or cooling to the dual temperature heating/cooling coil. A high efficiency condensing boiler incorporated into this dual temperature loop is recommended to provide supplemental heating capacity when needed (morning warm up, redundancy). As an alternative, DOAS units can be self-contained compressorized geothermal type units in lieu of the central station 2-pipe type.

Geothermal heat pumps take advantage of using the earth as the loop's heat sink. Approximately 5 ft. below the earth's surface, a relatively constant 55-57°F temperature is maintained. Due to the extended temperature operating range, the piping system must be insulated and the loop shall be provided with a high-efficiency condensing boiler which can provide supplemental heating to the loop while protecting the loop (i.e. clear water) from freezing conditions.

The proposed closed loop earth heat exchanger system utilizes the vertical well concept with plastic tubing installed in a U-bend configuration (1-1/4" loops) within a +/- 400 to 500 ft. deep well which is filled with an enhanced thermal conductivity grout-type material. It is recommended that a thermal conductivity test be performed at the site so that site-specific heat exchange characteristics can be determined. For this geological area, it is probable that each vertical well will be capable of +/- 1.5 – 1.75 tons of heat exchange. It is anticipated that between 200 - 250 bore holes located in a 15 ft. by 15 ft. grid would be required.

A base-mounted vertical inline pump with standby for the geothermal and dual temperature system will be in the Mechanical room. Variable speed pumping and individual unit solenoid valves will be utilized to minimize pump energy. Individual constant volume in-line circulating pumps will be used for the load side of water to water heat pumps.

Geothermal and dual temperature pumps will be trimmed with flexible connectors, strainers, check valves, isolation valves, pressure gauges and flow meters.

Water expansion and air removal devices will be provided in the Geothermal and Dual Temperature Water System. Water pressure regulators located downstream of backflow preventers will provide the make-up water requirements. Makeup water usage for the Geothermal and Dual Temperature System will be independently metered and monitored through the EMS.

Chemical treatment systems will be provided for the Geothermal and Dual Temperature Water Circulating System.

Geothermal and Dual Temperature Water System piping will be Schedule 40 Black Steel and insulated in accordance with ASHRAE Standards.

Advantages

The advantage of the geothermal heat pump system is the inherent heat recovery capabilities which transfer rejected heat from the interior spaces during the winter season in the common loop, which allows perimeter units to absorb this wasted heat. Only two pipes, supply and return, are needed, although they do require insulation. Any unit connected to the main water loop can heat or cool at all times. Since these units are self-contained refrigeration systems, there is little to maintain.

Disadvantages

A disadvantage of any heat pump/decentralized system is the anticipated life expectancy is shorter (20-25 years), compared to conventional centralized equipment (25-30 years). Typically, when they reach the end of their life expectancy, all units need to be replaced since these packaged-type units cannot typically be rebuilt and life extended. The earth heat exchanger has a longer life (greater than 50 years) so only the terminal units need to be replaced.

Constructability

The installation of a geothermal ground source heat pump system will be very flexible for the phasing requirements of this project. There are separate approaches recommend for each building:

Before any renovation works takes place (aside from abatement activities), the new geothermal field will need to be installed, purged, tested, balanced and the header piping brought into the Wicks Hall basement mechanical room.

For Wicks Hall, the existing dual duct system remains operational as the new geothermal water piping is installed throughout the building. New console water-to-air heat pump units will be installed along the exterior wall in each classroom/lab space behind the existing sheet metal cabinets/enclosures next to the existing floor-mounted dual duct boxes. Where required, new low-profile horizontal water-to-air heat pump units will be roughed in above the existing ceilings. As new equipment comes on-line and spaces are completely converted to the new heat pump system, one existing steam boiler will be removed freeing up floor space in the mechanical room for new equipment. The new central geothermal water to water heat pump dual temperature plant will be installed in this new floor space. Once the entire Wicks building is served by the water-to-air heat pump system, the existing dual duct air handling unit will be removed in its entirety. The sections of the existing hot deck ductwork will be reused as the ventilation air duct that is served by the new DOAS unit that will be in the Wicks basement mechanical room. All other ductwork (existing cold deck, exhaust duct, etc.) will be removed in its entirety.

For MacArthur Hall, it is recommended that one floor at a time be taken offline and renovated. Existing ductwork serving a floor will be cut and capped at the central shaft penetration, isolating the floor from the rest of the existing dual duct system and allowing the existing system to serve the remain floors yet to be renovated. The floor-mounted dual duct mixing box located under the window sills around the building perimeter walls will be replaced with floor-mounted console type water-to-air heat pumps in the same locations. Where required, new low-profile horizontal water-to-air heat pump units will be roughed in above the existing ceilings to serve interior spaces. New geothermal water piping will be installed and tied into the new central water loop with the main circulating pumps located in the Wicks Hall basement mechanical room. New ventilation air ductwork will be roughed in and extended to the central shaft where it will be energized in a later phase when the new DOAS unit and central geothermal water-to-water heat pump dual temperature plant is installed and operational. Final tie in to each floor from the central shaft will take place once each floor has been renovated and the existing chilled water plant and dual duct air handling unit located in the mechanical penthouse has been removed in its entirety.

System Performance

Under this option, the proposed first cost for installing a geothermal heat pump system would be $13,714,900. The annual energy cost projection based on energy modeling is $44,158. For this study, it has been assumed that at year 20, the DOAS units and hydronic loop pumps would have to be replaced. Also starting at year 20, individual water-to-air heat pump units would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,100,000. Refer to the Energy Modeling and LCCA section of this report for additional information

4.2.5. Option 5: Hybrid Geothermal System

A hybrid geothermal system can be used in conjunction with a traditional ground source water-to-air system as described above but help offset the size of the proposed geothermal field by using conventional high-efficiency condensing boilers and a cooling tower in peak conditions (Summer/Winter seasons) to assist in loop temp cooling and heating to optimize the geothermal field size. Geothermal water-to-air heat pumps have the inherent heat recovery capability to capture waste heat from interior spaces and reuse it for perimeter spaces when the building requires both heating and cooling in separate areas (Spring/Fall seasons). A cooling tower would supplement the geothermal system during peak cooling periods while the boilers would supplement the geothermal system during peak heating periods. In this option, there is a possibility of reusing the existing cooling tower on the roof of MacArthur Hall as it has been recently replaced and is in good condition.

Advantages

In addition to the advantages listed in System Option 4, here the existing EVAPCO cooling tower could be reused and a small condensing boiler utilized to supplement geothermal loop/field performance and assist in reducing the size/cost of the geothermal field.

Disadvantages

In addition to having the same disadvantages of the System Option 4, while employing the use of a cooling tower and boiler can help optimize the size geothermal field, it is also additional equipment that the Campus facilities department would have to service and maintain.

Constructability

The overall phasing concept remains the same as described in the Geothermal Heat Pump Constructability section above.

System Performance

Under this option, the proposed first cost for installing a hybrid geothermal heat pump system would be $13,249,400. The annual energy cost projection based on energy modeling is $44,297. For this study, it has been assumed that at year 20, the DOAS units, cooling tower, boiler, and hydronic loop pumps would have to be replaced. Also starting at year 20, individual water-to-air heat pump units would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,250,000. Refer to the Energy Modeling and LCCA section of this report for additional information

4.2.6. Option 6: Two-Pipe VAV with Geothermal Ground Source Heat Pump System

Under this option, traditional variable air volume (VAV) units will be provided as described under System Option 1. The difference, however, is that the units will be provided with a two-pipe/dual temperature coil and be served by a dual temperature system using geothermal water-to-water heat pumps. Water-to-water heat pumps or a geothermal chiller shall generate either chilled water (45°F supply) or low temperature heating water (110°F supply) which through a separate 2-pipe loop will provide heating or cooling to the dual temperature

Pathfinder
Engineers & Architects

heating/cooling coil. A high-efficiency condensing boiler incorporated into this dual temperature loop is recommended to provide supplemental heating capacity when needed (morning warm up, redundancy). As an alternative, the VAV air handling units can be self-contained compressorized geothermal type units in lieu of the central station 2-pipe type.

All outside air will be preconditioned using a heat recovery device so as to capture and reuse waste heat. A heat recovery device will be an integral component within an air handling unit.

VAV type air handling units will distribute supply air (55°F) to room terminal control units through a medium-pressure round/flat oval duct system. Each classroom and/or office will be provided with a room terminal control unit for independent space temperature control. The proposed room terminal control unit is a standard (i.e., non-fan powered) variable air volume terminal control unit equipped with hot water heating coil which will vary the amount of conditioned primary air to the space from the air handling unit. Low pressure sound lined rectangular supply air ductwork located at the outlet of room terminal control units will serve ceiling supply diffusers.

A low-pressure duct system will return air from room return air grilles to air handling units.

To help offset the size of the proposed geothermal field, this option will closely follow what was outlined in the 'Hybrid Geothermal" system option. Using conventional high efficiency condensing boilers and a cooling tower in peak conditions (Summer/Winter seasons) will assist in loop temperature cooling and heating to optimize the geothermal field size. A cooling tower would supplement the geothermal system during peak cooling periods while the boilers would supplement the geothermal system during peak heating periods. In this option, there is a possibility of reusing the existing cooling tower on the roof of MacArthur Hall as it has been recently replaced and is in good condition.

Advantages

The advantages are the same as the ones listed in System Option 1 and 5. The overall system will gain some energy efficiency over the standard VAV system by utilizing a geothermal field and GSHPs to generate heating and cooling versus conventional equipment (i.e. boilers and chillers).

Disadvantages

In addition to having the same disadvantages of System Option 1, it also shares some of the disadvantages of System Option 4 and 5 with regards to water to water heat pump replacement life and equipment maintenance.

Constructability

The installation of a two-pipe geothermal VAV system would be challenging. While the geothermal field could be installed relatively easily, the need to keep the existing mechanical systems operational while new systems are installed, may not provide enough room to fit all the associated components of this system above the ceiling. This includes new ductwork, piping, terminal control units and the associated valve packages. Additionally, new AHU zoning for the building while utilizing a VAV type system would be recommended. Locations in the building for new indoor AHUs does not appear to be available. Therefore, units will most likely have to be installed on the roof of Wicks Hall.

Reuse of existing duct systems under this option would be difficult as most of the existing systems are up-fed from the floor below and not with overhead distribution on the floor that the units serve. This means that most new VAV boxes would need to be supplied with new ductwork that was tied into the central shafts located in both Wicks and MacArthur Halls at each floor level to be feasible.

One phasing/constructability advantage over the standard VAV system listed in Option 1 is that the geothermal water to water heat pumps have a smaller footprint than chillers and boilers. This will potentially allow for a more flexible installation for these systems in existing mechanical and/or swing spaces where floor space is limited.

System Performance

Under this option, the proposed first cost for installing a hybrid geothermal heat pump system would be $14,613,313. The annual energy cost projection based on energy modeling is $50,416. For this study, it has been assumed that at year 20, the water-to-water heat pumps, cooling tower, boiler, and hydronic loop pumps would have to be replaced. Also starting at year 20, VAV boxes would start to be replaced at a rate of 10% per year. Total system replacement costs over 25 years is estimated at $1,310,000. Refer to the Energy Modeling and LCCA section of this report for additional information.

4.3 Building Automatic Temperature Controls / Energy Management System

The automatic temperature control system will utilize direct digital control (DDC) with electric/electronic actuation. The automatic temperature control system will be BACnet based and tied into a web-based energy management system. All control and monitoring points will be consistent with the Campus's current standards and be reviewed with the Facilities Department during design.

Automatic Temperature Controls shall be capable of operating per the sequence of operation, including when the Energy Management System is manually overridden.

The Basic Design Criteria shall be as follows:

1. Cooling Mode:
   a. Outdoor Temperature: 83°F DB, 70°F WB
   b. Indoor Temperature: 75°F DB, 65% RH or less
2. Heating Mode:
   a. Outdoor Temperature: -12°F DB
   b. Indoor Temperature: 70°F DB
3. Chilled Water System (at 83 deg F Ambient):
   a. 45°F Supply Water Temperature
   b. 60°F Return Water Temperature
4. Heating Water System (at -12 deg F Ambient):
   a. Conventional:
      i. 140°F Supply Water Temperature
      ii. 100°F Return Water Temperature
   a. Hybrid Geothermal:
      i. 110°F Supply Water Temperature
      ii. 90°F Return Water Temperature
5. Ventilation Rates (ASHRAE Standard 62):
   a. Classrooms/Labs:
      i. 10 CFM per person
      ii. 0.12 CFM per sq. ft.
   b. Office Spaces:
      i. 5 CFM per person
      ii. .06 CFM per sq. ft.

6. Water Source Heat Pump:
Geothermal Loop – Variable 40°F minimum to 90°F maximum supply water Temperature

Central Heating Plant

The building central heating system will be energized to operate whenever outside air temperatures are 65°F or less. When indexed on, the distribution pump will be energized and vary its flow through the variable speed controller to maintain its system differential pressure set-point. The differential setpoint will automatically be reset based on analyzing the positioning of all heating control valves.

Through integral sequencing software by the boiler manufacturer the boilers will be staged in lead-lag and rotational fashion to maintain system supply water set-point.

The heating water temperature supply will be reset (linear type) based on outside air temperature.

Central Chilled Water Plant

The building central chilled water system will be energized to operate whenever outside air temperatures are 50°F or above. The chilled water system will be variable primary flow where the system pump will vary in speed to maintain the system differential pressure setpoint. This setpoint will be automatically reset based on analyzing all the chilled water control valve positions. A system bypass valve should be controlled to maintain minimum flow through the chiller(s). When activated, the chillers and its associates chilled water pumps will be energized in lead-lag fashion. The cooling tower and condenser water pump(s) will be energized when their associated chiller is energized. The condenser water supply temperature will be reset based on outdoor air wet and dry bulb conditions.

The chiller will be controlled through its internal control panel to maintain discharge evaporator water temperatures.

Variable Air Volume Terminal Control Units will be controlled by room temperature sensors (direct digitally controlled). The room temperature sensors will modulate the quantity of supply air (from the air handling unit) via a modulating damper integral to the terminal control unit. When additional heat is required, the room temperature sensor will modulate the terminal room control unit’s heating coil valve.

For VAV Air Handling Units, a supply duct temperature sensor sensing the discharge air temperature will modulate preheat coil valve or chilled water valve in conjunction with air economizer control to maintain constant supply air temperature. A heat recovery device will be used to precondition the outside air (sensible and latent heat) required for ventilation purposes.

Duct static pressure sensors strategically located downstream in the supply duct will vary supply air fan speed to maintain its set-point.

The return air fan speed will vary to maintain a constant volumetric difference between supply air and return air (i.e. fan tracking). Relief/exhaust air system air flow rates will be slightly less than outside air flow rates to maintain a slight positive building pressure.

All air handling units will be provided with safety features such as low limit control, freeze stat, supply and return air smoke detectors, and high static pressure sensors (for variable air volume units only). All air handling units will be provided with energy conservation features such as economizer cycles, night setback, and morning warm-up cycles of operation. Space carbon dioxide sensors will be used for control of outdoor air (demand-controlled ventilation or DCV) for high occupancy spaces as currently classified as 25 or more occupants.

Space relative humidity sensors will be used throughout the building and will automatically index the dehumidification control mode if its maximum setpoint condition is reached.

Supply air discharge air temperature set-points will be reset based on the space within the zone requiring the greatest cooling.

Fan-coil units will be controlled by room temperature sensors. Cooling coil and heating coil control valves will modulate to maintain room temperature set-point.

Heat pump units will be controlled by room temperature sensors. Reversing valves will be positioned to either heating or cooling and the compressor will cycle (on/off) to maintain room temperature set-point.

Dedicated outdoor air units will provide 100% outside air to individual spaces. An enthalpy (sensible and latent heat) heat recovery wheel will pre-condition the outside air stream. A heating or cooling/dehumidification coil will heat or sub-dehumidify the outside air stream. When operating in a dehumidification mode, a reheat heat exchanger (typically a plate heat exchanger) will provide the necessary free reheat (sensible heat) to prevent sub-cooling the spaces while enhancing the efficiency of the heat wheel. A face and bypass damper control will be provided for the reheat heat recovery unit and a variable speed motor will control the enthalpy heat recovery wheel. The heat wheel will be stopped during the economizer outside air conditions and/or for frost control.

Air flow measuring will be utilized to monitor the supply, return, relief and outside air systems.

5.0 Electrical Concept Design Considerations

5.1.1 Electrical Service Entrance Switchgear and Branch Panelboards

It is difficult to pin point when electrical equipment will reach its end-of-life and fail, however the existing switchgear and electrical branch panelboards are beyond their life expectancies by approximately 10 years.

The original ITE switchgear was bought out by Gould in 1976 and redesigned under the name ITE/Gould. In 1983, Siemens assumed ITE and the switchgear line was completely abandoned. Only reconditioned parts are available. It is strongly recommended to replace the switchgear because a failure would jeopardize power to the entire building down. Note: Improved efficiency is also a significant portion of the economic case to replace the old transformer section.

The original ITE panelboards are obsolete, however some Siemens/ITE circuit breakers and reconditioned original ITE circuit breakers remain available on the market. A failed 200-amp circuit breaker in 2017 led to an emergency project to replace the failed circuit breaker. It is expected that there will be additional issues with the circuit breakers failing of falsely tripping. Due to the equipment age and that the facility is beginning to experience failing circuit breakers, it is recommended to replace these obsolete panelboards within the next few years.

5.1.2 Central Emergency and Exit Lighting Inverters System

Although not a desirable location to have the lighting inverters in the fire pump room, they do not need to be relocated immediately. However, it is strongly recommended to consider/develop a relocation plan in the near future.

The Fire Protection Water Line routed directly over the inverters is a violation of NEC Article 110, Requirements for Electrical Installations, and needs to be rerouted to be code complaint.

5.1.3 MicroLite Lighting Controls

Although it was indicated that replacement parts for the MicroLogic Control panels are difficult to obtain, the system is functioning and meets the Energy Conservation Codes requirements.

The college may want to consider not using these control panels for future renovations, and eventually phasing them out. Especially if repair/parts become more of an issue and/or there are problems with the panels.

5.1.4 Exterior Building Mounted Luminaires:

It is recommended to replace the old HID luminaires mounted on the side of the building, under the roof overhang. It is also recommended to replace the canopy (recessed can) luminaires at the building entrance that were originally incandescent (and have been retrofitted with LED lamps) and are missing lenses. New exterior luminaires would be energy efficient LED type.

6.0 System Recommendations

6.1 Mechanical System

The preliminary benefits and risks of each system are summarized in the following table.

Characteristics	**VAV System (1)**	**FCU System (2)**	**Chilled Beam System (3)**	**Geothermal System (4)**	**Hybrid Geothermal System (5)**	**Two-Pipe VAV Geothermal System (6)**
Individual zone control	Good	Excellent	Good	Excellent	Excellent	Good
Flexibility to add zones	Excellent	Good	Good	Good	Good	Excellent
Indoor air quality (ventilation)	Good	Excellent	Excellent	Excellent	Excellent	Good
Acoustic isolation	Good	Good	Excellent	Good	Good	Good
Energy efficiency	Good	Good	Excellent	Very Good	Very Good	Very Good
Risks	Phasing Distribution space for ductwork	Coil drainage in spaces	Phasing Coil drainage in spaces	Coil drainage in spaces	Coil drainage in spaces and additional mech equipment to maintain	Phasing Distribution space for ductwork
Ease of Installation	Poor	Fair	Poor	Fair to Good	Fair to Good	Poor
Ease of Maintenance	Fair	Fair	Fair	Good	Fair	Fair
Utility cost 1st yr (total building)	$53,045	$52,125	$50,539	$44,158	$44,297	$50,416
First cost	$13,628,200	$13,790,100	$13,954,700	$14,065,400	$13,987,200	$15,012,800
Life cycle cost (25 years, NPV)	$15,977,913	$16,001,855	$16,164,678	$15,904,893	$15,917,698	$17,206,149

Notes:
1. For all alternatives, the cost of the radiation heating system will be similar.
2. Refer to Energy Modeling and LCCA section of report for additional information on system costs.

Based on the analysis above, we recommend that the Hybrid Geothermal System be installed for both Wicks and MacArthur Hall. The Geothermal System allows for the most flexibility in construction phasing while providing the College with close to the best (2nd) life cycle cost out of the six HVAC systems analyzed. The system also has characteristics that compliment both buildings' usage and the need for good zone control, acoustical performance, and the ability to capture, reuse, and transfer heat/energy between perimeter and interior spaces (Heat Recovery/Energy Efficient).

This system also best aligns itself with the clean/green energy and sustainability goals of New York State, SUCF, SUNY, and SUNY Canton. The geothermal system meets Executive Order 88 and would be an ideal candidate for the new SUCF Deep Energy Retrofit of Existing Buildings program by reducing the building's annual site energy consumption by 50% and reducing the annual site carbon consumption by 25%. It also follows the directive issued by the current SUNY Chancellor by installing systems that use or can be supplied by clean power and can contribute to reducing carbon emissions through a 'deep-energy retrofit'. The system could also be used as a teaching tool for students who enroll in the SUNY Canton Alternative & Renewable Energy Systems Academic Program. The mechanical rooms could be laid out to allow for onsite learning about how a renewable energy system (geothermal) is installed and operated.

6.2 Electrical Recommendations

6.2.1. Electrical Service Entrance Switchgear and Branch Panelboards

It is difficult to pin point when electrical equipment will reach its end-of-life and fail, however the existing switchgear and electrical branch panelboards are beyond their life expectancies by approximately 10 years.

The original ITE switchgear was bought out by Gould in 1976 and redesigned under the name ITE/Gould. In 1983, Siemens assumed ITE and the switchgear line was completely abandoned. Only reconditioned parts are available. It is strongly recommended to replace the switchgear because a failure would jeopardize power to the entire building down. Note: Improved efficiency is also a significant portion of the economic case to replace the old transformer section.

The original ITE panelboards are obsolete, however some Siemens/ITE circuit breakers and reconditioned original ITE circuit breakers remain available on the market. A failed 200-amp circuit breaker in 2017 led to an emergency project to replace the failed circuit breaker. It is expected that there will be additional issues with the circuit breakers failing of falsely tripping. Due to the equipment age and that the facility is beginning to experience failing circuit breakers, it is recommended to replace these obsolete panelboards within the next few years.

6.2.2. Central Emergency and Exit Lighting Inverters System

Although not a desirable location to have the lighting inverters in the fire pump room, they do not need to be relocated immediately. However, it is strongly recommended to consider/develop a relocation plan in the near future.

The Fire Protection Water Line routed directly over the inverters is a violation of NEC Article 110, Requirements for Electrical Installations, and needs to be rerouted to be code complaint.

6.2.3. MicroLite Lighting Controls

Although it was indicated that replacement parts for the MicroLogic Control panels are difficult to obtain, the system is functioning and meets the Energy Conservation Codes requirements.

The college may want to consider not using these control panels for future renovations, and eventually phasing them out. Especially if repair/parts become more of an issue and/or there are problems with the panels.

6.2.4. Exterior Building Mounted Luminaires:

It is recommended to replace the old HID luminaires mounted on the side of the building, under the roof overhang. It is also recommended to replace the canopy (recessed can) luminaires at the building entrance that were originally incandescent (and have been retrofitted with LED lamps) and are missing lenses. New exterior luminaires would be energy efficient LED type.

7.0 Energy Modeling

SUNY Canton wants to upgrade the HVAC systems at Wicks and MacArthur Halls. Pathfinder is proposing five HVAC system alternatives for this study. In order to more thoroughly evaluate the proposed system alternatives, energy modeling is used to compare the relative energy performance of the system options. eQUEST energy modeling software was used to model annual energy consumption and energy costs of the five HVAC system options.

At the completion of this study, sufficient information should be available to better select HVAC system type(s) and features for design development of HVAC upgrades. Data was gathered during a walk-through of the facility, by interviewing facilities personnel and other employees, and by reviewing CAD files, drawings and other data provided by SUNY Canton. The engineering analysis was conducted using a combination of building energy model simulation and spreadsheet tools.

7.1 Utility Bill Analysis

Utility Summary

The 12-month period of January– December 2017 was analyzed for this study and represents "annual" values in this report unless stated otherwise. For the two buildings combined, annual energy costs were $138,634. Annual energy costs for Wicks Hall were $102,675, or $2.14/ft^2. Annual energy costs for MacArthur Hall were $35,956, or $0.99/ft^2. The 12 months of utility data for the period of analysis is broken out by building in the two tables below. The blended electric rate based on all electric utility charges is $0.052/kWh, consisting of average electric demand charges of $3.046/kW and electric energy charges of $0.046/kWh. Natural gas costs averaged $0.715 per therm.

Wicks Hall 12-Month Utility Analysis – January 2017 to December 2017

Energy Profile								
Date	KWH	$-KWH	KW	$-KW	$-Tot Elec.	Therms	$-Gas	$-Total
Jan-17	19,973	$ 921	*47*	$ 127	$ 1,047	9,760	$ 6,565.97	$ 7,613
Feb-17	19,353	$ 600	*50*	$ 134	$ 734	9,631	$ 6,224.05	$ 6,958
Mar-17	20,885	$ 839	*41*	$ 107	$ 946	12,715	$ 7,908.25	$ 8,855
Apr-17	19,915	$ 801	*38*	$ 114	$ 915	6,044	$ 4,812.06	$ 5,727
May-17	19,414	$ 992	*42*	$ 135	$ 1,127	36,665	$ 38,670.71	$ 39,797
Jun-17	16,762	$ 1,106	*40*	$ 133	$ 1,239	0	$ -	$ 1,239
Jul-17	18,616	$ 990	*44*	$ 141	$ 1,131	0	$ -	$ 1,131
Aug-17	21,144	$ 1,046	*48*	$ 153	$ 1,199	0	$ -	$ 1,199
Sep-17	23,387	$ 959	*61*	$ 193	$ 1,152	1,348	$ 1,600.72	$ 2,753
Oct-17	23,136	$ 919	*51*	$ 161	$ 1,080	3,657	$ 3,227.91	$ 4,308
Nov-17	21,816	$ 930	*46*	$ 145	$ 1,075	32,902	$ 12,614.64	$ 13,689
Dec-17	21,533	$ 958	*44*	$ 137	$ 1,096	13,100	$ 8,309.64	$ 9,405
Totals	245,934	$11,060	552	$1,680	$12,741	125,823	$89,934	$102,675

Pathfinder Engineers & Architects

MacArthur Hall 12-Month Utility Analysis – January 2017 to December 2017

Energy Profile								
Date	**KWH**	**$-KWH**	**KW**	**$-KW**	**$-Tot Elec.**	**Therms**	**$-Gas**	**$-Total**
Jan-17	58,558	$ 2,699	*124*	$ 330	$ 3,030	0	$ -	$ 3,030
Feb-17	50,547	$ 1,567	*131*	$ 349	$ 1,916	0	$ -	$ 1,916
Mar-17	68,461	$ 2,750	*133*	$ 352	$ 3,102	0	$ -	$ 3,102
Apr-17	45,881	$ 1,845	*87*	$ 263	$ 2,109	0	$ -	$ 2,109
May-17	47,042	$ 2,403	*102*	$ 327	$ 2,730	0	$ -	$ 2,730
Jun-17	56,514	$ 3,731	*136*	$ 447	$ 4,178	0	$ -	$ 4,178
Jul-17	70,016	$ 3,724	*166*	$ 531	$ 4,255	0	$ -	$ 4,255
Aug-17	74,228	$ 3,672	*170*	$ 537	$ 4,209	0	$ -	$ 4,209
Sep-17	61,391	$ 2,517	*159*	$ 507	$ 3,024	0	$ -	$ 3,024
Oct-17	42,279	$ 1,679	*92*	$ 294	$ 1,973	0	$ -	$ 1,973
Nov-17	46,869	$ 1,998	*98*	$ 312	$ 2,309	0	$ -	$ 2,309
Dec-17	61,342	$ 2,729	*125*	$ 392	$ 3,121	0	$ -	$ 3,121
Totals	683,128	$31,314	1,524	$4,642	$35,956	0	$0	$35,956

Utility costs used for calculating savings

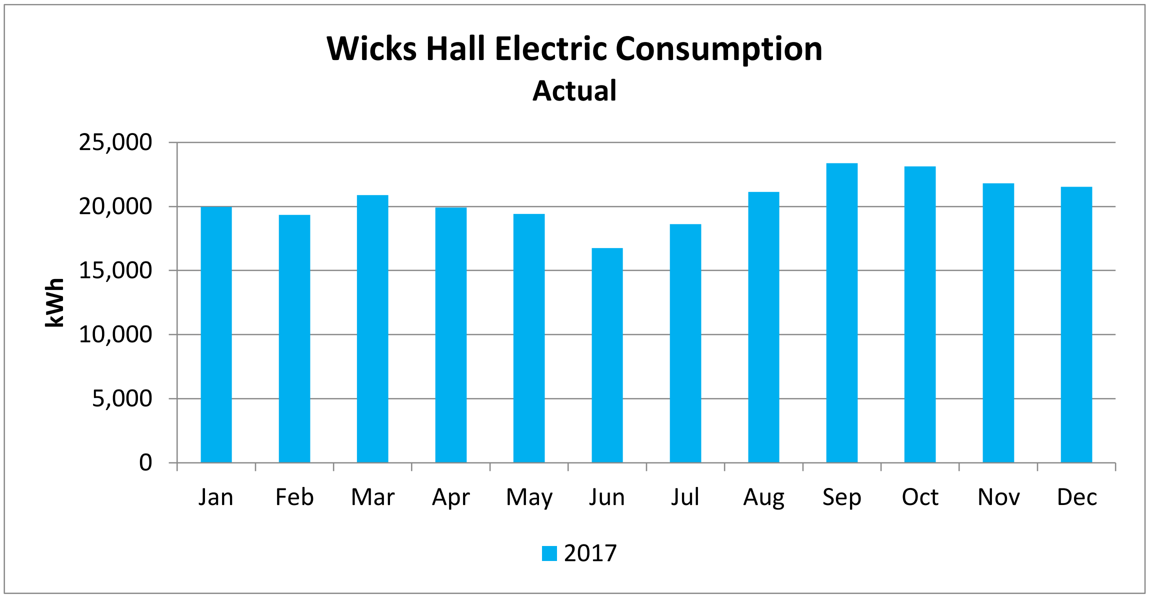
	$ / therm	$/kW	$/kWh
Unit Costs	**$0.715**	**$3.046**	**$0.046**

Electricity Consumption and Demand – Wicks Hall

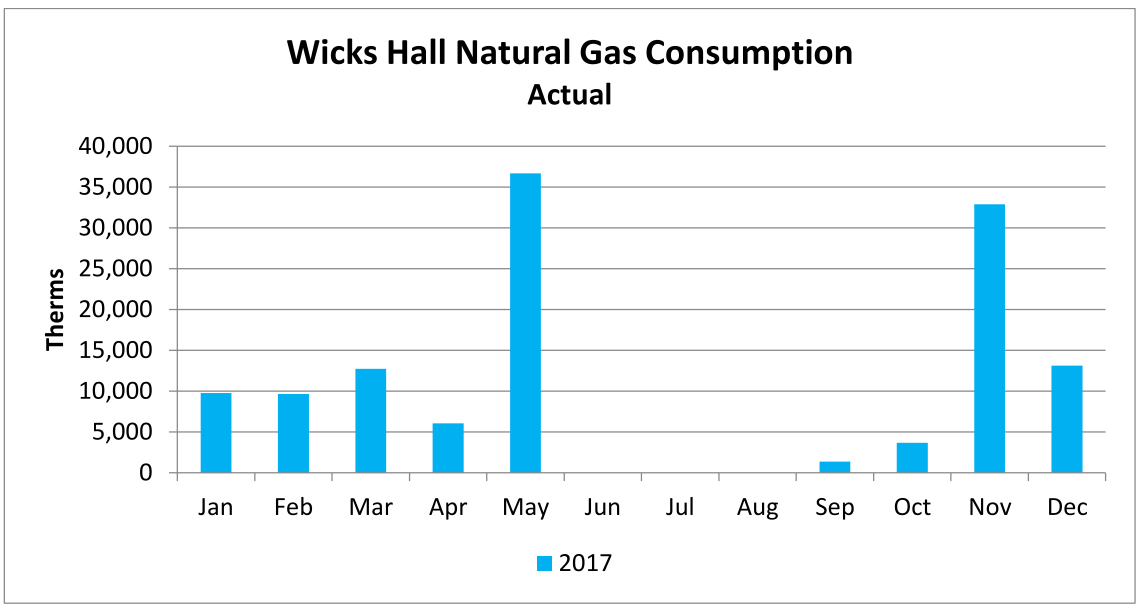
Campus electric utility bills for 2017 were provided, as well as data from building submeters for Wicks and MacArthur Halls. No electric demand data was available from the submeters. A rough estimation of monthly peak electric demand was made based on the monthly electric consumption and is shown in the two utility analysis tables above. Monthly electrical consumption at Wicks Hall for the 12-month period of January 2017 – December 2017 is shown in the figure below. Total electricity consumption was 235,934 kWh. This is low relative to the size of the building, but the chilled water cooling plant that provides cooling for Wicks Hall is located in MacArthur Hall, so the cooling energy associated with Wicks is reflected in the electricity data for MacArthur.

Natural Gas – Wicks Hall

Annual gas consumption from January 2017 through December 2017 was 125,823 therms. The monthly gas consumption is shown in the figure below. This is high relative to the size of the building, but the steam heating plant located in Wicks Hall also serves the heating loads of MacArthur Hall. There is no natural gas service or meter for MacArthur Hall, so the monthly gas consumption shown for Wicks Hall also includes the heating energy required for MacArthur Hall.



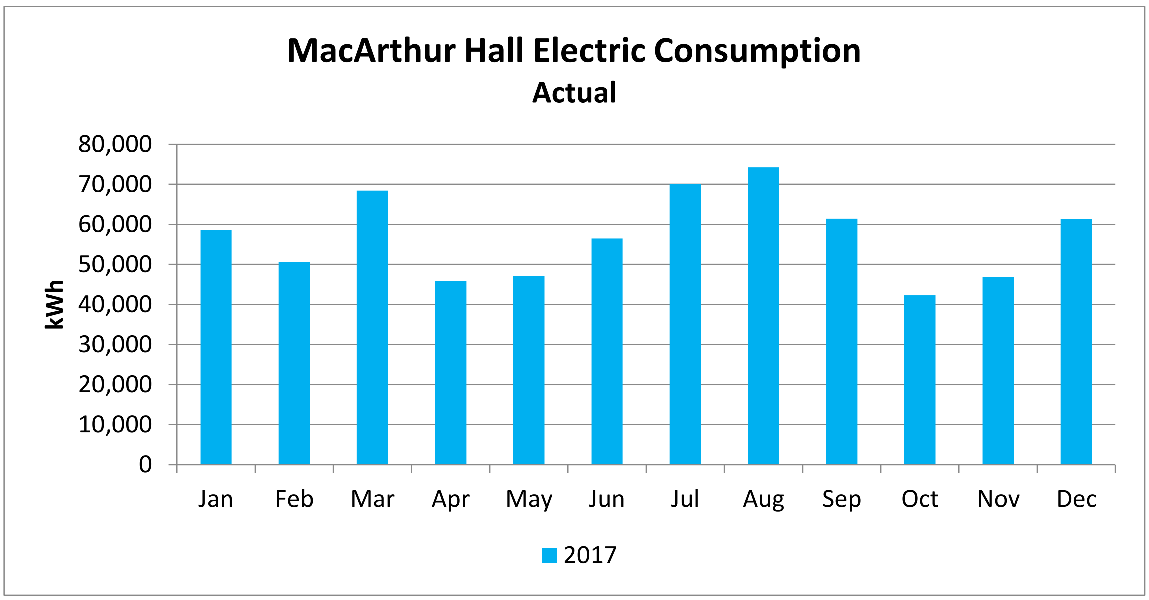
Monthly Electricity Consumption – Wicks Hall



Monthly Natural Gas Consumption – Wicks Hall

Electricity Consumption and Demand – MacArthur Hall

Campus electric utility bills for 2017 were provided, as well as data from building submeters for Wicks and MacArthur Halls. No electric demand data was available from the submeters. A rough estimation of monthly peak electric demand was made based on the monthly electric consumption and is shown in the two utility analysis tables above. Monthly electrical consumption at MacArthur Hall for the 12-month period of January 2017 – December 2017 is shown in the figure below. Total electricity consumption was 683,128 kWh. This is high relative to the size of the building, but the chilled water cooling plant that provides cooling for Wicks Hall is located in MacArthur Hall, so the cooling energy associated with Wicks is reflected in the electricity data for MacArthur.



Monthly Electricity Consumption – MacArthur Hall

Energy Use Intensity

The energy use intensity (EUI) is a metric for comparing buildings of similar use accounting for building size. The site EUI for Wicks Hall is 280 kBtu/ft^2-year, based on a building floor area of 47,980 ft^2. (The floor area used in the building simulation energy model is slightly lower – 44,916 ft^2.) The relative contributions of electricity and natural gas to the floor-area-based EUI are shown in the table below. The energy cost index based on floor area is broken out by electric consumption, demand and natural gas consumption in the table below.

Wicks Hall Energy Use Intensity

Annual Energy Consumption and EUI Profile				
Utility Type	**Annual Energy Consumption**	**Equivalent MMBtu**	**Energy Use Intensity EUI, kBtu/Sq.Ft.**	**% of Total**
Electricity (KWH)	245,934	839	17.5	6%
Gas (Therms)	125,823	12,582	262.2	94%
Total	**N.A.**	**13,421**	**280**	**100%**

Pathfinder
Engineers & Architects

Wicks Hall Energy Cost Index

Annual Energy Cost Profile				
Energy Type	**Annual Energy Costs**	**Average Cost/Unit**	**Annual Cost/Sq.Ft.**	**% of Total**
Electricity (KWH)	$11,060	$0.045	$0.23	11%
Electricity (KW)	$1,680	$3.046	$0.04	2%
Gas (Therms)	$89,934	$0.715	$1.87	88%
Total	**$102,675**	**$7.65 /MMBtu**	**$2.14**	**100%**

The site EUI for MacArthur Hall is 64 kBtu/ft^2-year, based on a building floor area of 36,442 ft^2. (The floor area used in the building simulation energy model is slightly higher – 37,003 ft^2.) The relative contributions of electricity and natural gas to the floor-area-based EUI are shown in the table below. The energy cost index based on floor area is broken out by electric consumption, demand and natural gas consumption in the table below.

MacArthur Hall Energy Use Intensity

Annual Energy Consumption and EUI Profile				
Utility Type	**Annual Energy Consumption**	**Equivalent MMBtu**	**Energy Use Intensity EUI, kBtu/Sq.Ft.**	**% of Total**
Electricity (KWH)	683,128	2,331	64.0	100%
Gas (Therms)	0	0	0.0	0%
Total	**N.A.**	**2,331**	**64**	**100%**

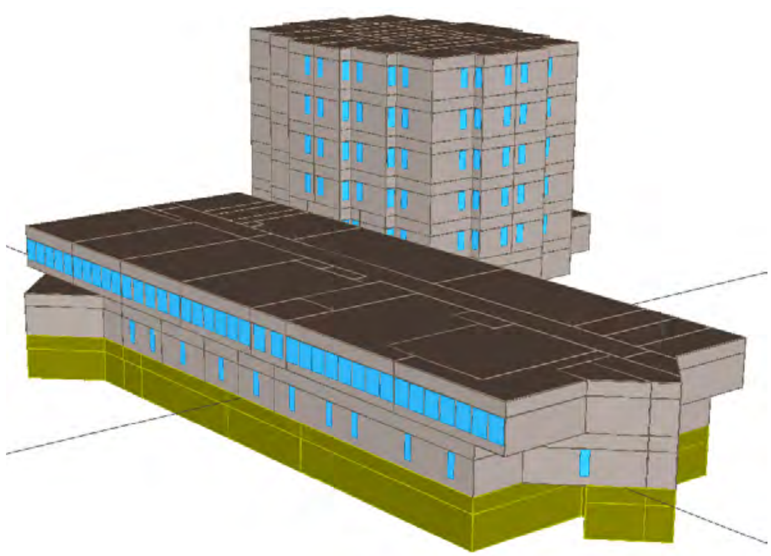
MacArthur Hall Energy Cost Index

Annual Energy Cost Profile				
Energy Type	**Annual Energy Costs**	**Average Cost/Unit**	**Annual Cost/Sq.Ft.**	**% of Total**
Electricity (KWH)	$31,314	$0.046	$0.86	87%
Electricity (KW)	$4,642	$3.047	$0.13	13%
Gas (Therms)	$0	N/A	$0.00	0%
Total	**$35,956**	**$15.43 /MMBtu**	**$0.99**	**100%**

7.2 Building Data & Modeling Inputs

The engineering analysis used a computer-model simulation of the existing buildings, created using eQUEST, a whole-building energy simulation software program. The model represents all energy-using systems associated with occupant and equipment loads, existing envelope, interior lighting, exterior lighting, mechanical heating and cooling systems, domestic hot water and general plug and process loads.

The building geometry for the energy model was generated based on CAD files and copies of floorplan drawings. Three floors were modeled for Wicks Hall (with the ground floor modeled as being underground) and seven floors were modeled for MacArthur Hall. A 3-D view of the energy model geometry is shown in the figure below.

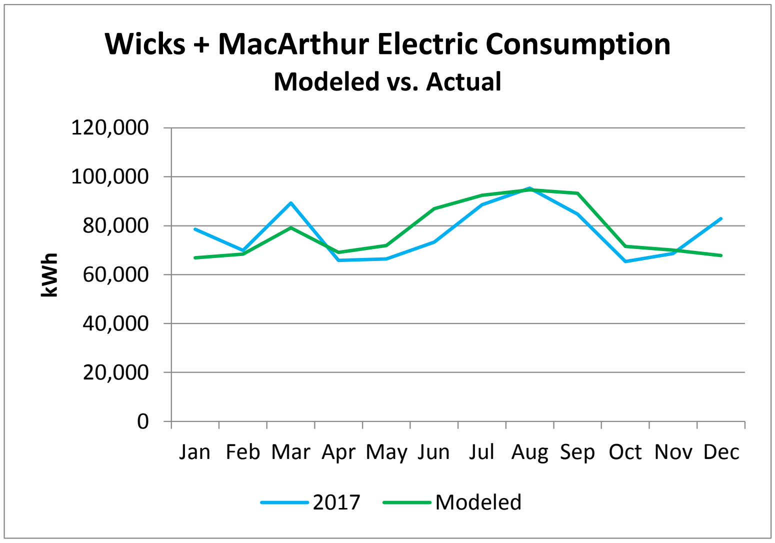


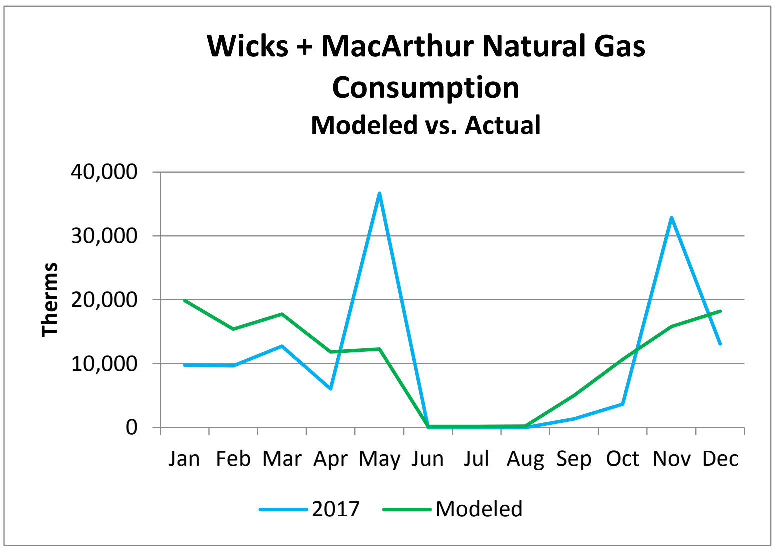
3-D View from eQUEST model of Wicks and MacArthur Halls

Calibrated Model

The computer model of existing conditions was calibrated to match the actual utility use of the facility as indicated by utility bills. The calibrated energy model was then used to evaluate the proposed HVAC system alternatives. To calibrate the model, adjustments were made primarily to loads and schedules, so that energy modeling output for electric consumption, electric demand and natural gas consumption closely matched the historic demand and energy use of Wicks and MacArthur Halls, in order to demonstrate that the model is representative of existing conditions. Since a detailed ASHRAE Level II energy audit was not within the scope of this study, a number of assumptions had to be made regarding details of building system components and loads. One of the larger loads for which there was no data is the chilled water load for Cook Hall which is provided by the chilled water system of MacArthur Hall.

Output from the calibrated energy model is compared to actual utility data in the graphs below. Total annual electricity consumption of the model is within 1% of the utility data. Modeled gas use is with 2% of utility data.





Modeling of Proposed System Options

Starting with the existing conditions calibrated energy model, five HVAC system options were evaluated. A six system was analyzed as recommended following review of the preliminary findings. Each of these systems is described in the main body of this report. Of the six options, the 4-Pipe VAV system can be considered to give performance consistent with a minimally code-compliant building. Based on the energy modeling output for each of the system option models, the annual electric and natural gas consumption and costs are shown in the table below.

Projected Annual Energy Consumption and Costs for Wicks and MacArthur Halls

System Option	Description	Electric kWh	Peak Electric kW	Natural Gas	Electric Cost	Gas Cost	Annual Utility Cost
4-Pipe VAV	ACUs w/HW & CHW	723,717	318	16,736	$41,079	$11,966	$53,045
4-Pipe FCU	Fan Coil Units	711,789	265	17,260	$39,785	$12,341	$52,125
Chilled Beam	DOAS + Chilled Beams	716,385	281	14,301	$40,314	$10,225	$50,539
GSHP	Geothermal Heat Pumps	677,934	213	8,352	$38,187	$5,972	$44,158
Hybrid GSHP	GSHP + Existing Clg Towe	678,401	216	8,352	$38,326	$5,972	$44,297
Heat Pump VAV	VAV with W2W Chillers	679,926	281	16,736	$38,449	$11,966	$50,416

Each of the proposed HVAC system options would provide a dramatic improvement in energy performance relative to the existing building conditions. To compare the proposed systems to the existing building, electricity and natural gas have been converted to the same energy units (millions of BTU, MMBtu) and summed in the table below.

Projected Annual Energy Consumption versus Existing Conditions

System Option	Description	Electric (kWh)	Electric (MMBtu)	Natural Gas (Therms)	Natural Gas (MMBtu)	Total Energy (MMBtu)
Existing	Existing conditions (2017)	929,062	3,171	125,823	12,582	15,753
4-Pipe VAV	ACUs w/HW & CHW	723,717	2,470	16,736	1,674	4,144
4-Pipe FCU	Fan Coil Units	711,789	2,429	17,260	1,726	4,155
Chilled Beam	DOAS + Chilled Beams	716,385	2,445	14,301	1,430	3,875
GSHP	Geothermal Heat Pumps	677,934	2,314	8,352	835	3,149
Hybrid GSHP	GSHP + Existing Clg Tower	678,401	2,315	8,352	835	3,151
Heat Pump VAV	VAV with W2W Chillers	679,926	2,321	16,736	1,674	3,994

SUCF published a new directive in July 2018 when this study for Wicks and MacArthur Halls was largely completed. Directive 1B-2, “Net Zero Carbon New Buildings and Deep Energy Retrofits of Existing Buildings” provides guidance and goals that apply to both new construction and major renovations or gut rehabilitations. Full building major renovations are to be designed to achieve SUNY’s goal for deep energy retrofits (DER). These goals are as follows:

Performance goal:

- 50% reduction of the building’s current annual site energy consumption.
- 25% reduction of the building’s current annual site carbon consumption.

Based on the energy modeling results, each of the proposed systems could satisfy the performance goals of the new directive. Starting with the existing building conditions, reductions in energy consumption and carbon emissions based on the projected performance of each of the evaluated system options is shown in the table below. While the proposed options provide many energy benefits, the largest impacts are from the reduction of heating and cooling of 100% outside air for the existing dual duct system, and the addition of energy recovery (DOAS) units.

Projected Reduction in Energy Consumption and Carbon Emissions versus Existing Conditions

		Total	SUCF Directive 1B-2 Deep Energy Retrofit (DER)			
System Option	Description	Energy (MMBtu)	Project EUI (kBtu/ft2-	Emissions* (Tons	Energy Reduction	Carbon Reduction
Existing	Existing conditions (2017)	15,753	187	1156		
4-Pipe VAV	ACUs w/HW & CHW	4,144	49	470	74%	59%
4-Pipe FCU	Fan Coil Units	4,155	49	466	74%	60%
Chilled Beam	DOAS + Chilled Beams	3,875	46	453	75%	61%
GSHP	Geothermal Heat Pumps	3,149	37	401	80%	65%
Hybrid GSHP	GSHP + Existing Clg Tower	3,151	37	401	80%	65%
Heat Pump VAV	VAV with W2W Chillers	3,994	47	446	75%	61%

*Based on CO2 emissions conversion factors from NYSERDA.

7.3 Life Cycle Cost Analysis (LCCA)

The life cycle costs of each of the HVAC options was determined based on first costs (estimated construction costs), annual energy costs and equipment replacement cost. Annual energy costs were determined by the energy models. A 25-year project life was used for the HVAC project. Equipment replacement costs were estimated for each option. Expected replacement costs at year 20 are shown in the table below.

	Replacements at Year 20				
System Option	Chiller + Tower	Boilers	VAV AHUs	DOAS Units	Pumps
4-Pipe VAV	$350,000	$250,000	$600,000	$0	$20,000
4-Pipe FCU	$350,000	$250,000	$0	$300,000	$20,000
Chilled Beam	$350,000	$250,000	$0	$300,000	$20,000
GSHP	$150,000	$150,000	$0	$300,000	$20,000
Hybrid GSHP	$250,000	$200,000	$0	$300,000	$20,000
Heat Pump VAV	$250,000	$200,000	600,000	$0	$20,000

Additionally, each of the systems is expected to require replacement of a portion of terminal units every year beginning in year 20. These annual replacement costs are shown in the table below.

	Annual Replacement Costs Starting in Year 20			
System Option	VAV Boxes	Heat Pumps	FCUs	Chilled Beams
4-Pipe VAV	$40,000	$0	$0	$0
4-Pipe FCU	$0	$0	$57,500	$0
Chilled Beam	$0	$0	$0	$76,000
GSHP	$0	$80,000	$0	$0
Hybrid GSHP	$0	$80,000	$0	$0
Heat Pump VAV	$40,000	$0	$0	$0

No residual value was credited for equipment usefulness past 25 years. The utility rates determined from the utility bill analysis were used as the initial project utility rates. Utility price escalation rates were determined for both electricity and natural gas, specific for the northeast region of the U.S. Parameters for the LCCA are shown in the table below.

Wicks/MacArthur Life Cycle Cost Analysis Parameters

Project Lifetime:	25	years
General Inflation Rate:	2.20	%
Nominal Discount Rate:	5.00	%
Real Discount Rate:	2.74	%
Uniform Electric Price Escalation Rate:	3.12	%
Uniform Natural Gas Price Escalation Rate:	5.51	%

The net present value (NPV) of each of the HVAC options was determined. Life Cycle Costs are summarized in the table below.

Wicks/MacArthur System Options - Life Cycle Costs and Net Present Value

	One-Time Costs			Total Utility Costs		Total Costs	LCC
System Option	First Cost	Replacement	LCC NPV	First Year	LCC NPV	LCC NPV	Rank
4-Pipe VAV	$13,628,200	$1,460,000	$14,469,485	$53,045	$1,508,428	$15,977,913	**3**
4-Pipe FCU	$13,790,100	$1,265,000	$14,513,885	$52,125	$1,487,969	$16,001,855	**4**
Chilled Beam	$13,954,700	$1,376,000	$14,738,970	$50,539	$1,425,708	$16,164,678	**5**
GSHP	$14,065,400	$1,100,000	$14,688,033	$44,158	$1,216,860	$15,904,893	**1**
Hybrid GSHP	$13,987,200	$1,250,000	$14,697,190	$44,297	$1,220,507	$15,917,698	**2**
Heat Pump VAV	$15,012,800	$1,310,000	$15,766,728	$50,416	$1,439,421	$17,206,149	**6**

Both of the GSHP options (hybrid and non-hybrid) have lower estimated life cycle costs than the baseline VAV option, even before considering potential financial incentives from utilities or New York State. The NYSERDA GSHP Rebate Program offers rebates of $1200/cooling-ton for large-scale systems. Based on the estimated size of a GSHP system serving Wicks and MacArthur Halls, the project should be eligible for a rebate of roughly $390,000 for the full GSHP system option or $260,000 for the Hybrid GSHP system option.

Section 8 - Energy Model Output Reports

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	643.0	40.1	398.4	7.2	156.1	939.9	0.0	0.0	52.2	65.3	3181.7
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	12330.0	0.0	0.0	0.0	0.0	0.0	0.0	397.6	0.0	12729.0
MBTU	879.5	0.0	643.0	12370.0	398.4	7.2	156.1	939.9	0.0	0.0	449.7	65.3	15911.0

TOTAL SITE ENERGY 15911.00 MBTU 194.2 KBTU/SQFT-YR GROSS-AREA 194.2 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 22274.40 MBTU 271.9 KBTU/SQFT-YR GROSS-AREA 271.9 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.47
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 129

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	257703.	0.	188394.	11747.	116744.	2110.	45734.	275379.	0.	0.	15292.	19135.	932238.
FM1 NATURAL-GAS													
THERM	0.	0.	0.	123318.	0.	0.	0.	0.	0.	0.	3976.	0.	127293.

TOTAL ELECTRICITY	932238. KWH	11.380 KWH	/SQFT-YR GROSS-AREA	11.380 KWH	/SQFT-YR NET-AREA
TOTAL NATURAL-GAS	127293. THERM	1.554 THERM	/SQFT-YR GROSS-AREA	1.554 THERM	/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.47
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 129

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	622.1	9.3	198.1	18.5	224.8	418.6	0.0	0.0	33.9	65.3	2470.0
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	1364.0	0.0	0.0	0.0	0.0	0.0	0.0	310.1	0.0	1673.6
MBTU	879.5	0.0	622.1	1373.0	198.1	18.5	224.8	418.6	0.0	0.0	344.0	65.3	4143.6

TOTAL SITE ENERGY 4143.64 MBTU 50.6 KBTU/SQFT-YR GROSS-AREA 50.6 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 9083.70 MBTU 110.9 KBTU/SQFT-YR GROSS-AREA 110.9 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.80
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 4
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 24

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	257703.	0.	182266.	2714.	58056.	5408.	65865.	122635.	0.	0.	9935.	19135.	723717.
FM1 NATURAL-GAS													
THERM	0.	0.	0.	13635.	0.	0.	0.	0.	0.	0.	3101.	0.	16736.

TOTAL ELECTRICITY	723717. KWH	8.835 KWH	/SQFT-YR GROSS-AREA	8.835 KWH	/SQFT-YR NET-AREA
TOTAL NATURAL-GAS	16736. THERM	0.204 THERM	/SQFT-YR GROSS-AREA	0.204 THERM	/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.80
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 4
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 24

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	723717. KWH	41079.	0.0568	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	16736. THERM	11966.	0.7150	YES
				53045.		

ENERGY COST/GROSS BLDG AREA: 0.65
ENERGY COST/NET BLDG AREA: 0.65

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	619.9	7.7	185.9	19.2	256.8	376.8	0.0	0.0	33.8	65.3	2445.0
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	1120.0	0.0	0.0	0.0	0.0	0.0	0.0	309.9	0.0	1430.1
MBTU	879.5	0.0	619.9	1128.0	185.9	19.2	256.8	376.8	0.0	0.0	343.8	65.3	3875.1

TOTAL SITE ENERGY 3875.08 MBTU 47.3 KBTU/SQFT-YR GROSS-AREA 47.3 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 8765.09 MBTU 107.0 KBTU/SQFT-YR GROSS-AREA 107.0 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.06
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 83
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 10

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	257703.	0.	181620.	2265.	54479.	5634.	75238.	110407.	0.	0.	9904.	19135.	716385.
FM1 NATURAL-GAS THERM	0.	0.	0.	11201.	0.	0.	0.	0.	0.	0.	3099.	0.	14301.

TOTAL ELECTRICITY 716385. KWH 8.745 KWH /SQFT-YR GROSS-AREA 8.745 KWH /SQFT-YR NET-AREA
TOTAL NATURAL-GAS 14301. THERM 0.175 THERM /SQFT-YR GROSS-AREA 0.175 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.06
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 83
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 10

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	716385. KWH	40314.	0.0563	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	14301. THERM	10225.	0.7150	YES
				==========		
				50539.		

ENERGY COST/GROSS BLDG AREA: 0.62
ENERGY COST/NET BLDG AREA: 0.62

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	598.5	8.4	160.0	19.7	322.6	341.5	0.0	0.0	33.7	65.3	2429.3
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	1416.0	0.0	0.0	0.0	0.0	0.0	0.0	310.0	0.0	1726.0
MBTU	879.5	0.0	598.5	1424.0	160.0	19.7	322.6	341.5	0.0	0.0	343.7	65.3	4155.3

TOTAL SITE ENERGY 4155.28 MBTU 50.7 KBTU/SQFT-YR GROSS-AREA 50.7 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 9013.91 MBTU 110.0 KBTU/SQFT-YR GROSS-AREA 110.0 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.03
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 1

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	257703.	0.	175359.	2470.	46877.	5779.	94531.	100068.	0.	0.	9868.	19135.	711789.
FM1 NATURAL-GAS THERM	0.	0.	0.	14159.	0.	0.	0.	0.	0.	0.	3100.	0.	17260.

TOTAL ELECTRICITY 711789. KWH 8.689 KWH /SQFT-YR GROSS-AREA 8.689 KWH /SQFT-YR NET-AREA
TOTAL NATURAL-GAS 17260. THERM 0.211 THERM /SQFT-YR GROSS-AREA 0.211 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.03
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 1

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	711789. KWH	39785.	0.0559	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	17260. THERM	12341.	0.7150	YES
				52125.		

ENERGY COST/GROSS BLDG AREA: 0.64
ENERGY COST/NET BLDG AREA: 0.64

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	581.1	149.3	153.9	0.0	99.1	351.8	0.0	0.0	33.7	65.3	2313.8
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	525.2	0.0	0.0	0.0	0.0	0.0	0.0	310.0	0.0	835.2
MBTU	879.5	0.0	581.1	674.5	153.9	0.0	99.1	351.8	0.0	0.0	343.7	65.3	3149.0

TOTAL SITE ENERGY 3148.96 MBTU 38.4 KBTU/SQFT-YR GROSS-AREA 38.4 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 7776.50 MBTU 94.9 KBTU/SQFT-YR GROSS-AREA 94.9 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.65
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 23

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	257703.	0.	170257.	43758.	45105.	0.	29040.	103066.	0.	0.	9870.	19135.	677934.
FM1 NATURAL-GAS													
THERM	0.	0.	0.	5252.	0.	0.	0.	0.	0.	0.	3100.	0.	8352.

TOTAL ELECTRICITY	677934. KWH	8.276 KWH	/SQFT-YR GROSS-AREA	8.276 KWH	/SQFT-YR NET-AREA
TOTAL NATURAL-GAS	8352. THERM	0.102 THERM	/SQFT-YR GROSS-AREA	0.102 THERM	/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.65
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 23

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	677934. KWH	38187.	0.0563	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	8352. THERM	5972.	0.7150	YES
				==========		
				44158.		

ENERGY COST/GROSS BLDG AREA: 0.54
ENERGY COST/NET BLDG AREA: 0.54

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	585.5	150.3	161.5	0.6	87.3	351.7	0.0	0.0	33.7	65.3	2315.4
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	525.2	0.0	0.0	0.0	0.0	0.0	0.0	310.0	0.0	835.2
MBTU	879.5	0.0	585.5	675.4	161.5	0.6	87.3	351.7	0.0	0.0	343.7	65.3	3150.6

TOTAL SITE ENERGY 3150.57 MBTU 38.5 KBTU/SQFT-YR GROSS-AREA 38.5 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 7781.30 MBTU 95.0 KBTU/SQFT-YR GROSS-AREA 95.0 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.88
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 31

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	257703.	0.	171551.	44026.	47329.	179.	25567.	103041.	0.	0.	9870.	19135.	678401.
FM1 NATURAL-GAS THERM	0.	0.	0.	5252.	0.	0.	0.	0.	0.	0.	3100.	0.	8352.

```
TOTAL ELECTRICITY    678401. KWH        8.281 KWH     /SQFT-YR GROSS-AREA    8.281 KWH     /SQFT-YR NET-AREA
TOTAL NATURAL-GAS      8352. THERM      0.102 THERM   /SQFT-YR GROSS-AREA    0.102 THERM   /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.88
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE                =     0
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE                =    31

NOTE:  ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.
```

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	678401. KWH	38326.	0.0565	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	8352. THERM	5972.	0.7150	YES
				========== 44297.		

ENERGY COST/GROSS BLDG AREA: 0.54
ENERGY COST/NET BLDG AREA: 0.54

REPORT- BEPS Building Energy Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	879.5	0.0	627.6	9.3	201.3	0.8	84.2	418.6	0.0	0.0	33.9	65.3	2320.6
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	1363.0	0.0	0.0	0.0	0.0	0.0	0.0	310.1	0.0	1673.6
MBTU	879.5	0.0	627.6	1373.0	201.3	0.8	84.2	418.6	0.0	0.0	344.0	65.3	3994.1

TOTAL SITE ENERGY 3994.14 MBTU 48.8 KBTU/SQFT-YR GROSS-AREA 48.8 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 8635.28 MBTU 105.4 KBTU/SQFT-YR GROSS-AREA 105.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.80
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 4
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 24

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- BEPU Building Utility Performance WEATHER FILE- Massena NY TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	257703.	0.	183901.	2714.	58988.	231.	24682.	122637.	0.	0.	9935.	19135.	679926.
FM1 NATURAL-GAS THERM	0.	0.	0.	13635.	0.	0.	0.	0.	0.	0.	3101.	0.	16736.

TOTAL ELECTRICITY	679926. KWH	8.300 KWH	/SQFT-YR GROSS-AREA	8.300 KWH	/SQFT-YR NET-AREA
TOTAL NATURAL-GAS	16736. THERM	0.204 THERM	/SQFT-YR GROSS-AREA	0.204 THERM	/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.80
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 4
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 24

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Massena NY TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
WicksMacArthur Elec Rate	ELECTRICITY	EM1	679926. KWH	38449.	0.0565	YES
WicksMacArthur Gas Rate	NATURAL-GAS	FM1	16736. THERM	11966.	0.7150	YES
				50416.		

ENERGY COST/GROSS BLDG AREA: 0.62
ENERGY COST/NET BLDG AREA: 0.62

Section 9 - Hazardous Materials Report

PRELIMINARY INVESTIGATION

FOR

ASBESTOS-CONTAINING MATERIALS

AND

POLYCHLORINATED BIPHENYLS IN CAULK

FOR

WICKS AND MACARTHUR HALLS
STATE UNIVERSITY COLLEGE AT CANTON
CANTON, NEW YORK

APRIL 2018

Prepared For:

Pathfinder Engineers & Architects
130 South Fitzhugh Street
Rochester, NY 14608

Prepared By:

95 Perry Street, Suite 300
Buffalo, New York 14203
p: 716.206.5100
f: 716.206.5199

WATTS
ARCHITECTURE &
ENGINEERING

TABLE OF CONTENTS

1.0 – EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

Watts Architecture & Engineering (Watts) was retained by Pathfinder Engineers & Architects (Pathfinder) to perform a preliminary investigation for asbestos-containing materials (ACM) and polychlorinated biphenyls (PCBs) for Wick and MacArthur Halls at the State University College at Canton (SUNY Canton) located in Canton, New York. The purpose of this investigation was to determine the presence, location, and approximate quantity of ACM and PCBs in caulk that could be disturbed during the proposed mechanical and electrical upgrades. Due to a limited budget only a preliminary investigation was performed at this time. A complete pre-renovation survey is required prior to renovation.

The field survey was conducted on March 1, 2018 and included the following:

- A visual site inspection of the buildings to identify suspect ACM and PCBs.
- Collection and laboratory analysis for asbestos content of samples from suspect materials associated with the building.
- Collection and laboratory analysis for the presence of PCBs in representative samples of caulk and/or sealants identified on the building.
- Documentation of sample/testing locations on drawings and chain-of-custody forms.

ASBESTOS-CONTAINING MATERIALS

The inspection included the collection of eighty-seven (42) asbestos bulk samples representing eighteen (18) suspect materials identified that may be disturbed during the project. ACM is defined as any material containing more than one percent (1%) of asbestos. Based on the testing performed for this project, **the following ACM have been identified:**

- Seam sealant associated with the air handling unit in the Mechanical room of MacArthur Hall;
- Stick pin mastic associated with the insulation on the walls, ceilings and mechanical equipment in the Mechanical Room in Wicks Hall;
- Seam sealant associated with the air handling unit in the Mechanical room of Wicks Hall; and
- Flange gaskets associated with the steam piping in the Mechanical Room of Wicks Hall.

The following materials were tested by Watts as part of this investigation, and have been determined to <u>not</u> be ACM:

- Red seam mastic on round ducts in the Mechanical Room of MacArthur Hall*;
- Wrap on fiberglass insulated piping in the Mechanical Rooms of MacArthur and Wicks Halls;

- Mudded joint fitting insulation in the Mechanical Rooms of MacArthur and Wicks Halls;
- White sealant on the ends of fiberglass insulated piping in the Mechanical Room of Wicks Hall;
- Drywall and associated drywall joint compound in MacArthur and Wicks Halls; and
- 2' x 2' ceiling tiles in MacArthur and Wicks Halls.

*Material does not exceed the threshold of greater than 1% asbestos which would classify the material as ACM, however a trace amount of asbestos does exist in this material

Watt's Sampling and Laboratory Methodology

A NYSDOL-certified asbestos inspector from Watts collected bulk samples of suspect ACM that was identified at each of the building systems/components. Bulk samples were collected using simple hand tools from each matrix identified as a potential ACM.

Samples were delivered with the proper chain-of-custody forms to a New York State accredited laboratory that is a participant in the Environmental Laboratory Approval Program (ELAP) and National Voluntary Laboratory Approval Program (NVLAP). All materials, except ceiling tiles and non-friable organically bound (NOB) materials, were analyzed using Polarized Light Microscopy (PLM) using Method 198.1. NOBs, which include but are not limited to, roof vapor barrier, mastics, and caulks underwent gravimetric reduction and analyzed by Polarized Light Microscopy (PLM) Method 198.6. Any ceiling tiles and NOBs that were found to be non-ACM under PLM were then analyzed by Transmission Electron Microscopy (TEM) Method 198.4. The New York State Department of Health (NYSDOH) protocol requires analysis by TEM if the PLM analysis of ceiling tiles and NOBs does not confirm the presence of asbestos.

Chain-of-custody forms, laboratory results, laboratory accreditation, and consultant's certifications and license are included in the report.

POLYCHLORINATED BIPHENYLS

Watts investigated caulks and sealants within the project limits to determine if polychlorinated biphenyls (PCBs) were present. Two samples were collected from representative locations identified by Watts based on visual observations made at the time of the site visit. EPA banned the production of PCBs in 1979 and their distribution after 1984.

The purpose of the laboratory testing was to determine if the materials contained PCBs and subsequent proper handling and disposal procedures that will be required if they are removed. The samples were analyzed by Schneider Laboratories Global of Richmond, Virginia. Schneider Laboratories Global is a New York State Department of Health (NYSDOH) approved laboratory. The samples were analyzed using USEPA SW-846 Method 8082, PCBs.

The Environmental Protection Agency (EPA) regulates PCBs and considers any debris generated from construction materials manufactured with PCBs derived from building renovation projects with a concentration of greater than 50 ppm PCB bulk waste product. The Toxic Substances Control Act (TSCA) regulations (40 CFR Part 761) prescribes requirements for the proper management of PCB materials, including their handling and disposal. PCB bulk product waste at concentrations $\geq$50 ppm must follow specific storage, transport and disposal requirements.

The following suspect caulk materials were sampled:

- Seam sealant associated with the air handling unit in the Mechanical room of MacArthur Hall; and
- Seam sealant associated with the air handling unit in the Mechanical room of Wicks Hall.

No PCBs were identified in the caulk materials sampled. Therefore, special handling and disposal are not required for these materials in regards to PCBs

Refer to Section 3.0 for additional information and laboratory analysis data.

2.0 – ASBESTOS-CONTAINING MATERIALS

2.0 ASBESTOS-CONTAINING MATERIALS

This section includes information on all suspect ACM sampled. This section contains the following: Homogeneous Materials List containing the homogeneous materials identified, their corresponding sample numbers and whether or not they are ACM, as well as drawings identifying the approximate locations of asbestos bulk samples.

This section also includes a summary of the identified ACM. Watts utilized the existing room numbers on the doors of the building. Each functional space is listed in the table which lists the identified ACM. For each functional space, all ACM that was identified within that space has been inspected in order to determine its approximate quantity, condition, and whether it is friable or non-friable. Refer to the sample location drawings for identifying room numbers.

Where possible, Watts visually inspected the identified ACM to assess its condition. The condition of the ACM was classified as good, fair or poor. The requirement for each designation is as follows:

Good - Material with no visible damage or deterioration or showing very limited damage or deterioration.

Fair - The surface of the material is crumbling, blistering, water-stained, gouged, punctured or otherwise damaged with the damage covering less than one tenth of the surface if the damage is evenly distributed or up to 25% of the material if the damage is localized.

Poor - The surface of the material is crumbling, blistering, water-stained, gouged, punctured or otherwise damaged with the damage covering more than one tenth of the surface if the damage is evenly distributed or more than 25% of the material if the damage is localized. Material with large areas hanging from the substrate, delaminated, heavily gouged, crushed, etc.

Abbreviations:

NA - Not analyzed.
ND - None detected.
NAD - No asbestos detected.
NON-ACM – Final Residue <1% of original subsample.
NA/PS – Not analyzed/Positive Stop

Type	ACM
T = Thermal	Y = Yes
S = Surfacing	N = No
M = Miscellaneous	

Bold rows identify asbestos-containing materials.

HOMOGENEOUS MATERIALS LIST WICKS AND MACARTUR HALLS SUNY CANTON CANTON, NY						
Material Description	Sample Location	Type	Sample Number	Results (% Asbestos)		ACM Y/N
				PLM	TEM	
MacArthur Hall						
Red Seam Mastic on Round Ducts	Penthouse – Mechanical Room	M	1803101-01 1803101-02	NAD NAD	Trace Chrysotile Trace Chrysotile	N
Wrap on Fiberglass Insulated Piping	Penthouse – Mechanical Room	M	1803101-03 1803101-04 1803101-05	NAD NAD NAD	NAD NAD NA	N
Mudded Joint Fitting Insulation	Penthouse – Mechanical Room	M	1803101-06 1803101-07 1803101-08	NAD NAD NAD	NA NA NA	N
Seam Sealant on Air Handler	**Penthouse – Mechanical Room**	**M**	**1803101-09 1803101-10**	**3.3% Chrysotile 3.6% Chrysotile**	**NA NA**	**Y**
2′ x 2′ Ceiling Tile	Room 614 Second Floor Corridor	M	1803101-11 1803101-12	NAD NAD	NAD NAD	N
Drywall	Room 614 Second Floor Corridor	M	1803101-13 1803101-14	NAD NAD	NA NA	N
Drywall Joint Compound	Room 614 Second Floor Corridor	M	1803101-15 1803101-16	NAD NAD	NA NA	N
Wicks Hall						
Wrap on Fiberglass Insulated Piping	Mechanical Room	M	1803101-17 1803101-18 1803101-19	NAD NAD NAD	NA NA NA	N
Mudded Joint Fitting Insulation – 4″ Piping	Mechanical Room	M	1803101-20 1803101-21 1803101-22	NAD NAD NAD	NA NA NA	N
Mudded Joint Fitting Insulation – 2″ Piping	Mechanical Room	M	1803101-23 1803101-24 1803101-25	NAD NAD NAD	NA NA NA	N
Stick Pin Mastic	**Mechanical Room**	**M**	**1803101-26 1803101-27**	**6.7% Chrysotile 5.8% Chrysotile**	**NA NA**	**Y**
White Sealant on Ends of Fiberglass Insulation	Mechanical Room	M	1803101-28 1803101-29	NAD NAD	NAD NAD	N

HOMOGENEOUS MATERIALS LIST WICKS AND MACARTUR HALLS SUNY CANTON CANTON, NY						
Material Description	Sample Location	Type	Sample Number	Results (% Asbestos)		ACM Y/N
				PLM	TEM	
Flange Gasket	Mechanical Room		1803101-30 1803101-31	7.3% Chrysotile 12.6% Chrysotile	NA NA	Y
Seam Sealant on Air Handler	Mechanical Room	M	1803101-32 1803101-33	3.3% Chrysotile NAD	NA Trace Anthophyllite	Y
2' x 2' Ceiling Tile	2nd Floor Corridor – East 2ndfloor Corridor - West	M	1803101-34 1803101-35	NAD NAD	NAD NAD	N
Drywall	2nd Floor Corridor – East 2ndfloor Corridor - West	M	1803101-36 1803101-37	NAD NAD	NA NA	N
Drywall Joint Compound	2nd Floor Corridor – East 2ndfloor Corridor - West		1803101-38 1803101-39	NAD NAD	NA NA	N
Canvas Wrap on Fiberglass Fittings	Mechanical Room		1803101-40 1803101-41 1803101-42	NAD NAD NAD	NAD NAD NAD	N

2.1 – LABORATORY REPORT AND CHAIN OF CUSTODY FORM

AmeriSci Richmond
13635 GENITO ROAD
MIDLOTHIAN, VIRGINIA 23112
TEL: (804) 763-1200 • FAX: (804) 763-1800

PLM Bulk Asbestos Report

Watts Architecture & Engineers
Attn: Jerry Grady
95 Perry Street
Suite 300
Buffalo, NY 14203

Date Received 03/06/18 **AmeriSci Job #** 118031184
Date Examined 03/09/18 **P.O. #**
ELAP # 10984
RE: 1803101; Mechanical Study Of Wicks And MacArthur Hall; Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-01	118031184-01	***No***	NAD

Location: Red Seam Mastic on Round Ducts; Penthouse Mechanical Room - MacArthur Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Tan, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 7.7 %, Heat Sensitive 88.3 %, Non-fibrous 4 %
Comment: Heat Sensitive (organic): 88.3%; Acid Soluble (inorganic): 7.7%; Inert (Non-asbestos): 3.9%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-02	118031184-02	***No***	NAD

Location: Red Seam Mastic on Round Ducts; Penthouse Mechanical Room - MacArthur Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Tan/ Silver, Heterogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 10.5 %, Heat Sensitive 83 %, Non-fibrous 6.5 %
Comment: Heat Sensitive (organic): 83.0%; Acid Soluble (inorganic): 10.5%; Inert (Non-asbestos): 6.4%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-03	118031184-03	***No***	NAD

Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Tan/ Silver, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 7.8 %, Heat Sensitive 62.7 %, Fibrous glass 8 %, Non-fibrous 21.5 %
Comment: Heat Sensitive (organic): 62.7%; Acid Soluble (inorganic): 7.8%; Inert (Non-asbestos): 29.5%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-04	118031184-04	***No***	NAD

Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Tan/ Silver, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 11.3 %, Heat Sensitive 61.8 %, Fibrous glass 6 %, Non-fibrous 20.9 %
Comment: Heat Sensitive (organic): 61.8%; Acid Soluble (inorganic): 11.3%; Inert (Non-asbestos): 26.9%

See Reporting notes on last page

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-05	118031184-05	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall
Analyst Description: Pink/ Silver, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 10 %, Fibrous glass 40 %, Non-fibrous 50 %
Comment: Pink Fiberglass Insulation attached to Tan Paper and Silver Colored Metallic Foil

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-06	118031184-06	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall
Analyst Description: Off White, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 5 %, Fibrous glass 10 %, Non-fibrous 85 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-07	118031184-07	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall
Analyst Description: Off White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 3 %, Fibrous glass 10 %, Non-fibrous 87 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-08	118031184-08	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall
Analyst Description: Off White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 3 %, Fibrous glass 10 %, Non-fibrous 87 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-09	118031184-09	***Yes***	3.3 % (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: Seam Sealant on Air Handler; Penthouse Mechanical Room - MacArthur Hall
Analyst Description: White/Black, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 3.3 %
Other Material: Acid Sensitive 44.7 %, Heat Sensitive 38.7 %, Non-fibrous 13.3 %
Comment: Heat Sensitive (organic): 38.7%; Acid Soluble (inorganic): 44.7%; Inert (Non-asbestos): 13.2%

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-10	118031184-10	***Yes***	3.6 %

Location: Seam Sealant on Air Handler; Penthouse Mechanical Room - MacArthur Hall (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: White/Black, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 3.6 %
Other Material: Acid Sensitive 43.6 %, Heat Sensitive 39.4 %, Non-fibrous 13.4 %
Comment: Heat Sensitive (organic): 39.4%; Acid Soluble (inorganic): 43.6%; Inert (Non-asbestos): 13.4%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-11	118031184-11	***No***	NAD

Location: 2' x 2' Ceiling Tile; Room 614 - MacArthur Hall (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 13.3 %, Heat Sensitive 23 %, Fibrous glass 6 %, Non-fibrous 57.7 %
Comment: Heat Sensitive (organic): 23.0%; Acid Soluble (inorganic): 13.3%; Inert (Non-asbestos): 63.7%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-12	118031184-12	***No***	NAD

Location: 2' x 2' Ceiling Tile; Second Floor Corridor - MacArthur Hall (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 12 %, Heat Sensitive 24.3 %, Fibrous glass 6 %, Non-fibrous 57.7 %
Comment: Heat Sensitive (organic): 24.3%; Acid Soluble (inorganic): 12.0%; Inert (Non-asbestos): 63.7%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-13	118031184-13	***No***	NAD

Location: Drywall; Room 614 - MacArthur Hall (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 8 %, Fibrous glass 2 %, Non-fibrous 90 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-14	118031184-14	***No***	NAD

Location: Drywall; Second Floor Corridor - MacArthur Hall (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: Off White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 8 %, Non-fibrous 92 %

See Reporting notes on last page

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-15	118031184-15	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Drywall Joint Compound; Room 614 - MacArthur Hall
Analyst Description: White, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Non-fibrous 100 %
Comment: Green paint covers top surface.

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-16	118031184-16	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Drywall Joint Compound; Second Floor Corridor - MacArthur Hall
Analyst Description: White, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Non-fibrous 100 %
Comment: Green paint covers top surface.

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-17	118031184-17	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room
Analyst Description: White/ Silver, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Fibrous glass 90 %, Non-fibrous 10 %
Comment: White Fiberglass Mesh attached to Silver Metallic Foil

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-18	118031184-18	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room
Analyst Description: Lt. Tan/ Silver, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Fibrous glass 15 %, Non-fibrous 85 %
Comment: Lt Tan Fiberglass Mesh attached to Silver Metallic Foil.

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-19	118031184-19	***No***	NAD (by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room
Analyst Description: Lt Tan/ Silver, Heterogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Fibrous glass 15 %, Non-fibrous 85 %
Comment: Lt Tan Fiberglass Mesh attached to Silver Metallic Foil.

See Reporting notes on last page

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-20	118031184-20	***No***	NAD
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			
1803101-21	118031184-21	***No***	NAD
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			
1803101-22	118031184-22	***No***	NAD
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			
1803101-23	118031184-23	***No***	NAD
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			
1803101-24	118031184-24	***No***	NAD
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			
1803101-25	118031184-25	***No***	NAD
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room			(by NYS ELAP 198.1) by C. David Mintz on 03/09/18
Analyst Description: Lt. Beige, Homogeneous, Fibrous, Bulk Material **Asbestos Types:** **Other Material:** Fibrous glass 12 %, Non-fibrous 88 %			

See Reporting notes on last page

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-26	118031184-26	***Yes***	6.7 % (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: Stick Pin Mastic; Wicks Hall Mechanical Room
Analyst Description: Brown, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 6.7 %
Other Material: Acid Sensitive 14.8 %, Heat Sensitive 48.5 %, Non-fibrous 30 %
Comment: Heat Sensitive (organic): 48.5%; Acid Soluble (inorganic): 14.8%; Inert (Non-asbestos): 30.0%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-27	118031184-27	***Yes***	5.8 % (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: Stick Pin Mastic; Wicks Hall Mechanical Room
Analyst Description: Brown, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 5.8 %
Other Material: Acid Sensitive 8 %, Heat Sensitive 54.5 %, Non-fibrous 31.7 %
Comment: Heat Sensitive (organic): 54.5%; Acid Soluble (inorganic): 8.0%; Inert (Non-asbestos): 31.7%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-28	118031184-28	***No***	NAD (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: White Sealant on Ends of Fiberglass Insulation; Wicks Hall Mechanical Room
Analyst Description: White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 26 %, Heat Sensitive 41.5 %, Fibrous glass 5 %, Non-fibrous 27.5 %
Comment: Heat Sensitive (organic): 41.5%; Acid Soluble (inorganic): 26.0%; Inert (Non-asbestos): 32.5%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-29	118031184-29	***No***	NAD (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: White Sealant on Ends of Fiberglass Insulation; Wicks Hall Mechanical Room
Analyst Description: White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 28.1 %, Heat Sensitive 29.7 %, Non-fibrous 42.2 %
Comment: Heat Sensitive (organic): 29.7%; Acid Soluble (inorganic): 28.1%; Inert (Non-asbestos): 42.2%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-30	118031184-30	***Yes***	7.3 % (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Location: Flange Gasket; Wicks Hall Mechanical Room
Analyst Description: Gray, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 7.3 %
Other Material: Acid Sensitive 8.2 %, Heat Sensitive 17.2 %, Non-fibrous 67.3 %
Comment: Heat Sensitive (organic): 17.2%; Acid Soluble (inorganic): 8.2%; Inert (Non-asbestos): 67.3%

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-31	118031184-31	***Yes***	12.7 %

Location: Flange Gasket; Wicks Hall Mechanical Room — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Gray/Brown, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 12.6 %
Other Material: Acid Sensitive 0.8 %, Heat Sensitive 16.9 %, Non-fibrous 69.6 %
Comment: Heat Sensitive (organic): 16.9%; Acid Soluble (inorganic): 0.8%; Inert (Non-asbestos): 69.6%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-32	118031184-32	***Yes***	3.3 %

Location: Seam Sealant on Air Handler; Wicks Hall Mechanical Room — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Silver/White, Homogeneous, Fibrous, Bulk Material
Asbestos Types: Chrysotile 3.3 %
Other Material: Acid Sensitive 45.1 %, Heat Sensitive 36.9 %, Non-fibrous 14.7 %
Comment: Heat Sensitive (organic): 36.9%; Acid Soluble (inorganic): 45.1%; Inert (Non-asbestos): 14.7%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-33	118031184-33	***No***	NAD

Location: Seam Sealant on Air Handler; Wicks Hall Mechanical Room — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Gray, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 49.4 %, Heat Sensitive 28.9 %, Fibrous Talc 4 %, Non-fibrous 17.7 %
Comment: Heat Sensitive (organic): 28.9%; Acid Soluble (inorganic): 49.4%; Inert (Non-asbestos): 21.8%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-34	118031184-34	***No***	NAD

Location: 2' x 2' Ceiling Tile; 2nd Floor Corridor (east) - Wicks Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Off White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 56.9 %, Heat Sensitive 13.6 %, Fibrous glass 5 %, Non-fibrous 24.5 %
Comment: Heat Sensitive (organic): 13.6%; Acid Soluble (inorganic): 56.9%; Inert (Non-asbestos): 29.6%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-35	118031184-35	***No***	NAD

Location: 2' x 2' Ceiling Tile; 2nd Floor Corridor (west) - Wicks Hall — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Off White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 50.8 %, Heat Sensitive 15.2 %, Fibrous glass 5 %, Non-fibrous 29 %
Comment: Heat Sensitive (organic): 15.2%; Acid Soluble (inorganic): 50.8%; Inert (Non-asbestos): 34.0%

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-36	118031184-36	***No***	NAD

Location: Drywall; 2nd Floor Corridor (east) - Wicks Hall

(by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: Off White/ Brown, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 6 %, Fibrous glass 1 %, Non-fibrous 93 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-37	118031184-37	***No***	NAD

Location: Drywall; 2nd Floor Corridor (west) - Wicks Hall

(by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: Off White/ Brown, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Cellulose 6 %, Fibrous glass 1 %, Non-fibrous 93 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-38	118031184-38	***No***	NAD

Location: Drywall Joint Compound; 2nd Floor Corridor (east) - Wicks Hall

(by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: White, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Non-fibrous 100 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-39	118031184-39	***No***	NAD

Location: Drywall Joint Compound; 2nd Floor Corridor (west) - Wicks Hall

(by NYS ELAP 198.1) by C. David Mintz on 03/09/18

Analyst Description: White, Homogeneous, Non-Fibrous, Bulk Material
Asbestos Types:
Other Material: Non-fibrous 100 %

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-40	118031184-40	***No***	NAD

Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room

(by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Lt Tan - White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 12.7 %, Heat Sensitive 27.2 %, Fibrous glass 50 %, Non-fibrous 10.1 %
Comment: Heat Sensitive (organic): 27.2%; Acid Soluble (inorganic): 12.7%; Inert (Non-asbestos): 60.1%

PLM Bulk Asbestos Report

1803101; Mechanical Study Of Wicks And MacArthur Hall;
Suny Canton, Canton, NY

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-41	118031184-41	***No***	NAD

Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Lt Tan/ White, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 9.3 %, Heat Sensitive 27.1 %, Fibrous glass 55 %, Non-fibrous 8.6 %
Comment: Heat Sensitive (organic): 27.1%; Acid Soluble (inorganic): 9.3%; Inert (Non-asbestos): 63.6%

Client No. / HGA	Lab No.	Asbestos Present	Total % Asbestos
1803101-42	118031184-42	***No***	NAD

Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room — (by NYS ELAP 198.6) by C. David Mintz on 03/09/18

Analyst Description: Tan, Homogeneous, Fibrous, Bulk Material
Asbestos Types:
Other Material: Acid Sensitive 9 %, Heat Sensitive 25.9 %, Fibrous glass 60 %, Non-fibrous 5.1 %
Comment: Heat Sensitive (organic): 25.9%; Acid Soluble (inorganic): 9.0%; Inert (Non-asbestos): 65.1%

Reporting Notes:

Analyzed by: C. David Mintz ____ Date: 3/9/2018 Reviewed by: ____

*NAD = no asbestos detected, Detection Limit <1%, Reporting Limits: CVES = 1%, 400 Pt Ct = 0.25%, 1000 Pt Ct = 0.1%; "Present" or NVA = "No Visible Asbestos" are observations made during a qualitative analysis; NA = not analyzed; NA/PS = not analyzed / positive stop; PLM Bulk Asbestos Analysis by EPA 600/R-93/116 per 40 CFR 763 (NVLAP Lab Code 101904-0) and ELAP PLM Analysis Protocol 198.1 for New York friable samples which includes quantitation of any vermiculite observed (198.6 for NOB samples) or EPA 400 pt ct by EPA 600/M4-82-020 (NYSDOH ELAP Lab # 10984); CA ELAP Lab # 2508; Note: PLM is not consistently reliable in detecting asbestos in floor coverings and similar NOB materials. NAD or Trace results by PLM are inconclusive, TEM is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos-containing in New York State (also see EPA Advisory for floor tile, FR 59, 146, 38970, 8/1/94). NIST Accreditation requirements mandate that this report must not be reproduced except in full without the approval of the laboratory. This PLM report relates ONLY to the items tested.

Table I
Summary of Bulk Asbestos Analysis Results
1803101; Mechanical Study Of Wicks And MacArthur Hall; Suny Canton, Canton, NY

AmeriSci Sample #	Client Sample#	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	** Asbestos % by PLM/DS	** Asbestos % by TEM
01	1803101-01		0.069	88.3	7.7	3.8	NAD	Chrysotile Trace
Location: Red Seam Mastic on Round Ducts; Penthouse Mechanical Room - MacArthur Hall								
02	1803101-02		0.090	83.0	10.5	6.3	NAD	Chrysotile Trace
Location: Red Seam Mastic on Round Ducts; Penthouse Mechanical Room - MacArthur Hall								
03	1803101-03		0.061	62.7	7.8	29.5	NAD	NAD
Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall								
04	1803101-04		0.052	61.8	11.3	26.9	NAD	NAD
Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall								
05	1803101-05		----	----	----	----	NAD	NA
Location: Wrap on Fiberglass Insulated Piping; Penthouse Mechanical Room - MacArthur Hall								
06	1803101-06		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall								
07	1803101-07		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall								
08	1803101-08		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation; Penthouse Mechanical Room - MacArthur Hall								
09	1803101-09		0.154	38.7	44.7	13.2	Chrysotile 3.3	NA
Location: Seam Sealant on Air Handler; Penthouse Mechanical Room - MacArthur Hall								
10	1803101-10		0.130	39.4	43.6	13.4	Chrysotile 3.6	NA
Location: Seam Sealant on Air Handler; Penthouse Mechanical Room - MacArthur Hall								
11	1803101-11		0.176	23.0	13.3	63.7	NAD	NAD
Location: 2' x 2' Ceiling Tile; Room 614 - MacArthur Hall								
12	1803101-12		0.182	24.3	12.0	63.7	NAD	NAD
Location: 2' x 2' Ceiling Tile; Second Floor Corridor - MacArthur Hall								
13	1803101-13		----	----	----	----	NAD	NA
Location: Drywall; Room 614 - MacArthur Hall								
14	1803101-14		----	----	----	----	NAD	NA
Location: Drywall; Second Floor Corridor - MacArthur Hall								
15	1803101-15		----	----	----	----	NAD	NA
Location: Drywall Joint Compound; Room 614 - MacArthur Hall								
16	1803101-16		----	----	----	----	NAD	NA
Location: Drywall Joint Compound; Second Floor Corridor - MacArthur Hall								
17	1803101-17		----	----	----	----	NAD	NA
Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room								

ee Reporting notes on last page

Table I
Summary of Bulk Asbestos Analysis Results

1803101; Mechanical Study Of Wicks And MacArthur Hall; Suny Canton, Canton, NY

AmeriSci Sample #	Client Sample#	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	** Asbestos % by PLM/DS	** Asbestos % by TEM
18	1803101-18		----	----	----	----	NAD	NA
Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room								
19	1803101-19		----	----	----	----	NAD	NA
Location: Wrap on Fiberglass Insulated Piping; Wicks Hall Mechanical Room								
20	1803101-20		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room								
21	1803101-21		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room								
22	1803101-22		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 4" Piping; Wicks Hall Mechanical Room								
23	1803101-23		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room								
24	1803101-24		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room								
25	1803101-25		----	----	----	----	NAD	NA
Location: Mudded Joint fitting Insulation - 2" Piping; Wicks Hall Mechanical Room								
26	1803101-26		0.093	48.5	14.8	30.0	Chrysotile 6.7	NA
Location: Stick Pin Mastic; Wicks Hall Mechanical Room								
27	1803101-27		0.117	54.5	8.0	31.7	Chrysotile 5.8	NA
Location: Stick Pin Mastic; Wicks Hall Mechanical Room								
28	1803101-28		0.279	41.5	26.0	32.5	NAD	NAD
Location: White Sealant on Ends of Fiberglass Insulation; Wicks Hall Mechanical Room								
29	1803101-29		0.119	29.7	28.1	42.2	NAD	NAD
Location: White Sealant on Ends of Fiberglass Insulation; Wicks Hall Mechanical Room								
30	1803101-30		0.112	17.2	8.2	67.3	Chrysotile 7.3	NA
Location: Flange Gasket; Wicks Hall Mechanical Room								
31	1803101-31		0.111	16.9	0.8	69.6	Chrysotile 12.6	NA
Location: Flange Gasket; Wicks Hall Mechanical Room								
32	1803101-32		0.189	36.9	45.1	14.7	Chrysotile 3.3	NA
Location: Seam Sealant on Air Handler; Wicks Hall Mechanical Room								
33	1803101-33		0.214	28.9	49.4	21.7	NAD	Anthophyllite Trace
Location: Seam Sealant on Air Handler; Wicks Hall Mechanical Room								
34	1803101-34		0.200	13.6	56.9	29.6	NAD	NAD
Location: 2' x 2' Ceiling Tile; 2nd Floor Corridor (east) - Wicks Hall								

Table I
Summary of Bulk Asbestos Analysis Results

1803101; Mechanical Study Of Wicks And MacArthur Hall; Suny Canton, Canton, NY

AmeriSci Sample #	Client Sample#	HG Area	Sample Weight (gram)	Heat Sensitive Organic %	Acid Soluble Inorganic %	Insoluble Non-Asbestos Inorganic %	** Asbestos % by PLM/DS	** Asbestos % by TEM
35	1803101-35		0.197	15.2	50.8	34.0	NAD	NAD
Location: 2' x 2' Ceiling Tile; 2nd Floor Corridor (west) - Wicks Hall								
36	1803101-36		----	----	----	----	NAD	NA
Location: Drywall; 2nd Floor Corridor (east) - Wicks Hall								
37	1803101-37		----	----	----	----	NAD	NA
Location: Drywall; 2nd Floor Corridor (west) - Wicks Hall								
38	1803101-38		----	----	----	----	NAD	NA
Location: Drywall Joint Compound; 2nd Floor Corridor (east) - Wicks Hall								
39	1803101-39		----	----	----	----	NAD	NA
Location: Drywall Joint Compound; 2nd Floor Corridor (west) - Wicks Hall								
40	1803101-40		0.071	27.2	12.7	60.1	NAD	NAD
Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room								
41	1803101-41		0.079	27.1	9.3	63.6	NAD	NAD
Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room								
42	1803101-42		0.129	25.9	9.0	65.1	NAD	NAD
Location: Canvas Wrap on Fiberglass Fittings; Wicks Hall Mechanical Room								

TEM Analyzed By: T. Brian Keith [signature] Date Analyzed: 3/9/2018 Reviewed By: [signature] Date Reviewed: 3/9/2018

Semi-Quantitative Analysis: NAD = no asbestos detected; NA = not analyzed; NA/PS = not analyzed due to positive stop; Trace = <1%;
PLM analysis by EPA 600/R-93/116 per 40 CFR 763 (NVLAP Lab Code 101904-0) or NY ELAP 198.1 for New York friable samples which includes quantitation of any vermiculite observed (198.6 for NOB samples) or EPA 400 pt ct by EPA 600/M4-82-020 (NY ELAP Lab # 10984);
TEM prep by EPA 600/R-93/116 Section 2.3 (analysis by Section 2.5, not covered by NVLAP Bulk accreditation); or NY ELAP 198.4 for New York NOB samples (NY ELAP Lab # 10984);

** Warning Notes: Consider PLM fiber diameter limitation, only TEM will resolve fibers <0.25 micrometers in diameter. TEM bulk analysis is representative of the fine grained matrix material and may not be representative of non-uniformly dispersed debris, soils or other heterogeneous materials for which a combination PLM/TEM evaluation is recommended; Quantitation for beginning weights of <0.1 grams should be considered as qualitative only.

BULK SAMPLE CHAIN-OF-CUSTODY FORM

The purpose of the chain-of-custody form is to reduce the possibility of misidentifying individual samples, to help trace any samples that may be lost, and to provide a record certifying that the samples were delivered to and received by the analytical laboratory.

An important feature of this form is the signature section at the bottom, identifying all persons who handled the samples.

WATTS ARCHITECTURE & ENGINEERING
ASBESTOS BULK SAMPLE CHAIN-OF-CUSTODY

118031184

Client: Pathfinder

Date: 3/2/2018

Project: Mechanical Study of Wicks and MacArthur Hall

Watts Project No.: 1803101

Building / Location: Suny Canton, Canton, NY

Email: Jerry Grady at jgrady@watts-ae.com

Fax Preliminary Results to: (716) 206-5199

Mail Report & Invoice to: Watts Architecture & Engineering
95 Perry Street, Suite 300, Buffalo, NY 14203

Turnaround Requested: ___ 3 Hr. ___ 48 Hr. ___ 6 Hr. ___ 72 Hr. ___ 12 Hr. x 5 Day ___ 24 Hr. ___ 6-10 Day

Analysis Requested: PLM x TEM x

1803101-01	Red Seam Mastic on Round Ducts	Penthouse Mechanical Room - MacArthur Hall		
1803101-02	Red Seam Mastic on Round Ducts	Penthouse Mechanical Room - MacArthur Hall		
1803101-03	Wrap on Fiberglass Insulated Piping	Penthouse Mechanical Room - MacArthur Hall		
1803101-04	Wrap on Fiberglass Insulated Piping	Penthouse Mechanical Room - MacArthur Hall		
1803101-05	Wrap on Fiberglass Insulated Piping	Penthouse Mechanical Room - MacArthur Hall		
1803101-06	Mudded Joint fitting Insulation	Penthouse Mechanical Room - MacArthur Hall		
1803101-07	Mudded Joint fitting Insulation	Penthouse Mechanical Room - MacArthur Hall		
1803101-08	Mudded Joint fitting Insulation	Penthouse Mechanical Room - MacArthur Hall		
1803101-09	Seam Sealant on Air Handler	Penthouse Mechanical Room - MacArthur Hall		
1803101-10	Seam Sealant on Air Handler	Penthouse Mechanical Room - MacArthur Hall		
1803101-11	2' x 2' Ceiling Tile	Room 614 - MacArthur Hall		
1803101-12	2' x 2' Ceiling Tile	Second Floor Corridor - MacArthur Hall		

Sampled By: Jerry Grady Date: 3/5/2018 Received By: ___ Date: ___

Relinquished By: Jerry Grady Date: 3/5/18 Received By: ___ Date: ___

Comments:

RECEIVED
MAR 06 2018
By

118031184

Page: 2 of 4

WATTS ARCHITECTURE & ENGINEERING
ASBESTOS BULK SAMPLE CHAIN-OF-CUSTODY

Client: Pathfinder

Date: 3/2/2018

Project: Mechanical Study of Wicks and MacArthur Hall

Watts Project No.: 1803101

Building / Location: Suny Canton, Canton, NY

Email: Jerry Grady at jgrady@watts-ae.com

Fax Preliminary Results to: (716) 206-5199

Mail Report & Invoice to: Watts Architecture & Engineering
95 Perry Street, Suite 300, Buffalo, NY 14203

Turnaround Requested: ___ 3 Hr. ___ 48 Hr. ___ 6 Hr. ___ 72 Hr. ___ 12 Hr. x 5 Day ___ 24 Hr. ___ 6-10 Day

Analysis Requested: PLM x TEM x

1803101-13	Drywall	Room 614 - MacArthur Hall		
1803101-14	Drywall	Second Floor Corridor - MacArthur Hall		
1803101-15	Drywall Joint Compound	Room 614 - MacArthur Hall		
1803101-16	Drywall Joint Compound	Second Floor Corridor - MacArthur Hall		
1803101-17	Wrap on Fiberglass Insulated Piping	Wicks Hall Mechanical Room		
1803101-18	Wrap on Fiberglass Insulated Piping	Wicks Hall Mechanical Room		
1803101-19	Wrap on Fiberglass Insulated Piping	Wicks Hall Mechanical Room		
1803101-20	Mudded Joint fitting Insulation - 4" Piping	Wicks Hall Mechanical Room		
1803101-21	Mudded Joint fitting Insulation - 4" Piping	Wicks Hall Mechanical Room		
1803101-22	Mudded Joint fitting Insulation - 4" Piping	Wicks Hall Mechanical Room		
1803101-23	Mudded Joint fitting Insulation - 2" Piping	Wicks Hall Mechanical Room		
1803101-24	Mudded Joint fitting Insulation - 2" Piping	Wicks Hall Mechanical Room		

Sampled By: Jerry Grady Date: 3/5/2018 Received By: ______ Date: ______

Relinquished By: Jerry Grady Date: 3/5/18 Received By: ______ Date: ______

Comments:

RECEIVED
MAR 06 2018
By [signature]

118031184

Page: 3 of 4

WATTS ARCHITECTURE & ENGINEERING
ASBESTOS BULK SAMPLE CHAIN-OF-CUSTODY

Client: Pathfinder

Date: 3/2/2018

Project: Mechanical Study of Wicks and MacArthur Hall

Watts Project No.: 1803101

Building / Location: Suny Canton, Canton, NY

Email: Jerry Grady at jgrady@watts-ae.com

Fax Preliminary Results to: (716) 206-5199

Mail Report & Invoice to: Watts Architecture & Engineering
95 Perry Street, Suite 300, Buffalo, NY 14203

Turnaround Requested: ___ 3 Hr. ___ 48 Hr.

Analysis Requested: ___ 6 Hr. ___ 72 Hr.

PLM x TEM x ___ 12 Hr. x 5 Day

___ 24 Hr. ___ 6-10 Day

1803101-25	Mudded Joint fitting Insulation - 2" Piping	Wicks Hall Mechanical Room		
1803101-26	Stick Pin Mastic	Wicks Hall Mechanical Room		
1803101-27	Stick Pin Mastic	Wicks Hall Mechanical Room		
1803101-28	White Sealant on Ends of Fiberglass Insulation	Wicks Hall Mechanical Room		
1803101-29	White Sealant on Ends of Fiberglass Insulation	Wicks Hall Mechanical Room		
1803101-30	Flange Gasket	Wicks Hall Mechanical Room		
1803101-31	Flange Gasket	Wicks Hall Mechanical Room		
1803101-32	Seam Sealant on Air Handler	Wicks Hall Mechanical Room		
1803101-33	Seam Sealant on Air Handler	Wicks Hall Mechanical Room		
1803101-34	2' x 2' Ceiling Tile	2nd Floor Corridor (east) - Wicks Hall		
1803101-35	2' x 2' Ceiling Tile	2nd Floor Corridor (west) - Wicks Hall		
1803101-36	Drywall	2nd Floor Corridor (east) - Wicks Hall		

Sampled By: Jerry Grady Date: 3/5/2018 Received By: ___ Date: ___

Relinquished By: Jerry Grady Date: 3/5/18 Received By: ___ Date: ___

Comments:

RECEIVED

MAR 06 2018

By: [signature]

118031184

WATTS ARCHITECTURE & ENGINEERING
ASBESTOS BULK SAMPLE CHAIN-OF-CUSTODY

Client: Pathfinder

Date: 3/2/2018

Project: Mechanical Study of Wicks and MacArthur Hall

Watts Project No.: 1803101

Building / Location: Suny Canton, Canton, NY

Email: Jerry Grady at jgrady@watts-ae.com

Fax Preliminary Results to: (716) 206-5199

Mail Report & Invoice to: Watts Architecture & Engineering
95 Perry Street, Suite 300, Buffalo, NY 14203

Turnaround Requested: ___ 3 Hr. ___ 48 Hr.

Analysis Requested: ___ 6 Hr. ___ 72 Hr.

PLM x TEM x ___ 12 Hr. x 5 Day

___ 24 Hr. ___ 6-10 Day

1803101-37	Drywall	2nd Floor Corridor (west) - Wicks Hall		
1803101-38	Drywall Joint Compound	2nd Floor Corridor (east) - Wicks Hall		
1803101-39	Drywall Joint Compound	2nd Floor Corridor (west) - Wicks Hall		
1803101-40	Canvas Wrap on Fiberglass Fittings	Wicks Hall Mechanical Room		
1803101-41	Canvas Wrap on Fiberglass Fittings	Wicks Hall Mechanical Room		
1803101-42	Canvas Wrap on Fiberglass Fittings	Wicks Hall Mechanical Room		
1803101-43				
1803101-44				
1803101-45				
1803101-46				
1803101-47				
1803101-48				

Sampled By: Jerry Grady Date: 3/5/2018 Received By: ___ Date: ___

Relinquished By: Jerry Grady Date: 3/5/18 Received By: ___ Date: ___

Comments:

RECEIVED
MAR 0 6 2018
By AM

2.1 – PHOTOGRAPHS

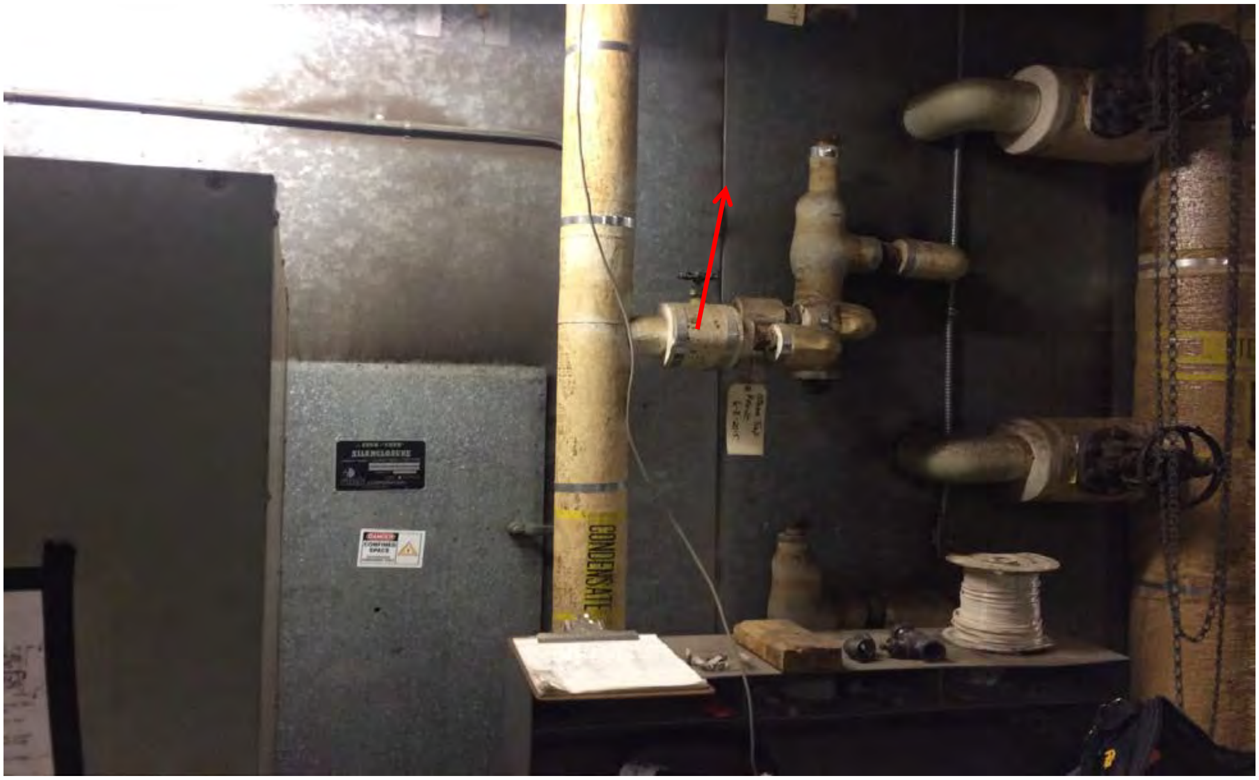


PHOTO #1- Photograph of asbestos-containing seam sealant on air handling unit in the Mechancial Roomof Wicks Hall.

PHOTO #2- Photograph of asbestos-containing stick pin mastic on ductwork in the Mecahnical Room of Wicks Hall.

WATTS ARCHITECTURE & ENGINEERING 95 Perry Street, Suite 300 Buffalo, NY 14203 Ph: (716) 206-5100 Fax: (716) 206-5199	**PRELIMINARY INSPECTION FOR ASBESTOS CONTAINING MATERIALS AND PCBS IN CAULK/SEALANTS**	PROJECT PHOTOGRAPHS
Prepared By: JG	**MACARTHUR AND WICKS HALLS** **STATE UNIVERSITY COLLEGE AT CANTON** **CANTON, NEW YORK**	1 Page No. *Watts Project No. 1803101*

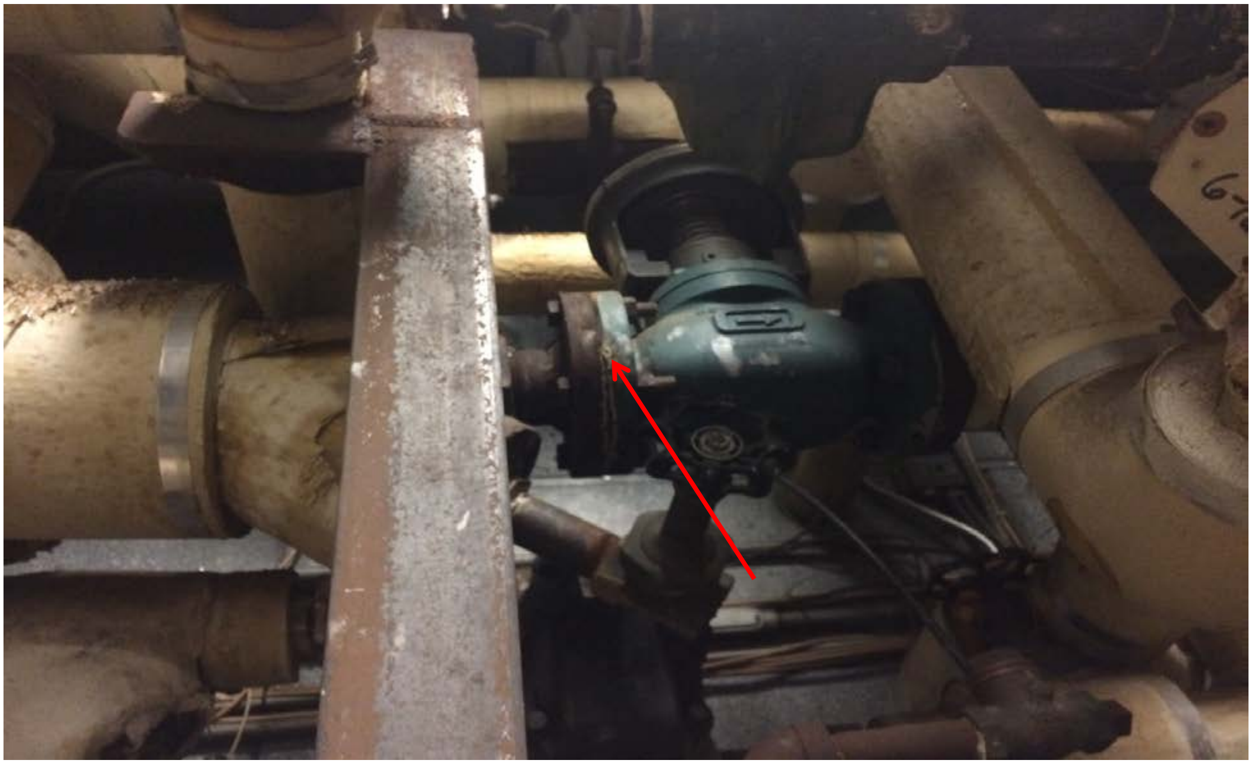


PHOTO #3 - Photograph of a typical flange, the gaskets associate with the flanges in Wicks Hall are asbestos-containing.

PHOTO #4- Photograph of asbestos-containing seam sealant on air handling unit in the Mechancial Room in MacArthur Hall.

WATTS ARCHITECTURE & ENGINEERING

95 Perry Street, Suite 300
Buffalo, NY 14203
Ph: (716) 206-5100 Fax: (716) 206-5199

Prepared By: JG

PRELIMINARY INSPECTION FOR ASBESTOS CONTAINING MATERIALS AND PCBS IN CAULK/SEALANTS

MACARTHUR AND WICKS HALLS
STATE UNIVERSITY COLLEGE AT CANTON
CANTON, NEW YORK

PROJECT PHOTOGRAPHS

Watts Project No. 1803101

PHOTO #5 - Photograph of trpical canvas wrapped eblows with fiberglass insulation in Mechancial Room of Wicks Hall. The canvas wrap was determined to be non-ACM.

PHOTO #6 - Photograph of the a typical mudded joint fitting insulation in the Mechanical Room of Wicks Hall. The mudded fitting insulation was determined to be non-ACM.

WATTS ARCHITECTURE & ENGINEERING

95 Perry Street, Suite 300

Buffalo, NY 14203

Ph: (716) 206-5100 Fax: (716) 206-5199

Prepared By: JG

PRELIMINARY INSPECTION FOR ASBESTOS CONTAINING MATERIALS AND PCBS IN CAULK/SEALANTS

MACARTHUR AND WICKS HALLS
STATE UNIVERSITY COLLEGE AT CANTON
CANTON, NEW YORK

PROJECT PHOTOGRAPHS

Watts Project No. 1803101

3.0 – POLYCHLORINATED BIPHENYLS IN CAULK

3.0 POLYCHLORINATED BIPHENYLS IN CAULK

The following table identifies the sample that was collected, the sample description and the laboratory results.

PCB ANALYTICAL RESULTS ROCKLAND COUNTY PYSCHIATRIC CENTER ORANGEBURG, NEW YORK BUILDING 11										
PCB Concentration (mg/kg or ppm)										
Sample Number	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268	Sample Location & Description
1803101-P-01	<0.929	<0.929	<0.929	<0.929	<0.929	<0.929	14.3	<0.929	<0.929	Air Handler Seam sealant MacArthur Hall
1803101-P-02	<0.948	<0.948	<0.948	<0.948	<0.948	<0.948	14.9	<0.948	<0.948	Seam sealant associated with the air handling unit in the Mechanical room of Wicks Hall

Abbreviations:
Bold = Value greater than (TSCA) regulations (50ppm)
mg/kg = milligram per kilogram
ppm = parts per million

3.1 – PCB LABORATORY REPORT AND CHAIN OF CUSTODY FORM

Analysis Report

Schneider Laboratories Global, Inc

2512 W. Cary Street • Richmond, Virginia • 23220-5117
804-353-6778 • 800-785-LABS (5227) • Fax 804-359-1475

Customer: Watts Architecture & Engineering (4637)
Address: 95 Perry Street Suite 300
Buffalo, NY 14203

Attn:

Project: Mechanical Study Of Wicks
Location: SUNY Canton, Canton, NY
Number: 1803101

Order #: 250199

Matrix Bulk
Received 03/06/18
Reported 03/07/18

PO Number: 7628

Sample ID / Parameter	Cust. Sample ID	Location / Method	Result	RL*	Units	Analysis Date	Analyst
250199-001	1803101-PCB-01	Seam Caulk M					
Semi-volatile Organic Compounds							
Aroclor - 1016		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1221		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1232		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1242		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1248		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1254		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1260		SW846 8082A	**14300**	928	µg/Kg	03/06/18	AE
Aroclor - 1262		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
Aroclor - 1268		SW846 8082A	**<929**	928	µg/Kg	03/06/18	AE
PCB - Surrogate Recoveries							
DCB		D					
TCMX		D					
250199-002	1803101-PCB-02	Seam Caulk W					
Semi-volatile Organic Compounds							
Aroclor - 1016		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1221		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1232		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1242		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1248		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1254		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1260		SW846 8082A	**14900**	948	µg/Kg	03/06/18	AE
Aroclor - 1262		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
Aroclor - 1268		SW846 8082A	**<948**	948	µg/Kg	03/06/18	AE
PCB - Surrogate Recoveries							
DCB		D					
TCMX		D					

All internal QC parameters were met. Unusual sample conditions, if any, are described. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Concentration and *Reporting Limit (RL) based on areas provided by client. Values are reported to three significant figures. Solid PPM = mg/kg | PPB = µg/kg and Water PPM = mg/L | PPB = µg/L. The test results reported relate only to the samples submitted.

Analysis Report

Schneider Laboratories Global, Inc

2512 W. Cary Street • Richmond, Virginia • 23220-5117
804-353-6778 • 800-785-LABS (5227) • Fax 804-359-1475

Customer: Watts Architecture & Engineering (4637)
Address: 95 Perry Street Suite 300
Buffalo, NY 14203

Attn:

Project: Mechanical Study Of Wicks
Location: SUNY Canton, Canton, NY
Number: 1803101

Order #: 250199

Matrix Bulk
Received 03/06/18
Reported 03/07/18

PO Number: 7628

Sample ID / Parameter	Cust. Sample ID	Location / Method	Result	RL*	Units	Analysis Date	Analyst
250199-03/07/18 04:35 PM							

Reviewed By:
Analyst

State Certifications

Method	Parameter	New York	Virginia
SW846 8082A	Aroclor - 1016	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1221	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1232	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1242	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1248	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1254	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1260	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1262	ELAP Certified	VELAP Certified
SW846 8082A	Aroclor - 1268	ELAP Certified	VELAP Certified

State	Certificate Number
New York	ELAP 56000
Virginia	VELAP 9017

All internal QC parameters were met. Unusual sample conditions, if any, are described. Surrogate Spike results designated with "D" indicate that the analyte was diluted out. "MI" indicates matrix interference. Concentration and *Reporting Limit (RL) based on areas provided by client. Values are reported to three significant figures. Solid PPM = mg/kg | PPB = µg/kg and Water PPM = mg/L | PPB = µg/L. The test results reported relate only to the samples submitted.

250199 O 2

V:\250\250199

fghraizi 3/6/2018 9:20:00 AM

UPS 1Z2E2899845 ?465985

SCHNEIDER LABORATORIES GLOBAL, INC.

2512 West Cary Street, Richmond, Virginia 23220-5117
804-353-6778 • 800-785-LABS (5227) • Fax 804-359-1475
www.slabinc.com e-mail: info@slabinc.com

Submitting Co.	Watts Architecture and Engineering	Lab WO#		Phone	716.206.5100
95 Perry Street, Suite 300		Acct #		Fax \ Email	jgrady@watts-ae.com
Buffalo, NY 14203		**State of Collection	NY	**Cert. Required	☒ Yes ☐ No

Project Name:	Mechanical Study of Wicks and MacArthur Hall
Project Location:	SUNY Canton, Canton, NY
Project Number:	1803101
Purchase Order #	
TAT Requested	(Business Day) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 10 ☐ Other: ______

Special Instructions [include requests for special reporting or data packages]

Analysis Request: BTEX ☐ MTBE ☐ Naphthalene ☐; Purgeable Aromatics 8021 ☐; Petrol Hydrocarbons GC 8015M Diesel ☐ 8015M Gas ☐; TPH 418.1 ☐; Corrosivity ☐ Reactivity ☐ Flashpoint, Closed Cup ☐; Volatile Organics 624 ☐ 8260 ☐; Semivolatile Organics 625 ☐ 8270 ☐; PAHs 610 ☐ 8270 ☐ 8310 By HPLC ☐; TCLP Semi-Vols ☐ BNAs ☐ Pest ☐ Herb ☐ VOAs ☐ Full ☐; Pesticides 608 ☐ 8081 ☐ Herbicides 8151 ☐ PCB's 8082 ☒; Other

Sample #	**Date Sampled	**Time Sampled	# Containers	Chlorine (Cl)	Temp *	pH	Drinking Water	Waste Water	Ground Water	Soil / Sludge	Wipe	Oil or Air	Bulk	BTEX / MTBE / Naphthalene	Purgeable Aromatics 8021	Petrol Hydrocarbons	TPH 418.1	Corrosivity / Reactivity / Flashpoint	Volatile Organics	Semivolatile Organics	PAHs	TCLP	Pesticides / Herbicides / PCB's 8082	Other	
1803101-PCB-01 (Seam Caulk M)	03/1/18	1100	1										x										x		
1803101-PCB-02 (Seam Caulk W	03/1/18	1200	1										x										x		

Sampled by	Relinquished to lab by
NAME JERRY GRADY	NAME JERRY GRADY
SIGNATURE	SIGNATURE Jerry Grady
DATE/TIME	DATE/TIME 3/5/18

Sample Disposal If samples over req. weight (Refer to Fee Schedule)
☐ Return to Sender (Shipping fees)
☐ Disposal by lab ($50 fee)

Shipping Methods
☐ FX ☐ UPS ☐ USM
☐ HD ☐ DB
WB: ______

Preserved ☐ Yes ☐ No ☐ Ambient temp ☐ Ice ☐ R ☐ S ☐ X ☐ Receive a physical copy of report.

* Temperature taken with IR Gun A. **Required. Chain-of-Custody documentation continued internally within lab. Terms and conditions page 2.

4.0 – LABORATORY ACCREDITATIONS

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2019
Issued April 01, 2018

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

NY Lab Id No: 10984

DR. THOMAS R. MCKEE
AMERISCI RICHMOND
13635 GENITO RD
MIDLOTHIAN, VA 23112

is hereby APPROVED as an Environmental Laboratory for the category
ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE
All approved subcategories and/or analytes are listed below:

Miscellaneous

Asbestos in Friable Material	Item 198.1 of Manual
	EPA 600/M4/82/020
Asbestos in Non-Friable Material-PLM	Item 198.6 of Manual (NOB by PLM)
Asbestos in Non-Friable Material-TEM	Item 198.4 of Manual
Asbestos-Vermiculite-Containing Material	Item 198.8 of Manual

Serial No.: 57653

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 101904-0

AmeriSci Richmond
Midlothian, VA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

DEPARTMENT OF COMMERCE UNITED STATES OF AMERICA

2017-07-01 through 2018-06-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

NVLAP® National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

AmeriSci Richmond
dba AmeriSci Richmond
13635 Genito Road
Midlothian, VA 23112
Mr. Thomas B. Keith
Phone: 804-763-1200 Fax: 804-763-1800
Email: bkeith@amerisci.com
http://www.amerisci.com

ASBESTOS FIBER ANALYSIS

NVLAP LAB CODE 101904-0

Bulk Asbestos Analysis

Code	Description
18/A01	EPA -- Appendix E to Subpart E of Part 763 -- Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	Description
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

Effective 2017-07-01 through 2018-06-30

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2019
Issued April 01, 2018

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. FAYEZ ABOUZAKI
SCHNEIDER LABORATORIES GLOBAL, INC
2512 WEST CARY STREET
RICHMOND, VA 23220-5117

NY Lab Id No: 11413

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards (2003) for the category ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE
All approved analytes are listed below:

Metals III

Molybdenum, Total	EPA 6010D	
Thallium, Total	EPA 6010C	
	EPA 6010D	
Tin, Total	EPA 6010C	
	EPA 6010D	
Titanium, Total	EPA 6010C	
	EPA 6010D	

Sample Preparation Methods

EPA 3010A
EPA 3050B
EPA 3550C

Miscellaneous

Asbestos in Friable Material	EPA 600/M4/82/020
Asbestos in Non-Friable Material-PLM	Item 198.6 of Manual (NOB by PLM)
Boron, Total	EPA 6010D
Lead in Dust Wipes	EPA 7000B
Lead in Paint	EPA 7000B

Polychlorinated Biphenyls

PCB-1016	EPA 8082A
PCB-1221	EPA 8082A
PCB-1232	EPA 8082A
PCB-1242	EPA 8082A
PCB-1248	EPA 8082A
PCB-1254	EPA 8082A
PCB-1260	EPA 8082A
PCB-1262	EPA 8082A
PCB-1268	EPA 8082A

Serial No.: 57776

5.0 – CONSULTANT'S LICENSES AND CERTIFICATIONS

New York State – Department of Labor
Division of Safety and Health
License and Certificate Unit
State Campus, Building 12
Albany, NY 12240

ASBESTOS HANDLING LICENSE

Watts Architecture & Engineering, D.P.C.
Suite 300
95 Perry Street

Buffalo, NY 14203

FILE NUMBER: 12-68007
LICENSE NUMBER: 68007
LICENSE CLASS: RESTRICTED
DATE OF ISSUE: 08/24/2017
EXPIRATION DATE: 09/30/2018

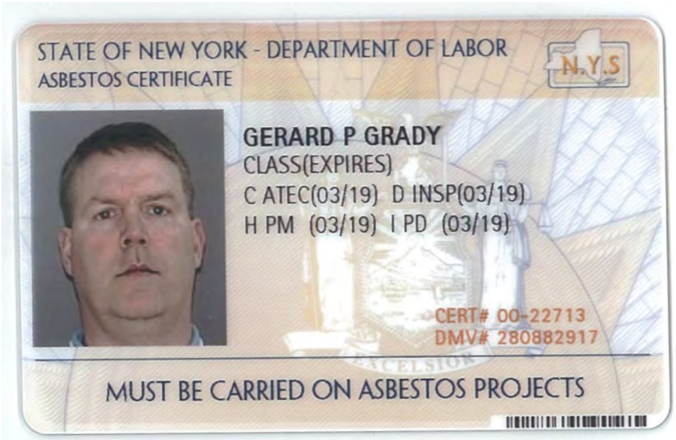
Duly Authorized Representative – Edward Watts:

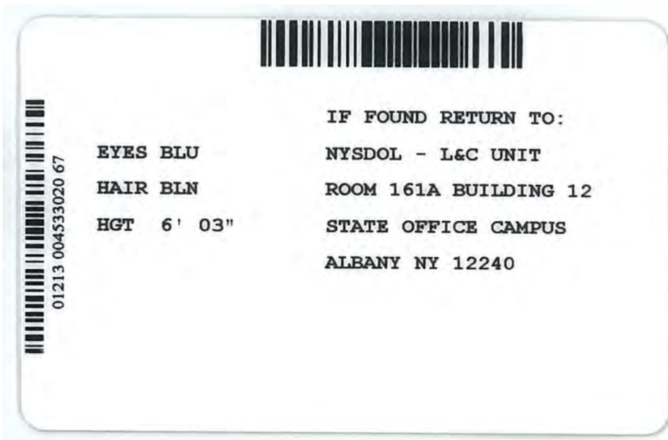
This license has been issued in accordance with applicable provisions of Article 30 of the Labor Law of New York State and of the New York State Codes, Rules and Regulations (12 NYCRR Part 56). It is subject to suspension or revocation for a (1) serious violation of state, federal or local laws with regard to the conduct of an asbestos project, or (2) demonstrated lack of responsibility in the conduct of any job involving asbestos or asbestos material.

This license is valid only for the contractor named above and this license or a photocopy must be prominently displayed at the asbestos project worksite. This license verifies that all persons employed by the licensee on an asbestos project in New York State have been issued an Asbestos Certificate, appropriate for the type of work they perform, by the New York State Department of Labor.

Eileen M. Franko, Director
For the Commissioner of Labor

SH 432 (8/12)





Jerry Grady

C – Air Sampling Technician
D – Inspector
H – Project Monitor
I – Project Designer

Section 10 – System Option Cost Estimates

PROGRAM REPORT ESTIMATE

WICKS AND MACARTHUR HALLS - MECHANICAL/ELECTRICAL STUDY
SUNY CANTON

CANTON, NY

SUCF PROJECT NO. 23102

PREPARED FOR:
PATHFINDER ENGINEERS & ARCHITECTS, LLP

PROJECT NO: 18-0019a-0076

November 07, 2018
(Revision 2)

Trophy Point, LLC
Construction Services & Consulting

4588 South Park Avenue
Blasdell, NY 14219
Phone: (716) 823-0006
Fax: (716) 831-0001

700 River Avenue, Suite 423
Pittsburgh, PA 15212
Phone: (716) 436-5571
Fax: (716) 831-0001

WWW.TROPHYPOINT.COM

PROJECT SUMMARY		TOTAL COST
PROJECT CONSTRUCTION COST OPTIONS (PHASING PREMIUM % INCLUDED)		
VARIABLE AIR VOLUME VAV (7.5%)	**$**	**13,628,200**
FAN COIL UNIT (FCU) WITH DOAS (5%)	**$**	**13,790,100**
ACTIVE CHILLED BEAM (ACB) INDUCTION UNIT WITH DOAS (4.5%)	**$**	**13,954,700**
GEOTHERMAL WITH DOAS (3.5%)	**$**	**14,065,400**
HYBRID GEOTHERMAL WITH DOAS (3.5%)	**$**	**13,987,200**
HYBRID GEOTHERMAL WITH VAV (6.5%)	**$**	**15,012,800**
ALL OPTIONS INCLUDE GAS FIRED HEATING BOILERS		

ESTIMATE NOTES / ASSUMPTIONS / CLARIFICATIONS

- BASED ON PATHFINDER ENGINEERS & ARCHITECTS, LLP PROGRAM REPORT DOCUMENTS DATED 10/23/2018.
- NEW YORK STATE PREVAILING WAGE RATES FOR ST. LAWRENCE COUNTY.
- CONSTRUCTION START APRIL 2020; COMPLETION DECEMBER 2022; MID-POINT AUGUST 2021.
- NORMAL WORKING HOURS AND CONDITIONS; EXCLUDES PREMIUMS FOR A CONDENSED CONSTRUCTION SCHEDULE.
- SINGLE PRIME CONTRACT (COMPETITIVELY BID) - ENTIRE PROJECT BID AT ONE TIME.
- PREMISES TO BE OCCUPIED DURING CONSTRUCTION (WORK AREAS TO BE VACANT).
- HVAC ZONING (PER NARRATIVE) ESTIMATED BASED ON EXISTING FLOOR PLANS PROVIDED BY ENGINEER.
- CHILLED BEAM OPTION INCLUDES TEMPERATURE MIXING CONTROL (EXCLUDES HEAT EXCHANGERS).
- HYBRID GEOTHERMAL OPTIONS INCLUDE RE-PURPOSING OF THE EXISTING (2012 CONSTRUCTION) 325-TON OPEN COOLING TOWER - TO PROVIDE APPROX. 100-TONS OF HEAT REJECTION CAPACITY IN CONJUNCTION WITH THE REDUCED CAPACITY GEOTHERMAL WELL FIELD SYSTEMS (AT APPROX. 2/3 OF FULL CAPACITY).
- HYBRID GEOTHERMAL OPTIONS INCLUDE HEAT EXCHANGER SEPARATION OF THE WELL FIELD (CLOSED LOOP) PIPING FROM THE RE-PURPOSED COOLING TOWER HEAT REJECTION SYSTEM (OPEN LOOP).
- GEOTHERMAL AND HYBRID GEOTHERMAL OPTIONS INCLUDE GAS FIRED BOILERS - TO PROVIDE SUPPLEMENTAL CAPACITY, AND TO PRECLUDE THE USE OF GLYCOL IN THE WELL FIELD PIPING SYSTEMS.
- GEOTHERMAL AND HYBRID GEOTHERMAL OPTIONS EXCLUDE HEAT EXCHANGER SEPARATION OF THE WELL FIELD SYSTEM FROM THE BUILDING HEAT PUMP SYSTEM.
- PHASING PREMIUM % VARIES WITH EACH HVAC SYSTEM OPTION. PHASING PREMIUM % IS ESTIMATED BASED ON THE CONSTRUCTABILITY OF EACH OPTTION - AS DESCRIBED IN THE PROGRAM REPORT NARRATIVE.

Note: This estimate represents a reasonable opinion of cost based on several public and proprietary sources of information. It is not a prediction of the successful bid from a contractor as bids will vary due to fluctuating market conditions, errors and omissions, proprietary specifications, lack of surplus bidders, perception of risk, and so on. Consequently, this estimate is expected to fall within the range of bids from multiple competitive contractors or subcontractors. However, we do not warrant that bids or negotiated prices will not vary from the final construction cost estimate.

VAV SUMMARY

S U M M A R Y		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.73%
DIVISION 9 - FINISHES		$425,300	$474,800	$900,100	6.60%
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.30%
DIVISION 23 - HVAC		$2,939,700	$2,981,300	$5,921,000	43.45%
DIVISION 26 - ELECTRICAL		$667,100	$383,200	$1,050,300	7.71%
SUB-TOTAL		$4,201,500	$4,083,600	$8,285,100	60.79%
GENERAL CONDITIONS	10.0%			$828,500	6.08%
SUB-TOTAL				$9,113,600	66.87%
OVERHEAD AND PROFIT	8.0%			$729,100	5.35%
SUB-TOTAL				$9,842,700	72.22%
PHASING (VAV)	7.5%			$738,203	5.42%
SUB-TOTAL				$10,580,900	77.64%
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,269,700	9.32%
SUB-TOTAL				$11,850,600	86.96%
DESIGN CONTINGENCY	15.0%			$1,777,600	13.04%
TOTAL - VAV SUMMARY	**89,625 GSF**			**$13,628,200**	**100.00%**

BLDG $ / GSF
$1.12
$10.04
$3.50
$66.06
$11.72
$92.44
$9.24
$101.69
$8.14
$109.82
$8.24
$118.06
$14.17
$132.22
$19.83
$152.06

VAV DETAIL

DESCRIPTION	QUANTITY		MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT							
Asbestos abatement including air monitoring	1	ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT				**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT SAY				**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES							
Remove and replace ceilings including soffits (where required) for VAV system ductwork	75,000	SF	$4.47	$335,250	$4.53	$339,750	$675,000
Mechanical and electrical rooms (construct new / modify existing as required)	1	ALLOW	60,000.00	60,000	90,000.00	90,000	150,000
Other miscellaneous general trades work	1	LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES				**425,250**		**474,750**	**900,000**
TOTAL DIVISION 9 - FINISHES SAY				**$425,300**		**$474,800**	**$900,000**
DIVISION 21 - FIRE PROTECTION							
Wet sprinkler system	89,625	SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION				**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY				**$134,400**		**$179,300**	**$313,700**

VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 23 - HVAC						
DEMOLITION						
HVAC Demolition	1 LS	$20,000.00	$20,000	$70,000.00	$70,000	$90,000
COOLING PLANT WORK						
Cooling plant equipment (e.g. chillers, cooling towers, refrigerant monitor, emergency ventilation exhaust fan, primary and secondary chilled water pumps, condenser water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, secondary condenser water sidestream separator, chemical water treatment for closed and open systems)	1 LS	532,500.00	532,500	89,624.00	89,624	622,124
Cooling plant prefabricated piped valve assemblies, chilled water piping, condenser water piping, expansion tank and chemical treatment piping, misc. cooling tower piping (e.g. overflow, drain, water makeup, etc.), chiller refrigerant vent piping, pipe insulation, equipment insulation, cooling plant sheetmetal work including insulation, cooling plant testing, adjusting and balancing	1 LS	113,000.00	113,000	136,248.00	136,248	249,248
Cooling plant direct digital controls	1 LS	44,000.00	44,000	44,000.00	44,000	88,000
Cooling plant miscellaneous items	1 LS	13,500.00	13,500	9,088.00	9,088	22,588
HEATING PLANT WORK						
Heating plant equipment (e.g. gas fired condensing boilers, boiler pumps, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	171,000.00	171,000	53,960.00	53,960	224,960
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	42,500.00	42,500	36,240.00	36,240	78,740
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	31,500.00	31,500	45,808.00	45,808	77,308
Heating plant direct digital controls	1 LS	25,000.00	25,000	25,000.00	25,000	50,000
Heating plant miscellaneous items	1 LS	7,500.00	7,500	6,816.00	6,816	14,316

VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
PERIMETER HEATING WORK						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
HVAC DISTRIBUTION WORK						
Enthalpy energy recovery variable air volume hvac air handling units, both units installed on Wicks Hall roof per report narrative	1 LS	540,000.00	540,000	28,400.00	28,400	568,400
VAV supply air terminal units including hot water reheat coil (per hvac zoning)	205 EA	1,100.00	225,500	355.00	72,775	298,275
Prefabricated piped valve assemblies for VAV supply air terminal units	410 EA	150.00	61,500	142.00	58,220	119,720
Heating hot water piping and chilled water piping to VAV hvac air handling units	800 LF	38.28	30,624	46.01	36,808	67,432
Pipe insulation	800 LF	9.98	7,984	11.22	8,976	16,960
Heating hot water piping to 205 VAV supply air terminal unit reheat coils						
- Building mains (each floor) and risers	4,560 LF	18.15	82,764	30.18	137,621	220,385
- Distribution from mains to equipment	4,100 LF	11.20	45,920	12.25	50,225	96,145
- Pipe insulation	8,660 LF	7.11	61,573	8.12	70,319	131,892
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	113,000 LB	1.13	127,690	6.50	734,500	862,190
Duct insulation	1 LS	75,000.00	75,000	385,000.00	385,000	460,000
Air inlets and outlets	450 EA	75.00	33,750	65.00	29,250	63,000
Louvers, roof ventilators, fire dampers, etc.	1 LS	25,000.00	25,000	20,800.00	20,800	45,800

VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	90,000.00	90,000	90,000
Direct digital controls	1 LS	330,000.00	330,000	330,000.00	330,000	660,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	20,000.00	20,000	115,000.00	115,000	135,000
TOTAL DIVISION 23 - HVAC			**2,939,705**		**2,981,315**	**5,921,020**
TOTAL DIVISION 23 - HVAC SAY			**$2,939,700**		**$2,981,300**	**$5,921,000**
DIVISION 26 - ELECTRICAL						
DISTRIBUTION						
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
LIGHTING						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999

VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
EQUIPMENT CONNECTIONS						
Cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	12,500.00	12,500	16,060.00	16,060	28,560
Heating plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	10,000.00	10,000	13,140.00	13,140	23,140
Electrical connections at rooftop HVAC units including means of disconnect and circuiting back to source power panel	1 ALLOW	5,000.00	5,000	7,300.00	7,300	12,300
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
VAV unit connection and circuiting	205 EA	100.00	20,500	219.00	44,895	65,395
FIRE ALARM						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**667,131**		**383,183**	**1,050,314**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$667,100**		**$383,200**	**$1,050,300**

FCU SUMMARY

SUMMARY		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL	BLDG $ / GSF
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.73%	$1.12
DIVISION 9 - FINISHES		$414,800	$410,300	$825,100	5.98%	$9.21
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.27%	$3.50
DIVISION 23 - HVAC		$3,188,300	$3,105,800	$6,294,100	45.64%	$70.23
DIVISION 26 - ELECTRICAL		$667,100	$383,200	$1,050,300	7.62%	$11.72
SUB-TOTAL		$4,439,600	$4,143,600	$8,583,200	62.24%	$95.77
GENERAL CONDITIONS	10.0%			$858,300	6.22%	$9.58
SUB-TOTAL				$9,441,500	68.47%	$105.34
OVERHEAD AND PROFIT	8.0%			$755,300	5.48%	$8.43
SUB-TOTAL				$10,196,800	73.94%	$113.77
PHASING (FCU)	5.0%			$509,840	3.70%	$5.69
SUB-TOTAL				$10,706,600	77.64%	$119.46
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,284,800	9.32%	$14.34
SUB-TOTAL				$11,991,400	86.96%	$133.80
DESIGN CONTINGENCY	15.0%			$1,798,700	13.04%	$20.07
TOTAL - FCU SUMMARY	**89,625 GSF**			**$13,790,100**	**100.00%**	**$153.86**

FCU DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 2- HAZARDOUS MATERIALS ABATEMENT						
Asbestos abatement including air monitoring	1 ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2- HAZARDOUS MATERIALS ABATEMENT			**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2- HAZARDOUS MATERIALS ABATEMENT SAY			**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES						
Remove and replace ceilings	75,000 SF	$4.33	$324,750	$3.67	$275,250	$600,000
Mechanical and electrical rooms (construct new / modify existing as required)	1 ALLOW	60,000.00	60,000	90,000.00	90,000	150,000
Other miscellaneous general trades work	1 LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES			**414,750**		**410,250**	**825,000**
TOTAL DIVISION 9 - FINISHES SAY			**$414,800**		**$410,300**	**$825,100**
DIVISION 21 - FIRE PROTECTION						
Wet sprinkler system	89,625 SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION			**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY			**$134,400**		**$179,300**	**$313,700**

FCU DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 23 - HVAC						
DEMOLITION						
HVAC Demolition	1 LS	$20,000.00	$20,000	$70,000.00	$70,000	$90,000
COOLING PLANT WORK						
Cooling plant equipment (e.g. chillers, cooling towers, refrigerant monitor, emergency ventilation exhaust fan, primary and secondary chilled water pumps, condenser water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, secondary condenser water sidestream separator, chemical water treatment for closed and open systems)	1 LS	532,500.00	532,500	89,624.00	89,624	622,124
Cooling plant prefabricated piped valve assemblies, chilled water piping, condenser water piping, expansion tank and chemical treatment piping, misc. cooling tower piping (e.g. overflow, drain, water makeup, etc.), chiller refrigerant vent piping, pipe insulation, equipment insulation, cooling plant sheetmetal work including insulation, cooling plant testing, adjusting and balancing	1 LS	113,000.00	113,000	136,248.00	136,248	249,248
Cooling plant direct digital controls	1 LS	44,000.00	44,000	44,000.00	44,000	88,000
Cooling plant miscellaneous items	1 LS	13,500.00	13,500	9,088.00	9,088	22,588
HEATING PLANT WORK						
Heating plant equipment (e.g. gas fired condensing boilers, boiler pumps, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	171,000.00	171,000	53,960.00	53,960	224,960
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	42,500.00	42,500	36,240.00	36,240	78,740
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	31,500.00	31,500	45,808.00	45,808	77,308
Heating plant direct digital controls	1 LS	25,000.00	25,000	25,000.00	25,000	50,000
Heating plant miscellaneous items	1 LS	7,500.00	7,500	6,816.00	6,816	14,316

FCU DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
PERIMETER HEATING WORK						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
HVAC DISTRIBUTION WORK						
Enthalpy energy DOAS hvac air handling units	1 LS	250,000.00	250,000	17,040.00	17,040	267,040
4-pipe fan coil units (per hvac zoning) including ducted units	205 EA	2,000.00	410,000	568.00	116,440	526,440
Prefabricated piped valve assemblies for fan coil units	792 EA	150.00	118,800	142.00	112,464	231,264
Heating hot water piping and chilled water piping to DOAS hvac air handling units	800 LF	28.60	22,880	39.62	31,696	54,576
Pipe insulation	800 LF	8.62	6,896	9.13	7,304	14,200
Heating hot water piping and chilled water piping to 205 4-pipe fan coil units						
- Building mains (each floor) and risers	9,120 LF	21.00	191,520	31.60	288,192	479,712
- Distribution from mains to equipment	8,200 LF	11.20	91,840	12.25	100,450	192,290
- Pipe insulation	17,320 LF	7.11	123,145	8.12	140,638	263,784
Condensate drain piping	5,225 LF	11.20	58,520	12.25	64,006	122,526
Pipe insulation	5,225 LF	1.83	9,562	6.48	33,858	43,420
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	67,000 LB	1.13	75,710	6.50	435,500	511,210
Duct insulation	1 LS	45,000.00	45,000	231,000.00	231,000	276,000
Air inlets and outlets	360 EA	75.00	27,000	65.00	23,400	50,400
Louvers, roof ventilators, fire dampers, etc.	1 LS	15,000.00	15,000	10,400.00	10,400	25,400

FCU DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	115,000.00	115,000	115,000
Direct digital controls	1 LS	450,000.00	450,000	450,000.00	450,000	900,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	20,000.00	20,000	115,000.00	115,000	135,000
TOTAL DIVISION 23 - HVAC			**3,188,273**		**3,105,810**	**6,294,083**
TOTAL DIVISION 23 - HVAC SAY			**$3,188,300**		**$3,105,800**	**$6,294,100**
DIVISION 26 - ELECTRICAL						
DISTRIBUTION						
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
LIGHTING						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999

FCU DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
EQUIPMENT CONNECTIONS						
Cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	12,500.00	12,500	16,060.00	16,060	28,560
Heating plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	10,000.00	10,000	13,140.00	13,140	23,140
Electrical connections at DOAS HVAC air handling units including means of disconnect and circuiting back to source power panel	1 ALLOW	5,000.00	5,000	7,300.00	7,300	12,300
Fan coil unit connection and circuiting	205 EA	100.00	20,500	219.00	44,895	65,395
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
FIRE ALARM						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**667,131**		**383,183**	**1,050,314**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$667,100**		**$383,200**	**$1,050,300**

CHILLED BEAM SUMMARY

SUMMARY		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL	BLDG $ / GSF
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.72%	$1.12
DIVISION 9 - FINISHES		$414,800	$410,300	$825,100	5.91%	$9.21
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.25%	$3.50
DIVISION 23 - HVAC		$3,368,700	$3,134,700	$6,503,400	46.60%	$72.56
DIVISION 26 - ELECTRICAL		$646,600	$338,300	$984,900	7.06%	$10.99
SUB-TOTAL		$4,599,500	$4,127,600	$8,727,100	62.54%	$97.37
GENERAL CONDITIONS	10.0%			$872,700	6.25%	$9.74
SUB-TOTAL				$9,599,800	68.79%	$107.11
OVERHEAD AND PROFIT	8.0%			$768,000	5.50%	$8.57
SUB-TOTAL				$10,367,800	74.30%	$115.68
PHASING (CH BEAM)	4.5%			$466,551	3.34%	$5.21
SUB-TOTAL				$10,834,400	77.64%	$120.89
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,300,100	9.32%	$14.51
SUB-TOTAL				$12,134,500	86.96%	$135.39
DESIGN CONTINGENCY	15.0%			$1,820,200	13.04%	$20.31
TOTAL - CHILLED BEAM SUMMARY	**89,625 GSF**			**$13,954,700**	**100.00%**	**$155.70**

CHILLED BEAM DETAIL

		MATERIAL		LABOR		
DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT						
Asbestos abatement including air monitoring	1 ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT			**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT SAY			**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES						
Remove and replace ceilings	75,000 SF	$4.33	$324,750	$3.67	$275,250	$600,000
Mechanical and electrical rooms (construct new / modify existing as required)	1 ALLOW	60,000.00	60,000	90,000.00	90,000	150,000
Other miscellaneous general trades work	1 LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES			**414,750**		**410,250**	**825,000**
TOTAL DIVISION 9 - FINISHES SAY			**$414,800**		**$410,300**	**$825,000**
DIVISION 21 - FIRE PROTECTION						
Wet sprinkler system	89,625 SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION			**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY			**$134,400**		**$179,300**	**$313,700**

CHILLED BEAM DETAIL

		MATERIAL		LABOR		
DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	TOTAL
DIVISION 23 - HVAC						
<u>DEMOLITION</u>						
HVAC Demolition	1 LS	$20,000.00	$20,000	$70,000.00	$70,000	$90,000
<u>COOLING PLANT WORK</u>						
Cooling plant equipment (e.g. chillers, cooling towers, refrigerant monitor, emergency ventilation exhaust fan, primary and secondary chilled water pumps, condenser water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, secondary condenser water sidestream separator, chemical water treatment for closed and open systems)	1 LS	532,500.00	532,500	89,624.00	89,624	622,124
Cooling plant prefabricated piped valve assemblies, chilled water piping, condenser water piping, expansion tank and chemical treatment piping, misc. cooling tower piping (e.g. overflow, drain, water makeup, etc.), chiller refrigerant vent piping, pipe insulation, equipment insulation, cooling plant sheetmetal work including insulation, cooling plant testing, adjusting and balancing	1 LS	113,000.00	113,000	136,248.00	136,248	249,248
Cooling plant direct digital controls	1 LS	44,000.00	44,000	44,000.00	44,000	88,000
Cooling plant miscellaneous items	1 LS	13,500.00	13,500	9,088.00	9,088	22,588
<u>HEATING PLANT WORK</u>						
Heating plant equipment (e.g. gas fired condensing boilers, boiler pumps, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	171,000.00	171,000	53,960.00	53,960	224,960
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	42,500.00	42,500	36,240.00	36,240	78,740
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	31,500.00	31,500	45,808.00	45,808	77,308
Heating plant direct digital controls	1 LS	25,000.00	25,000	25,000.00	25,000	50,000
Heating plant miscellaneous items	1 LS	7,500.00	7,500	6,816.00	6,816	14,316

CHILLED BEAM DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
PERIMETER HEATING WORK						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
HVAC DISTRIBUTION WORK						
Enthalpy energy DOAS hvac air handling units	1 LS	250,000.00	250,000	17,040.00	17,040	267,040
4-pipe active chilled beam induction units	400 EA	1,500.00	600,000	284.00	113,600	713,600
Prefabricated piped valve assemblies for 4-pipe chilled beam induction unit control zones	792 EA	75.00	59,400	71.00	56,232	115,632
Heating hot water piping and chilled water piping to DOAS hvac air handling units	800 LF	28.60	22,880	39.62	31,696	54,576
Pipe insulation	800 LF	8.62	6,896	9.13	7,304	14,200
Heating hot water piping and chilled water piping to 420 4-pipe active chilled beam induction units						
- Building mains (each floor) and risers	9,120 LF	21.00	191,520	31.91	291,019	482,539
- Distribution from mains to equipment	16,000 LF	4.34	69,440	7.46	119,360	188,800
- Pipe insulation	25,120 LF	5.00	125,600	7.62	191,414	317,014
Condensate drain piping	8,000 LF	8.72	69,760	10.47	83,760	153,520
Pipe insulation	8,000 LF	1.79	14,320	6.30	50,400	64,720
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	54,000 LB	1.13	61,020	6.50	351,000	412,020
Duct insulation	1 LS	37,500.00	37,500	192,500.00	192,500	230,000
Air inlets and outlets	240 EA	75.00	18,000	65.00	15,600	33,600
Louvers, roof ventilators, fire dampers, etc.	1 LS	15,000.00	15,000	10,400.00	10,400	25,400

CHILLED BEAM DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	135,000.00	135,000	135,000
Direct digital controls	1 LS	530,000.00	530,000	530,000.00	530,000	1,060,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	25,000.00	25,000	125,000.00	125,000	150,000
TOTAL DIVISION 23 - HVAC			**3,368,736**		**3,134,747**	**6,503,483**
TOTAL DIVISION 23 - HVAC SAY			**$3,368,700**		**$3,134,700**	**$6,503,500**
DIVISION 26 - ELECTRICAL						
DISTRIBUTION						
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
LIGHTING						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999

CHILLED BEAM DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
EQUIPMENT CONNECTIONS						
Cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	12,500.00	12,500	16,060.00	16,060	28,560
Heating plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	10,000.00	10,000	13,140.00	13,140	23,140
Electrical connections at DOAS HVAC air handling units including means of disconnect and circuiting back to source power panel	1 ALLOW	5,000.00	5,000	7,300.00	7,300	12,300
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
FIRE ALARM						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**646,631**		**338,288**	**984,919**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$646,600**		**$338,300**	**$984,900**

GEOTHERMAL SUMMARY

SUMMARY		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL	BLDG $ / GSF
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.71%	$1.12
DIVISION 9 - FINISHES		$354,800	$320,300	$675,100	4.80%	$7.53
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.23%	$3.50
DIVISION 23 - HVAC		$3,401,100	$3,352,900	$6,754,000	48.02%	$75.36
DIVISION 26 - ELECTRICAL		$662,100	$376,500	$1,038,600	7.38%	$11.59
SUB-TOTAL		$4,587,400	$4,294,000	$8,881,400	63.14%	$99.10
GENERAL CONDITIONS	10.0%			$888,100	6.31%	$9.91
SUB-TOTAL				$9,769,500	69.46%	$109.00
OVERHEAD AND PROFIT	8.0%			$781,600	5.56%	$8.72
SUB-TOTAL				$10,551,100	75.01%	$117.72
PHASING (GEOTHERMAL)	3.5%			$369,289	2.63%	$4.12
SUB-TOTAL				$10,920,400	77.64%	$121.85
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,310,400	9.32%	$14.62
SUB-TOTAL				$12,230,800	86.96%	$136.47
DESIGN CONTINGENCY	15.0%			$1,834,600	13.04%	$20.47
TOTAL - GEOTHERMAL SUMMARY	**89,625 GSF**			**$14,065,400**	**100.00%**	**$156.94**

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT						
Asbestos abatement including air monitoring	1 ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT			**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT SAY			**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES						
Remove and replace ceilings	75,000 SF	$4.33	$324,750	$3.67	$275,250	$600,000
Other miscellaneous general trades work	1 LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES			**354,750**		**320,250**	**675,000**
TOTAL DIVISION 9 - FINISHES SAY			**$354,800**		**$320,300**	**$675,000**
DIVISION 21 - FIRE PROTECTION						
Wet sprinkler system	89,625 SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION			**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY			**$134,400**		**$179,300**	**$313,700**
DIVISION 23 - HVAC						
DEMOLITION						
HVAC Demolition	1 LS	$20,000.00	$20,000	$70,000.00	$70,000	$90,000
GEOTHERMAL PLANT WORK						
Ground coupled heat exchanger consisting of 163 vertical closed loop wells (400 ft. depth each well) including boring, thermal conductive grout, casing as required, underground well field piping to building, 1-1/4" diameter closed loop well piping, earthwork - to be installed in an existing parking lot, costs expressed per well	163 EA	2,500.00	407,500	3,500.00	570,500	978,000
Site underground geothermal vault, including earthwork, vault piping and valves, manhole access from grade	1 LS	35,000.00	35,000	11,360.00	11,360	46,360

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Replace Parking Lot Pavements (for geothermal well field installation in existing parking lot)						
- Remove asphalt paving and dispose	4,912 SY	2.78	13,655	4.29	21,072	34,728
- 12" stone base, 3" binder, and 1-1/2" asphalt topping	4,912 SY	27.00	132,624	9.55	46,910	179,534
- Pavement striping	1 LS	1,500.00	1,500	4,500.00	4,500	6,000
Remainder of site restoration for geothermal vault and for piping systems between well field and building, including allowances for both lawns and pavements	1,200 SY	12.00	14,400	13.00	15,600	30,000
Geothermal heating / cooling water-to-water heat pumps, to generate dual temperature (either heating hot water or chilled water) - for enthalpy energy recovery doas air handling units - estimated quantity at 30-ton nominal cooling capacity each	4 EA	50,000.00	200,000	5,680.00	22,720	222,720
Other geothermal plant equipment (e.g. refrigerant monitor, emergency ventilation exhaust fan, geothermal well field pumps and dual temperature loop pumps, pump trim, pump variable frequency drives, air separators, thermal expansion tanks, makeup water assemblies, chemical water treatment for closed systems, testing, adjusting and balancing)	1 LS	103,000.00	103,000	38,504.00	38,504	141,504
Geothermal plant prefabricated piped valve assemblies, mechanical room well field piping and dual temperature heating / cooling piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, geothermal plant testing, adjusting and balancing	1 LS	62,500.00	62,500	77,868.00	77,868	140,368
Geothermal plant direct digital controls	1 LS	37,500.00	37,500	37,500.00	37,500	75,000
Geothermal plant miscellaneous items	1 LS	12,000.00	12,000	8,500.00	8,500	20,500

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
HEATING PLANT WORK (GAS FIRED BOILER HEATING PLANT FOR PERIMETER HEATING AND TO SUPPLEMENT GEOTHERMAL SYSTEM)						
Heating plant equipment (e.g. gas fired condensing boilers, boiler pumps, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	126,000.00	126,000	41,180.00	41,180	167,180
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	30,000.00	30,000	29,160.00	29,160	59,160
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	22,700.00	22,700	35,908.00	35,908	58,608
Heating plant direct digital controls	1 LS	20,000.00	20,000	20,000.00	20,000	40,000
Heating plant miscellaneous items	1 LS	7,000.00	7,000	6,000.00	6,000	13,000
PERIMETER HEATING WORK						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
HVAC DISTRIBUTION WORK						
Enthalpy energy DOAS hvac air handling units	1 LS	250,000.00	250,000	17,040.00	17,040	267,040
Water source heat pumps including ducted units	205 EA	3,000.00	615,000	710.00	145,550	760,550
Prefabricated piped valve assemblies for water source heat pumps	410 EA	150.00	61,500	142.00	58,220	119,720
Heating hot water piping and chilled water piping to DOAS hvac air handling units	800 LF	28.60	22,880	39.62	31,696	54,576
Pipe insulation	800 LF	8.62	6,896	9.13	7,304	14,200
Building heat pump loop piping serving water source heat pumps						

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
- Building mains (each floor) and risers	4,560 LF	23.83	108,665	33.02	150,571	259,236
- Distribution from mains to equipment	4,100 LF	12.83	52,603	12.96	53,136	105,739
- Pipe insulation	8,660 LF	7.56	65,470	8.35	72,311	137,781
Condensate drain piping	5,225 LF	11.20	58,520	12.25	64,006	122,526
Pipe insulation	5,225 LF	1.83	9,562	6.48	33,858	43,420
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	67,000 LB	1.13	75,710	6.50	435,500	511,210
Duct insulation	1 LS	45,000.00	45,000	231,000.00	231,000	276,000
Air inlets and outlets	360 EA	75.00	27,000	65.00	23,400	50,400
Louvers, roof ventilators, fire dampers, etc.	1 LS	15,000.00	15,000	10,400.00	10,400	25,400
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	100,000.00	100,000	100,000
Direct digital controls	1 LS	450,000.00	450,000	450,000.00	450,000	900,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	20,000.00	20,000	115,000.00	115,000	135,000
TOTAL DIVISION 23 - HVAC			**3,401,085**		**3,352,912**	**6,753,996**
TOTAL DIVISION 23 - HVAC SAY			**$3,401,100**		**$3,352,900**	**$6,754,000**

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 26 - ELECTRICAL						
DISTRIBUTION						
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
LIGHTING						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999
EQUIPMENT CONNECTIONS						
Geothermal heating and cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	17,500.00	17,500	22,500.00	22,500	40,000
Electrical connections at DOAS HVAC air handling units including means of disconnect and circuiting back to source power panel	1 ALLOW	5,000.00	5,000	7,300.00	7,300	12,300
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
Heat pump connection and circuiting	205 EA	100.00	20,500	219.00	44,895	65,395

GEOTHERMAL DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
FIRE ALARM						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**662,131**		**376,483**	**1,038,614**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$662,100**		**$376,500**	**$1,038,600**

HYBRID GEO DOAS SUMMARY

SUMMARY		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL	BLDG $ / GSF
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.71%	$1.12
DIVISION 9 - FINISHES		$354,800	$320,300	$675,100	4.83%	$7.53
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.24%	$3.50
DIVISION 23 - HVAC		$3,452,100	$3,241,700	$6,693,800	47.86%	$74.69
DIVISION 26 - ELECTRICAL		$667,100	$382,300	$1,049,400	7.50%	$11.71
SUB-TOTAL		$4,643,400	$4,188,600	$8,832,000	63.14%	$98.54
GENERAL CONDITIONS	10.0%			$883,200	6.31%	$9.85
SUB-TOTAL				$9,715,200	69.46%	$108.40
OVERHEAD AND PROFIT	8.0%			$777,200	5.56%	$8.67
SUB-TOTAL				$10,492,400	75.01%	$117.07
PHASING (HYBRID GEO DOAS)	3.5%			$367,234	2.63%	$4.10
SUB-TOTAL				$10,859,600	77.64%	$121.17
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,303,200	9.32%	$14.54
SUB-TOTAL				$12,162,800	86.96%	$135.71
DESIGN CONTINGENCY	15.0%			$1,824,400	13.04%	$20.36
TOTAL - HYBRID GEO DOAS SUMMARY	**89,625 GSF**			**$13,987,200**	**100.00%**	**$156.06**

HYBRID GEO DOAS DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT						
Asbestos abatement including air monitoring	1 ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT			**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT SAY			**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES						
Remove and replace ceilings	75,000 SF	$4.33	$324,750	$3.67	$275,250	$600,000
Other miscellaneous general trades work	1 LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES			**354,750**		**320,250**	**675,000**
TOTAL DIVISION 9 - FINISHES SAY			**$354,800**		**$320,300**	**$675,000**
DIVISION 21 - FIRE PROTECTION						
Wet sprinkler system	89,625 SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION			**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY			**$134,400**		**$179,300**	**$313,700**
DIVISION 23 - HVAC						
DEMOLITION						
HVAC Demolition	1 LS	$19,000.00	$19,000	$68,500.00	$68,500	$87,500
HYBRID GEOTHERMAL PLANT WORK						
Ground coupled heat exchanger consisting of 109 vertical closed loop wells (400 ft. depth each well) including boring, thermal conductive grout, casing as required, underground well field piping, 1-1/4" diameter closed loop well piping, earthwork - to be installed in an existing parking lot - costs expressed per well (per engineer quantity of wells at 2/3 of full geothermal option)	109 EA	2,500.00	272,500	3,500.00	381,500	654,000
Site underground geothermal vault, including earthwork, vault piping and valves, manhole access from grade	1 LS	35,000.00	35,000	11,360.00	11,360	46,360

HYBRID GEO DOAS DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Replace Parking Lot Pavements (for geothermal well field installation in existing parking lot)						
- Remove asphalt paving and dispose	4,912 SY	2.78	13,655	4.29	21,072	34,728
- 12" stone base, 3" binder, and 1-1/2" asphalt topping	4,912 SY	27.00	132,624	9.55	46,910	179,534
- Pavement striping	1 LS	1,500.00	1,500	4,500.00	4,500	6,000
Remainder of site restoration for geothermal vault and for piping systems between well field and building, including allowances for both lawns and for asphalt pavements	1,200 SY	12.00	14,400	13.00	15,600	30,000
Geothermal heating / cooling water-to-water heat pumps, to generate dual temperature (either heating hot water or chilled water) - for enthalpy energy recovery doas air handling units - estimated quantity at 30-ton nominal cooling capacity each	4 EA	50,000.00	200,000	5,680.00	22,720	222,720
Other geothermal plant equipment (e.g. refrigerant monitor, emergency ventilation exhaust fan, geothermal well field pumps and dual temperature loop pumps, pump trim, pump variable frequency drives, air separators, thermal expansion tanks, makeup water assemblies, chemical water treatment for closed systems, testing, adjusting and balancing)	1 LS	100,000.00	100,000	37,000.00	37,000	137,000
Geothermal plant prefabricated piped valve assemblies, mechanical room well field piping and dual temperature heating / cooling piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, geothermal plant testing, adjusting and balancing	1 LS	62,500.00	62,500	78,000.00	78,000	140,500
Hybrid geothermal (doas) plant direct digital controls	1 LS	40,000.00	40,000	40,000.00	40,000	80,000
Hybrid geothermal plant (doas) miscellaneous items	1 LS	12,500.00	12,500	9,000.00	9,000	21,500
Additional work required to re-purpose and to incorporate the existing (2012 construction) 325-ton open cooling tower (MacArthur roof) for reduced capacity (approx. 100-ton) heat rejection - in conjunction with the reduced capacity 109-well (is approx. 2/3 of full capacity) geothermal welll field systems - in lieu of a full (163-well) geothermal well field capacity	1 LS	151,000.00	151,000	60,000.00	60,000	211,000
<u>HEATING PLANT WORK (GAS FIRED BOILER HEATING PLANT FOR PERIMETER HEATING AND TO SUPPLEMENT HYBRID GEOTHERMAL SYSTEM)</u>						

HYBRID GEO DOAS DETAIL

		MATERIAL		LABOR		
DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	TOTAL
Heating plant equipment (e.g. gas fired condensing boilers, boiler pumps, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	149,000.00	149,000	48,000.00	48,000	197,000
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	36,000.00	36,000	33,000.00	33,000	69,000
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	27,000.00	27,000	40,000.00	40,000	67,000
Heating plant direct digital controls	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Heating plant miscellaneous items	1 LS	7,200.00	7,200	6,400.00	6,400	13,600
<u>PERIMETER HEATING WORK</u>						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
<u>HVAC DISTRIBUTION WORK</u>						
Enthalpy energy DOAS hvac air handling units	1 LS	250,000.00	250,000	17,040.00	17,040	267,040
Water source heat pumps including ducted units	205 EA	3,000.00	615,000	710.00	145,550	760,550
Prefabricated piped valve assemblies for water source heat pumps	410 EA	150.00	61,500	142.00	58,220	119,720
Heating hot water piping and chilled water piping to DOAS hvac air handling units	800 LF	28.60	22,880	39.62	31,696	54,576
Pipe insulation	800 LF	8.62	6,896	9.13	7,304	14,200
Building heat pump loop piping serving water source heat pumps						
- Building mains (each floor) and risers	4,560 LF	23.83	108,665	33.02	150,571	259,236
- Distribution from mains to equipment	4,100 LF	12.83	52,603	12.96	53,136	105,739

HYBRID GEO DOAS DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
- Pipe insulation	8,660 LF	7.56	65,470	8.35	72,311	137,781
Condensate drain piping	5,225 LF	11.20	58,520	12.25	64,006	122,526
Pipe insulation	5,225 LF	1.83	9,562	6.48	33,858	43,420
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	67,000 LB	1.13	75,710	6.50	435,500	511,210
Duct insulation	1 LS	45,000.00	45,000	231,000.00	231,000	276,000
Air inlets and outlets	360 EA	75.00	27,000	65.00	23,400	50,400
Louvers, roof ventilators, fire dampers, etc.	1 LS	15,000.00	15,000	10,400.00	10,400	25,400
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	100,000.00	100,000	100,000
Direct digital controls	1 LS	450,000.00	450,000	450,000.00	450,000	900,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	20,000.00	20,000	115,000.00	115,000	135,000
TOTAL DIVISION 23 - HVAC			**3,452,085**		**3,241,692**	**6,693,776**
TOTAL DIVISION 23 - HVAC SAY			**$3,452,100**		**$3,241,700**	**$6,693,800**

DIVISION 26 - ELECTRICAL

<u>DISTRIBUTION</u>

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360

HYBRID GEO DOAS DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
<u>LIGHTING</u>						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999
<u>EQUIPMENT CONNECTIONS</u>						
Geothermal heating and cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	17,500.00	17,500	22,500.00	22,500	40,000
Electrical connections at DOAS HVAC air handling units including means of disconnect and circuiting back to source power panel	1 ALLOW	5,000.00	5,000	7,300.00	7,300	12,300
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
Electrical work required to accommodate cooling tower re-purposing including disconnection and reconnecting of existing equipment, pump connection and all associated conduit and circuiting	1 ALLOW	5,000.00	5,000	5,840.00	5,840	10,840
Heat pump connection and circuiting	205 EA	100.00	20,500	219.00	44,895	65,395
<u>FIRE ALARM</u>						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826

HYBRID GEO DOAS DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**667,131**		**382,323**	**1,049,454**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$667,100**		**$382,300**	**$1,049,500**

HYBRID GEO VAV SUMMARY

SUMMARY		TOTAL MATERIAL	TOTAL LABOR	TOTAL COST	% OF TOTAL	BLDG $ / GSF
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT		$35,000	$65,000	$100,000	0.67%	$1.12
DIVISION 9 - FINISHES		$354,800	$320,300	$675,100	4.50%	$7.53
DIVISION 21 - FIRE PROTECTION		$134,400	$179,300	$313,700	2.09%	$3.50
DIVISION 23 - HVAC		$3,595,100	$3,494,900	$7,090,000	47.23%	$79.11
DIVISION 26 - ELECTRICAL		$658,900	$374,800	$1,033,700	6.89%	$11.53
SUB-TOTAL		$4,778,200	$4,434,300	$9,212,500	61.36%	$102.79
GENERAL CONDITIONS	10.0%			$921,300	6.14%	$10.28
SUB-TOTAL				$10,133,800	67.50%	$113.07
OVERHEAD AND PROFIT	8.0%			$810,700	5.40%	$9.05
SUB-TOTAL				$10,944,500	72.90%	$122.11
PHASING (HYBRID GEO VAV)	6.5%			$711,393	4.74%	$7.94
SUB-TOTAL				$11,655,900	77.64%	$130.05
ESCALATION (TO MID-POINT AUG-2021)	12.0%			$1,398,700	9.32%	$15.61
SUB-TOTAL				$13,054,600	86.96%	$145.66
DESIGN CONTINGENCY	15.0%			$1,958,200	13.04%	$21.85
TOTAL - HYBRID GEO VAV SUMMARY	**89,625 GSF**			**$15,012,800**	**100.00%**	**$167.51**

HYBRID GEO VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT						
Asbestos abatement including air monitoring	1 ALLOW	$35,000.00	$35,000	$65,000.00	$65,000	$100,000
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT			**35,000**		**65,000**	**100,000**
TOTAL DIVISION 2 - HAZARDOUS MATERIALS ABATEMENT SAY			**$35,000**		**$65,000**	**$100,000**
DIVISION 9 - FINISHES						
Remove and replace ceilings	75,000 SF	$4.33	$324,750	$3.67	$275,250	$600,000
Other miscellaneous general trades work	1 LS	30,000.00	30,000	45,000.00	45,000	75,000
TOTAL DIVISION 9 - FINISHES			**354,750**		**320,250**	**675,000**
TOTAL DIVISION 9 - FINISHES SAY			**$354,800**		**$320,300**	**$675,100**
DIVISION 21 - FIRE PROTECTION						
Wet sprinkler system	89,625 SF	$1.50	$134,438	$2.00	$179,250	$313,688
TOTAL DIVISION 21 - FIRE PROTECTION			**134,438**		**179,250**	**313,688**
TOTAL DIVISION 21 - FIRE PROTECTION SAY			**$134,400**		**$179,300**	**$313,700**
DIVISION 23 - HVAC						
DEMOLITION						
HVAC Demolition	1 LS	$19,000.00	$19,000	$68,500.00	$68,500	$87,500
HYBRID GEOTHERMAL PLANT WORK						
Ground coupled heat exchanger consisting of 109 vertical closed loop wells (400 ft. depth each well) including boring, thermal conductive grout, casing as required, underground well field piping, 1-1/4" diameter closed loop well piping, earthwork - to be installed in an existing parking lot - costs expressed per well (per engineer quantity of wells at 2/3 of full geothermal option)	109 EA	2,500.00	272,500	3,500.00	381,500	654,000
Site underground geothermal vault, including earthwork, vault piping and valves, manhole access from grade	1 LS	35,000.00	35,000	11,360.00	11,360	46,360

HYBRID GEO VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Replace Parking Lot Pavements (for geothermal well field installation in existing parking lot)						
- Remove asphalt paving and dispose	4,912 SY	2.78	13,655	4.29	21,072	34,728
- 12" stone base, 3" binder, and 1-1/2" asphalt topping	4,912 SY	27.00	132,624	9.55	46,910	179,534
- Pavement striping	1 LS	1,500.00	1,500	4,500.00	4,500	6,000
Remainder of site restoration for geothermal vault and for piping systems between well field and building, including allowances for both lawns and for asphalt pavements	1,200 SY	12.00	14,400	13.00	15,600	30,000
Geothermal heating / cooling water-to-water heat pumps, to generate dual temperature (either heating hot water or chilled water) - for enthalpy energy recovery VAV air handling units - estimated quantity at 30-ton nominal cooling capacity each	11 EA	50,000.00	550,000	5,680.00	62,480	612,480
Other geothermal plant equipment (e.g. refrigerant monitor, emergency ventilation exhaust fan, geothermal well field pumps and dual temperature loop pumps, pump trim, pump variable frequency drives, air separators, thermal expansion tanks, makeup water assemblies, chemical water treatment for closed systems, testing, adjusting and balancing)	1 LS	100,000.00	100,000	37,000.00	37,000	137,000
Geothermal plant prefabricated piped valve assemblies, mechanical room well field piping and dual temperature heating / cooling piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, geothermal plant testing, adjusting and balancing	1 LS	78,000.00	78,000	91,500.00	91,500	169,500
Hybrid geothermal (vav) plant direct digital controls	1 LS	50,500.00	50,500	50,500.00	50,500	101,000
Hybrid geothermal plant (vav) miscellaneous items	1 LS	12,500.00	12,500	9,000.00	9,000	21,500
Additional work required to re-purpose and to incorporate the existing (2012 construction) 325-ton open cooling tower (MacArthur roof) for reduced capacity (approx. 100-ton) heat rejection - in conjunction with the reduced capacity 109-well (is approx. 2/3 of full capacity) geothermal well field systems - in lieu of a full (163-well) geothermal well field capacity	1 LS	193,000.00	193,000	99,000.00	99,000	292,000

HYBRID GEO VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
HEATING PLANT WORK (GAS FIRED BOILER HEATING PLANT FOR PERIMETER HEATING AND TO SUPPLEMENT HYBRID GEOTHERMAL SYSTEM)						
Heating plant equipment (e.g. gas fired condensing boiler, boiler pump, heating hot water pumps, pump trim, pump variable frequency drives, air separator, thermal expansion tank, makeup water assembly, chemical treatment for closed systems)	1 LS	104,000.00	104,000	35,000.00	35,000	139,000
Prefabricated double wall stainless steel combustion vents, other heating plant sheetmetal work including insulation	1 LS	29,000.00	29,000	31,000.00	31,000	60,000
Heating plant prefabricated piped valve assemblies, heating hot water piping, natural gas piping, expansion tank and chemical treatment piping, pipe insulation, equipment insulation, heating plant testing, adjusting and balancing	1 LS	23,000.00	23,000	39,000.00	39,000	62,000
Heating plant direct digital controls	1 LS	20,000.00	20,000	20,000.00	20,000	40,000
Heating plant miscellaneous items	1 LS	7,200.00	7,200	6,400.00	6,400	13,600
PERIMETER HEATING WORK						
Finned tube radiation	2,460 LF	40.00	98,400	43.00	105,780	204,180
Other perimeter heating equipment (e.g. cabinet unit heaters, suspended unit heaters, etc.)	1 LS	30,000.00	30,000	21,300.00	21,300	51,300
Insulated heating hot water piping serving perimeter heating equipment	1 LS	40,000.00	40,000	60,000.00	60,000	100,000
Testing, adjusting and balancing	1 LS	0.00	0	12,993.00	12,993	12,993
Direct digital controls - finned tube control zones	122 EA	500.00	61,000	500.00	61,000	122,000
Direct digital controls - other perimeter heating equipment	1 LS	22,500.00	22,500	22,500.00	22,500	45,000
Perimeter heating plant miscellaneous items	1 LS	5,000.00	5,000	8,520.00	8,520	13,520
HVAC DISTRIBUTION WORK						
Enthalpy energy recovery variable air volume hvac air handling units, both units installed on Wicks Hall roof per report narrative	1 LS	540,000.00	540,000	28,400.00	28,400	568,400
VAV supply air terminal units including hot water reheat coil (per hvac zoning)	205 EA	1,100.00	225,500	355.00	72,775	298,275
Prefabricated piped valve assemblies for VAV supply air terminal units	410 EA	150.00	61,500	142.00	58,220	119,720
Heating hot water piping and chilled water piping to VAV hvac air handling units	800 LF	38.28	30,624	46.01	36,808	67,432
Pipe insulation	800 LF	9.98	7,984	11.22	8,976	16,960

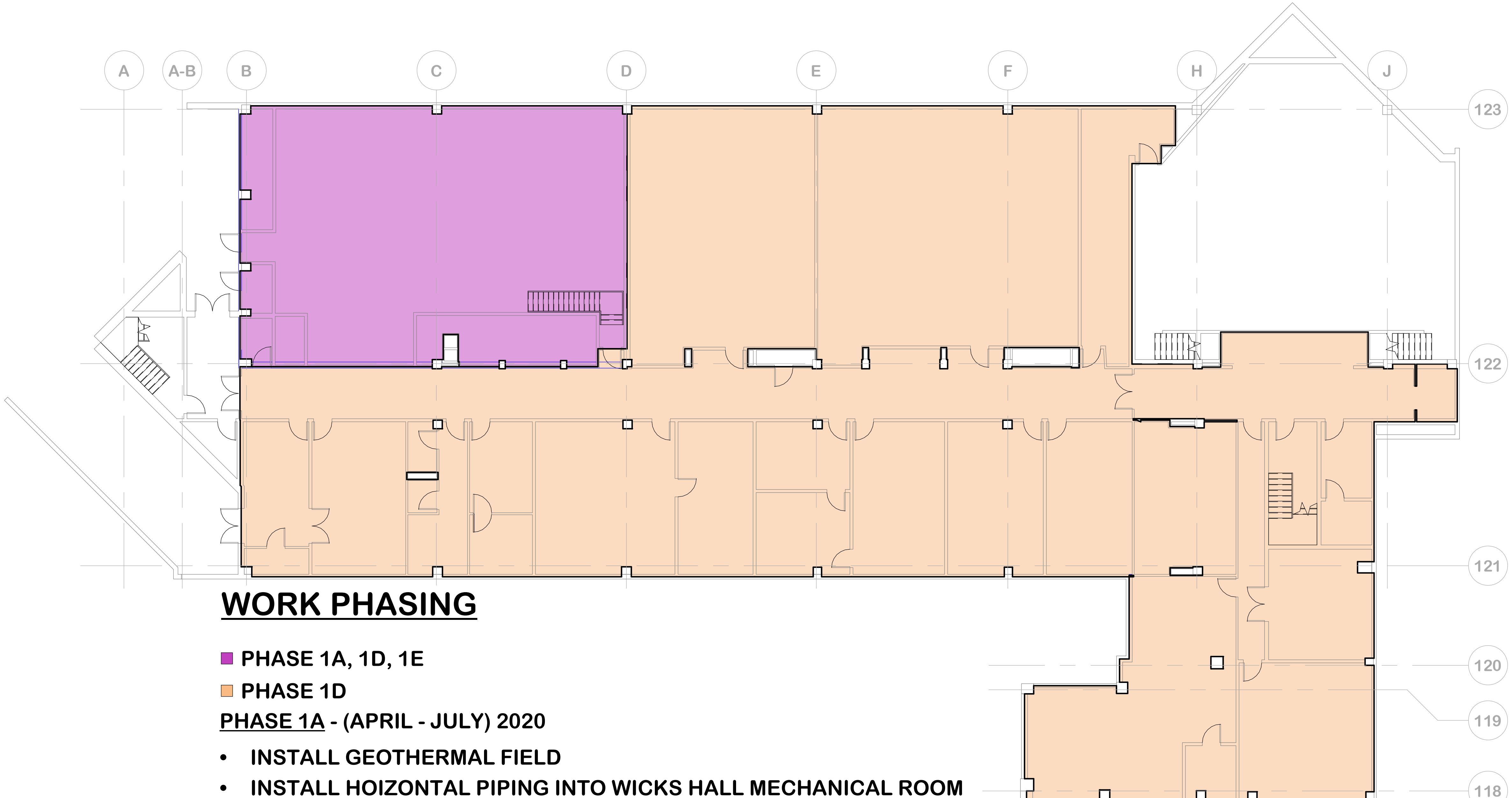
HYBRID GEO VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Heating hot water piping to 205 VAV supply air terminal unit reheat coils						
- Building mains (each floor) and risers	4,560 LF	18.15	82,764	30.18	137,621	220,385
- Distribution from mains to equipment	4,100 LF	11.20	45,920	12.25	50,225	96,145
- Pipe insulation	8,660 LF	7.11	61,573	8.12	70,319	131,892
Galvanized steel ductwork including duct fittings, duct hanger assemblies, shop fabrication, field installation, duct cleaning, duct sealing	113,000 LB	1.13	127,690	6.50	734,500	862,190
Duct insulation	1 LS	75,000.00	75,000	385,000.00	385,000	460,000
Air inlets and outlets	450 EA	75.00	33,750	65.00	29,250	63,000
Louvers, roof ventilators, fire dampers, etc.	1 LS	25,000.00	25,000	20,800.00	20,800	45,800
Testing, adjusting and balancing - air and water systems	1 LS	0.00	0	90,000.00	90,000	90,000
Direct digital controls	1 LS	330,000.00	330,000	330,000.00	330,000	660,000
Crane and rigging for equipment	1 LS	15,000.00	15,000	4,544.00	4,544	19,544
Miscellaneous items	1 LS	20,000.00	20,000	115,000.00	115,000	135,000
TOTAL DIVISION 23 - HVAC			**3,595,084**		**3,494,853**	**7,089,937**
TOTAL DIVISION 23 - HVAC SAY			**$3,595,100**		**$3,494,900**	**$7,090,000**
DIVISION 26 - ELECTRICAL						
DISTRIBUTION						
Disconnect and remove existing service entrance switchgear line-up - protect and maintain existing 5 kV feeders for reuse	1 LS	$2,500.00	$2,500	$5,256.00	$5,256	$7,756
Electrical service entrance switchgear line-up consisting of 5 kV transfer switch, interrupter switch, transition section, 1000 kVA transformer, secondary main circuit breaker, fire pump circuit breaker and secondary distribution section	1 ALLOW	185,000.00	185,000	23,360.00	23,360	208,360

HYBRID GEO VAV DETAIL

DESCRIPTION	QUANTITY	MATERIAL UNIT PRICE	MATERIAL TOTAL	LABOR UNIT PRICE	LABOR TOTAL	TOTAL
Remove and replace existing lighting and power branch circuit panelboards and associated feeders at each electrical closet throughout Wicks and MacArthur Halls (allowance per floor)						
- Wicks Hall (2 closets per floor)	3 EA	13,000.00	39,000	9,344.00	28,032	67,032
- MacArthur Hall (1 closet per floor)	8 EA	6,500.00	52,000	5,840.00	46,720	98,720
LIGHTING						
LED light fixture upgrades throughout Wicks and MacArthur Halls including fixture removal - controls, conduit and circuiting to be reused						
- Wicks Hall	47,886 SF	3.30	158,024	1.30	62,252	220,276
- MacArthur Hall	41,739 SF	3.30	137,739	1.30	54,261	191,999
EQUIPMENT CONNECTIONS						
Geothermal heating and cooling plant equipment connections including means of disconnect and circuiting back to source power panel	1 ALLOW	17,500.00	17,500	22,500.00	22,500	40,000
Electrical connections at DOAS HVAC air handling units including means of disconnect and circuiting back to source power panel	1 ALLOW	10,000.00	10,000	13,140.00	13,140	23,140
Heating equipment (unit heaters, cabinet unit heaters) connections throughout buildings including means of disconnect and circuiting back to source power panel	1 ALLOW	7,500.00	7,500	11,250.00	11,250	18,750
VAV air terminal unit connection and circuiting	205 EA	60.00	12,300	182.50	37,413	49,713
FIRE ALARM						
Temporarily remove ceiling mounted fire alarm devices and reinstall in new ceiling including pre-testing, final testing and programming						
- Wicks Hall	47,886 SF	0.35	16,760	0.70	33,520	50,280
- MacArthur Hall	41,739 SF	0.35	14,609	0.70	29,217	43,826
MISCELLANEOUS						
Temporarily remove miscellaneous ceiling mounted devices and reinstall in new ceiling - provide new devices as necessary	1 ALLOW	5,000.00	5,000	5,000.00	5,000	10,000
Cutting, patching and firestopping	1 LS	1,000.00	1,000	2,920.00	2,920	3,920
TOTAL DIVISION 26 - ELECTRICAL			**658,931**		**374,841**	**1,033,772**
TOTAL DIVISION 26 - ELECTRICAL SAY			**$658,900**		**$374,800**	**$1,033,700**

Section 11 – Proposed Phasing Plans
(System 5 – Hybrid Geothermal Option Only)



WORK PHASING

- PHASE 1A, 1D, 1E
- PHASE 1D

PHASE 1A - (APRIL - JULY) 2020

- INSTALL GEOTHERMAL FIELD
- INSTALL HOIZONTAL PIPING INTO WICKS HALL MECHANICAL ROOM

PHASE 1D - (MAY - AUGUST) 2022

- RENOVATE GROUND FLOOR OF WICKS HALL
- DEMOLISH MECHANICAL ROOM IN WICKS HALL
- INSTALL NEW DOAS AIR HANDLING UNIT (AHU) AND WATER TO WATER HPS IN WICKS HALL

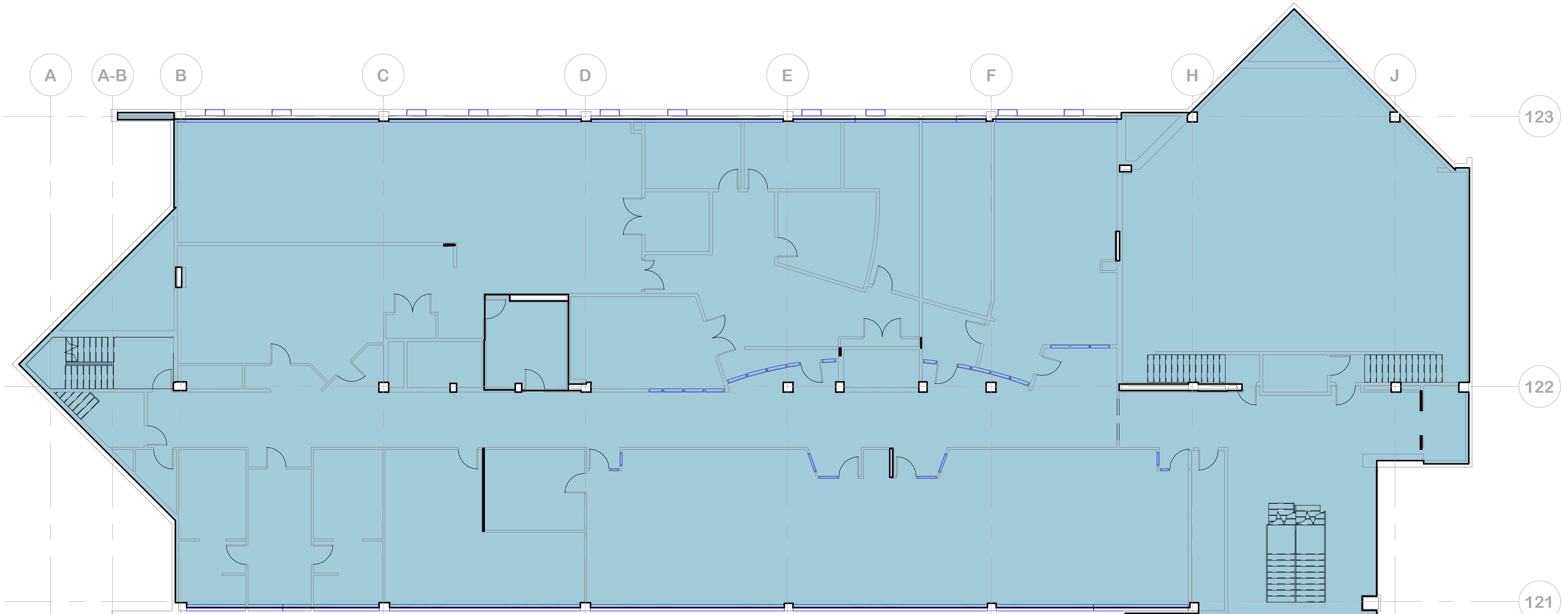
PHASE 1E - (SEPTEMBER - DECEMBER) 2022

- COMPLETE MECHANICAL ROOM WORK

1 SK-2 WICKS MACAUTHUR GROUND FLOOR PLAN
NO SCALE

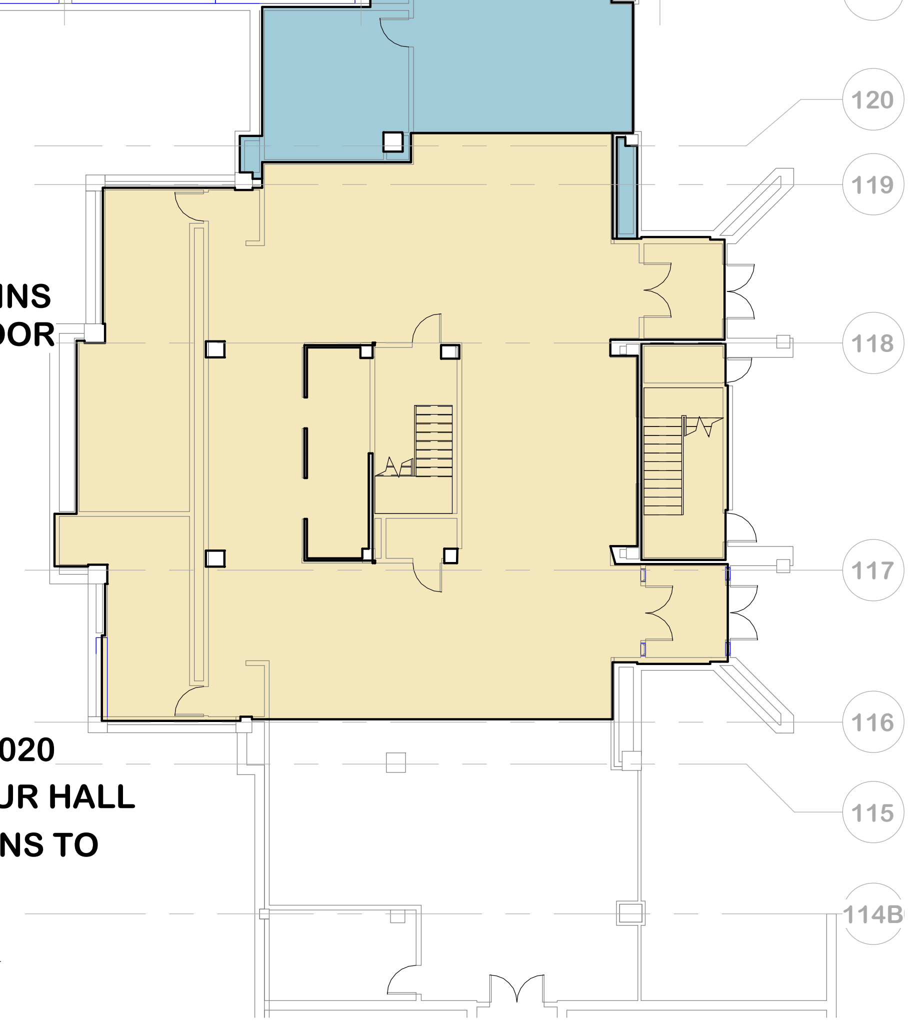
Pathfinder Engineers & Architects
585-325-6004 pathfinder-ea.com

PROJECT	SUNY CANTON MECHANICAL/ ELECTRICAL CONDITIONS STUDY WICKS MACAUTHUR HALLS CANTON, NY 13617
TITLE OF DRAWING	WICKS MACAUTHUR HALL PHASE 1A, PHASE 1D, & PHASE 1E
DATE	08/17/2018
SCALE	1" = 20'-0"
PROJECT NO.	051802



WORK PHASING

- PHASE 1B, 1C
- PHASE 2A



PHASE 1B - (MAY - AUGUST) 2020

- CAP EXISTING CHILLED WATER LINES THAT SERVE WICKS HALL (MACAUTHUR HALL CHILLED WATER STAYS ACTIVE)
- CAP STEAM LINES THAT SERVE MACAUTHUR HALL & REMOVE STEAM COILS IN PENTHOUSE (WICKS HALL STEAM STAYS ACTIVE)
- INSTALL SATELLITE BOILER PLANT IN MACAUTHUR STORAGE ROOM
- INSTALL HEATING WATER PUMPS AND HOT WATER PIPING TO NEW DUCT MOUNTED HEATING COILS IN EXISTING MACAUTHUR AHU IN PENTHOUSE
- INSTALL NEW GEOTHERMAL PIPE MAINS AND RUNOUT PIPING IN FIRST FLOOR CEILING SPACE (SERVES 2ND FLOOR UNITS) OF WICKS HALL
- REMOVE EXISTING CONSOLE DUAL DUCT BOXES ON 2ND FLOOR OF WICKS HALL
- INSTALL NEW GSHP CONSOLE UNITS ON 2ND FLOOR OF WICKS HALL
- INSTALL NEW GEOTHERMAL MAINS TO MACAUTHUR HALL FOR FUTURE PHASE 2 TIE-IN

PHASE 1C - (MAY - AUGUST) 2021

- INSTALL NEW GEOTHERMAL PIPE MAINS AND RUNOUT PIPING IN GROUND FLOOR CEILING SPACE (SERVES 1ST FLOOR UNITS) OF WICKS HALL
- REMOVE EXISTING CONSOLE DUAL DUCT BOXES ON 1ST FLOOR OF WICKS HALL
- INSTALL NEW GSHP CONSOLE UNITS ON 1ST FLOOR OF WICKS HALL

PHASE 2A - (SEPTEMBER - DECEMBER) 2020

- RENOVATE 1ST FLOOR OF MACAUTHUR HALL
- EXTEND NEW GEOTHERMAL PIPE MAINS TO MACAUTHUR HALL PENTHOUSE

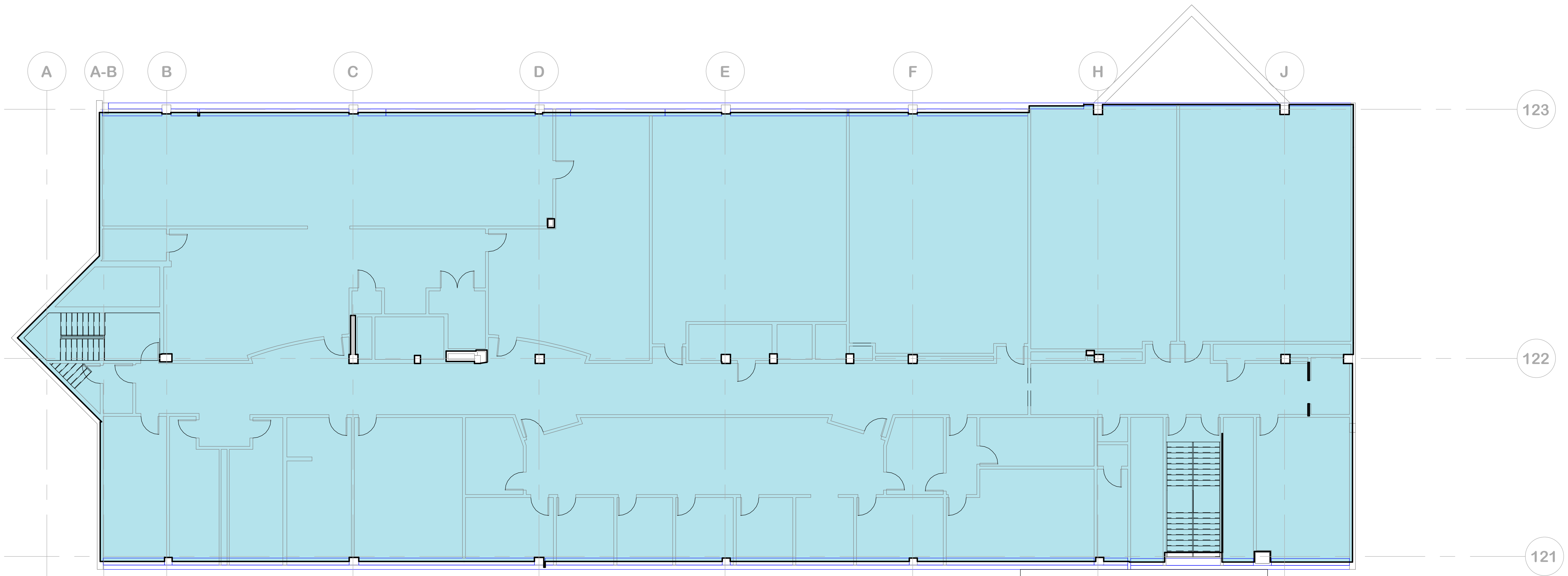
1 SK-3 WICKS MACAUTHUR HALL FIRST FLOOR PLAN
NO SCALE

DATE 08/17/2018
SCALE NTS
PROJECT NO. 051802

PROJECT
SUNY CANTON MECHANICAL/ ELECTRICAL CONDITIONS STUDY WICKS MACAUTHUR HALLS
CANTON, NY 13617

TITLE OF DRAWING
WICKS MACAUTHUR HALL PHASE 1B, PHASE 1C & PHASE 2A

Pathfinder
Engineers & Architects
585-325-6004 pathfinder-ea.com



WORK PHASING

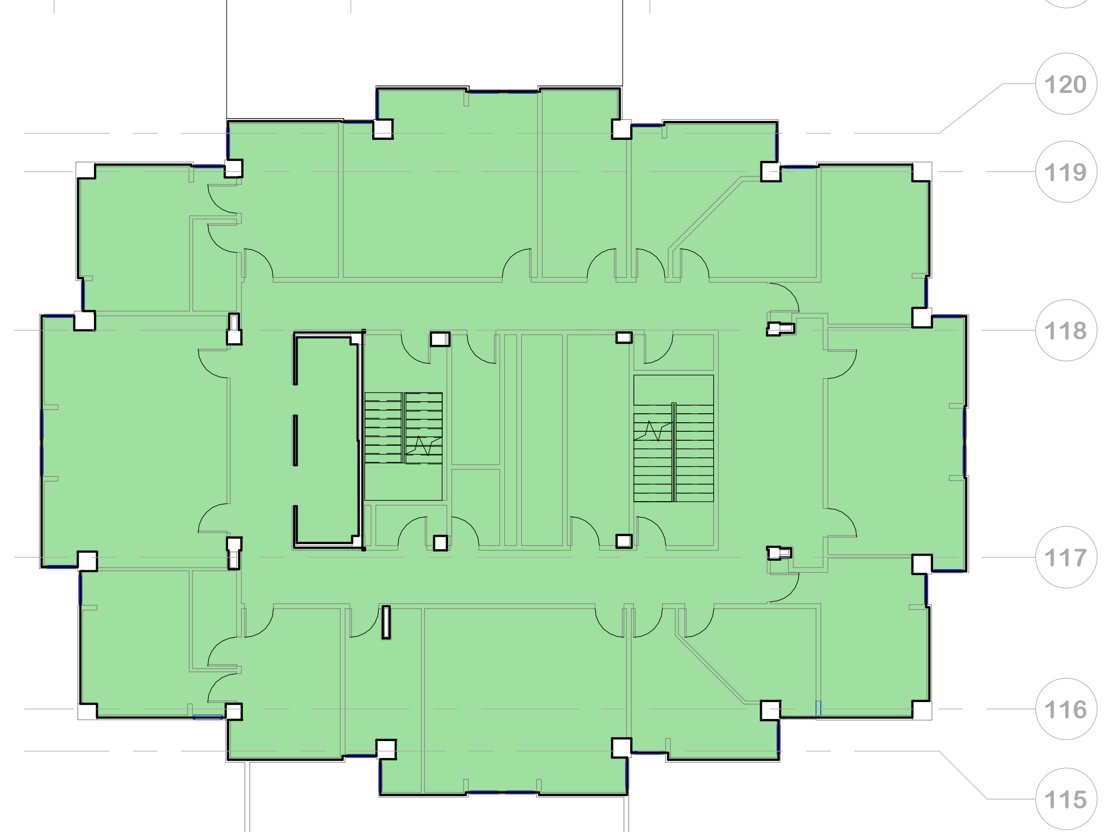
- PHASE 1B
- PHASE 2B

PHASE 1B

- INSTALL NEW GEOTHERMAL PIPE MAINS AND RUNOUT PIPING IN FIRST FLOOR CEILING SPACE (SERVES 2ND FLOOR UNITS) OF WICKS HALL
- REMOVE EXISTING CONSOLE DUAL DUCT BOXES ON 2ND FLOOR OF WICKS HALL
- INSTALL NEW GSHP CONSOLE UNITS ON 2ND FLOOR OF WICKS HALL

PHASE 2B

- RENOVATE MACAUTHUR HALL 2ND FLOOR

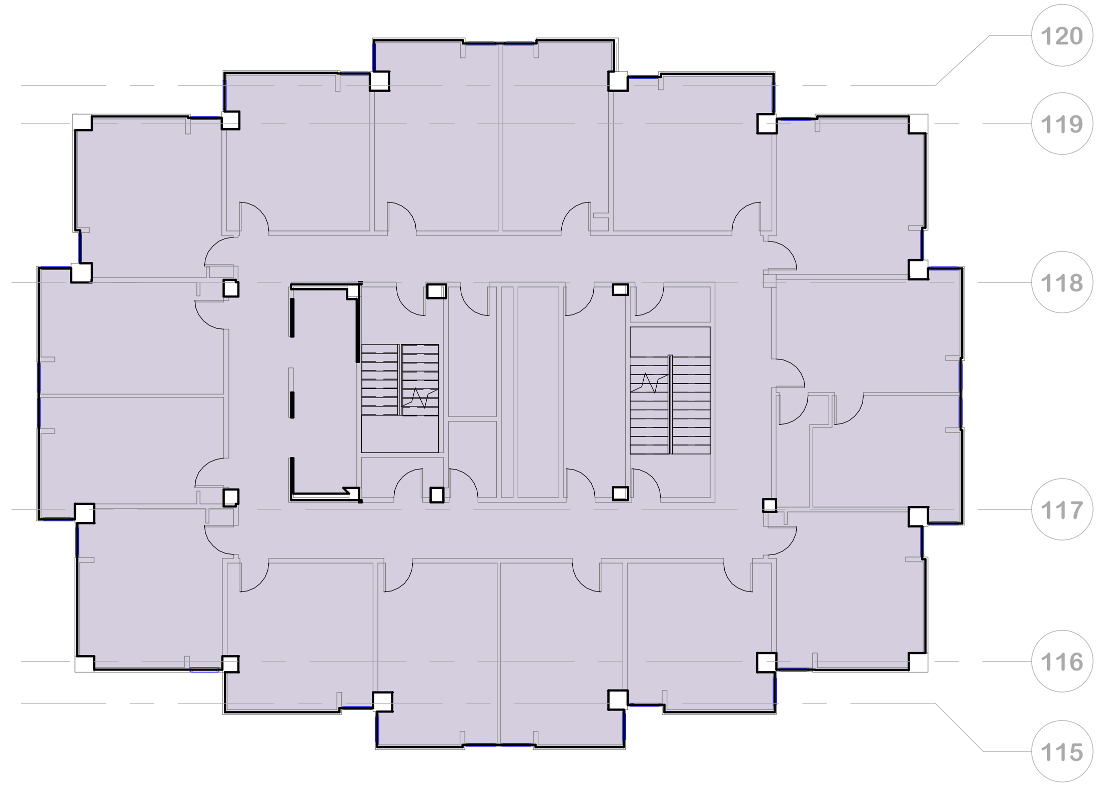


1 SK-4 WICKS MACAUTHUR HALL SECOND FLOOR PLAN
NO SCALE

DATE 08/17/2018
SCALE NTS
PROJECT NO. 051802

PROJECT CANTON, NY 13617
TITLE OF DRAWING WICKS MACAUTHUR HALL PHASE 1B & PHASE 2B

Pathfinder Engineers & Architects
585-325-6004 pathfinder-ea.com



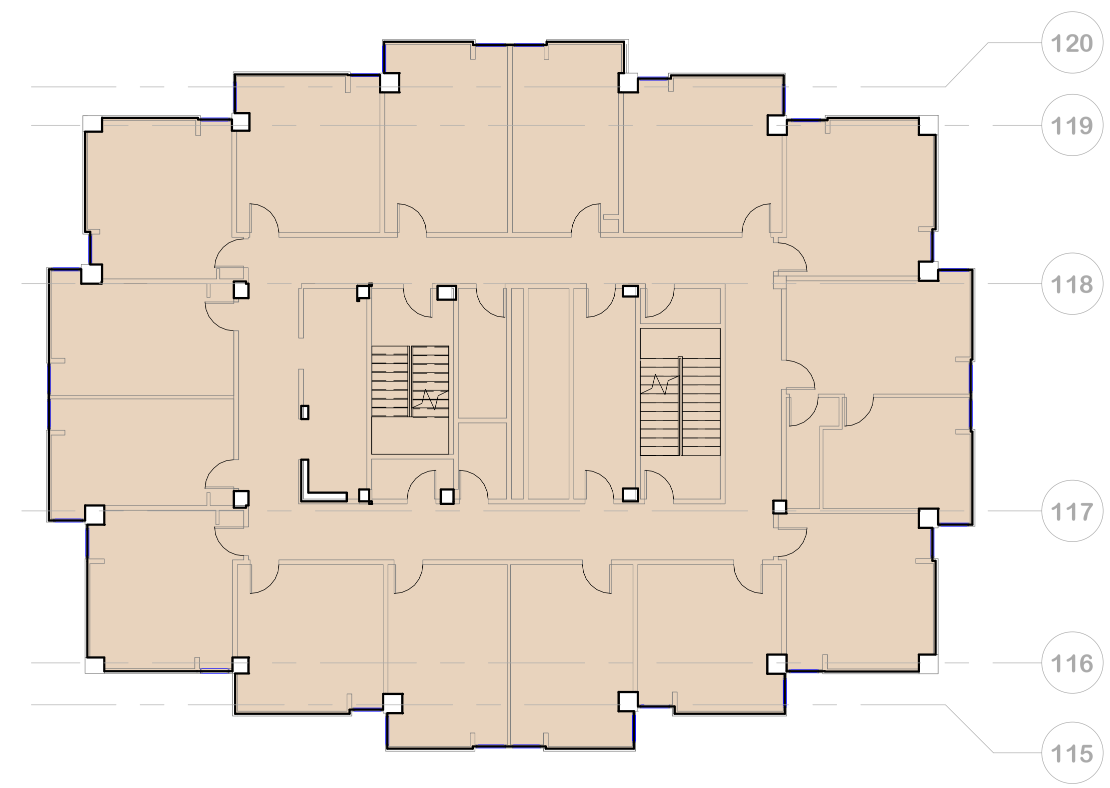
WORK PHASING

■ PHASE 2C

PHASE 2C

- **RENOVATE 3RD FLOOR OF MACAUTHUR HALL**

1 SK-5 MACAUTHUR HALL THIRD FLOOR PLAN
NO SCALE



WORK PHASING

■ PHASE 2D

PHASE 2D

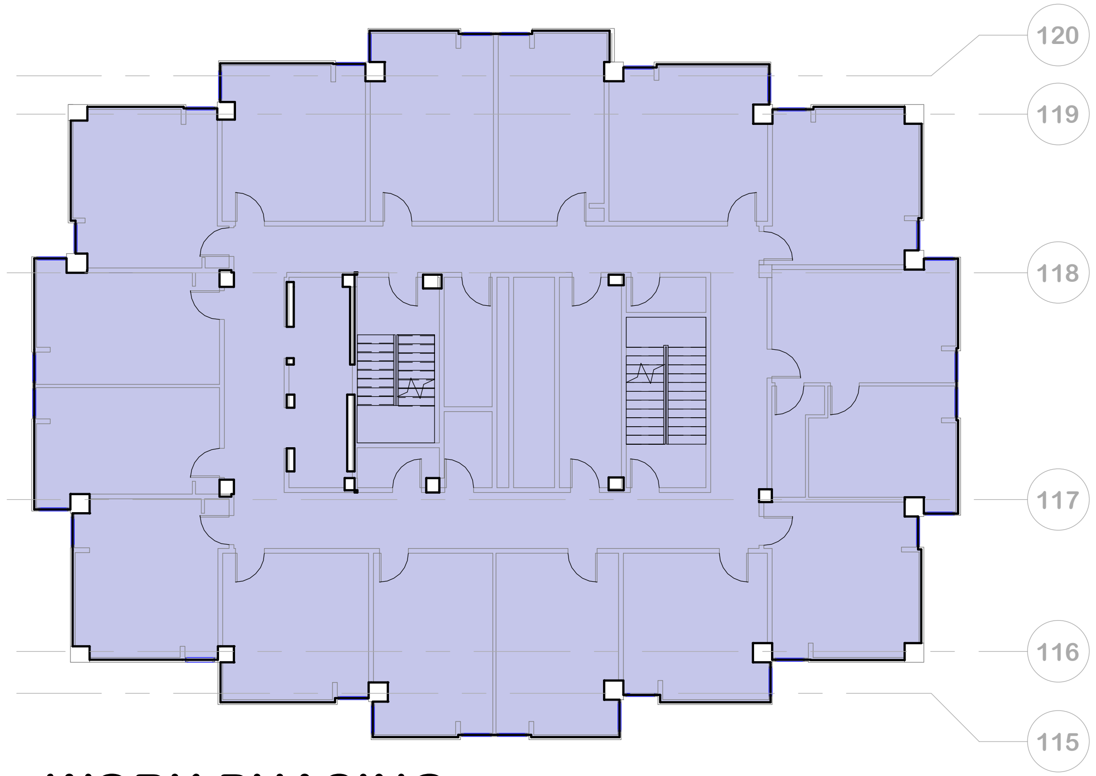
- **RENOVATE 4TH FLOOR OF MACAUTHUR HALL**

2 SK-5 MACAUTHUR HALL FOURTH FLOOR PLAN
NO SCALE

Pathfinder Engineers & Architects
585-325-6004 pathfinder-ea.com

PROJECT
CANTON, NY 13617
TITLE OF DRAWING
MACAUTHUR HALL PHASE 2C & PHASE 2D

DATE 08/17/2018
SCALE NTS
PROJECT NO. 051802



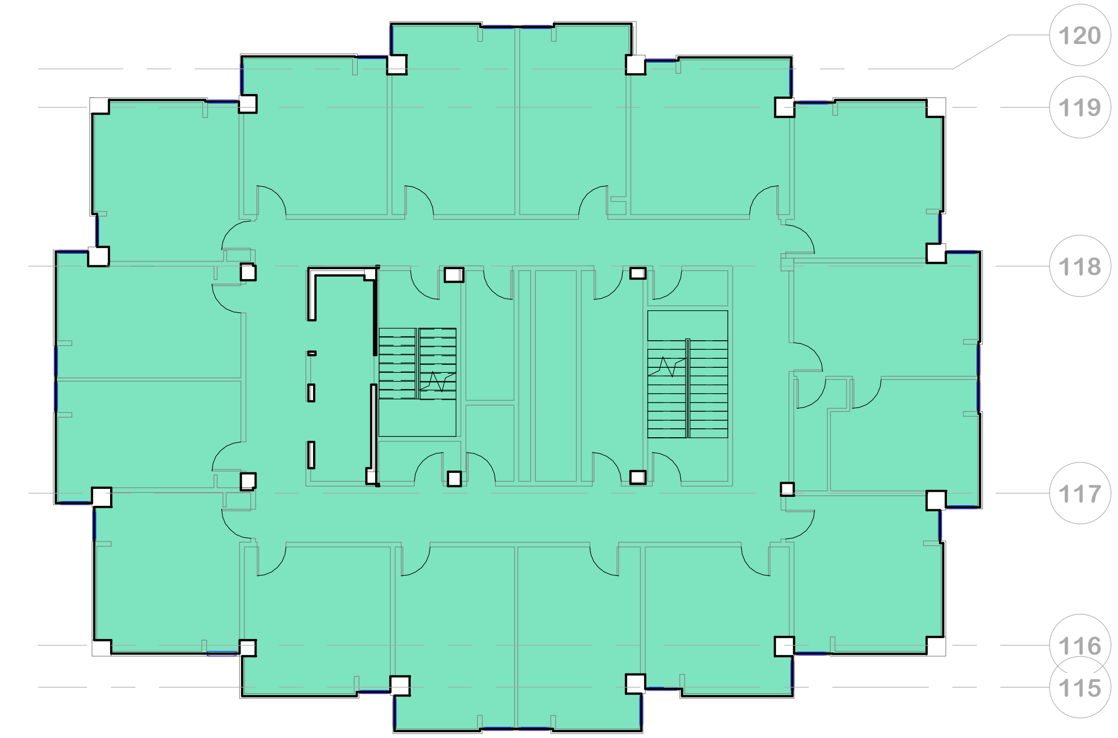
WORK PHASING

■ **PHASE 2E**

PHASE 2E

- **RENOVATE 5TH FLOOR OF MACAUTHUR HALL**

1 / SK-6 MACAUTHUR HALL FIFTH FLOOR PLAN
NO SCALE



WORK PHASING

■ **PHASE 2F**

PHASE 2F

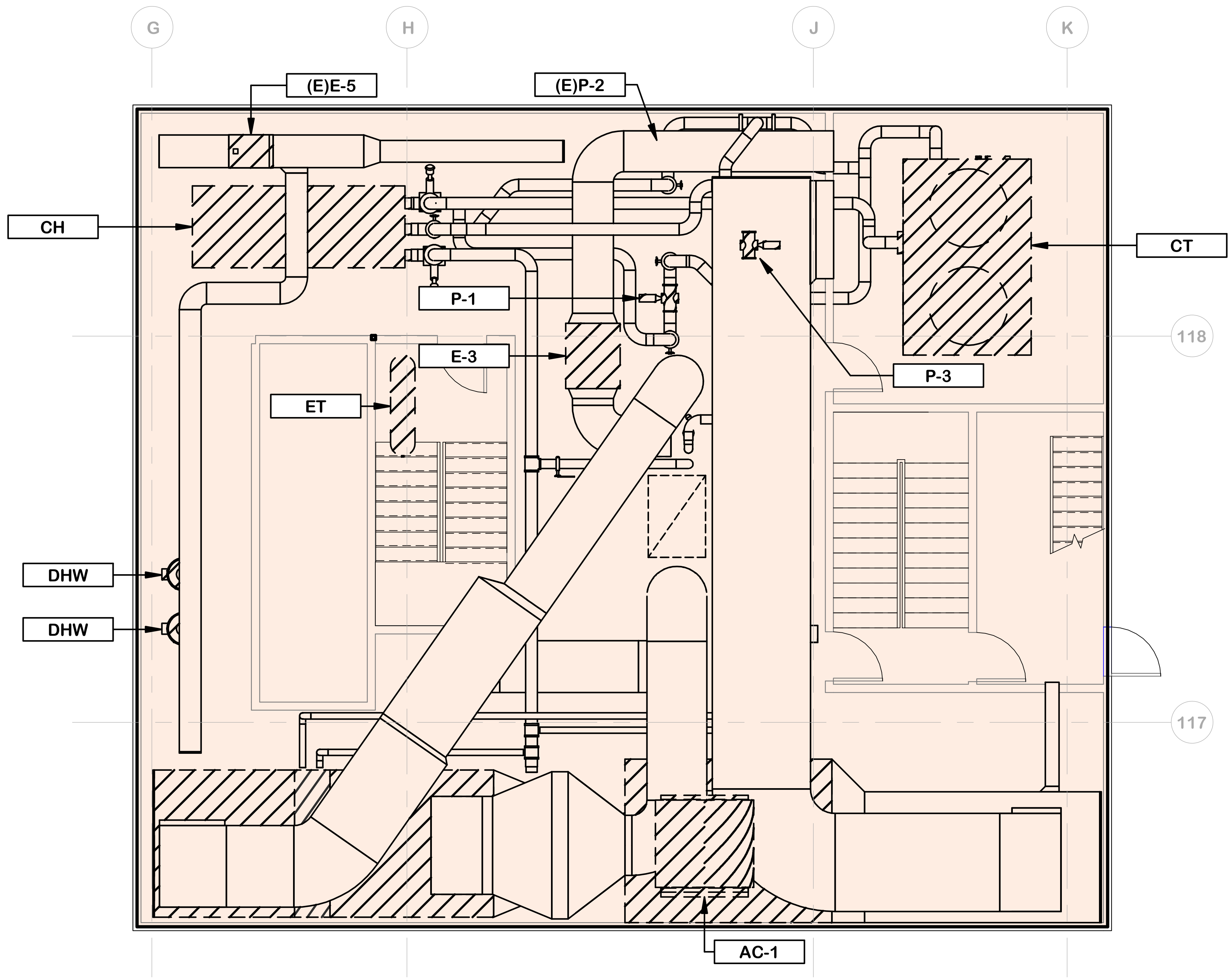
- **RENOVATE 6TH FLOOR OF MACAUTHUR HALL**

2 / SK-6 MACAUTHUR HALL SIXTH FLOOR PLAN
NO SCALE

DATE 08/17/2018
SCALE NTS
PROJECT NO. 051802

PROJECT
CANTON, NY 13617
TITLE OF DRAWING
MACAUTHUR HALL PHASE 2E & PHASE 2F

Pathfinder
Engineers & Architects
585-325-6004 pathfinder-ea.com



1 SK-7 MACAUTHUR HALL PENTHOUSE PLAN PLAN
NO SCALE

WORK PHASING

PHASE 1B, 2G

PHASE 1B - (MAY - AUGUST) 2020

- CAP EXISTING CHILLED WATER LINES THAT SERVE WICKS HALL (MACAUTHUR HALL CHILLED WATER STAYS ACTIVE)
- CAP STEAM LINES THAT SERVE MACAUTHUR HALL & REMOVE STEAM COILS IN PENTHOUSE (WICKS HALL STEAM STAYS ACTIVE)
- INSTALL SATELLITE BOILER PLANT IN MACAUTHUR STORAGE ROOM
- INSTALL HEATING WATER PUMPS AND HOT WATER PIPING TO NEW DUCT MOUNTED HEATING COILS IN EXISTING MACAUTHUR AHU IN PENTHOUSE
- INSTALL NEW GEOTHERMAL MAINS TO MACAUTHUR HALL FOR FUTURE PHASE 2 TIE-IN

PHASE 2G - (SEPTEMBER - DECEMBER) 2022

- DEMOLISH MACAUTHUR HALL PENTHOUSE
- INSTALL NEW DOAS AIR HANDLING UNIT (AHU)

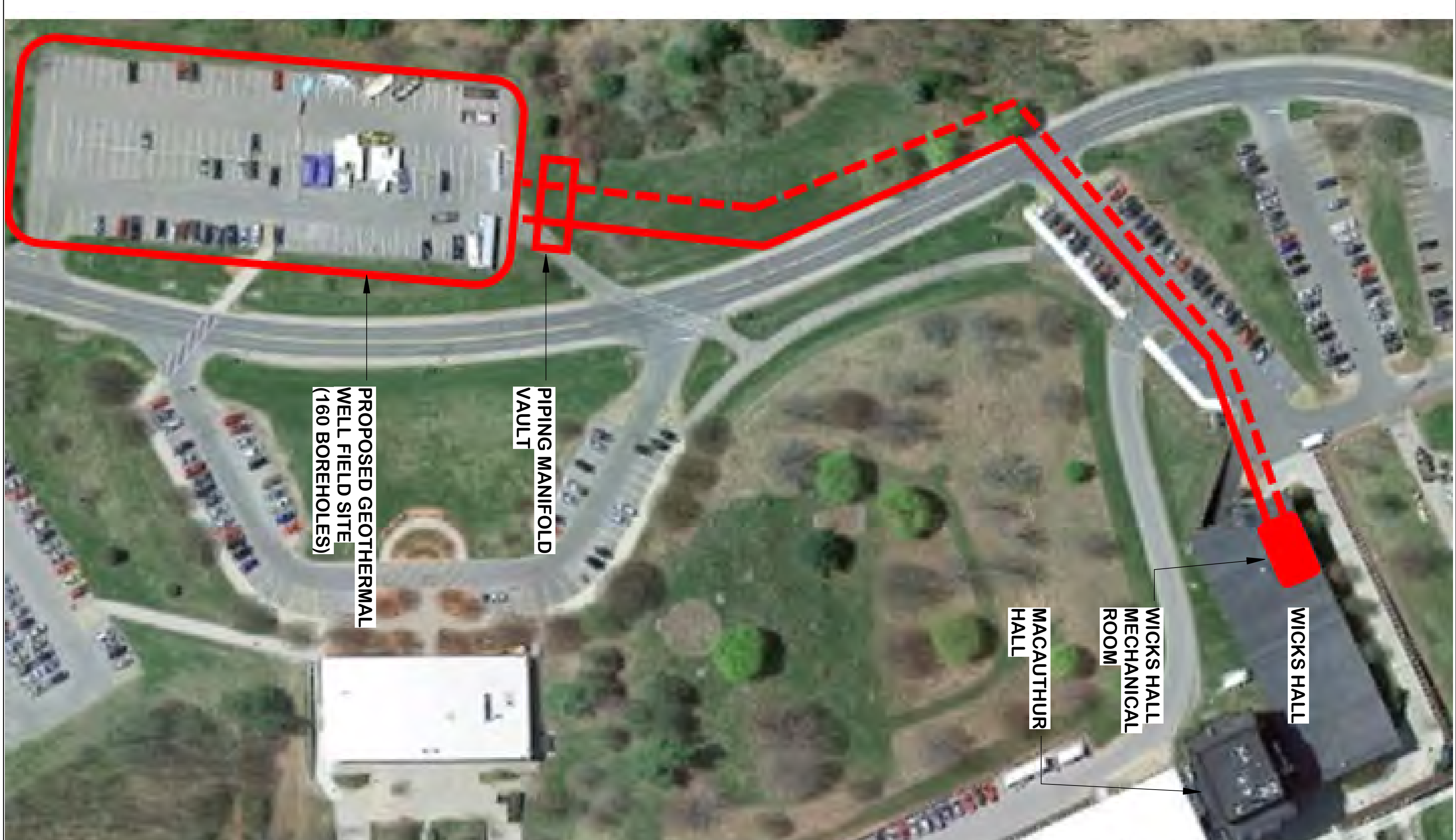
DATE	08/17/2018
SCALE	1/8" = 1'-0"
PROJECT NO.	051802

PROJECT
SUNY CANTON MECHANICAL/ ELECTRICAL CONDITIONS STUDY WICKS MACAUTHUR HALLS
CANTON, NY 13617

TITLE OF DRAWING
MACAUTHUR HALL PENTHOUSE PHASE 1B & PHASE 2G

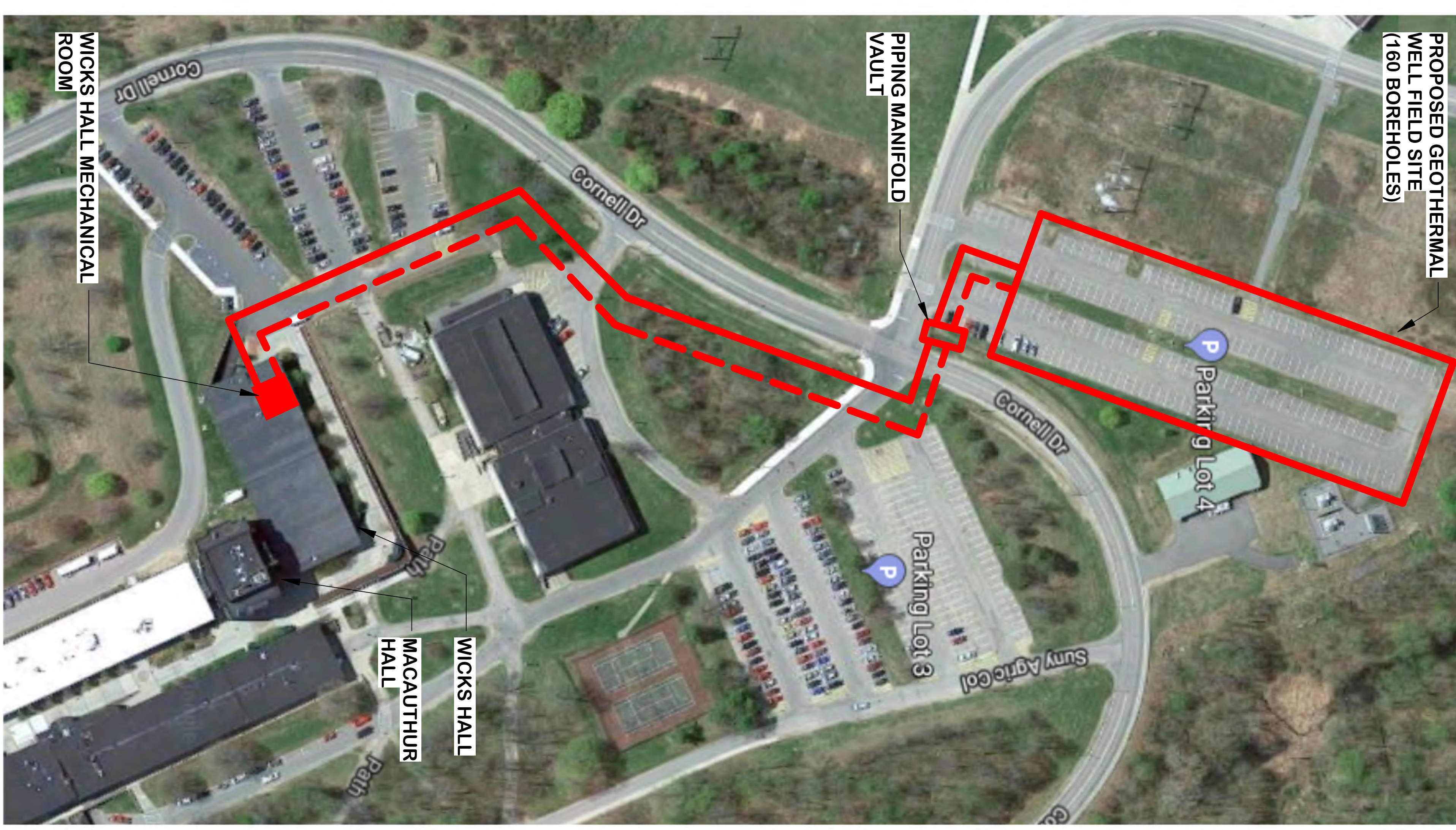
Pathfinder
Engineers & Architects
585-325-6004 pathfinder-ea.com

Section 12 – Geothermal Borefield Location Options



Pathfinder
Engineers & Architects
585-325-6004 pathfinder-ea.com

PROJECT SUNY CANTON MECHANICAL/ ELECTRICAL CONDITIONS STUDY WICKS MACAUTHUR HALLS CANTON, NY 13617	DATE 08/17/2018
	SCALE NTS
TITLE OF DRAWING PROPOSED GEOTHERMAL WELL SITE OPTION 1	PROJECT NO. 051802



Pathfinder Engineers & Architects
585-325-6004 pathfinder-ea.com

PROJECT
SUNY CANTON MECHANICAL/ ELECTRICAL CONDITIONS STUDY WICKS MACAUTHUR HALLS
CANTON, NY 13617

TITLE OF DRAWING
PROPOSED GEOTHERMAL WELL SITE OPTION 2

DATE
08/17/2018

SCALE
NTS

PROJECT NO.
051802