UNIVERSITY OF WYOMING

The University of Wyoming

UTILITY MASTERPLAN

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GLHN Architects & Engineers, Inc. Job#18085.00

GLHN
ARCHITECTS & ENGINEERS, INC

COFFEY
ENGINEERING & SURVEYING

University of Wyoming Utility Masterplan

Executive Summary

The University of Wyoming contracted with Sasaki in early 2019 to assemble a long-term Campus Masterplan. In turn, Sasaki contracted with GLHN Architects & Engineers and Coffey Engineering and Surveying to generate a campus Utility Master Plan (UMP) to parallel the campus planning efforts. An overall assessment of the existing campus utility systems was conducted including Utility Tunnels, Potable and Fire Protection Water, Steam/Condensate, Chilled Water, Heating Water, Energy Management and Control System, Compressed Air, Primary Power, Emergency Power, Exterior Lighting, Fire Alarm Network, Data, Irrigation Water, Sanitary Sewer, Storm Water, and Natural Gas. An initial assessment included onsite field investigations, interviews with UW Operations staff, and review of campus utility metered data and as-build documentation. The Tunnel Assessment report dated April 2019, generated by GLHN Architects & Engineers should be utilized in conjunction with this UMP. The Tunnel Assessment Report details the condition of the campus tunnel system, identifies characteristics of the utilities within, and provides common nomenclature of systems utilized within this report. After the utility condition and data was gathered, computer models were generated to identify the current and long-term loads of the various utilities. This UMP provides a road map for the next 20 to 30 years that if followed, will help to assure the uninterrupted provision of utilities to all students, staff, and campus visitors. A summary table of the estimated utility infrastructure costs is included below.

Estimated UMP Capital Construction Costs	
Utility	Capital Cost in 2019 Dollars
Hot Water Distribution Improvements	$27,300,000
Chilled Water Distribution Improvements	$4,300,000
Building Mechanical Rooms Steam Conversion	$7,300,000
Hot Water Production Expansion	$24,200,000
Natural Gas Distribution Improvements	$2,200,000
Domestic/Fire Water Distribution	$3,100,000
Irrigation Water Production/Distribution	$1,400,000
Sanitary Sewer System Improvements	$1,100,000
Storm Sewer System Improvements	$3,200,000
Electrical Power	$29,900,000
Communications/Data Improvements	$1,700,000
Roadway/Areaway Lighting Improvements	$2,200,000
Tunnel Improvements	$5,700,000
Central Energy Plant Improvements	$9,600,000
Total 20-30 Year Recommended Infrastructure Improvements	**$123,200,000**

The Breakdown of project costs is included as **Appendix 4.0**.

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Introduction and Methodology

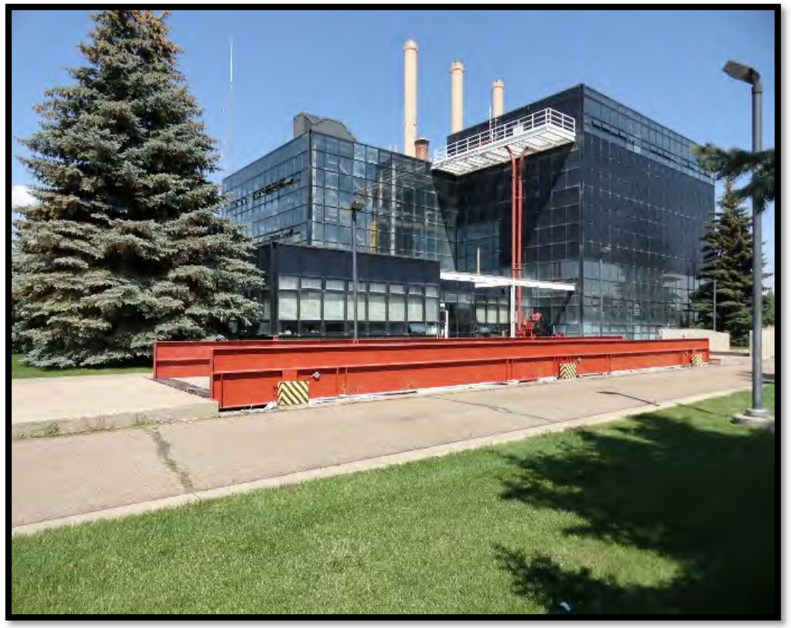
The University of Wyoming was founded in 1886 with its first building (Old Main) holding classes in 1887. For the next 30 or so years the need for a centralized heating plant was realized as buildings were constructed and brought online. These buildings included Geology, Merica Hall, Health Sciences, and Hoyt Hall, along with others that have since been demolished. At that point, around 1920, a Powerhouse was constructed in the present area of the Energy Innovation Center and Engineering which supplied steam to the original campus. As time progressed, more Buildings were constructed, and the heating production and distribution system grew. In 1981, the present-day Central Energy Plant (CEP) was constructed along with a robust steam and chilled water distribution system. Continued campus growth through present day has pushed the CEP to its production and distribution limits creating a need for a new West Campus Plant (currently under construction and expected complete in 2021). This growth has led to a total main campus building count of 87 with a conditioned area of over 6 million square feet. The campus is interconnected into the City of Laramie's domestic water, sanitary sewer, and stormwater systems for supply of these utilities. Campus operations rely on Black Hills Energy and Rocky Mountain Power for natural gas and electricity utility, respectively.

The University has contracted with Sasaki to develop a 20-year Campus Masterplan. To parallel these master planning efforts, Sasaki contracted with GLHN Architects & Engineers as well as Coffey Engineering and Surveying to identify current utility system limitations as well as to develop a parallel Utility Masterplan (UMP) that will take the University's utility infrastructure into the future to meet the needs of a growing campus. The Utilities investigated within this UMP include Utility Tunnels, Potable and Fire Protection Water, Steam/Condensate, Chilled Water, Heating Water, Energy Management and Control System, Compressed Air, Primary Power, Emergency Power, Exterior Lighting, Fire Alarm Network, Data, Irrigation Water, Sanitary Sewer, Storm Water, and Natural Gas. This UMP process includes three distinct Phases of work. The first phase is called the Problem Definition Phase and is comprised of gathering existing utility conditions, capacities, and deficiencies. Phase II is the Strategy Development Phase where the expected growth of campus is realized and the possible utility infrastructure to meet these needs is presented. Hydronic distribution simulations, life cycle costing, and plausible designs are considered. The final Phase of the process is the development of a final UMP including a detailed strategy, costing, operational and scheduling considerations, sequencing, and capital cost breakdown. It is with this three-step process that the University of Wyoming will have the proper tools to plan and make ready the campus infrastructure to accommodate future utility needs.

Central Utility Plants

Overview

The University of Wyoming owns and operates a Central Energy Plant (CEP) located on the north-east corner of campus between Harney Street and Gibbon Street, directly west of 19th Street. It produces and distributes steam and/or chilled water to the majority of main campus for HVAC heating and cooling needs. Here steam is produced at 125psig saturated pressure and reduced at various points throughout the distribution system. The majority of buildings on campus are equipped with steam-to-hot-water converter systems for heating and domestic water requirements. Some of the older buildings on campus utilize direct steam throughout the building. Chilled water is produced at the CEP and distributed via a direct primary, variable flow pumping system. There are also numerous buildings on campus that are evaporatively cooled or do not include any cooling capabilities.



A new West Campus Satellite Plant and accompanying hot water distribution system is currently in construction. The plant will be located on the north-east corner of the lot, bound by Lewis Street to the South, Bradley Street to the north, 12th Street to the west, and 13th Street to the East. It is scheduled to be operational the spring of 2021. This plant is designed to incorporate 70MMbtu worth of high efficiency natural gas fired condensing hot water boilers and associated direct primary, variable flow pumps and appurtenances. This plant is also being designed to incorporate 11,000 ton-hours of chilled water thermal energy storage. The chilled water components include 1.8 million gallons of chilled water storage, (3) chilled water distribution pumps, as well as interconnection into the existing campus chilled water distribution network of piping.

CEP Steam Production System

The steam system consists of one 30,000 pound per hour (PPH) gas boiler and three 60,000 PPH coal-fired stoker boilers. Boiler No. 1 (30,000 PPH) is a D-style, watertube boiler manufactured by E. Keeler Co. that fires natural gas with a single burner manufactured by Faber and utilizes single-point positioning. Boiler Nos. 2 through 4 (60,000 PPH each) are balanced draft, watertube, spreader stoker coal boilers capable of firing natural gas with two side-mounted burners at a rate of 60,000 PPH on gas. Boiler Nos. 2 through 4 were manufactured by International Boiler Works Co., and the burners were manufactured by Coen Co. All three are equipped with air pre-heaters. None of the existing boilers have economizers used for pre-heating boiler feedwater, and all four boilers were installed in 1980. Information relating to the heating system equipment follows.

The CEP plant operations staff have been working through a range of problems with quality and reliability of coal supply in recent years. Although quality and availability of coal mined in the Powder River Basin (PRB) in north east Wyoming remains robust and supplying fuel to electric power utilities throughout the Midwest and Texas, the relatively low annual volume required to heat the University of Wyoming, combined with long trucking distance from mine to the CEP make it a relatively expensive source. Coal supply to UW has historically been provided by mines of substantially smaller scale, and with shorter haul distance to Laramie. Many of these have closed in years, and quality of loads from the remaining alternatives has created problems. General demand for coal in Colorado and Wyoming has dropped in recent years along with declining price of natural gas and increasing regulatory pressures. Similarly, the number of alternative ash disposal sites is diminishing. Longer haul distances for coal and ash increase the sensitivity of coal price at UW to the cost of transportation fuel, a more volatile commodity than coal. Coal quality can create operational issues when the heat content, moisture level, and % of fines diverge from the plant equipment design specification. At the CEP this has manifested in early bag house bag replacement, incomplete combustion, high stoker maintenance and problems with the conveying systems. Installation of underthrow coal distribution is intended to mitigate some of the issues with fines. The option to truck (or rail) PRB coal does exist, and could be employed if all else fails, but is currently estimated to be on the order of a 25% premium.

Boilers

Boiler No. 1: 30,000 lb/hr, E.Keeler Co. Manufacturers Serial Number 16719, Std. number NB5418, built in 1980. Model SWP-200. Burner is Faber Air Register burner unit. Size VP-20, Contract No. 16720, E.Keeler Co, Williamsport, PA.

Boiler No. 2: 60,000 lb/hr, International Boiler Works, East Stroudsburg, PA. National Board No. 11728. 250 psi maximum working pressure, Serial No. 14803, built in 1980. The primary fuel is coal. The burner is a Coen gas burner, Coen File D7829-1. Gas only, fuel oil was removed. Detroit Stoker, Job No. RG967, Stoker No. 2195.

Boiler No. 3: 60,000 lb/hr, International Boiler Works, East Stroudsburg, PA. National Board No. 11729. 250 psi maximum working pressure, Serial No. 14004, built in 1980. The primary fuel is coal. The burner is Coen file D7829-3. Detroit Stoker, Monroe, MI; Job number RG967, Stoker no. 2196.

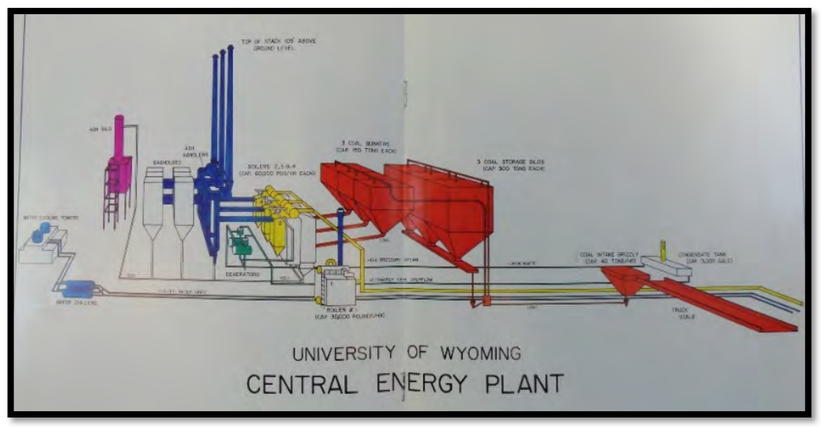
Boiler No. 4: 60,000 lb/hr, International Boiler Works, East Stroudsburg, PA. National Board No. 11730. 250 psi maximum working pressure, Serial No. 14805, built in 1980. The primary fuel is coal. The burner is Coen file D7829-2. Detroit Stoker, Monroe, MI; Job number RG967, Stoker no. 2197.

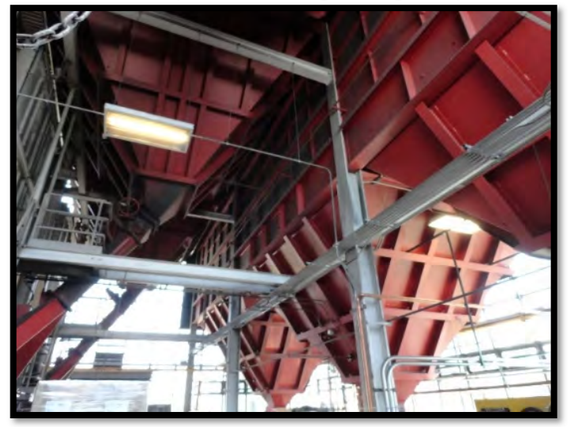
O2 analyzers are measured on each of the 3 coal machines. Rosemount, model no. IFT 3000.

The gas boiler (No. 1) has no economizers. Feedwater: 6" stubbed out, 4" natural gas, 2" fuel oil return, 1-1/2" fuel oil supply. Gas service has capacity to produce 110,000 pounds per hour. Gas service comes from Black Hills energy with 6" out of ground, 25-30 psig operating pressure. Burners require 9 psig.

Feedwater pumps, 2 electric and 2 steam

Electric Pumps 1 and 2: Pentair, Aurora, No. 13-2356648-1 and No. 13-2356648-2. Size 2x4x9, type 431B BF. 144 gpm, 346 feet of head, 3500 rpm, 25 hp, 208-230/460V.
Steam Turbine Drive Pumps 1 and 2: Pentair, Aurora, No. 13-2356651 and No. 12-2241753, size 2x4x9, type 431B BF. 144 gpm, 346 feet of head, 3500 rpm.
Steam Turbine: Coppus, Serial No. 07-4237, Model no. RL-20L, Tre-Job No. 07-4237. 30 hp, 3550 rated rpm, 125/15 psi inlet/discharge pressure, 352.9°F inlet temperature. Single stage. Trip RPM: 4509.





Plant Air Compressors

There are many uses around campus for compressed air. These include pneumatically actuated valves/positioners as well as various needs for the boiler system. There are several locations around campus where pneumatic power is generated including the CEP as well as Engineering Addition. New compressors are being installed as part of the new West Campus Satellite Plant.

Air Compressor for steam control valves: Model SSR-EP75. 332 CFM capacity, 125 psig rated operating pressure, 75 hp nominal drive horsepower. Serial No. CK176OU99333.

Air compressors in power plant main floor: Ingersoll Rand, Model SSR-EP100, 446 CFM capacity, 125 psig rated operating pressure, 100 HP nominal drive horsepower. Serial Numbers CK2335U99212 and CK233U99212.

Two air compressors in plant basement: Ingersoll Rand, Model SSR-EPE50, 208 CFM capacity, 128 psig rated operating pressure, 50 HP nominal drive horsepower. Serial Numbers F4923U92 and F4999U92.

Deaerators and Feedwater Storage Tanks

DA No.1 and No.2: Chicago Heater Co. SN 3884 and SN 3885. Allied Steel Products, Cordova, Alabama. National Board No. 9246 and 9247. Serial No. C80-119 and C80-120. 50 psi maximum working pressure, 650°F maximum water temperature. Installed in 1980. The storage tanks were built by American Steel and Iron Works, Denver, CO. Working pressure 50 psig, built in 1980. Two tanks are present.

Fans

ID Fan: 150 HP, 1192 RPM, VFD present. South ID fan: VFD does work. Harmonic Guard Power conditioning is suspect.
Center ID fan: Clarage Fan, manufactured by Air Systems, Kalamazoo, MI. Serial No. 2696CM-5. Size 132, type XLR, series 1250. 1200 Max safe RPM at 430°F.
North ID fan: Clarage Fan, manufactured by Air Systems, Kalamazoo, MI. Serial No. 2696CM-4. Size 132, type XLR, series 1250. 1200 Max safe RPM at 430°F.
No. 2 FD fan: Clarage Fan, Serial No. 2696CM-1, Series 5350A. Size 66, type AFM. 1800 Max safe RPM at 200°F.
No. 3 FD fan: Clarage Fan, Serial No. 2696CM-2, Series 5350A. Size 66, type AFM. 1800 Max safe RPM at 200°F.
No. 4 FD fan: Clarage Fan, Serial No. 2696CM-3, series 5350A. Size 66, type AFM. 1800 Max safe RPM at 200°F.
No. 2 Overfire Air Fan: Buffalo, Shop order number N2345. 26" wheel diameter, Size 7x26, Type E, 50 HP.
No. 3 Overfire Air Fan: Buffalo, Shop order number N2345. 26" wheel diameter, Size 7x26, Type E, 50 HP.
No. 4 Overfire Air Fan: Buffalo, Shop order number N2345. 26" wheel diameter, Size7x26, Type E, 50 HP.

Macawber Pneumatic Conveying System

From truck dump, coal is transferred to the Denseveyor Pot in basement. This can blow to the silos or dry storage. Silos are along outside wall, 3 present. Dry storage is boiler specific. East pot is from truck dump.

Roots Vacuum for Bottom Ash and Bag House

Easyair X2, model 250-600 RAMX, Serial No. 0903985001, Part No. RH-EAPK600350. Ash vacuum: 5-7,000 pounds per hour. Ash silo holds 70 tons of ash and is constructed of steel. Each semi load carries 15-20 tons. Rotary feeder is available. No ash conditioner is available; it had been removed as it produced a slurry. There are 7 cells of baghouse (5 original). The bags in all 7 cells have been replaced at 165 bags per cell.

Heating Loads and Capacity

The current peak steam load including plant consumption and distribution losses is approximately 140,000 lb/hr. Building Peak loads are approximately 125,000 lb/hr.

Condition

The condition assessment has identified several significant capital expenditures that must be considered over the next 20 years. This report includes a description of the improvements and estimate of probable construction costs for CEP heating related items.

Inspections of the boilers and associated equipment along with discussions of equipment condition with boiler plant leadership led to the recommendations of the following improvements.

Summary of Capital Improvements:

1. Repair or Replace Induced Draft Fans on Coal Boilers:

   Fan is $158,695; Installation is $100,000. The induced draft fans on the coal boilers are subject to the abrasive fly ash and operate at temperatures of 425ºF which can cause bearing failure and erosion of the fan housing. The existing ID fans are Clarage Series 1250 Model 132XLR rated at 44,387 CFM at 375ºF. A quotation on a complete new fan assembly including the 150 horsepower motor is $158,695. Installed in 1980, the ID fans are now 36 years old, and should not require complete replacement. At this age, the parts that may require replacement are the fan wheel, shaft and cartridge bearings. A similar ID fan shows signs of erosion of the outside radius of the fan housing. This report includes a plan to repair the housing by re-lining it with a layer of Hastelloy-C alloy steel welded to the outside of the fan housing. The mechanical overhaul estimate consists of new fan shaft, wheel, cartridge bearings, and limited fan housing repair with Hastelloy-C at a budgetary cost of $100,000 per fan. Complete replacement of the ID fan and motor assembly in year 2030 is estimated at $250,000 per ID fan.

2. Replace Elbow Sweeps on Macawber Coal Conveying System:

   Coal from the outdoor truck dump pit gravity-flows to a Macawber Denseveyor pneumatic transfer system where it is blown to either coal silos or the day storage. Coal from the silos can be transferred to any of the day storage bunkers, but once placed in a day bunker it is destined for a particular boiler. Discussions with powerplant engineers have indicated that two areas are expected to require upgrades in the next five years. The ten dump valve boxes located and the individual silos and day storage bunkers will require replacement. Cost for each of ten dump valve boxes is estimated at approximately $1,000,000. Replacement of the pneumatic 8" coal conveying line pipe and radiused elbows is considered on-going maintenance, with elbows requiring replacement approximately every 2 years. The cost of elbow replacement is approximately $10,000 each.

3. Boiler Condition Assessment:

Boiler tubes would be expected to last at least 50 years as long as water chemistry and blowdown are managed, and the tubes are not subjected to flame impingement. UW's three IBW and one Keeler boilers were all installed together in 1980 and are now 40 years old. Some selective tube repair and replacement has occurred over the past years, but there is no reason to believe that a complete tube replacement on any of the boilers is imminent.

Performing tube evaluation is recommended, both non-destructive and destructive testing, to obtain an assessment of tube condition and determine what sections of the boiler may require retubing. A definitive assessment of tube condition will also allow specific tube sections requiring replacement to be identified as well as an estimate of when this expense would occur.

Babcock & Wilcox Power (B&W) can provide both the nondestructive evaluation (NDE) and the destructive tube testing to determine the condition of the boiler. Their NDE evaluation consists of an ultrasonic testing of all tubes to determine wall thickness. A linear regression analysis is performed on the data to develop an analysis that predicts remaining tube life. B&W predicts that a two-man crew could do the ultrasonic testing on one of the IBW boilers in approximately one day. Assuming two days of travel to/from Worcester, MA to Laramie, and one day on each of three boilers, we could expect a total travel and inspection time of ten-man days. Preparation of the report is expected to take an additional eight hours per boiler. Total cost is estimated at $15,000 - $20,000 for this evaluation on all three IBW boilers.

With the boilers now 39 years old, B&W recommends performing a tube sample analysis in which a small section of a representative tube is removed and sent for metallurgical analysis. The tube section is analyzed for deposits on the inside and outside diameter. A composition analysis determines if the deposits are corrosive and if the metallurgy of the tube has been changed. A local boiler contractor would be responsible for removing and replacing the tube. B&W recommends only analyzing one representative tube; cost is $3,000 per tube.

4. Boiler Retube and Refractory Repair:

Should retubing be required, a cost of approximately $400,000 is anticipated to retube each IBW boiler. This estimate is based upon actual project costs for a full retube and rebuild of both the front and rear wall refractory on a 70,000 lb/hour Springfield dual fuel (natural gas and No. 2 fuel oil) fired boiler in Chicago, Illinois that had been in near continuous operation since 1964. Wyoming's IBW boiler does have a more complex tube geometry, as many tubes originate in the burner side of the boiler and offset over ten feet with six bends to their entry into the steam drum.

Improvements to Coal Stokers:

The three IBW coal-fired boilers have Detroit Stoker Rotograte overthrow style spreader stokers which feature a top discharge rotor to distribute the coal evenly over the chain type travelling grate which were designed for Wyoming's Powder River Basin coal. Although the coal specifications call for a coal size distribution of one-third at ¾" or less, one-third at ¾" – 1-1/4", and one third at 1-1/4" -2", the plant regularly receives coal with significantly greater quantity of fines. Oftentimes the coal is sized at 60% at less than ¾", which creates significant combustion problems.

With the existing Rotograte stoker, coal with a high concentration of fines will be unevenly distributed from the front of the boiler to the back, resulting in high concentration of fines at the front of the boiler and ash bridging. Temperature of the travelling chain grate can also become elevated due to inadequate insulating ash cover at the rear of the chain grate. Having an EPA permit limit of 36,000 tons of coal per year, the plant is not a large enough coal consumer to have significant market influence with the larger mines. As a small plant, the likelihood is that irregular coal size will continue to be an operational issue for the future. Several of the plant's previous coal suppliers have closed mines, succumbed to bankruptcy, or are not interested in supplying the relatively small amounts of properly graded stoker coal. While the recommendations on alternate mines should be explored, addressing the excessive coal fines through machinery modifications is a viable alternative.

The three coal boilers currently have Detroit Stoker overshot coal stokers that distribute the coal from the top of the rotary feeder. This overshot design worked very well on stokers when a consistent supply of properly sized coal was available. With significantly greater variability in coal size, the overshot coal feeders did not distribute the coal fines to the back of the boiler. Seeing this operational complaint from many coal-fired plants about twenty years ago, Detroit Stoker developed the Underthrow Coal Distributor that contacts the coal at the bottom of the rotor and flings it into the boiler. The new underthrow distributor also has an air assist that helps blow the fines to the rear of the boiler. Specifically designed for the size gradation and coal characteristics of Wyoming's Powder River Basin coal, the underthrow stoker provides a viable solution to efficient combustion of local Wyoming coal for many years.

Since their introduction, Detroit Stoker has installed the Underthrow Coal Distributor in over one hundred powerplants and report excellent results. A peer institution, the University of Iowa, has installed the Detroit Underthrow distributors on their coal boilers and do not have the problems with ash bridging at the front of the boilers, or too many fines combusting in the upper sections of the boiler. Several other universities with similar size boilers have the underthrow distributors and would be available for tour. The list includes, the University of Kentucky, Duke University, Clemson, University of Cincinnati, and many others. Locally, the Solvay soda ash plant located in Green River, WY and Brigham Young University in Provo have installed the Detroit Stoker Underthrow Coal Distributors. Several other plants having underthrow feeders along with contact information for the boiler plant engineers are listed on the next page.

Scope of Improvements:
Installation of the underthrow feeders is relatively easy, as they are made to bolt into the place of the existing feeders. The coal delivery chute may have to be modified, but no other significant changes are required to the stoker. Each boiler will be fitted with three underthrow distributors, six separate drives for the conveyor and rotor drums, and one distribution air fan. Electrical installation consists of wiring and control of these motors.

Detroit Stoker has been to the plant and inspected their stokers, as they performed a complete rebuild of the three stokers in 2015. The stokers are thus in excellent condition and additional overhaul work is not anticipated prior to installation of the new feeders. Detroit has provided a quotation of $509,000 for the equipment, and estimates an additional $300,000 for mechanical installation and $150,000 for electrical installation. Total installed cost is thus $959,000 for all three boilers.

As a recommendation made in the 2009 Utility Master Plan, a redundant steam exhauster for the ash system was recently installed but incorporates poor filtration. This is causing excessive steam consumption (~5,000 lbs/hr) and should be remedied.

CEP Chilled Water Production System

Overview

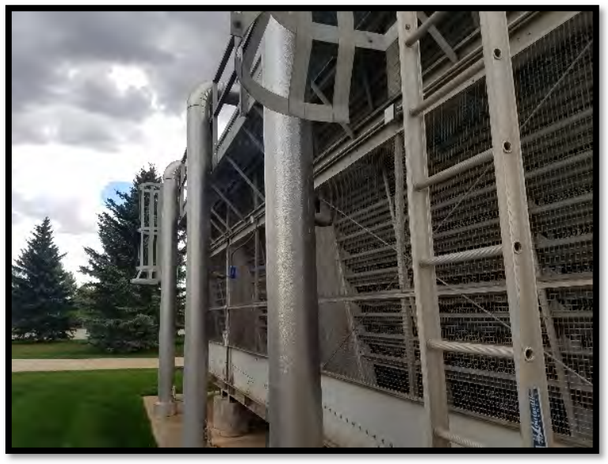
The University of Wyoming owns and maintains a centralized chilled water production and distribution system located at the CEP. Production is accomplished via two 1,200-ton centrifugal water-cooled chillers and inducted draft cooling towers. Chiller #1 was recently installed in 2018 and Chiller #2 in 2009. These chillers produce 42F-44F degree chilled water and (3) variable speed chilled water pumps distribute the water through the distribution system. Two plate and frame economizers provide up to 1,000 tons of cooling utilizing two 1,200-ton cooling towers. Condenser water flow is variable as are the fans on the cooling towers.

Loads and Capacity

The current peak campus chilled water load is approximately 1,500 tons typically experienced during the month of August. Unique to campuses located within cooler climate zones, the typical peak cooling load does not last long. Typically at a 5-8 hour duration, the peak load occurs during the afternoon of a design day. This contributed to the design of the new West Campus thermal energy storage (TES) system which allows the load to be serviced at two different ends of campus taking advantage of split flow and lower piping flowrates and reducing distribution infrastructure size. During peak thermal energy discharge, the University will have a peak cooling capacity of 3,600 tons which includes 2,400 tons of cooling from the CEP chillers and 1,200 tons of cooling from the TES system.

Condition/Deficiencies

The chilled water production system is in relatively good shape. The motor on chiller 2 was recently replaced and the north cooling towers were reconditioned within the last several years.



The cooling towers are independently operated with no common sump or basin equalizing method. The sumps are installed at differing levels, causing unstable water levels and the draining/overflowing of sumps when operational changes occur. A solution to this issue would be to provide a larger sump for tower #1 at the same operating level as tower #2 and interconnect the sumps with an equalizing line. Another option would be to install an additional redundant tower which would share a larger sump with the existing southern tower. This would allow wintertime operation of the north tower which contains anti-freezing measures, and operation of the southern towers during peak loads. An estimate of project cost is $2M to complete this work.

A focused improvement that the University should make relates to the chilled water system flow and building differential. The higher the temperature differential within a building, the lower the chilled water flow requirement which leads to lower operational horsepower and more efficient heat transfer. A higher system delta T will also allow a greater potential of thermal storage capacity on campus.

Recommendations

It is anticipated that the replacement of chiller #1 and the cooling towers will be necessary within the next 10-15 years. It is also recommended that the tower sump issue mentioned above be resolved as soon as possible. This will allow flexibility in the operations of the condenser water system.

Campus Tunnel System

Overview

The University of Wyoming's subterranean tunnel system includes approximately 3 miles of tunnel. It is comprised mostly of walking tunnels with a few sections that are short and narrow trenches. The earliest portions of tunnel date back to the early 1920s and the newest 2014. The reconfiguration of the Wyoming Hall Tunnel which runs between 15th Street and Wyoming Union Tunnel is currently in design as part of the Student Housing project. Various sections of tunnels convey utilities including, high/medium/low pressure steam, pumped steam condensate, chilled water supply/return, compressed air, sanitary sewer, power, communications, irrigation, equipment vents, and domestic water. For the most part, the network has concrete floors with dim lighting. As initially identified in the 2009 Utility Master Plan, several sections of the of the older tunnel system are deteriorating. There are many high priority structural and life safety issues that have led to partial collapses in the recent past. As part of the Tunnel Assessment Report dated April 2019, unique names were assigned to each tunnel section and vault/intersection identifiers were assigned. This allows the University and associated partners to reference specific areas of the tunnel system without confusion. Generally, the last tunnel section at each building is numbered per the University building number. This Assessment involved documentation of the tunnel system including general condition of the structure, characteristics of the utilities within the tunnel system (type, size, condition) as well as unique notes about each section. Reference **Appendix TU-01** for a campus map with tunnel naming convention shown.

In 2018, Landmark Environmental was contracted by the University to perform a survey of the tunnel systems and identify the areas and condition of asbestos containing material (ACM) within the tunnels. A report was issued on the findings. Included within the UMP is a summary of ACM sections of tunnels which is incorporated into **Appendix TU-02** for reference.

As the newer campus utilities are installed direct buried, the need for new tunnels does not exist. Generally, tunnels are necessary for steam related maintenance of the distribution components. As the dependence on steam reduces, the need for maintenance on the tunnels will reduce and ultimately fall off. Refer to **Appendices TU-01** and **TU-02** for overall tunnel layout plans and an ACM map respectively.

CEP Tunnels

The tunnels located between the Central Energy Plant and the Law building and are referenced as part of the "CEP Tunnel" system and supply utilities to Regulated Material Management Center, Wyoming Technology Business Center, High Bay Research Center, Animal Sciences, Centennial Complex, and the Arena Auditorium. Generally, these tunnels are in fair to great condition with working tunnel lighting. It should be noted that the cast–in-concrete conduit for the tunnel system lighting is corroding to a level that is causing electrical shorts within the junction boxes. Some water infiltration and cracking in the structure was observed. A sump pump leak west of the Arena is causing standing water in this area. The section of tunnel along 19th Street utilizes the tunnel lid as the sidewalk above. The steel channel between the tunnel sections pose an issue during snow removal and catch the snowplow blades. The steel access hatches are also showing signs of being overloaded and should be replaced.

Fraternity Row Tunnels

The tunnels located between Corbett, north to the Interconnection of the CEP Tunnel, and West along Fraternity Row to Wyoming Hall were designated the "Fraternity Row tunnels". This series of tunnels supply utilities to Corbett, Memorial Fieldhouse, Law, Buchanan, Beta House, Health Science Living, ΣΑΕ, ΣΧΞ, ΣΝ, PKA, Honors House and Wyoming Hall. Generally, these tunnels are in poor to fair condition with working tunnel lighting. Portions of this tunnel were witnessed to be experiencing severe water infiltration. Exposed concrete reinforcement was observed. This entire section of tunnel contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018. Areas of tunnel structure are severely deteriorated. There is a location between tunnel vaults V217D and V217E where the telecommunication installation combined with the location of the piping and associated supports almost makes the tunnel impassible.

Sorority Row Tunnels

The tunnels located south of the Fraternity Row tunnels spanning from Crane, along Sorority Row, down to Washakie, Downey, and Orr Halls, and west to Old Main were designated the "Sorority Row Tunnels". This network supplies utilities to Crane, IT, Orr Hall, Washakie, Mcintyre Hall, Downey Hall, White Hall, XO, ΔΔΔ, ΚΚΓ, ΣΦΕ,, Tobin, Business, Wyoming Union, Coe Library, Ross Hall, Knight Hall, Hoyt Hall, Student Health, Merica, and Old Main. Generally, these tunnels range from extremely poor to fair condition with working tunnel lighting. There are some areas of standing water and exposed concrete reinforcement. Several areas south of Prexy's Pasture are at a condition to which collapse is very possible. This entire section of tunnel contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018.

Sciences Tunnels

The tunnels located west of Prexy's spanning from Old Main north to the Energy Innovation Center were designated the "Sciences Tunnels". This network supplies utilities to Biological Sciences, Arts and Sciences, Physical Sciences, Williams Conservatory, Aven Nelson, Classroom, Physical Sciences, Health Sciences Center, Geology, and Earth Sciences. Generally, these tunnels range from fair to excellent condition with working tunnel lighting. This entire section of tunnel contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018.

McWhinnie Tunnels

The tunnels located along the northern side of west camps are designated the "McWhinnie Tunnels". They span from the Energy Innovation Center east to Wyoming Hall and include the northern tunnel that runs to the Anthropology Building. This network supplies utilities to Geological Survey, Engineering, Agriculture, Anthropology, Education, McWhinnie, and Wyoming Hall. Generally, these tunnels range from extremely poor to excellent condition with working tunnel lighting. There are some areas of exposed concrete reinforcement. Several areas between Engineering and Education are at a condition to which collapse is very possible. The section below Engineering to Education contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018. It is recommended to abandon and infill the portion of this tunnel that is located between the Anthropology Tunnel interconnection to the west and the Union Tunnel interconnection to the south. Reference **Appendix TU-01** within the appendices for locations.

Wyoming Union Tunnels

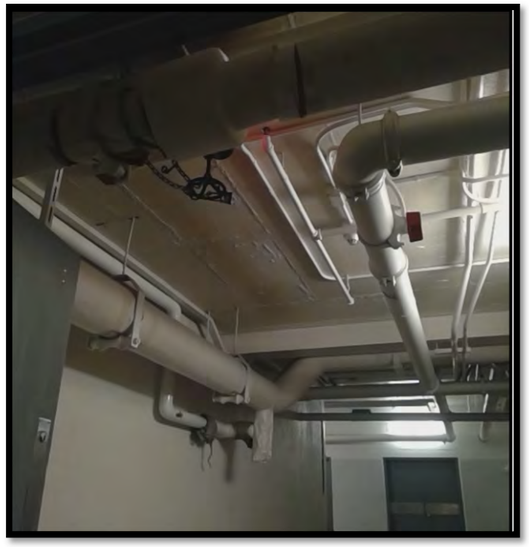
The tunnels located along the eastern end of Prexy's are designated "the Wyoming Union Tunnels". They extend utilities between Education, Half Acre Gym, and Wyoming Union. Generally, these tunnels range from extremely poor to fair condition with working tunnel lighting. The entire section contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018.

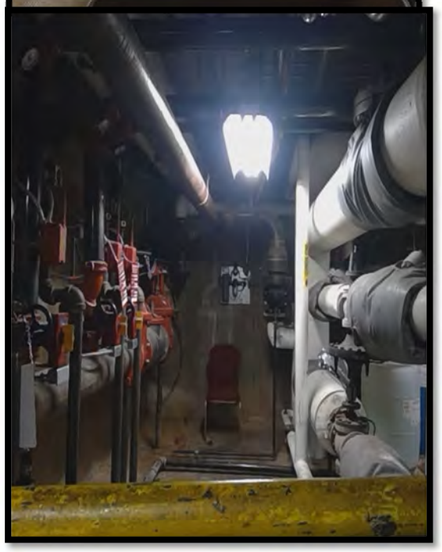
South Prexy Tunnels

The tunnels located between Old Main and Tobin House along the southern end of Prexy's are designated "the South Prexy Tunnels". They extend utilities between Old Main, Merica, Cheney, Hoyt Hall, Ross hall, Knight Hall, Wyoming Union, Coe Library, Business, and Tobin. Much of this tunnel contains asbestos containing material (ACM) in the form o piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018. The overall condition of these tunnels ranges from extremely poor to fair condition with the worst section being around the Old Main lateral east to Hoyt/Ross Hall. It is recommended that this portion be abandoned and infilled as newer utilities do not require the maintenance access that tunnels provide, and steam use will be reduced as the buildings are converted to heating water. The existing Coe Condensate return station is currently out of commission. This station should be restored to full functionality.

Corridor Tunnels

The tunnels located within the student housing area of campus including White, Downey, McIntyre, and Orr Halls and within the Waskakie Center are designated as the "Corridor Tunnels". These are mostly hallway type tunnels that not only provide a corridor for utilities, but also permit access to the public. Generally, these tunnels range from good to excellent condition. Much of this tunnel contains asbestos containing material (ACM) in the form of piping insulation as identified by a report produced by Landmark Environmental Inc., dated March 27th, 2018.





Improvement Recommendations

The range of age and condition of the UW tunnel system varies tremendously. Some portions are respectable in terms of structural integrity, and others are on the verge of collapse. There are two areas in particular that were documented within the Tunnel Assessment Report dated April 2019 that are in state of near collapse. These areas include the section of tunnel around the Education building as well as the tunnel around Merica Hall to Knight Hall. It is recommended that the utilities within these portions of tunnel be rerouted and the tunnel sections infilled. **Appendix TU-01** identifies the areas of tunnel recommended for infill.

Steam, Chilled Water, and Heating Water Calculations and Flow Simulation

A spreadsheet of campus buildings along with corresponding building area, type, heated and cooled square footage was assembled. This interactive spreadsheet allows the user to assign diversity factors and assume energy metrics in the form of load per unit areas to estimate individual building loads. This model was calibrated against University utility metered data and separated by areas of campus; North-West, North and North-East, West and South-West, East, and South. Projected campus renovation and development was then incorporated into the phasing portion of this spreadsheet. The results are displayed within **Appendices MC-01** through **MC-05**. It was with this data that campus loads were estimated and input into the flow models described below. A summary heating/cooling load table of existing, and anticipated short term, midterm, and long term is provided as follows:

	Campus Total Heated Area (sqft)	Campus Heating Load (MBH)	CEP Steam Flow (klb/hr)	HW Plant Load (MBH)	Campus CEP Cooled Area (sq-ft)	Average SF/ton	Campus CHW Load (Tons)	Campus CHW Flow (gpm)
Existing Campus Totals	5,743,799	154,577	148,366	0	1,998,655	1,600	1,249	2,998
Short Term Plan-Campus Net Totals	5,908,353	156,044	85,342	74,277	3,521,417	1,863	1,890	5,033
Mid Term Plan-Campus Net Totals	6,399,024	169,653	24,646	136,153	4,814,647	1,647	2,923	7,105
Long Term Plan-Campus Net Totals	6,330,018	169,709	0	148,251	5,072,601	1,657	3,061	7,435

The steam, chilled water (CHW), and heating water (HW) hydronic systems on the UW campus were modeled utilizing the flow simulation software, Pipe-FLO Professional, a comprehensive distribution piping analysis software that takes an in depth look at the interaction of pumps, control valves, and other system components to provide the user with a complete picture of modelled piping distribution systems. These models were used to provide a better understanding of the system's hydraulic performance as well as its constraints in response to the projected UW campus cooling and heating load growth. For this project, models of the existing utility distribution systems were created to understand their hydraulic performance and to evaluate proposed future modifications. Base information for building load data was projected from the field survey as well as operational data from the UW Operations group to provide approximations for total building square footage of cooled and heated space. Building cooling load data was translated into the required volumetric flowrates by way of the fundamental heat transfer equation,

$$Load\ (tons) = \frac{GPM\ \times dT\ (°\mathrm{F})}{24}$$

using a temperature differential of 10 $°\mathrm{F}$. Heating load demands and steam flowrates were provided by U.W. Facilities Management. Following a series of assumptions, the campus utility systems were then simulated in the PipeFLO modeling software using the Darcy-Weisbach calculation method. The simulations explored the effects of phased loading on the system in regard to the required pumping capacity (gpm, feet of head) for effective operations.

Existing CHW pumps at the CEP were modelled as a single "sizing pump" to simplify the simulation. In large distribution systems which circulate a considerable amount of flow, pumps are often placed in parallel. Pumps are described as operating in parallel when they receive liquid from the same suction manifold, and discharge into a common discharge manifold. Two pumps placed in parallel operation will halve the total flow seen by each while maintaining the same discharge head, making them more attractive for low head-large flow systems. The modelled sizing pumps thus represent the actual head required for each existing/future pump.

Pipes in the hydronic flow models were color coded to represent varying flow velocity (green being the lowest velocity and red being the highest within the system) to provide a visual representation for possible physical constraints the system may experience as it is subject to phased loading. Using the continuity equation, $v = \frac{4}{\pi}\frac{w}{\rho D^2}$ it is shown that the average pipe flow velocity is related to the pipe's internal pipe diameter (D), mass flow rate (^{w}), and fluid density ($^{\rho}$). The increase in mass flow rate and decrease in pipe diameter size results in an increase of flow velocity. A maximum velocity of 10 ft/s is typically used to minimize the possibility of erosion by solids, excess noise, and water hammer for heating and chilled water systems. For steam systems, velocity over 200 ft/s should be avoided. As more build-out occurs and load demand increases the mass flow rate must increase to satisfy system loads, and existing pipes will prove to become a major physical constraint to future growth. System velocity model reports are included within **Appendices CS-02, CS-03**, and **CS-04** for Steam, Heating Water, and Chilled Water, respectively.

The following table summarizes assumptions made while simulating campus hydronic utility distribution.

HYDRONIC MODELING ASSUMPTIONS		
CHILLED WATER	**HEATING HOT WATER**	**STEAM**
Fluid properties simulate water at constant supply & return temperatures of 45F and 55F, respectively	Fluid properties simulate water at constant supply & return temperatures of 180F & 150F, respectively	Constant fluid properties: *High pressure steam* 125psig, 353F *Medium pressure steam* 60psig, 307F *Low pressure steam* 8psig, 235F
Where building cooling load is unavailable, load calculated using approximated rates (i.e. SQFT/ton)	Where building heating load is unavailable, load calculated using approximated rates (i.e. BTU/SQFT)	Where building heating load us unavailable, load calculated using approximated rates (i.e. BTU/SQFT)
Sizing pumps at CEP and west plant set to maintain discharge pressure of 65psig (150ft-hd)	Sizing pumps at CEP, west plant, and central plant set to maintain discharge pressure of 65psig (150ft-hd)	Distribution pressure from CEP fixed at 125psig, pressure reduced in tunnels or buildings per site investigations
CEP chillers maximum pressure drop rated at 22.8ft at 3,000gpm	CEP and central-plant hot-water boilers maximum pressure drop rated at 9.5ft at 4,500 gpm	
Piping is modeled as high-density polyethylene (HDPE) DR-11	Piping is Sched 40 Steel	Piping is Sched 40 Steel
Building pressure drops are simulated using a maximum 60 ft-hd loss rated against a curved flow profile ranging to approximately 150% of the maximum building flow demand		
Pipe lengths are estimated using a campus map as a scaling tool with predetermined routing as presented in the utility master plan		Most distribution pipe is existing as observed during site investigation
Quantities of pipe fittings required for campus routing were estimated		Pipe fittings modeled based on field observations
Expansion tank utilized as source flow as required by modeling software with surface pressure of 15psig, liquid level at 0ft elevation		Pressure boundary used as source flow with a 125psig output
		Majority of piping located within steam tunnels based on field observations
Model represents maximum campus cooling and heating demand conditions		

Campus Steam Distribution System

Overview

All steam heating for the purposes of heating hot water and domestic hot water produced on campus is currently generated at the CEP at approximately 125 psig saturated steam pressure. Through a network of tunnel routed and direct buried piping, steam is distributed throughout campus. This piping ranges in age and condition, with some of the oldest being approximately 60 years and the newest being only 4 years. After the steam condenses, condensate is pumped back to the CEP for reuse via steam powered and electric pumps located at various collection points around campus. The 125 psig steam is transported through this piping to pressure reducing stations around campus and at the building entrances. These stations reduce the CEP generated pressure to 60 psig or 12 psig, depending on the point of use need. Reference **Appendix CS-01** for a printout of the campus distribution model identifying the various pressure systems throughout the campus. Higher pressure steam traps are routed to lower pressure distribution mains to avoid losses in the latent energy change. Condensate return lines are sloped towards campus collection pits where the condensate is then pumped back to the CEP. See **Appendix ST-01** for a map of the campus steam and condensate system including locations of system pressure reducing stations, condensate collection stations, and identified areas of recommended improvement.

As previously mentioned, steam is generated at the CEP located on the north east corner of campus. It routes south down the CEP tunnel along 19th Street, picking up the individual buildings via tunnel and direct buried laterals. A main high-pressure line traverses westerly through Greenhill Cemetery, along Lewis Street, and interconnects into the West Campus steam distribution infrastructure. High pressure continues south after the Greenhill direct buried branch to supply steam to the south-east quadrant of campus where it is reduced to medium pressure to supply south campus. A high pressure direct buried line runs along Willett Drive to the area around the "Willet Pit Vault" where steam is reduced to medium pressure and interconnected to the south campus distribution network. Two medium pressure steam lines cross 15th Street westerly to supply west campus with medium pressure steam. The southernmost line is routed within the South Prexy's Tunnel and supplies steam to the connected buildings. The northern most medium pressure steam line crosses 15th Street at Willett and runs through Wyoming Hall and Education. Within education, the lines split and head south along Half Acre and Wyoming Union to loop West campus. The westerly running lines out of Education are routed within the McWhinnie Tunnel over to the Energy Innovation Center (EIC). Approximately centered on the north side of Agriculture, steam is piped under Lewis to the Anthropology Building. At the EIC, the Greenhill high pressure line is introduced into the medium pressure system via pressure regulating valves. From here medium pressure is supplied north of Lewis Street to STEM, as well as south of EIC to Physical Sciences. A westerly branch supplies a set of steam lines that supply the Health Science Center, Classroom Building and Aven Nelson. A southerly branch continues along Arts and Sciences towards Merica and loops back into the South Prexy Tunnel piping.

Generally, West Campus steam condensate returns to the EIC condensate pumping station, commonly known as the "Lewis Street Pit" via gravity flow. From this pit, condensate is pumped by a 6" direct buried condensate line that parallels the steam piping in Lewis Street and Greenhill Cemetery, and by (2) direct buried 6" condensate lines that run along the north side of Prexy's easterly to the Fraternity Row Tunnel. Condensate from south campus generally flows to the Willet Pit pumping station located along Willett Street, east of 15th Street. From here, liquid movers pump back to the CEP collection tank that is located east of the plant.

Portions of several critical buildings on campus are backed up by local boilers. In the event that the campus steam system is down, these local boilers can be operated to maintain some degree of heating water and/or domestic water for the users. **Appendix ST-02** identifies the location of buildings that have local boilers on campus. Note that there is a temporary steam boiler connection on the south side of campus to provide heating needs for the dorm areas. This allows the annual summer steam shutdown to occur yet still provides the heating needs for students residing within the dorms.

The majority of buildings on campus utilize steam from the CEP and convert it locally within the building via a shell and tube heat exchanger to hot water or a glycol mixture for efficient distribution. There are several older buildings on campus that utilize the CEP steam directly and distribute a portion or entirety throughout the building. A campus map showing the building distribution type (steam or hot water) is included for reference within **Appendix HW-02**. Note that at some point, the direct steam usage buildings must be converted to hot water distribution to allow the hydronic campus loop to satisfy the heating loads.

Known Deficiencies

Several areas of the condensate distribution system were observed to need repair or replacement. The fiberglass system that is routed throughout many areas of campus is a constant maintenance item. The 3" direct buried condensate piping that connects Sorority and Fraternity Tunnels requires replacement. The liquid mover pump station located between Coe Library and the Business Building is in poor condition and should be replaced with electric condensate pumps. See **Appendix ST-01** for a map of the campus steam and condensate system including identified areas of recommended improvement.

Due to the distance of the CEP from the mathematical locus of building heating demand and portions of poorly insulated piping, there are significant thermal distribution losses through the systems 38,000 LF of steam and 37,000 linear feet of condensate. A thermal loss calculation suggests steam piping losses on the order of 5,500 lbs/hr. Additional losses in building mechanical rooms, pressure regulating equipment, building heating water converter stations, and motive steam to power condensate return pumps is estimated at an additional 6,500 lb/hr. Plant metering data corroborates university utility engineers estimates that residual steam necessary maintain the system with no building load is on the order of 12,000 lb/hr. Annualizing this number (and considering a 760 hr summer steam shutdown) yields an estimate of 96,000 MMBTU/year or 28% of annual steam production. Losses on the condensate return system are estimated by adding the heat necessary to bring the 90% condensate returned, from a temperature of 180F to 210F (feedwater temperature leaving the deaerator) to the heat necessary to bring the 10% cold make up water to the 210F feedwater temperature. Annualized, this amounts to a loss of roughly 4.2% of total plant thermal output. Combining these inefficiencies (fuel-boiler steam, plant (deaerator) losses, and distribution losses results in a net conversion efficiency of approximately 53%.

As outlined within the West Campus Heating and Cooling Analysis Report performed by GLHN Architects & Engineers, Henneman Engineering, and Coffey Engineering and Surveying in 2016, and the planned construction of the West Campus Satellite Plant, the University has taken steps away from the reliance on steam heat. This new plant and associated distribution system is the first phase of a long term plan to integrate several smaller HW plants into a new distribution system. This change will have a large impact on the future cost of maintenance and operations of the campus HHW system.

Campus Chilled Water Distribution System

Overview

Many of the buildings on the University of Wyoming campus are not mechanically cooled. Buildings that are cooled utilize several methods to do so. These methods include evaporative cooling (local), direct expansion mini split units (approximately 100 units around campus) and CEP provided chilled water cooling. A campus map included within **Appendix CW-02** identifies which buildings are evaporatively cooled and which buildings utilize chilled water.

Several critical buildings such as High Bay Research and the Information Technology Building contain local backup chillers to utilize in the event that the CEP is unable to produce chilled water.

CEP chilled water currently conditions roughly 30% of the net square footage of occupied space on campus, and peaks at approximately 1,300 tons. Chilled water is generated at the CEP between 42F and 44F and supplied to campus via a direct primary, variable speed pumping system. The majority of chilled water supply and return piping is direct buried with a variety of materials including ductile iron, transite, steel, high density polyethylene (HDPE), and C900 Polyvinyl chloride. Chilled water leaves the plant through 14" diameter chilled water piping and heads south paralleling the CEP Tunnel along 19th Street, picking up individual buildings along the way. The mains head west along the southern end of Greenhill Cemetery separating and creating a campus loop. The northern branch of the loop runs along the south end of the cemetery, crosses 15th and runs along the north edge of Prexy's. Several laterals extend from this loop to supply buildings to the north including Anthropology and the group of buildings around the EIC. This loop continues along the west end of campus via a north-south running line between Bio Sciences, A&S, and Physical Sciences. The southern branch of the campus loop routes along Sorority Row, crosses 15th Street and runs the corridor between the Union, Coe, Ross and Knight. An interconnect between the north and south loops occurs along the Wyoming Union Tunnel. Currently under construction, the West Campus Satellite Plant Project in installing a network of chilled water piping that is direct buried along Bradley, and extends into the Prexy's loop. See **Appendix CW-01** for a campus map of the chilled water distribution network.

Known Deficiencies

As part of the Anthropology building construction, schedule 20 piping along Anthro Tunnel was installed. This piping, although meeting the pressure and temperature requirements of the system, is of lesser strength than the rest of the piping on campus. This should be noted as there is a section of this piping that crosses within the existing tunnel system. It is recommended that moisture sensors and automatic isolation valves be installed in this area to reduce a catastrophic flooding event within the tunnel system.

There are numerous areas within buildings on campus that have had local direct expansion air conditioning units installed. The total combined nominal capacity of Direct Expansion (DX) A/C units on campus is approximately 400 tons. A campus map identifying these buildings is included within **Appendix DX-01**. The installed DX capacity within each building is included within the Mechanical Calculation (MC) sheets of the Appendix.

The main chilled water loop does not connect on the very west end of campus. A relatively short section of 8" supply and return piping should be interconnected in the area around Biological Sciences and Merica Hall to increase flow distribution around west campus. See **Appendix CW-01** for the location of this interconnect. This work is recommended to be included within the Short Term range time frame of work to help the west campus thermal energy storage system work more efficiently.

Improvement Recommendations

As buildings are renovated or constructed on campus, the need to connect into the campus chilled water system should be considered. The main loop infrastructure for the chilled water system is installed. For the most part, laterals from the main loop should be extended as appropriate. The mains along Bradley should be continued to the east from the West Campus Plant to serve the new student housing facility. The south east end of campus around the Memorial Fieldhouse and Arena requires an extension of main piping to be able to satisfy the cooling loads of existing and new buildings within this area. The new 22nd Street Research area will require a new CHW loop that extends from the 10" mains north of High Bay and connects back around to the 10" mains north of Centennial. See **Appendix CW-01** for a proposed routing scheme for this area.

Campus Heating Hot Water Distribution System

Overview

The hot water production and distribution system on campus is not yet able to be utilized but is scheduled to be operational in 2021. A portion of the distribution piping was previously installed in 2018 during the construction of the EERB building. The appropriate piping and vaults were installed to allow simple future continuation of the system. A larger section of distribution piping currently under construction will allow the extension along Bradley, crossing Lewis and extend to Prexy's. A new hot water satellite plant is also being installed as part of this project. Included will be the interconnection of the new Science Initiative Building, EERB, STEM, Anthropology, Agriculture, and the 1980s addition to the Engineering Building. The momentum of this project should be continued to extend a Prexy's loop as well as a 15th street branch to serve new buildings along Harney. Depending on the number of buildings transferred from steam reliance to natural gas fired hot water, a second satellite hot water plant will be required. This could be incorporated into the Student Union Addition. The Intermediate phase growth of the HW system will extend into the south and east portions of campus and allow for a further reduction of CEP steam. The long-term recommendations would be to continue the interconnection of buildings into the HW system and removal of the need for steam. See **Appendix HW-01A** for a campus map identifying the existing and proposed routing of the hot water distribution system. As the remaining buildings are converted to hot water, the CEP could provide a location for a third satellite hot water plant.

There are currently three heating loads on the very far north-east corner of campus (north of Wilett Drive and East of 22nd Street), all currently with standalone heating systems. These loads include the Armory Building, Indoor Tennis Courts Facility as well as the Plant Sciences Greenhouse Facility. The Armory building contains a full standalone steam heating system. The Indoor Tennis building is mostly natural gas unit heaters. The Plant Sciences Greenhouse Facility has a hot water system to heat the main building and steam boilers to heat the greenhouses. The newly proposed Campus Masterplan growth in this area include the New Facilities Building as well as the New Fieldhouse. As these new and existing loads are located a significant distance from the proposed main heating water loop, the cost to interconnect these remote buildings would be significant. It is recommended at this time to install standalone heating/cooling systems at the building level. If at a later point in the future, additional load is added to this area of campus, an evaluation of interconnection into the new HW loop could be performed. Reference **Appendix HW-01B** for a potential loop layout for this area of campus. A satellite heating plant could be constructed at the New Facilities Building which could be extended as required.

Campus Primary Power Distribution System

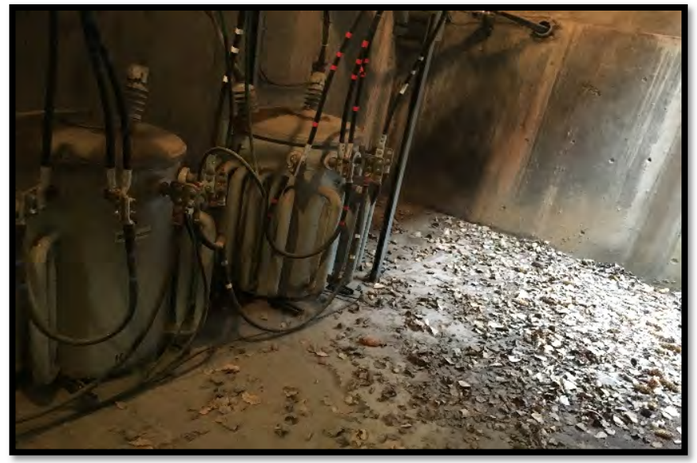
Overview

Rocky Mountain Power provides 13.2 kV to the two main substations on campus: West (Cowboy), located in the basement of Physical Sciences and East (Alta Vista) located in an enclosure near the southeast corner of Greenhill Cemetery. Each is loaded to roughly 60% rated capacity with a campus radial connecting the two. 15th Street represents the boundary between loads normally fed from the east and loads from the west. Apart from the main campus' two-substation distribution system, Rocky Mountain Power (RMP) and Carbon Power (West Laramie) also provide direct service to some campus and off-campus facilities. RMP has taken steps to improve its service to the university over the past two years, but extended power outages are still occurring. Of note, the above ground power poles along the east side of 15th Street between Ivinson and Willett are subject to vehicular damage as is the pole that feeds the East Substation. Campus electrical single line diagrams are included as **Appendices EL-03** and **EL-04** for reference.

The West Campus (Cowboy) Substation was installed in the 1960s. It is 13.2kV/7620V, with a 480A main circuit breaker. The equipment has five radial feeds with an estimated current peak load of 5 MVA. Conservative estimates have the normal connected load near 6.3 MVA or 276A. There is no space in the existing equipment room where the substation is located to allow for an additional section of gear. The present location of this substation places limitations on the ability for this unit to expand. Consideration should be given to the potential relocation of this substation to allow for future expansions and additions.

The East Campus (Alta Vista) Substation was installed in the 1980s. It is 13.2kV/7620V, with a 480A main circuit breaker. The equipment has five radial feeds with an estimated current peak load of 5 MVA. Conservative estimates have the normal connected load near 7.15 MVA or 312A.

Each substation is loaded to approximately 60% of capacity and each could nearly support the campus on its own after following established and coordinated switching procedures.



Based on a review of the report prepared by Emerson in 2007, the existing underground 15kV distribution cables and their associated points of attachment did not indicate any significant problems but recommend routine re-testing and trending to anticipate potential cable or termination failures. Two locations where feeders of improper rating were flagged have been corrected. Some higher partial discharge was recorded for the feeder and associated terminations between 'Switch Q' and the 'Storage Building' and maintenance was recommended. Follow up information has not indicated impending failures. In general, most of the feeders on site have been in service at or past a recommended industry standard life. A feeder cable replacement plan is recommended to systematically begin replacement of these cables to avoid unplanned outages due to cable failures.

Radial feeders from East and West substations are not overloaded. For better balancing, the following lines could (and are slated to) assume more load:

- 'C', 'CEP', 'I' and 'T'

Feeder 'Z' from East substation was recently tested and found to have comprised insulation. It is currently scheduled for replacement.

Other medium voltage cables in need of replacement include:

- Faulted cable between Switches F and K4 which has been identified and targeted for replacement.
- Cables connected to Switches D1, D2 and H should be tested, since their installations precedes the 1980s.
- From the Emerson 2007 study, only one set of cables remains without replacement due to the likelihood that the building will be replaced and the fact that the MV conductors pass through a steam tunnel:
    - From Switch Q to the Service Building transformer. (Compromised insulation)

For pad-mounted switches, only one appears to need replacing. Switch 'E' on the east distribution side. Many of the pad-mounted switches could use general clean up, maintenance and re-painting. Due to the general age of most of these switches it is recommended that as facilities are renovated the associated pad-mounted switches should be replaced.

- None are overloaded. Refer to the single line diagrams included within the Appendices **EL-03** and **EL-04** for load estimates.
- It is impossible to evaluate the performance of the switch visually and without operating it, but we understand that Switch 'E' is in need and scheduled for replacement.
- We observed that at least the following switches could use repainting:
    - F, P, O-1, O-2, O-4, T-1, V, U, M-1, M-3, S-1 and S-2.

Of the medium voltage transformers, we have identified those in the SDMyers report that require servicing and paint. We have also observed numerous pot transformers that leak and are surrounded by leaves and general debris.

- Nearly all indoor oil-filled transformers lack proper oil containment.
    - Applies to all pod transformers as well as Coe Library.
- Testing and observed deficiencies per the SDMyers report and our site visit
    - Orr Hall. Leaking and surrounded by leaves and debris.
    - Crane Hall. Leaking and surrounded by leaves and debris.
    - Student Health. Observed oil seepage. Was address in the 2012 report but condition remains.
    - Physical Sciences- 1500 kVA and (2) 15 kVA are beyond useful life and should be replaced with the West Substation upgrade.

  - Pharmacy
  - Ross. Leaves and debris.
  - Knight Hall. Old pot transformers.
  - Education. Located in the vault. Secondary switch lacks proper clearance.
  - Classroom. Secondary disconnect switch located in a shaft that is not readily accessible.
  - McWhinnie and Wyoming. Pot transformers in the vault.
  - Old Engineering. Two sets of old pots.
  - Service Building. If building is to remain, pot transformers should be replaced.
  - Arena. Possibly the best-looking floor-mounted pot transformers, but containment may be insufficient.
  - Law Building
  - Crane Hill. Leaves and debris. Transformers for Crane should be replaced with building renovation.
  - Downey Hall.
- Transformers in reasonable condition that could use repainting
  - Centennial
  - Sigma AE/Sigma Chi
  - Phi Delta Theta/ATO
  - Beta House
  - Animal Sciences
  - Geo Survey
  - Berry
  - Earth Sciences
  - Arts & Sciences
  - Williams Conservatory
  - WRI
  - Wyoming Student Union
  - Field House 208
  - Chi Omega/Honors Hall
  - Corbett
  - Rochelle
  - Hoyt
  - Engineering Addition
  - Agriculture C Addition
  - Merica
  - Old Main

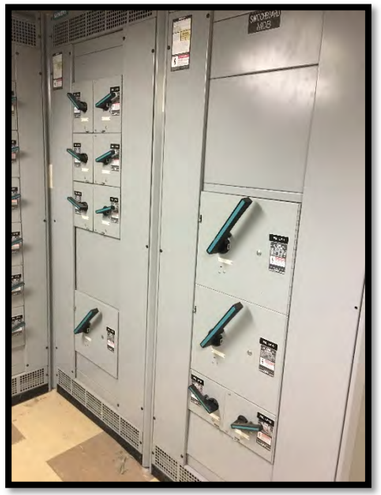
- Under-loaded transformers (under 20% loading)- Not a problem that needs to be addressed but should be noted so that future replacements are not like for like. There may be others worth review too, but we noted the following:
  - Berry
  - Williams Conservatory
  - Engineering West
  - Geo Survey
  - Old Geology
  - College of Business
  - Visual Arts
  - Animal Science
- History Building transformer was difficult to find. Distribution to the transformer should be clearly labeled.

We observed the main service boards and emergency lighting. We have listed main boards that appear to be beyond useful life meaning that factory parts are most likely no longer available. We have also noted the following:

- Any clearly observable NEC violations.
- Boards lacking surge protection.
- Lack of adequate egress lighting.

Old switchboards in need of replacement:

- Physical Sciences 5-section board
- WRI Bureau of Mines
- Pharmacy
- Bio Sciences
- Merica Hall
- Aven Nelson
- Ross
- Knight (West Wing pending demolition)
- Cheney
- History (insufficient working clearance for panel mounted to side end of lineup). No meter.
- Old Engineering
- Corbett Hall- Old GE buckets; should be replaced with upcoming building renovation.
- Performing Arts- Old GE lineup. 2000A, 480/277V with 3 sections. There is an old and new section. The old is past its useful life.
  - Basement switching station also needs to be properly labeled. Has 'A' been removed?



Newer switchboards with concerns to address:

- Education (1995 lineup missing MCB. More than 6 handles NEC violation. Disconnect is down in the vault and lacks proper working clearance.)
- Energy Innovation (new board, but meter display is off. Max load cannot be 32 MW as displayed.)
- CUP (service board correction- shutters on new 1200A breaker are not closing properly)
- Indoor Practice Field
- Need to evaluate the output of the PV array. 200A MCB but only 100A breaker at the main service board.
- Field house
    - Massive wire-way with possible de-rating concerns. Needs further investigation.

Missing surge protection:

- Geo Survey
- History
- Education Annex
- RMMC (missing from main but located on downstream panel)
- Indoor Practice Field (Needs replacement)
- Crane Hill
- Rochelle

No readily identifiable egress lighting:

- Merica Hall
- William Conservancy
- Cheney
- McWhinnie Hall
- Agriculture (old building)
- Service Building
- Arena
    - Take a close look at the NEC 700 system.
    - Red emergency panel in Field House fed from EH2 in Arena. ATS not yet installed. This appears to be the only emergency panel feeding the Arena. Need to evaluate how egress lights supplied. Confirm the bus size of the red EM panel and determine whether or not it is large enough if the emergency feed is 200A.

- Law Building
    - We found an unutilized inverter room. No battery packs found except for the stairwell. Egress lighting does not appear to be installed.
- Corbett Hall
    - Generator is rusted and out of commission since last basement flooding. Needs to be redesigned. No emergency system in place. Generator should be replaced with building renovation.

We observed that the university has made tremendous headway since the 2009 report by installing building electrical meters and by commencing the installation of arc flash labeling.

Short Term Improvements

Reference **Appendix EL-02** for a campus map with locations of major equipment.

- Additions and modification of existing campus MV distribution system to supply power to new buildings and modify for renovations. This work shall include new distribution and isolation switches, 15kV cables, manholes, duct banks and transformers.
  - New Service Facility on Armory Street (This should be a stand-alone service from Rocky Mountain Power.)
  - Student Housing along 15th Street
  - Student Union Addition
  - Knight Hall West Wing Addition and Reconstruction
  - New Ivinson Parking Garage

  Required MV system repairs:
  - Replace faulted MV Feeder between Switch 'F' and Switch "K4" of the east (Alta Vista) substation distribution.
  - Existing MV Switch 'E' of the east (Alta Vista) substation distribution is in poor condition and should be replaced.
  - Install arc-flash labeling on all MV equipment.
- Replacement of 15KV cable at (these were installed from 1960 to 1977):
  - MH-7 to C-2,
  - D-1 to E,
  - Switch E to Switch F,
  - Switch E replace and new feeds to Crane, Hill and Crane-Hill Cafeteria as the building is renovated.
  - Note that the duct bank from MH3-MH1 is no longer in use as it was prefabbed in sections and they settled at the joints, pinching the cable in place. The cable has been disconnected and removed as much as possible.
- Modifications to secondary electrical utilities to support the renovation to existing buildings. This work shall include new facilities low voltage distribution, emergency power, lighting modifications and upgrades and upgrades to building transformers.
  - Renovation of the Arts and Science Building
  - Renovation of the Biological Science Building
  - Renovation of Crane Hall
  - Renovation of Student Union Building
  - Renovation of McWhinnie Hall (office to housing)
  - Renovation of Ross Hall (office to housing)
  - Renovation of Knight Hall (office to housing)
  - Renovation of Corbett
- Modifications to primary and secondary campus electrical distribution to support the demolition of the existing Service Building, Wyoming Hall, Knight Hall West Wing (being done this summer), White Hall (has new 15kV with past renovation), Downey Hall (has new 15kV with past renovation), McIntyre Hall (has new 15kV with past renovation), Orr Hall (replace original cable) and the Washakie Center.
- It is estimated that the above immediate or short-term site electrical distribution modifications will result in a load reduction of the east MV distribution of 690 kW and an increase in the west MV distribution of 971 kW. (Based on projected locations of new and demolished facilities.) Overall campus electrical utility impact of an increased load of 281 kW.
- Replacement of MV power switches and transformers serving renovated buildings.
  - Arts and Science Building
  - Biological Science Building
  - Crane Hill Cafeteria and Crane and Hill Halls as they are renovated
  - Wyoming Student Union Building
  - McWhinnie Hall with Wyoming deconstruction
  - Ross Hall
  - Knight Hall (in process summer 2020)

  - Law (transformer outside, new switch summer 2020)
  - Education Building (High priority, to include distribution to Ed Annex)
  - Physical Sciences Building (High priority)

- Update power surge protection at all existing buildings being renovated.
- Replacement of existing metal halide exterior lighting throughout campus.
- Ground lighting around Tennis courts, baseball field, Physical Sciences, Biological Sciences, and Health Sciences and Arts and Sciences buildings.

Mid Term Improvements

- Additions and modification of existing campus MV distribution system to supply power to new buildings and modify for renovations. This work shall include new distribution and isolation switches, 15kV cables, manholes, duct banks and transformers.
  - New Lab School
  - New Bradley Street Parking Garage
  - Law School Expansion
  - Natatorium
  - Health Sciences
- Modifications to secondary electrical utilities to support the renovation to existing buildings. This work shall include new facilities low voltage distribution, emergency power, lighting modifications and upgrades and upgrades to building transformers.
  - Renovation of Bureau of Mines
  - Renovation of Engineering Building
  - Renovation of Agriculture Building
  - Renovation of Education Building
  - Renovation of the Physical Sciences Building **(West Campus Substation)**
  - Renovation of Aven Nelson Building
  - Renovation of Merica Hall
  - Renovation of Law School
  - Renovation of the Animal Sciences Building (east part)
- Modifications to primary and secondary campus electrical distribution to support the demolition of the existing UW University Police Facility, and 555 N 14th Street Graduate Research Offices.
- Replacement or expansion of the West Campus Electrical Substation. This work will take place as a part of the renovation of the Physical Sciences Building where the west substation is now housed. Possible new locations for the substation include the Bureau of Mines or perhaps modifications to the existing MDG room to allow for new gear at that location.
- It is estimated that the above site intermediate electrical distribution modifications will result in a load increase of the east MV distribution of 1025 kW and an increase in the west MV distribution of 328 kW. (Based on locations of new and demolished facilities.) Overall campus electrical utility impact of an increased load of 1634 kW.
- Replacement of power switches and transformers serving renovated buildings.
  - Bureau of Mines
  - Engineering Building
  - Aven Nelson Building
  - Merica Hall
  - Law School (will be completed summer of 2020)
  - Animal Sciences Building

Long Term Improvements

- Additions and modification of existing campus MV distribution system to supply power to new buildings. This work shall include new distribution and isolation switches, 15kV cables, manholes, duct banks and transformers.
  - New Memorial Fieldhouse Expansion
  - Four new Academic and Research Facilities (One on 19th and three on 22nd Street)
  - Replacement of the East Campus Electrical Substation. Possible new location includes the existing CEP.
- Modifications to secondary (and possibly primary) electrical utilities to support the renovation of existing Memorial Fieldhouse.
- Replacement of power switches and transformers serving renovated buildings.
- Modifications to primary and secondary campus electrical distribution to support the demolition of the existing Fieldhouse North.
- Additions and modification of existing campus MV distribution system to supply power to new south-west campus hot water boiler plant.
- It is estimated that the above site long term electrical distribution modifications will result in a load increase of the east MV distribution of 502 kW and an increase in the west MV distribution of 160 kW. (Based on locations of new and demolished facilities.) Overall campus electrical utility impact of an increased load of 662 kW.

Campus Emergency Power Production and Distribution System

Overview

The total sum of emergency generator capacity on campus is comparable to the total campus electrical load. That being said, most existing generators are oversized for the loads they serve. The electrical shop starts and transfers one generator each morning for testing. Diesel fuel is ordered only when sufficient depletion makes a refueling order worthwhile. As these generators reach their end of anticipated life and replacement is being considered, some evaluation should be given to changing the present emergency generation set up. Since most of the generators are oversized, consideration should be given to multiple buildings from a single generation point and paralleling smaller generator units to avoid wet stacking on under-loaded units.

Known Deficiencies

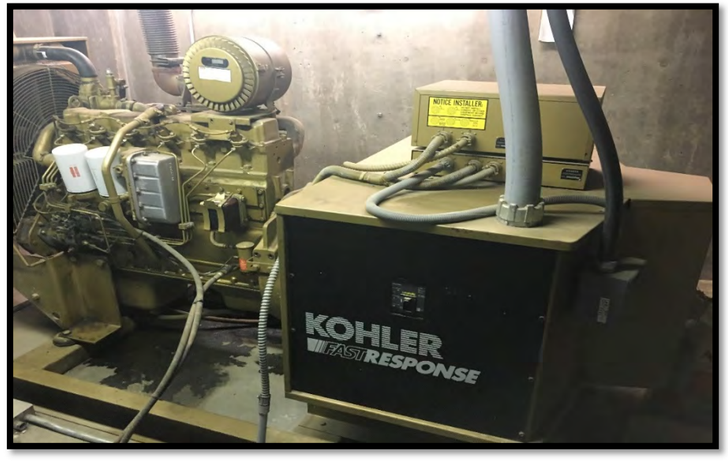
- Poor performance as determined by the service technicians.
- Improper NEC 700, 701 and 702 separations as observed in the field.
- Problems switching and returning to normal power. Controls issues as explained by building operators.
- Fuel limitations.
- Unclear distribution systems. Lack of appropriate single line diagrams to indicate how the generators feed certain buildings.
- Improper circuit breaker sizing which result in unprotected conductors.
- Fire pumps not connected to generator backup. (There has been some waffling in the past, but we understand that the fire marshal no longer considers the utility to be a reliable source of power, so – per NEC – the pumps need a separate power source.) Plans should be made to provide emergency power to existing fire pumps that are not currently connected to generators.

  Fire pumps not on generator:

  - 100 hp in Physical Sciences
  - 75 hp in Pharmacy that also serves Health Sciences
  - 75 hp Earth Sciences that also serves Health Sciences.
  - 100 hp Coe Library
  - 75 hp in Agriculture
  - 75 hp at STEM Unsure as we couldn't find feed from generator.
  - 50 hp at Anthropology- ATS available but no generator feed?
  - 60 hp at EERB Unsure as it has an ATS but couldn't locate feed.
  - 40hp in Animal Sciences Molecular Biology (normal feed is downstream of the MCB and therefore not NEC-compliant)
  - 100 hp serving McIntyre and Orr (any necessary upgrades until buildings demolition)
  - 100 hp serving White and Downey (any necessary upgrades until buildings demolition)
  - 100 hp in Engineering diesel, installed in 1980 is ready for replacement.

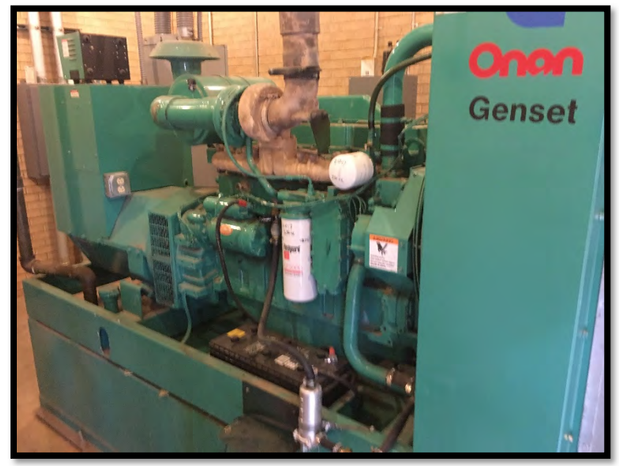
Problematic Generator Systems:

Observations: Most generators have plenty of spare capacity. A centralized system would require significant investment. UW may look to consolidate generators by serving multiple buildings. Systems are often not properly separated into NEC 700, 701 and 702 systems, even with the newer installations.



- Berry
  - Generator is new and functions well, but the systems are not separated.
  - The generator feeds to Physical Sciences, Biological Sciences and Arts & Sciences emergency loads from an emergency panel located outside of Berry close to the generator. Empirical testing indicates that loss of power in any of the three buildings starts the generator. If the NEC 700 violations in the other two buildings are not corrected, at a minimum, a single line diagram should be displayed in the Berry emergency room to clarify how all these buildings' emergency systems are derived.
- Earth Sciences
  - The generator feeds to Health Sciences Center and Classroom Building.
  - fails to separate all systems.
  - unclear distribution without a single line diagram.
- Coe Library
  - Underperforming. 2011 Generac natural gas.
  - Better labeling of distribution required.
  - Breaker feeding Radio station does not properly protect the switch in Knight. Downsize breaker or upsize switch.
  - Business is backed up by the Coe generator.
  - Coe has potential to for emergency backup of multiple additional buildings including Ross, Merica, Health Services, Old Main, Aven Nelson and Knight.
- Energy Innovation
  - #1 AWGs are not adequately protected by 225A breaker at the emergency ATS. This must be corrected.
- STEM
  - Belly tank is too small.
  - It is believed that smoke evacuation loads are fed from ATS-LS.
- Vet Lab (West Laramie)
  - Controls issues. Clayton not coming up after transfer to normal.
- Centennial Hall
  - 800A generator breaker does not protect 600A ATS.
- Visual Arts
  - 250A generator breaker to ATS-S is oversized. Does not protect #3/0 AWGs.
- UW Conference Center
  - UW coordinating taking over the generator maintenance.

- Generator also serves Hilton.
- If Hilton has fire pump, it does not appear to be powered by the generator.
  - Agriculture
- 1980 installation.
- Beyond useful life.
  - Animal Sciences/Molecular Biology
- 1987 installation
- Unable to carry full load.
  - Engineering
- 1980 installation.
- Beyond useful life.
  - Red Buttes
- 1994 installation, used
- Beyond useful life.
  - Residence Halls
- 1989 installation, used
- Beyond useful life.



Short Term Improvements

- Provide Emergency Power to unbacked up buildings. The following list of facilities do not have sources of emergency power and emergency generators should be considered for reliable back-up during unplanned utility outages.
  - Aven Nelson / Williams Conservatory
  - Bureau of Mines
  - Old Main (will be added to the Coe/COB emergency generator)
  - Student Health / Cheney International Center (will be added to the Coe/COB emergency generator)
  - Merica Hall
  - Hoyt Hall
  - Knight Hall (will be added to the Coe/COB emergency generator)
  - Ross Hall (will be added to the Coe/COB emergency generator)
  - Education Classroom Literacy Center
  - Education Building
  - McWhinnie Hall
  - Law (completed by the summer of 2020 (BCPA genset))
  - Corbett PE (completed by summer 2020 (BCPA genset))
  - Memorial Fieldhouse
- Correct one-line diagrams and improve labelling of all emergency equipment to clarify what buildings are backed up by emergency generators. Several of the above facilities are located and oriented such that a single emergency generator may be able to serve multiples. Each facility should be evaluated as to its emergency requirements to determine the most feasible solution for emergency power.
- Replace existing Emergency Power generators on existing buildings that have reached or will soon reach their end of useful life.
  - Ag C Building Addition Generator – Installed ~1980, currently past estimated life expectancy of 30 years and should be replaced as soon as possible.
  - Engineering Building Generator – Installed ~1980, currently past estimated life expectancy of 30 years and should be replaced as soon as possible.

- Engineering Fire Pump Generator – Installed ~1980, currently past estimated life expectancy of 30 years and should be replaced as soon as possible. This is a generator driven fire pump that should be replaced with an electric motor driven pump with back-up generator.
- Animal Science / Molecular Biology Building Generator – Installed ~1987, currently past estimated life expectancy of 30 years and should be replaced as soon as possible.
- AHC (Centennial Complex) Generator – Installed ~1993, will be reaching estimated life expectancy of 30 years within the next four years and should be replaced within that time frame. Attention is required to address the 600 amp ATS being fed from an 800-amp generator breaker as soon as possible.
- Red Buttes Generator – Installed ~1994, used unit at a site that is remote from the campus. This unit should be replaced as soon as possible.
- RMMC Generator – Installed ~1994, will be reaching estimated life expectancy of 30 years within the next five years and should be replaced within that time frame.
- Earth Sciences Building Generator – Installed ~1997, will be reaching estimated life expectancy of 30 years within the next seven years and should be replaced within that time frame.
- Crane Hill Generator – Installed ~1989, currently reaching estimated life expectancy of 30 years and should be replaced as soon as possible.
- RLDS (Residence Halls) Generators – Installed ~1989, considering current plan to demolish these building within the next 5 to 7 years' recommendation is to maintain existing generator for short term until buildings de-commissioned.
- Vet Lab Old USDA Area 300 Generator – Installed ~1990, currently reaching estimated life expectancy of 30 years and should be replaced as soon as possible. Attention is required to address the control issues preventing Clayton from coming up after transfer to normal power as soon as possible.

- Enzi/STEM (Michael B. Enzi STEM undergraduate Lab Facility) Generator – Investigate lack of connected loads to 'ATS-LR'. Installed ~2012, undersized fuel capacity and has been a problematic unit that damages equipment during transfer and should be considered for replacement as soon as possible to provide reliable back up power.
- Energy Innovation - #1 AWG conductors are not adequately protected by a 225-amp breaker at the ATS. This condition should be corrected as soon as possible.
- Visual Arts - The 250-amp generator breaker does not adequately protect the connected #3/0 AWG conductors. This condition should be corrected as soon as possible.

- COB/Coe Library Generators – Installed ~2011, Generac units that have been extremely problematic and cause equipment damage during load transfers. To avoid extensive maintenance and equipment repairs and replacements these units should be replaced as soon as possible.
- Provide Emergency Power to fire pumps that are not currently connected to emergency generator back up. In addition, it is recommended that variable frequency drives be added to all fire pumps to reduce starting loads and improve performance.
  - 100 hp in Physical Sciences
  - 75 hp in Pharmacy that also serves Health Sciences
  - 75 hp Earth Sciences that also serves Health Sciences.
  - 100 hp Coe Library
  - 75 hp in Agriculture
  - 75 hp at STEM - Couldn't find feed from generator.
  - 50 hp at Anthropology- This should be corrected during the West Campus Satellite Plant construction.
  - 60 hp at EERB - Has ATS but couldn't locate feed. Further evaluation required.
  - 40hp in Animal Sciences Molecular Biology (normal feed is downstream of the MCB and therefore not NEC-compliant)
  - 100 hp serving McIntyre and Orr (maintain until buildings demolition)
  - 100 hp serving White and Downey (maintain until buildings demolition)
  - 100 hp in Engineering, diesel, installed in 1980 is ready for replacement.

- The existing fuel station located adjacent to the CEP is utilized to store fuel for the campus generators. The underground storage tanks have exceeded their useful life and are recommended to be replaced with above ground storage.

Mid Term Improvements

- Replace existing Emergency Power generators on existing buildings that have reached their end of useful life.
  - Rochelle Athletic Center (RAC) Generator – Installed ~2002, will be reaching estimated life expectancy of 30 years within the next thirteen years and should be replaced within that time frame
  - Wyoming Student Union Generator – Installed ~2002, will be reaching estimated life expectancy of 30 years within the next thirteen years and should be replaced within that time frame.

Long Term Improvements

- Replace existing Emergency Power generators on existing buildings that will reach their end of useful life.
  - ITC Generator– Installed ~2006, will be reaching estimated life expectancy of 30 years within the next seventeen years and should be replaced within that time frame.
  - Anthropology Generator – Installed ~2008, will be reaching estimated life expectancy of 30 years within the next nineteen years and should be replaced within that time frame.
  - Plant Science Green House Generator – Installed ~2008, will be reaching estimated life expectancy of 30 years within the next nineteen years and should be replaced within that time frame.
  - Vet Lab Generator – Installed ~2008, will be reaching estimated life expectancy of 30 years within the next nineteen years and should be replaced within that time frame.
  - UW Conference Center Generator – Installed ~2008, will be reaching estimated life expectancy of 30 years within the next nineteen years and should be replaced within that time frame.
  - Visual Arts Generator – Installed ~2009, will be reaching estimated life expectancy of 30 years within the next twenty years and should be replaced within that time frame.
  - Engineering 105B Generator (Piri's Lab) – Installed ~2009, will be reaching estimated life expectancy of 30 years within the next twenty years and should be replaced within that time frame.
  - Energy Innovation Center Generator – Installed ~2009, will be reaching estimated life expectancy of 30 years within the next twenty years and should be replaced within that time frame.
  - Wildcatter Suites Generator – Installed ~2011, will be reaching estimated life expectancy of 30 years within the next twenty-two years and should be replaced within that time frame.
  - Buchanan Center for the Performing Arts Generator – Installed ~2011, will be reaching estimated life expectancy of 30 years within the next twenty-two years and should be replaced within that time frame.
  - Wyoming Technology Business Center (WTBC) Generator – Installed ~2005, will be reaching estimated life expectancy of 30 years within the next sixteen years and should be replaced within that time frame. This data center is indicated as no longer in use.
  - All remain site generators have been installed within the past 5 to 7 years and should not require replace within the next twenty-five years.

Campus Roadway and Area Lighting

Overview

Existing Lighting on the University of Wyoming campus is currently served by either LED or Metal Halide lighting. The existing metal halide lighting is being replaced with LED lighting as the opportunity arises. Roadway lighting is supplied by Rocky Mountain Power. The majority of the roadway lighting is low pressure sodium and fed directly from the utility pole. Due to the size of the campus multiple styles of pole, pole bases, pole heights, and fixture styles are being utilized. A campus standard has been identified for pole bases that are more decorative in style in areas that are high in pedestrian traffic.
The majority of the lighting on campus is "cut-off" or "full cut-off" and thereby meets the standards of the City of Laramie. **See Appendix EL-01** for a campus map identifying the types and locations of existing area lighting.

Existing control of area lighting is via astronomical time clock. The stadium parking lot lighting was utilizing a Lutron control scheme that was never fully functional. Roadway lighting provided by Rocky Mountain Power is controlled via fixture mounted photo controls.

Known Deficiencies

The lighting to the west of the Mines building is poorly lit and can present safety issues. Roadways and crossings that are lit by Rocky Mountain Power lighting are poorly lit with low uniformity and in some cases, such as the walkway on Willet drive directly behind fraternity row are unlit. The LED lighting in the dirt parking lot east of the stadium is poorly lit with very low uniformity. Parking areas at Fraternity and Sorority row are not lit in some areas.

Lighting fixtures around the Outdoor Tennis Courts, Cowboy Baseball Field, Physical, Bio, Health and Arts, and Sciences were fed by a 2-wire system and metal conduit. These feeds lack a ground wire and present a shock hazard. This should be re-fed to include a ground wire as soon as possible.

Identification of Strategies

The change out of existing metal halide lighting to LED will continue as the opportunities present themselves. Where possible existing electrical feeds, poles, pole bases, and building mount locations should be reused to reduce replacement costs of the lighting fixtures. Areas that lack proper lighting should be addressed, especially those areas served by Rocky Mountain Power, crosswalks, sidewalks, and bus stops. Standards for lighting fixtures, color temperatures, pole heights, pole bases, and pole styles should be identified to maintain a consistent style throughout campus.

To have better control over maintenance needs, it is recommended that the University remove themselves from the Rocky Mountain Power controlled roadway lighting.

Campus Fire Alarm Network

The fire alarm system is well-maintained. We noted only a handful of buildings (Aven Nelson and Education) that were in dire need of upgrades. As existing buildings across the campus are renovated their associated fire alarm panels and components should be updated.

Short Term Improvements

- Upgrade fire alarm systems of Aven Nelson and Education buildings.

Mid Term and Long Term Improvements

- Continue fire alarm system maintenance and upgrade of systems as necessary.

Campus Communications System (Fiber)

Overview

The data and communications network for the site utilizes the existing tunnel system as its main route around the east and west campus. Duct banks from the existing tunnel system to each of the individual building provide pathways to bring fiber data lines from the tunnels to the individual building data closets/rooms.

Immediate (Short Term) Needs

- Additions and modification of existing campus fiber communications systems to supply data to new buildings including:
  - New Service Facilities
  - Student housing along 15th Street
  - Student Union addition
  - Knight Hall West Wing addition
  - New Ivinson Garage Facility
  - New Fieldhouse
  - Modifications and relocations due to Wyoming Hall deconstruction
- New fiber will be routed from existing utility tunnels and new conduit runs for new buildings and from existing data rooms in existing renovated buildings.
- Support data re-routing due to tunnel modifications.

Intermediate Needs

- Additions and modification of existing campus fiber communications systems to supply data to new buildings including:
  - New Lab School
  - New Bradley Street Parking Garage
  - Law School Expansion
  - Natatorium
  - New Health Sciences Building
  - New Research Buildings

  New fiber will be routed from existing utility tunnels for new buildings and from existing data rooms in existing renovated buildings.

Long Term Needs

- Additions and modification of existing campus fiber communications systems to supply data to new buildings including new Memorial Fieldhouse Expansion. New fiber will be routed from existing utility tunnels for new buildings and from existing data rooms in existing renovated buildings.

Campus Potable/Fire Water System

Overview

The University of Wyoming (UW) falls within the boundary of the City of Laramie's domestic water distribution system and therefore ownership lies with the City. The UW campus, with its central location, is effectively surrounded by adjacent City of Laramie potable water infrastructure, and as a result completely dependent on the City's water distribution system as it is supplied with potable water from numerous direct feeds around campus. In total, there are 16 master water meters located around the University along with a few direct metered buildings. From west of 22nd to 9th Street, there are 12 master meters that are essentially interconnected and two others that tie in buildings north of Willett Drive and east of 19th Street. Additionally, two others tie the area south of Willett Drive to Arrowhead Lane and east of 22nd Street to 30th Street. Being centrally located within the City of Laramie and its water distribution system, allows the campus to have flexibility when it comes to expansion. There are no real constraints to speak of outside of the general ability of the City's system to continue to deliver required minimum pressures and fire flows to the campus as it grows beyond its current boundary. According to the *Laramie Water Masterplan Level I Study*, completed in 2015 by WWC Engineering, the City currently has capacity to meet the domestic water demands for a planning horizon year of 2050.

Known Deficiencies

As indicated, the main deficiency the University is experiencing with the potable water distribution is the existence of undersized (6") aging cast iron water mains on campus. There are two primary sections of this deficient water main, the first originating east of Wyoming Hall where it goes westward past Prexy's Pasture to the Health and Science Center where it turns south and goes by Old Main, and then finally back down to the east end of Ross Hall. The second section starts at 15th Street and Fraternity Row (FR) where it then goes east down FR and loops back west to about midway along Sorority Row. There are additionally some undersized cast-iron mains located in Willet Drive from approximately the parking lot north of the Law Building to just west of the UW Telecom Building. There are also some known deficiencies within certain areas of City's pressure distribution zones. These areas of deficiency, as defined in the 2015 City Comprehensive Plan, are experiencing low water flows while meeting the peak water demands of the system or are not able to produce a required fire flow. These fire flow deficient areas are those that cannot meet the flow requirement but do the minimum pressure requirement of 35psi.

Source and Delivery Characteristics

The UW campus falls primarily within the City's Zone 2 pressure boundary which is supplied from two water tanks located on the east end of Willet Drive. These water storage tanks supply two City 16" water mains that serve as the domestic water supply pipelines for the campus. The first of these 16" mains runs westward under Grand Avenue from 30th Street to 9th Street, and the second main runs northward along 30th St. and then west across campus along Willett Drive and Lewis St.

There is a portion of the campus that does receive Pressure Zone 1 water which is supplied from an 8 MG reservoir located along east Grand Avenue. A boundary between city Pressure Zone 1 and Pressure Zone 2 is located along a portion of the current west and north campus boundary. Future campus development will therefore take place in areas that are currently within City Pressure Zone 1 which has been a more problematic zone as it relates to pressures and fire flows. A map of the current campus domestic water system is shown in **Appendix WA-01**.

Existing Loading and Capacity

Based on discussions with UW personnel, the existing loading on the potable water distribution system appears to be sustainable and demand is being met from a pressure standpoint. There have been longstanding issues with some of the hydrants around campus not meeting required fire flows as documented in the original 2009 UMP. Based off the campus growth in the last 10 years and given the minor changes to the water distribution system, it is anticipated that many if not all the same hydrants have the same lack of capacity in 2019. Updated WaterCAD models were completed which evaluated existing water pressures and fire flows across the campus distribution system. In 2009 existing water usage was estimated by using diversified load factors for each building but for the updated modeling actual University water usage was able to be obtained from the City of Laramie and incorporated into the model. Additionally, the model was updated with current water system components. A copy of the water usage tables used in modeling can be found I **Appendix 2.1**.

The capacity of the University to continue to provide serviceable pressures and fire flows is primarily controlled by the capacity and condition of the overall City water distribution system, and as previously mentioned, the 2015 Laramie Water Masterplan indicates the system currently has capacity to meet 2050 horizon year demands.

Offsite Improvements

The City of Laramie North Tank Project which is still in the planning phase and tentatively scheduled for completion in 2021 or 2022, will provide the City of Laramie water distribution system with better pressure and increased capacity for required fire flows for existing areas as well as future growth. The North Tank Project is expected to provide a 1 MG buried concrete water storage tank, 22,000 lineal feet of transmission pipeline (12" to 24") and will be tied into current Pressure Zones 1-3.

Future Projected Load Growth

Future load growth values were calculated using gross square footage (GSF)estimates for future planned buildings on campus. Sasaki developed short term, midterm, and long term growth plans for the University and those plans were provided to the team for modeling of future utility demands. Future domestic water demands were calculated by multiplying diversified load factors by the GSF of the different planned buildings. These demands were then incorporated into the WaterCAD models at locations that corresponded to future building locations. Based on the project growth plans development will primarily be centered around west campus and when complete will produce 450+ GPM of additional water demand.

Modeling Approach

As previously mentioned, the future demand of 450+GPM was brought into WaterCAD and scenarios developed in order to determine where pressure and/or fire flow deficiencies may exist. The different scenarios that were evaluated are described as follows:

- Scenario F1 – Looked at average daily demand with existing and future fire flow demands
- Scenario F2 – Looked at peak daily demand with existing and future fire flow demands
- Scenario F3 – Looked at peak daily demand with irrigation, existing fire flow, and future fire flow demands
- Scenario F4 – Same conditions as F3, but looked at increasing existing 6" mains to 8"
- Scenario F5 – Same conditions as F3 but looked at increasing existing 6" mains to 10"

Modeling Assumptions/Constraints

For modeling purposes certain assumptions had to be made about the existing and future conditions of the water distribution system and they were:

1. Demand was fixed not variable (data on variable demand for the campus is not available)
2. Fire flow demand nodes were placed every 400ft along anticipated future waterline loops (typical hydrant spacing)
3. A required minimum fire flow of 2,000GPM (based on assumed future building size and material – 2018 IFC)
4. A majority of the 450+GPM of future demand was distributed along the west side of campus
5. A peaking factor of 2.7 was used for determining peak daily demand
6. Model was limited to 250 system pipes (license limitation)

Modeling Results

The WaterCAD modeling results largely appear to agree with the previously described deficiencies within the current system. Scenario F3 which is effectively a "worst case scenario" from a demand standpoint indicated in several areas across campus, where old undersized water mains exist, that achieving minimum serviceable pressures and required fire flows would likely not be possible given existing conditions. Scenarios F4 and F5 suggested replacement and upsizing of these old undersized mains would allow the system to better meet the additional pressure and fire flow demand from campus growth with the upsizing to 10" mains being the most impactful. A screen image of the system modeling can be seen in **Appendix 2.2** of this report. Actual junction (pressure) and fire flow reports can be produced at the request of University.

Recommended Improvements

Given that much of the old undersized watermains that were indicated as problematic in the 2009 UMP are still in use and have not been replaced, it is paramount that in the near term that this infrastructure be upgraded. Since the last utility study was performed the campus has continued to develop and expand without an equitable improvement in the water distribution system. On top of that, considering there are several large residential projects (UW Housing) scheduled to be completed in the next few years on the west side of campus the demand and subsequent stress on a system that has been showing signs of inadequacy for years is only going to get worse. Given all these conditions it is recommended that the following near and midterm improvement be made:

- Upsize/replace older 6" cast-iron water mains located around Prexy's Pasture to at least 8" PVC mains.
- Upsizing/replacement of 8" mains located along Ivinson Ave, 9th Street, and 15th Street to 10" PVC mains.
- Remove old 8" CIP main from Lewis Street to north of College of Business to get it off campus property.
- Extension of new water mains along and into15th Street, Bradley Street, and Flint Street (Ivinson to Gibbon) with 12" being preferred but 10" being the minimum needed. This will establish new utility routing and allow UW to grow north of Lewis and allow the City of Laramie to vacate some of the utilities located in the area.
- Replace and upsize old 6" and 8" mains in fraternity and sorority row to 10" (minimum) when streets are rebuilt.
- Extend 10" water main up into area between 19th and 22nd Street (north of Willet Drive) to accommodate future growth that is projected for this corridor.
- Continue to look for opportunities through utility projects to get the entire campus of master meters and individually meter buildings which will help in the future better identify system issues which in turn will help with overall system management. This will include the installation of back flow prevention valves on both fire and domestic lines.

As for long term recommended improvements, the University will need to continue to monitor its infrastructure and identify aging components in relationship to where future campus growth is heading. The University needs to continue its efforts to phase out the old master meters and replace them with City meters. This would include the installation of required back flow preventer valves at each of these locations as UW is still responsible for the operation of the lines between the meters and the buildings. While currently the majority of campus has adequate pressure and fire flow protection, 20 years from now newer infrastructure may be reaching its serviceable life and new campus development may warrant the expediting of system upgrades. It is recommended that the campus continue to develop and improve its GIS utility mapping system as well as build a robust WaterCAD model of the entire campus water distribution system. This model could then be updated annually via the updates in the GIS mapping and be calibrated periodically with real pressure and fire flow testing results.

Sanitary Sewer System

Overview

The University of Wyoming campus sanitary sewer collection system is owned and maintained by the University where it doesn't fall within the City of Laramie's Streets (Right-of-Way). As indicated by the split ownership, the existing UW sanitary sewer collection system intermingles with the City's system. There are City sewer lines and manholes than are located in public streets that enter campus as well as on the peripheral. As a result of its central location, eventually all campus wastewater discharges into the City's collection system and thus is completely dependent on the capacity and condition of downstream municipal sanitary sewer infrastructure.

Given the fact that the City's sanitary sewer collection system surrounds and receives essentially all wastewater from the campus, there is a constraint on the University's ability to upgrade the conveyance capacity of its system components. Downstream public infrastructure will have to be upgraded in symmetry with UW system upgrades in order for those enhancements to be fully realized and benefited from.

The existing University sanitary sewer collection system and portions of the City of Laramie sanitary sewer collection system consist of around 400+ manholes with connecting gravity flow pipelines of various diameters, material, and condition. The campus sanitary sewer collection system discharges into the City collection system, at various locations, where it all ultimately gets conveyed to the City wastewater treatment plant. The campus is located east and somewhat south of the treatment plant. A map of the current campus sanitary sewer collection system is shown in **Appendix SS-01**.

Based on comments from UW staff, the general consensus is the sanitary collection system works adequately and the City system has the capacity to currently accept and treat their wastewater production. There is a general concern, however, about aging infrastructure and future capacity to serve campus growth. The University has expressed a desire to line many of these older sections of sanitary sewer which will be addressed later in this report.

Known Deficiencies

Besides general aging and deterioration of system components, there are some specific areas of concern when it comes to the campus sanitary sewer collection system. Many of these areas were previously identified and described in the 2009 UMP but, according to UW personnel, still need to be addressed. The known issues are as follows:

- Two existing westward-flowing gravity sanitary sewer lines under King Row, which convey both campus and City wastewater, are old and in poor condition and are more than likely overloaded;
- Near the southwest corner of Corbett, a 10" diameter gravity line and a 12" diameter gravity sewer line discharge into a manhole from which a single 10" diameter gravity sewer line conveys wastewater westward;
- A similar condition exists southeast of the stadium, where two 10" diameter lines discharge into a manhole from which one 10" diameter line conveys wastewater westward;
- North of Crane Hall, a westward-flowing 12" diameter gravity sanitary sewer line discharges into an 8" diameter line;
- Undersized 8" diameter and 10" diameter King Row lines extend westward down Ivinson Avenue, resulting in surcharging during periods of peak wastewater discharge;
- Past repairs to the Physical Sciences sanitary sewer service line were not full encompassing and restrictions still are evident within this line;
- A confluence of major gravity sanitary sewer lines from the stadium and the field house does not occur inside a manhole, thereby rendering assessment and maintenance of these lines impossible;
- An existing 6" diameter vitrified clay pipe (VCP) gravity sanitary sewer line that runs westward from the Arts & Sciences building beneath the Biological Sciences building is in poor condition and cannot be maintained properly because of its location beneath the Biological Sciences building;
- The impact of tree roots on the sanitary system is a continuous issue.
- The Washakie Dining Center poses a continuous clogging issue. It is apparent to UW staff that all grease is not being collected at this facility and the sanitary systems in the area continuously clog. (It should be noted this facility is scheduled for future demolition which will eliminate this issue)

Source and Delivery Characteristics

The campus sanitary sewer collection system discharges by gravity into the City collection system, and campus domestic wastewater is conveyed to and treated at the City wastewater treatment plant. The campus is located east and somewhat south of the treatment plant. Sanitary sewer lines in the southern and eastern portions of campus generally discharge southward into the City sanitary sewer lines in Grand Avenue, which flow in a westerly direction. Sanitary sewer lines in the older northwestern portion of campus typically discharge westward or northward into the City sanitary sewer lines in existing residential districts.

Existing Utility Loading and Capacity

The University does not currently meter their sanitary collection system flows and so in order to perform an existing loading/modeling analyses, this type of information would need to be made available along with a thorough inflow and infiltration study. However, based on discussions with UW personnel, the wastewater collection system seems to generally accept and convey the current campus production. Existing capacity is adequate outside of a handful of areas where lines are potentially undersized which UW will need to continue to work to upsize when projects and funds become available. Overall sanitary sewer collection capacity for the University will be dependent on downstream City infrastructure improvements. There are a few future projects that the City will be completing that will potentially increase campus capacity.

Offsite Improvements

Future City of Laramie sanitary sewer infrastructure improvement projects that will potentially improve conditions for the University's collection system include extension and upsizing of the "C-Line", "B-Line" and Reynold Street sanitary trunk mains which all when complete will provide much needed downstream sanitary sewer capacity. No timetable has been set on those projects to date. The University desires to grow north of Lewis Street (between 9th and 15th) and to do so will need to create new sewer utility corridors either along Bradley, Flint or Gibbon to allow the for ease of City vacation of the existing utilities that exist in the area.

Future Projected Load Growth

Once again diversified load factors were applied to GSF values developed by Sasaki which produced future wastewater demand values for the campus. As expected, sanitary growth patterns followed that of the water system with the majority of growth centering around west campus. In total future planned campus growth will produce 350+GPM of additional sanitary sewer demand and it is anticipated that without various system improvements some areas of the University will not be able to accommodate said demand.

Recommended Improvements

Considering that much of the 350+GPM of impending sanitary sewer production is anticipated to be in the near to midterm future, it is recommended that at a minimum the University focus on improving the following areas of the existing sanitary sewer system:

- Upsizing/replacement of 8" sewer mains located along Ivinson Ave, 9th Street, and 15th Street to minimum10" mains (City may want to upsize to 12") primarily to accommodate the coming student housing development projects.
- Upsizing/replacement of old clay mains in Ivinson Avenue (varying sizes) at least to a 10" but preferable 12" main
- Upsizing/replacement of sewer mains along 15th Street from 8" to preferable 12" but at a minimum to 10" lines to allow for more growth along these corridors
- Replacing and upgrading the undersized sanitary mains under King's Row to a 10" lines, ideally when the street is rebuilt
- A possible grease interceptor south of the Washakie Center if any food service operations remain in this location after the new dining hall is constructed
- Prioritize old sewer mains (that are not undersized) for lining in order to mitigate future failure and extend the life of aging infrastructure
- Establish a new sanitary sewer corridor along Flint Street to accommodate future growth north of Lewis Street, with the installation of at least 10" mains but preferably 12"
- Extend sewer main (8") north of Willett Drive between 19th and 22nd Street to service future potential research buildings as there is no existing sewer in any of the surrounding streets
- Continue to work towards fixing the additional known deficiencies (as described earlier) that are not specifically mentioned in these recommendations

As for long term, it is vital that University know and understand the condition and capacity of its sanitary sewer collection system beyond observations made by utility personnel. It recommended that the University implement continuous flow metering at key locations across campus so actual data can be compiled which will better identify where and when sewer mains are nearing capacity and allow the University to better prioritize upgrade/replacement of system components. As mentioned earlier in this report the campus sanitary sewer system discharges into the City's collection system which makes its ability to continue to expand (with inevitable future campus growth) dependent on off campus downstream infrastructure. Not unlike the University the City has issues with aging utility systems that are struggling to meet current demand let alone future projected demand. Now while the City has begun to address some of these issues through projects such as the B-Line and C-line, it will be important the University continually coordinate with the City on its future development plans and work with them to address potential utility constraints so it does not slow down or impede campus growth. One such area that has been identified as being a potential bottleneck for sanitary flow is the main at 6th and Gibbon (18" main that has an 18"and 12" main coming into it).

Storm Water System

Overview

The University of Wyoming (UW) campus storm sewer collection system is owned and maintained by the University where it doesn't fall within the City of Laramie's Streets (Right-of-Way). Similar to the sanitary sewer, the existing UW storm sewer collection system interconnects with the City's system. With City storm infrastructure located around the perimeter as well as down many streets that are internal to the campus, all University storm water discharges into the City's collection system. As a result, UW is entirely dependent on the size and condition of downstream City storm management infrastructure. The central location of the University and its storm water collection system severs as a constraint when it comes to future campus expansion as it will be controlled by downstream municipal storm infrastructure. Certain sections of campus are already seeing this constraint and is affecting current development.

The existing UW campus storm water management system consists of approximately 390+ manholes and catch basins with connecting pipelines, and storm water management devices such as swales, detention ponds, and sump pumps. The campus storm water management system is intended to collect and discharge campus storm water runoff into the surrounding City of Laramie collection system. A map of the current campus storm sewer collection system is included within **Appendix SW-01**.

Similar to sanitary, based on comments from UW staff, the storm water collection system is considered functioning and serviceable as of 2019, but there is a general concern however, about the potential for current infrastructure to fail and enough future capacity to serve campus development. The University would like to see some of the storm lines around campus lined to extend their useful life as well as look at some current areas of campus where storm water management is a challenge and find ways to improve those conditions.

Known Deficiencies

Besides general concern of maintain aging infrastructure and capacity limitations being applied to the University by limiting City of Laramie storm water infrastructure, there are a few specific areas of concern when it comes to the current management scheme. These areas are as follows:

- The Willett St./15th St. corridor
- The area between the Arena Auditorium, the football stadium, Memorial Field House, and the Law Building
- The field located south of the Fieldhouse which serves as a detention pond
- The east side of the Health Sciences Complex
- The area located north of Arts and Sciences and the Physical Sciences buildings; and
- The Ivinson Avenue corridor
- The Lewis Street corridor

Many of these problematic areas were previously identified and studied in the 2009 UMP, but according to recent conversations with UW staff, still need to be addressed.

Source and Delivery Characteristics

As described earlier in this report, the UW storm management system consists of storm sewer pipes, inlets, catch basins, swales, and detention ponds that ultimately discharge storm water by gravity into the adjacent City collection system.

Existing Utility Loading and Capacity

Existing loading on the University storm water management system varies by each individual storm event and the runoff it produces. For smaller recurring storm events (typical precipitation seen year to year) the existing infrastructure appears to generally convey storm water effectively off campus and into the City's collection system. For larger storm events (10-100yr recurring storms) it has been observed in certain areas of campus that storm water management devices do not perform as well and temporary localized flooding has occurred. However much of the poor performance was contributed to improper maintenance of storm water infrastructure (i.e. clogged inlets) which was well documented in the 2009 UMP.

Overall storm sewer collection capacity for the University will be reliant on downstream City infrastructure improvements. There are several future projects that the City has had recommended via the drainage masterplans previously mentioned to improve the functionality of the City storm water management system, and it will be critical that these projects are completed in symmetry with future campus growth in order to assure increased runoff production can be serviced.

Offsite Improvements

There are several improvements that the 2013 North Laramie and 2017 South Laramie Drainage Masterplans lay out for the City that would improve the condition and performance of the University's storm water collection system. The recommended improvements include:

- Extension of 24" storm main up to Jacoby Golf Course Pond Outlet
- Upsizing of 22nd Street storm main to 6'x4' box culvert (Rainbow to Spring Creek Channel)
- Upsizing of 21st Street storm main to 36" (Rainbow to Spring Creek Channel)
- Upsizing of storm main at Ivinson and 5th Street to 36"
- Upsizing storm main at 11th and Gibbon Street to a 60" RCP
- Upsizing of additional downstream trunk mains

Future Projected Load Growth

The previous 2009 UMP did a good job of breaking the campus into several basins that looked at pre and post development conditions and found that much of the projected growth would not significantly increase runoff in regard to historic (preconstruction) discharge rates. Based on the most recent campus development plans it was determined that the projected growth both in type and quantity fell within the same boundaries and assumptions made in the previous report and thus basins and developed runoff values are still valid and can be referenced in said report.

Recommended Improvements

While is anticipated that the majority of future building/site development around campus, if planned appropriately and best management practices implemented, will not significantly increase or impact the existing campus stormwater infrastructure, it is crucial the University focus on replacing and rehabilitating existing aging infrastructure to maintain acceptable levels of service as well improve the overall connectivity of the storm sewer collection system across campus. The following items represent recommended near and midterm improvements:

- Enhancement/extension of stormwater infrastructure along 15th, Bradley, Flint, Lewis, and 9th Street (18"-24" mains)
- Install new storm sewer along Fraternity and Sorority Row if and when the streets are rebuilt
- Tie-in drainage of Law Building parking lot and catch basins along Willet Drive into Frat/Sorority Row storm sewer
- Develop some storm sewer infrastructure (12"-18" mains w/ area and curb inlets) on the south side of Willet Drive and tying it into the new Fraternity row sewer to alleviate runoff in this area
- Extend storm sewer (18"-24") main north of Willet Drive (between 19th and 22nd Street) where future growth is projected to occur.
- Prioritize existing storm sewer mains for lining in order to mitigate future failure and extend the life of aging infrastructure.
- Identification and development of surface runoff detention areas within landscaping/open areas for new building development

As for long term recommendations, it is again important the University track and monitor the condition and capacity of its stormwater collection system; implementing permanent flow metering in primary sanitary sewer mains across campus would help in predicting volume issues and better plan for where and when future system upgrades will need to be made. Also given that The University's stormwater system is reliant on the downstream performance of the City system. It is highly recommended the University work closely with the City on current and future infrastructure projects that will benefit both. East campus is highly underserved from a storm sewer perspective and relies heavily on surface runoff and detention areas, however if campus growth accelerates beyond the current proposed developments (Fieldhouse and Service Building) it may become necessary for UW to begin looking at a large storm sewer infrastructure project that extends existing lines into these underserved areas.

Campus Natural Gas System

Overview

A majority of the buildings on campus have natural gas supplies for various uses, including but not limited to, central plant boiler, electric generators, heating, lab use, and hot water production. Natural gas is supplied to the campus by Black Hills Energy. The majority of gas supply is brought to a meter and regulator at individual buildings. There are few master meters noted on campus. All lines up to the gas meters are public lines under the jurisdiction of Black Hills Energy. Lines from the meter to the buildings are University service lines.

A campus walking survey occurred the week of April 1, 2019. Utilizing existing building plans and GIS mapping, verification and an update of all data was performed using GIS data collection, photography and field notes. Interviews with campus facilities staff also took place throughout the survey period. The current data collection was amended to include gas lines no longer in service, new gas meters not located within the current documentation and adjusting locations as necessary for better accuracy. In some locations, bluestake markings for gas lines were discovered and documented to the extent possible and are included in the GIS inventory.

Notable differences in documented data and field verified gas services include a gas meter and regulator at the southeast corner of the History building, the addition of gas lines at Bison Run Village and River Village, and documentation of the regulator station north of Harvey St, that feeds the Central Energy Plant. Through interviews, concerns were noted regarding the lack of cathodic protection on the lines maintained by Black Hills Energy, however no notable deficiencies were identified due to this issue.

Many of the supply lines to buildings were smaller services and noted to be adequate for the current needs, according to staff interviews. It is noted as the building uses have evolved, demands have changed, and some buildings no longer have a large demand, if any demand at all. Larger services noted include the Student Union, the Central Energy Plant, the master meter at Engineering, a master meter and enclosure at the Landmark Square Apartments, a master meter at the Hilton Garden Convention center, a master meter at the Rochelle Gateway Center, Memorial Fieldhouse and a master meter at Spanish Walk Apartments.

In total roughly 140 gas services were identified, including meters and regulators, valves, and various gas lines.

Known Deficiencies

Overall, no significant deficiencies were discovered through the field analysis or through staff interviews. All equipment appeared acceptable. No noted capacity issues were identified in the existing system. Roughly 5-10 locations noted in existing documents were unable to be field verified at this time. No large discrepancies in supply or existing are noted at this time. Most newly discovered equipment was due to new construction.

Source and Delivery Characteristics

As noted previously, Black Hills Energy supplies the campus gas demands through their existing infrastructure, with their infrastructure running up to the building's meter. Gas lines from the meter and regulator are private lines owned by the University.

Existing Utility Loading and Capacity

Existing loading the University gas system varies by individual building and building use. The existing infrastructure appears to generally meet the demands. The largest demands on the system are from the central plants, primarily.

Offsite Improvements

Offsite improvements are provided by Black Hills Energy. Coordination with the group for the future needs on campus will be required to ensure the utility's infrastructure system will keep up with the projected growth and demand. Several improvements have been completed in recent years and future improvements are anticipated.

Future Projected Load Growth and Campus Improvements

- Provide new gas service connection to buildings coming online:
  - Extend gas line from Lewis St north to the W Campus Boiler Plant. Includes meters and regulators.
  - Extend gas line along Bradley St for new service connections to new student housing west of 15th St. as required. Includes meters and regulators.
  - Extend gas line along the alley north of Lewis St for new service connection to Lab School. Includes meters and regulators.
  - Add new service connections off of main in 15th St for new housing buildings, as required. Includes meters and regulators. It is recommended that gas fired domestic water heating is provided at any new dormitory and food service area.
  - Add new service connections off of the line serving the Little League Fields to supply gas to the new Facilities Service Building on Armory. This line to be oversized for future growth and development of the area.
  - Add new service connections off of Ivinson St for renovation of Knight. Includes meters and regulators.
  - Extend gas line to Student Union expansion and second HW Plant. Includes meters and regulators.
  - Extend existing gas service to indoor Track and Field off of Armory Rd. Includes new meters and regulators.
  - New gas service at proposed Natatorium (in addition to HWS). Includes meters and regulators.
  - New gas service at Law School expansion. Includes meters and regulators.
  - Extend new gas piping from the 18th Street main to supply the new 22nd Street Research Facilities.

- Maintain or adjust existing gas service connection to buildings to be renovated/expanded
  - New garage at Ivinson St (for services/office as required). May include upgrade to meters and regulators.
  - New student housing west of 15th St. May include upgrade to meters and regulators.
- Renovated buildings will not require new or modified services in most cases.
- Fraternity and Sorority houses are all being fed by natural gas, and appear to be adequately sized for the current structure and use. Renovations or expansions of any of the houses, should consider and evaluate changes in demand and available supply of the current natural gas service.

Refer to **Appendix NG-01** for a campus map showing existing and proposed routings.

Campus Compressed Air System

Overview

The University of Wyoming campus compressed air system is owned, operated, and maintained by the University. The centralized campus air system is utilized for the pneumatic control of the older buildings that are not currently utilizing digital control systems. Air is distributed throughout the campus system utilizing a variety of piping types including copper, steel, galvanized, and polypropylene and ranging in size from 3" to ½" in diameter. System air pressure is maintained at 100psig, and is produced with (3) 75HP Ingersoll Rand, screw type air compressors. (2) Compressors are located in the basement mechanical room of the Engineering Addition building, and one is located at the CEP. The air is dried with the use of a desiccant dryers and filtered for particulates and oil.

The current compressed air load is being satisfied by the existing infrastructure but the equipment is starting to show its age. Compressor oil has made its way into the network distribution system causing improper operation of valves and dampers throughout the system. Significant quantities of air (up to 25%) is utilized to recharge the desiccant systems, resulting in increased operational costs. Reliability of the system is becoming an issue.

As newer buildings are constructed and existing buildings undergo renovations, the switch to direct digital controls (DDC) is reducing the need for a centralized pneumatic production and distribution system.

Campus Irrigation Water System

Overview

The University of Wyoming (UW) campus irrigation water system is privately owned and maintained by the University. While the large majority of campus irrigation water is supplied via University owned wells, City of Laramie water does partially supplement the system. Additionally, the Jacoby Golf Course operates solely on City water. Given that the existing wells cannot keep up with current irrigation demand and supplemental City water must be utilized, there is a potential for there to be a constraint on future campus irrigation development. If the use of public water increases with future campus growth, it is reasonable to expect there to be some impact on surrounding residential areas as well. The core campus irrigation water distribution system consists of approximately 45,000+ lineal ft of pipe (estimate based on previous UMP field survey) of varying diameters and materials that receive water primarily from three campus water wells. Some peripheral components of the irrigation distribution system receive metered flow from the City of Laramie water mains. The water distribution system irrigates approximately 94+ acres of campus landscaping and is managed by a master control system which was installed in 2015. AutoCAD map of the current campus irrigation water distribution system can be seen in **Appendix IR-01**.

The primary irrigation water supply well is located near the northwest corner of the Fine Arts, and it has an average output of 400 gpm. The second well is located just west of the Central Energy Plant with an average output of 120 gpm. The third well is located near the American Heritage Center and produces around 100 gpm; it is also referred to as the VAF well. There is a fourth well on campus but is currently inoperative. This well is located in the Half Acre parking lot near the southwest corner of the intersection of 15 St. and Willett Drive. This well has been shut down because well discharge has contained significant quantities of sediment.

The UW campus irrigation water system does supplement with City of Laramie water via the Cowboy Field well which is not a well but essentially a pump house located just south of the UW tennis courts and provides access to City water. The Jacoby Golf Course also irrigates completely off City water.

The general condition of the irrigation system is considered by UW staff to be acceptable, there were issues in the past with pressure and volume but with the addition of the Cowboy Field injection well, those concerns have been mitigated. However, there is an overall need to develop additional wells for the campus in an attempt to get off more costly City water but also to provide additional irrigation water that future campus expansion will demand.

Currently the University is the process of developing two more wells both near the Jacoby Golf Course but there is no timetable on when either of these wells will be completed and in operation at this time.

Known Deficiencies

Overall the UW campus irrigation water distribution system performs adequately and meets the existing irrigation demands of the landscaping. However, the system's serviceability is dependent on the use of City of Laramie water (Cowboy Field well and Jacoby Golf Course) which is not a desired long-term solution for the University. Additionally, the University irrigates at 2"/week during the peak season which coupled with the high TDS of the well water causes several issues that need to be addresses. Currently UW gets reduced water pricing from the City but if long term water agreements cannot be reached between parties or water rates are increased, the cost to operate the system becomes prohibitive.

Existing Utility Loading and Capacity

The existing loading on the campus irrigation system is seasonal with typical operation from late April to October, with the highest production occurring in the summer months of June and July. UW irrigation criteria includes supplying water to provide 2" per week of ground penetration over all irrigated areas and for the most part this criterion is being met by the current system configuration. There has been quite a bit of landscaping added in recent years with the addition of new buildings and the system has shown that there is capacity to accommodate this additional demand. However, this is again being only accomplished via the addition of City water into the system, so effectively campus irrigation is dependent on the City water distribution system and its operating conditions.

Offsite Improvements

The City of Laramie North Tank Project which is still in the planning phase and tentatively scheduled for completion in 2021 or 2022, will provide the City of Laramie water distribution system with better pressure and increased capacity for required fire flows for existing areas as well as future growth. The North Tank Project is expected to provide a 1MG buried concrete water storage tank, 22,000 lineal feet of transmission pipeline (12" to 24") and will be tied into current Pressure Zones 1-3.

Future Projected Load Growth

Provided that recent building sites have had to directly irrigate landscaping with City municipal water and overall the campus irrigations system supplements with City water, it is anticipated that any future planned campus growth will continue to require this auxiliary source. For that reason, the University needs to focus on reducing the irrigation consumption of future building sites. The previous 2009 UMP estimated some future loading values for projected growth areas, but the conclusion was the current irrigation system configuration (with supplemental Cowboy Field) could meet any of those demands,

so new future loading was not completed as part of this updated report. Based on comments from UW staff, the campus will always be reliant on City of Laramie water as backup and supplemental irrigation source so it is critical that continual negotiations occur with the City and agreements set up to reduce the costs of City irrigation.

Recommended Improvements

The existing irrigation system is pretty much at capacity as new buildings are irrigating landscaping via municipal water and so moving forward the University, if they want to reduce the reliance on City water for irrigation needs, will need to work towards the following improvements:

- Invest in some new production wells and connect them into the irrigation system or look at ways to reduce the amount of irrigation with new facilities
  - The University is currently working to permit two (2) production wells north of Jacoby Golf Course (4^{5th} and Crow). These wells have had positive initial production rates of 800GPM and 1,200GPM respectively

- Connection of the new well into the existing system with the installation of irrigation mains, currently the routing is proposed to be south of the golf course where it would tie into the Jacoby pump house and then go underneath 30th street and then into campus

- Regardless if the irrigation system continues to supplement with City water or not, is should be a priority/policy of the University to continue to explore new irrigation techniques and technology as well as alternative landscaping designs that reduce the amount of needed irrigation. One technique is the potential of storing irrigation water in lined ponds east of the golf course.

Cost Summary

An opinion of probable construction cost was assembled for each project of each utility. Typical cost per unit metrics were assumed on each item with dependency on pipe sizing and material. Individual equipment installation costs were assumed as an average lump sum. The summary lookup table to which drives the unit costs within the spreadsheet is located below for reference. Note that due to the regional local of campus, an adjustable "Laramie Multiplier" was implemented and is adjusted to 20% greater than non-regional elevated costs.

	Piping Utilities										Electrical Utilities							
Laramie Multiplier=		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Pipe Size (in)	Tunnel Demo	Chilled Water	Heating Water	Steam/ Condensate	Domestic/Fire Water	Compressed Air	Sanitary Sewer	Storm Sewer	Irrigation Main	Natural Gas	Primary Power	Emergency Power	Communications	Generator Installation	Electrical Switch	Transformer	Substation Replacement	Roadway/ Areaway Lighting
1	$2,000	-	-	-	-	-	-	-	-	-	$360	-	$60	$240,000	$60,000	$60,000	$1,500,000	$650,000
2	-	-	-	-	$36	$48	-	-	$36	$48	-	-	-	-	-	-	-	-
4	-	$240	$240	$480	$42	$60	$18	$18	$42	$60	-	-	-	-	-	-	-	-
6	-	$360	$360	$540	$48	$96	$30	$30	$48	$96	-	-	-	-	-	-	-	-
8	-	$480	$480	$570	$72	-	$36	$36	$72	-	-	-	-	-	-	-	-	-
10	-	$600	$600	$600	$90	-	$42	$42	$90	-	-	-	-	-	-	-	-	-
12	-	$780	$780	$660	$106	-	$48	$48	$106	-	-	-	-	-	-	-	-	-
14	-	$840	$840	$792	$144	-	$54	$54	-	-	-	-	-	-	-	-	-	-
16	-	$960	$960	$840	$162	-	$60	$60	-	-	-	-	-	-	-	-	-	-
18	-	$1,200	$1,200	$1,020	$168	-	$72	$72	-	-	-	-	-	-	-	-	-	-
20	-	$1,440	$1,440	$1,080	$210	-	$108	$108	-	-	-	-	-	-	-	-	-	-
24	-	$1,560	$1,560	$1,200	-	-	-	$156	-	-	-	-	-	-	-	-	-	-

Within the Cost Summary document which is provided in **Appendix 4.0** of this report, there are several adjustment factors that have been applied to the direct costs. A table of these factors with corresponding multiplies are summarized here;

Design Contingency	10%
G.C. Markups	15%
CM Fee	5%
Construction Contingency	10%
Soft Costs	10%
Annual Escalation	3%

Each of these multipliers have a dedicated column within the Cost Summary spreadsheet for each project. Note that all projects are assumed to occur present day without the application of the inflation factor. As the University identifies the priority projects vs the longer term projects, the escalation factors can be applied as appropriate. The overall utility infrastructure cost projected over the next 20 -30 years is on the order of $123 M.

Estimated UMP Capital Construction Costs	
Utility	Capital Cost in 2019 Dollars
Hot Water Distribution Improvements	$27,300,000
Chilled Water Distribution Improvements	$4,300,000
Building Mechanical Rooms Steam Conversion	$7,300,000
Hot Water Production Expansion	$24,200,000
Natural Gas Distribution Improvements	$2,200,000
Domestic/Fire Water Distribution	$3,100,000
Irrigation Water Production/Distribution	$1,400,000
Sanitary Sewer System Improvements	$1,100,000
Storm Sewer System Improvements	$3,200,000
Electrical Power	$29,900,000
Communications/Data Improvements	$1,700,000
Roadway/Areaway Lighting Improvements	$2,200,000
Tunnel Improvements	$5,700,000
Central Energy Plant Improvements	$9,600,000
Total 20-30 Year Recommended Infrastructure Improvements	**$123,200,000**

NORTH-WEST CAMPUS

UW BUILDING NAME	UW BUILDING #	Building (sqft)	Building Function	HEATING INFORMATION: Heated Building Area (sqft)	Local Bulding Heating Backup	Heating Source (CEP or HW Plant)	Heating Diversity Factor	Heating Density (Btu/sqft)	Diversified Heating Density (Btu/sqft)	Estimated Diversified Heating Load (MBH)	CEP Steam Flow (lb/hr)	HW Plant Flow (GPM)	Minimum HW Pipe Size (in)	COOLING INFORMATION: Cooled Building Area (sqft)	Local Building Cooling Capacity (Tons)	Cooling Diversity Factor	Cooling Density (sqft/ton)	Diversified Cooling Density (sqft/ton)	Estimated Diversified Cooling Load (Tons)	Corresponding CHW Building Flow (GPM)	Minimum CHW Pipe Size (in)
Existing Connected Building-North-West Campus																					
Engineering and Applied Science 1927/59/65	1	309,365	Academic/Classroom	309,365		CEP	0.65	40	26	8,043	7,312	0		30,937	84	0.40	750	1875	16	40	2
Agriculture C	2	73,912	Academic/Classroom	73,912		CEP	0.65	40	26	1,922	1,747	0		3,400	19	0.40	750	1875	2	4	1
Agriculture C Addition	2	118,553	Academic/Classroom	118,553		CEP	0.65	40	26	3,082	2,802	0									0
Education Annex (Vocational)	6	27,840	Academic/Classroom	27,840		CEP	0.65	40	26	724	658	0		27,840		0.40	750	1875	15	36	2
Education (LRC)	14	123,674	Academic/Classroom	123,674		CEP	0.65	40	26	3,216	2,923	0		6,000	6	0.40	750	1875	3	8	1
McWhinnie Hall	19	26,625	Office	26,625		CEP	0.70	40	28	746	678	0									0
Half Acre Gymnasium w/o 2014 addition	22	119,306	Athletics/Gymnasium	119,306		CEP	0.65	40	26	3,102	2,820	0		6,000		0.40	750	1875	3	8	1
Service Bldg Orig w/1956 & 60 additions	36	81,268	Support	81,268		CEP	0.80	40	32	2,601	2,364	0			29						0
Wyoming Hall	38	69,579	Office	69,579		CEP	0.70	40	28	1,948	1,771	0									0
Earth Sciences	81	65,000	Academic/Classroom	65,000		CEP	0.65	40	26	1,690	1,536	0		65,000	8	0.40	750	1875	35	65	3
Berry Center	92	39,081	Academic/Classroom	39,081		CEP	0.65	40	26	1,016	924	0									0
Bureau of Mines	93	77,916	Academic/Classroom	77,916		CEP	0.65	40	26	2,026	1,842	0			19						0
Anthropology (AARF)	133	52,499	Academic/Classroom	52,499		CEP	0.65	40	26	1,365	1,241	0		52,499		0.40	750	1875	28	67	2
Half Acre Gym Addition (HAG)	22	75,034	Athletics/Gymnasium	75,034		CEP	0.65	40	26	1,951	1,774	0		75,034		0.40	750	1875	40	96	3
Enzi STEM	130	99,000	Laboratory/Research	99,000	(1) HOT WATER	CEP	0.95	45	43	4,232	3,848	0			6			EVAPORATIVELY COOLED			0
Energy Innovation Center (ERC, EIC)	87	57,000	Academic/Classroom	57,000	(1) HOT WATER	CEP	0.65	40	26	1,482	1,347	0						EVAPORATIVELY COOLED			0
EERB	132	107,000	Laboratory/Research	107,000	(2) HOT WATER	SELF CONT.	0.95	45	43	4,574	0	0		107,000		0.60	550	917	117	280	
Existing NW Campus Subtotals		***1,522,652***		***1,522,652***						***43,719***	***35,587***	***0***		***373,710***	171				***259***	***622***	
Near Term Plan-North-West Campus																					
New West Campus Satellite Plant (2021)	N/A	8,205	Support	8,205		HW Plant	0.80	40	32	263	0	18									0
New UW Science Initiative (2021)	N/A	148,284	Laboratory/Research	148,284		HW Plant	0.95	45	43	6,339	0	423		148,284		0.60	550	917	162	388	6
EERB HW Conversion (2021)	132	107,000	Laboratory/Research	107,000		HW Plant	0.95	45	43	4,574	0	305									0
Enzi STEM HW Conversion (2021)	130	99,000	Academic/Classroom	99,000		HW Plant	0.65	40	26	2,574	-3,848	172									0
Anthropology HW Conversion (2021)	133	52,499	Academic/Classroom	52,499		HW Plant	0.65	40	26	1,365	-1,241	91									0
Agriculture C HW Conversion	2	73912	Academic/Classroom	73,912		HW Plant	0.65	40	26	1,922	-1,747	128									
Agriculture C Addition HW Conversion (2021)	2	118,553	Academic/Classroom	118,553		HW Plant	0.65	40	26	3,082	-2,802	205									0
Engineering and Applied Science 1927/59/65 HW Conversion (20	1	309,365	Academic/Classroom	309,365		HW Plant	0.65	40	26	8,043	-7,312	536									0
Demolish Service Building	36	-81,268	Support	-81,268						-2,601	-2,364				-29						0
Demolish Wyoming Hall	38	-69,579	Office	-69,579						-1,948	-1,771										0
Renovate McWhinnie Hall	19	26,625	Office	26,625		HW Plant	0.70	40	28	746	-678	50		26,625		0.40	750	1875	14	34	2
Half Acre Gymnasium HW Conversion	22	119,306	Athletics/Gymnasium	119,306		HW Plant	0.65	40	26	3,102	-4,593	207									0
New Student Housing-Phase IA	N/A	164,860	Student Housing/Life	164,860		HW Plant	0.70	35	25	4,039	0	269		164,860		0.30	900	3000	55	132	3
New Student Housing-Phase IB	N/A	125,540	Student Housing/Life	125,540		HW Plant	0.70	35	25	3,076	0	205		125,540		0.30	900	3000	42	100	3
New Student Housing-Phase II	N/A	127,738	Student Housing/Life	127,738		HW Plant	0.70	35	25	3,130	0	209		127,738		0.30	900	3000	43	102	3
New Student Dining	N/A	22,483	ood Service/Restaurar	22,483		HW Plant	0.70	40	28	630	0	42		22,483		0.50	650	1300	17	42	2
Near Term Plan-NW Campus Subtotals		***1,968,915***		***1,968,915***						***56,646***	***9,230***	***2,859***		***989,240***	142				***592***	***1,420***	
Mid Term Plan-North-West Campus																					
Renovation of Education	14	123,674	Academic/Classroom	123,674		HW Plant	0.65	40	26	3,216	-2,923	214		123,674		0.40	750	1875	66	158	4
Renovation of Education Annex	6	27,840	Academic/Classroom	27,840		HW Plant	0.65	40	26	724	-658	48		27,840		0.40	750	1875	15	36	2
Earth Sciences HW Conversion	81	65,000	Academic/Classroom	65,000		HW Plant	0.65	40	26	1,690	-1,536	113									0
Berry Center HW Conversion	92	39,081	Academic/Classroom	39,081		HW Plant	0.65	40	26	1,016	-924	68									0
Energy Innovation Center HW Conversion	87	57,000	Academic/Classroom	57,000		HW Plant	0.65	40	26	1,482	-1,347	99									0
New Education Addition (Lab School)	N/A	58,563	Academic/Classroom	58,563		HW Plant	0.65	40	26	1,523	0	102		58,563		0	750	1,875	31	75	3
Renovation of Engineering and Applied Science (HW accounte	1	309,365	Academic/Classroom											309,365		0	750	1,875	165	396	6
Renovation of Agriculture (HW accounted for in Phase I)	2	73,912	Academic/Classroom											73,912		0	750	1,875	39	95	3
Renovation of Bureau of Mines	93	77,916	Academic/Classroom	77,916		HW Plant	0.65	40	26	2,026	-1,842	135		77,916		0	750	1,875	42	100	3
New Bradley Street Parking Garage (No central heating/cooling	N/A	268,800	Support																		
Mid Term Plan-NW Campus Subtotals		***2,296,278***		***2,027,478***						***58,169***	***0***	***3,637***		***1,660,510***	142				***950***	***2,279***	
Long Term Plan-North-West Campus (No Change)		***2,296,278***		***2,027,478***						***58,169***	***0***	***3,637***		***1,660,510***	142				***950***	***2,279***	

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UNIVERSITY OF WYOMING

UNIVERSITY OF WYOMING
UTILITY MASTER PLAN

MECHANICAL CALCULATIONS

APRIL 2020

MC-01

NORTH AND NORTH-EAST CAMPUS

				HEATING INFORMATION										COOLING INFORMATION							
UW BUILDING NAME	UW BUILDING #	Building (sqft)	Building Function	Heated Building Area (sqft)	Local Bulding Heating Backup	Heating Source (CEP or HW Plant)	Heating Diversity Factor	Heating Density (Btu/sqft)	Diversified Heating Density (Btu/sqft)	Estimated Diversified Heating Load (MBH)	CEP Steam Flow (lb/hr)	HW Plant Flow (GPM)	Minimum HW Pipe Size (in)	Cooled Building Area (sqft)	Local Building Cooling Capacity (Tons)	Cooling Diversity Factor	Cooling Density (sqft/ton)	Diversified Cooling Density (sqft/ton)	Estimated Diversified Cooling Load (Tons)	Corresponding CHW Building Flow (GPM)	Minimum CHW Pipe Size (in)
Existing Connected Buildings-North and North-East Campus																					
Animal Sc/Molecular Biology	80	52,841	Laboratory/Research	52,841	(1) STEAM	CEP	0.95	45	43	2,259	2,054	0	[illegible]		9						0
Central Energy Plant	90	57,803	Support	57,803		CEP	0.80	40	32	1,850	1,682	0	[illegible]								0
Central Energy Plant Ash Silo	101	585	Support	585		CEP	0.80	40	32	19	17	0	[illegible]								0
Central Energy Plant Steam Production Usage											5,500										0
Campus Steam Distribution System Steam Usage											6,500										0
Regulated Materials Mgmt Ctr	111	15,775	Support	15,775		CEP	0.80	40	32	505	459	0	[illegible]								0
Centennial Complex	125	126,200	Office	126,200		CEP	0.70	40	28	3,534	3,212	0	[illegible]	126,200		0.40	750	1875	67	162	4
WY Technology Business Center	150	31,793	Office	31,793		CEP	0.70	40	28	890	809	0	[illegible]	31,793		0.40	750	1875	17	41	2
Visual Arts Facility (VAF)	126	74,833	Auditorium	74,833		CEP	0.60	30	18	1,347	1,225	0	[illegible]								0
High Bay Research Facility	131	79,701	Laboratory/Research	79,701	(2) HOT WATER	CEP	0.95	45	43	3,407	3,097	0	[illegible]	79,701		0.60	550	917	87	209	4
Existing N and NE Campus Subtotals		**439,531**		**439,531**						**13,810**	**24,555**	**0**		**237,694**	**9**				**171**	**411**	
Near Term Plan-North and North-East Campus (No Change)		**439,531**		**439,531**						**13,810**	**24,555**	**0**		**237,694**	**9**				**171**	**411**	
Mid Term Plan-North and North-East Campus																					
Renovation of Animal Sc/Molecular Biology	N/A	52,841	Laboratory/Research	52,841		HW Plant	0.95	45	43	2,259	-2,054	151	[illegible]	52,841		0.60	550	917	58	138	3
19th Street Research 1	N/A	69,090	Laboratory/Research	69,090		HW Plant	0.95	45	43	2,954		197	[illegible]	69,090		0.60	550	917	75	181	4
19th Street Research 2	N/A	34,304	Laboratory/Research	34,304		HW Plant	0.95	45	43	1,466		98	[illegible]	34,304		0.60	550	917	37	90	3
19th Street Research 3	N/A	44,840	Laboratory/Research	44,840		HW Plant	0.95	45	43	1,917		128	[illegible]	44,840		0.60	550	917	49	117	3
19th Street Research 4	N/A	43,464	Laboratory/Research	43,464		HW Plant	0.95	45	43	1,858		124	[illegible]	43,464		0.60	550	917	47	114	3
Regulated Materials Mgmt Ctr HW Conversion	111	15,775	Support	15,775		HW Plant	0.80	40	32	505	-459	34	[illegible]								0
Centennial Complex HW Conversion	125	126,200	Office	126,200		HW Plant	0.70	40	28	3,534	-3,212	236	[illegible]								0
WY Technology Business Center HW Conversion	150	31,793	Office	31,793		HW Plant	0.70	40	28	890	-809	59	[illegible]								0
Visual Arts Facility HW Conversion	126	74,833	Auditorium	74,833		HW Plant	0.60	30	18	1,347	-1,225	90	[illegible]								0
High Bay Research Facility HW Conversion	131	79,701	Laboratory/Research	79,701		HW Plant	0.95	45	43	3,407	-3,097	227	[illegible]								0
Mid Term Plan-N and NE Campus Subtotals		**631,229**		**631,229**						**22,005**	**13,699**	**546**		**482,233**	**9**				**438**	**1,051**	
LongTerm Plan-North and North-East Campus																					
Central Energy Plant	90	57,803	Support	57,803		HW Plant	0.80	40	32	1,850	-1,682	123	[illegible]								
Central Energy Plant Ash Silo	101	585	Support	585		CEP	0.80	40	32		-17	0	[illegible]								
Central Energy Plant Steam Production Usage											-5,500										
Campus Steam Distribution System Steam Usage											-6,500										
Long Term Plan-North and North-East Campus Subtotals		**631,229**		**631,229**						**23,855**	**0**	**670**		**482,233**	**9**				**438**	**1,051**	

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UNIVERSITY OF WYOMING

UNIVERSITY OF WYOMING
UTILITY MASTER PLAN

MECHANICAL CALCULATIONS

APRIL 2020

MC-02

WEST AND SOUTH-WEST CAMPUS

UW BUILDING NAME	UW BUILDING #	Building (sqft)	Building Function	Heated Building Area (sqft)	Local Building Heating Backup	Heating Source (CEP or HW Plant)	Heating Diversity Factor	Heating Density (Btu/sqft)	Diversified Heating Density (Btu/sqft)	Estimated Diversified Heating Load (MBH)	CEP Steam Flow (lb/hr)	HW Plant Flow (GPM)	Minimum HW Pipe Size (in)	Cooled Building Area (sqft)	Local Building Cooling Capacity (Tons)	Cooling Diversity Factor	Cooling Density (sqft/ton)	Diversified Cooling Density (sqft/ton)	Estimated Diversified Cooling Load (Tons)	Corresponding CHW Building Flow (GPM)	Minimum CHW Pipe Size (in)
				HEATING INFORMATION										COOLING INFORMATION							
Existing Connected Buildings-West and South-West Campus																					
Arts & Sciences	7	66,186	Academic/Classroom	66,186		CEP	0.65	40	26	1,721	1,564	0			12						
Biological Sciences (includes Science Library Annex)	9	205,350	Laboratory (Light)	205,350	YES (?) HW/STEAM	CEP	0.70	40	28	5,750	5,227	0		81,200	8	0.40	600	1,500	54	130	3
Health Sciences Complex (Bio-Chem; Pharmacy; HS in 07)	11	124,348	Laboratory (Light)	124,348		CEP	0.70	40	28	3,482	3,165	0		88,000		0.40	600	1,500	59	141	3
Classroom Bldg w/2007 addn	12	96,061	Academic/Classroom	96,061		CEP	0.65	40	26	2,498	2,271	0		96,061		0.40	750	1,875	51	123	3
College of Business w/o auditorium (demo 2008)	13	61,081	Academic/Classroom	61,081		CEP	0.65	40	26	1,588	1,444	0		61,081		0.40	750	1,875	33	78	3
College of Business Addition	13	102,821	Academic/Classroom	102,821		CEP	0.65	40	26	2,673	2,430	0									0
Geology w/ 86 addn	18	57,771	Academic/Classroom	57,771		CEP	0.65	40	26	1,502	1,365	0		12,220	5	0.40	750	1,875	7	16	1
Cheney International Center/Student Health	23	32,013	Office	32,013		CEP	0.70	40	28	896	815	0		32,013	9	0.40	750	1,875	17	41	2
Hoyt Hall	24	29,939	Office	29,939		CEP	0.70	40	28	838	762	0			8	0.40	750	1,875	0	0	0
Coe 1977 addition	26	85,676	Academic/Classroom	85,676		CEP	0.65	40	26	2,228	2,025	0		85,676		0.40	750	1,875	46	110	3
Coe 58 orig and History	26	119,390	Academic/Classroom	119,390		CEP	0.65	40	26	3,104	2,822	0		100,000		0.40	750	1,875	53	128	3
Coe Library/LLC Addition	26	92,876	Academic/Classroom	92,876		CEP	0.65	40	26	2,415	2,195	0		92,876		0.40	750	1,875	50	119	3
Merica Hall	27	17,651	Office	17,651		CEP	0.70	40	28	494	449	0			3						0
Aven Nelson	30	32,832	Academic/Classroom	32,832		CEP	0.65	40	26	854	776	0			4						0
Old Main	31	34,089	Office	34,089		CEP	0.70	40	28	954	868	0			9						0
Physical Sciences	33	179,777	Academic/Classroom	179,777		CEP	0.65	40	26	4,674	4,249	0		65,157	8	0.40	750	1,875	35	83	3
Wyoming Union 2002 addition	39	25,000	Food Service/Restaurant	25,000		CEP	0.70	40	28	700	636	0		40,000		0.50	650	1,300	31	74	3
Wyoming Union w 79 additions	39	137,418	Food Service/Restaurant	137,418		CEP	0.70	40	28	3,848	3,498	0		68,480	28	0.50	650	1,300	53	126	3
Knight Hall 41 orig/46 addn/50 food ser	44	81,671	Office	81,671		CEP	0.70	40	28	2,287	2,079	0		14,056	17	0.40	750	1,875	7	18	2
Ross Hall	50	90,665	Office	90,665		CEP	0.70	40	28	2,539	2,308	0			30						0
Aven Nelson - Williams Conservatory	82	15,443	Academic/Classroom	15,443		CEP	0.65	40	26	402	365	0									0
WY State Geological Survey	920	23,171	Office	23,171		CEP	0.70	40	28	649	590	0		23,171		0.40	750	1,875	12	30	2
Existing W and SW Subtotals		**1,711,229**		**1,711,229**						**46,095**	**41,904**	**0**		**859,991**	**141**				**507**	**1,216**	
Near Term Plan-West and South-West Campus																					
Renovation of Wyoming Union	39	137,418	Food Service/Restaurant	137,418		HW Plant	0.70	40	28	3,848	-3,498	257		137,418		1	650	1,300	106	254	4
Wyoming Union Addition HW Conversion	39	25,000	Food Service/Restaurant	25,000		HW Plant	0.70	40	28	700	-636	47									0
Renovation of Biological Sciences	9	205,350	Laboratory (Light)	205,350		HW Plant	0.70	40	28	5,750	-5,227	383		205,350		0	600	1,500	137	329	6
Renovation of Ross Hall	50	90,665	Office	90,665		HW Plant	0.70	40	28	2,539	-2,308	169		90,665		0	750	1,875	48	116	3
Renovation of Physical Sciences	33	179,777	Academic/Classroom	179,777		HW Plant	0.65	40	26	4,674	-4,249	312		179,777		0	750	1,875	96	230	4
New Wyoming Union Expansion	N/A	16,724	Student Housing/Life	16,724		HW Plant	0.70	35	25	410	0	27		16,724		0	900	3,000	6	13	1
Renovation of Knight Hall	44	81,671	Office	81,671		HW Plant	0.70	40	28	2,287	-2,079	152		81,671		0	750	1,875	44	105	3
Cheney Internation Center HW Conversion	23	32,013	Office	32,013		HW Plant	0.70	40	28	896	-815	60									0
Hoyt Hall HW Conversion	24	29,939	Office	29,939		HW Plant	0.70	40	28	838	-762	56									0
Extend HW and CHW to Old Main	31	34,089	Office	34,089		HW Plant	0.70	40	28	954	-868	64		34,089		0.40	750	1,875	18	44	2
New Knight Hall Expansion	N/A	46,000	Student Housing/Life	46,000		HW Plant	0.70	35	25	1,127	0	75		46,000		0	900	3,000	15	37	2
New Ivinson Parking Garage (No central heating/cooling utilities)	N/A	201,600	Support																		0
Near Term Plan-W and SW Campus Subtotals		**1,975,553**		**1,773,953**						**47,631**	**21,462**	**1,602**		**1,503,992**	**141**				**881**	**2,115**	
Mid Term Plan-West and South-West Campus																					
Renovation of Guthrie House (No central heating/cooling utilities)																					
Renovation of Aven Nelson	30	32,832	Academic/Classroom	32,832		HW Plant	0.65	40	26	854	-776	57		32,832		0.40	750	1,875	18	42	2
Renovation of Aven Nelson Williams Conservatory	82	15,443	Academic/Classroom	15,443		HW Plant	0.65	40	26	402	-365	27		15,443		0	750	1,875	8	20	2
Renovation of Merica Hall	27	17,651	Office	17,651		HW Plant	0.70	40	28	494	-449	33		17,651		0	750	1,875	9	23	2
Renovation of Arts and Science	7	66,186	Academic/Classroom	66,186		HW Plant	0.65	40	26	1,721	-1,564	115		66,186		0	750	1,875	35	85	3
Health Sciences Complex HW Conversion	11	124,348	Laboratory (Light)	124,348		HW Plant	0.70	40	28	3,482	-3,165	232									0
Classroom Building HW Conversion	12	96,061	Academic/Classroom	96,061		HW Plant	0.65	40	26	2,498	-2,271	167									0
College of Business HW Conversion	13	61,081	Academic/Classroom	61,081		HW Plant	0.65	40	26	1,588	-1,444	106									0
College of Business Addition HW Conversion	13	102,821	Academic/Classroom	102,821		HW Plant	0.65	40	26	2,673	-2,430	178									0
Geology HW Conversion	18	57,771	Academic/Classroom	57,771		HW Plant	0.65	40	26	1,502	-1,365	100					evaporatively cooled				0
Coe Addition HW Conversion	26	85,676	Academic/Classroom	85,676		HW Plant	0.65	40	26	2,228	-2,025	149									0
Coe HW Conversion	26	119,390	Academic/Classroom	119,390		HW Plant	0.65	40	26	3,104	-2,822	207									0
Coe Library/LLC HW Conversion	26	92,876	Academic/Classroom	92,876		HW Plant	0.65	40	26	2,415	-2,195	161									0
WY State Geological Survey HW Conversion	920	23,171	Office	23,171		HW Plant	0.70	40	28	649	-590	43		23,171		0.40	750	1,875	12	30	2
Mid Term Plan-W and SW Campus Subtotals		**1,975,553**		**1,773,953**						**47,631**	**0**	**3,175**		**1,636,104**	**141**				**952**	**2,284**	0
Long Term Plan-West and South-West Campus (No Change)		**1,975,553**		**1,773,953**						**47,631**	**0**	**3,175**		**1,636,104**	**141**				**952**	**2,284**	

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UNIVERSITY OF WYOMING

UNIVERSITY OF WYOMING
UTILITY MASTER PLAN

MECHANICAL CALCULATIONS

APRIL 2020

MC-03

EAST CAMPUS																					
UW BUILDING NAME	UW BUILDING #	Building (sqft)	Building Function	Heated Building Area (sqft)	Local Building Heating Backup	Heating Source (CEP or HW Plant)	Heating Diversity Factor	Heating Density (Btu/sqft)	Diversified Heating Density (Btu/sqft)	Estimated Diversified Heating Load (MBH)	CEP Steam Flow (lb/hr)	HW Plant Flow (GPM)	Minimum HW Pipe Size (in)	Cooled Building Area (sqft)	Local Building Cooling Capacity (Tons)	Cooling Diversity Factor	Cooling Density (sqft/ton)	Diversified Cooling Density (sqft/ton)	Estimated Diversified Cooling Load (Tons)	Corresponding CHW Building Flow (GPM)	Minimum CHW Pipe Size (in)
				HEATING INFORMATION										COOLING INFORMATION							
Existing Connected Buildings-East Campus																					
Information Technology Center	64	86,664	Academic/Classroom	86,664		CEP	0.65	40	26	2,253	2,048	0		86,664		0.40	750	875	46	111	3
Law School w 93 addn/09 Moot addn	77	69,805	Academic/Classroom	69,805		CEP	0.65	40	26	1,815	1,650	0		69,805		0.40	750	875	37	89	3
Buchanan Center Fine Arts w/ 1999 Studio Addn/ w/o 2014 PAF	78	183,706	Auditorium	183,706		CEP	0.60	30	18	3,307	3,006	0		112,000		0.25	350	400	80	192	4
Corbett	79	83,646	Academic/Classroom	83,646		CEP	0.65	40	26	2,175	1,977	0			7						
East Campus Distribution Center	9	276	Support	276		CEP	0.80	40	32	9	8	0									0
Buchanan Center for the Performing Arts Center (Addn to Fine A	78	62,325	Auditorium	62,025		CEP	0.60	30	18	1,116	1,015	0		60,225		0.25	350	400	43	103	3
Existing E Campus Subtotals		***486,122***		***486,122***						***10,675***	***9,705***	***0***		***328,694***	7				***206***	***496***	
Near Term Plan-East Campus (No Change)		***486,122***		***486,122***						***10,675***	***9,705***	***0***		***328,694***					***206***	***496***	
Mid Term Plan-East Campus																					
Corbett	79	83,646	Academic/Classroom	83,646		HW Plant	0.65	40	26	2,175	-1,977	145		83,646		0.40	750	875	45	107	3
New Natatorium	N/A	75,000	Athletics/Gymnasium	75,000		HW Plant	0.65	40	26	1,950	0	130		75,000		0.40	750	875	40	96	3
Buchanan Center for the Performing Arts HW Conversion	78	62,325	Auditorium	62,025		HW Plant	0.60	30	18	1,116	-4,021	74									0
Information Technology Center HW Conversion	64	86,664	Academic/Classroom	86,664		HW Plant	0.65	40	26	2,253	-2,048	150									0
East Campus Distribution Center	9	276	Support	276		HW Plant	0.80	40	32	9	-8	1									
Renovation of Law	77	69,805	Academic/Classroom	69,805		HW Plant	0.65	40	26	1,815	-1,650	121		69,805		0.40	750	875	37	89	3
New Law Addition	N/A	40,491	Academic/Classroom	40,491		HW Plant	0.65	40	26	1,053	0	70		86,664		0.40	750	875	46	111	3
Mid Term Plan-E Campus Subtotals		***735,259***		***726,613***						***16,928***	***0***	***691***		***574,004***					***337***	***899***	
Long Term Plan-East Campus (No Change)		***735,259***		***726,613***						***16,928***	***0***	***691***		***574,004***					***337***	***899***	

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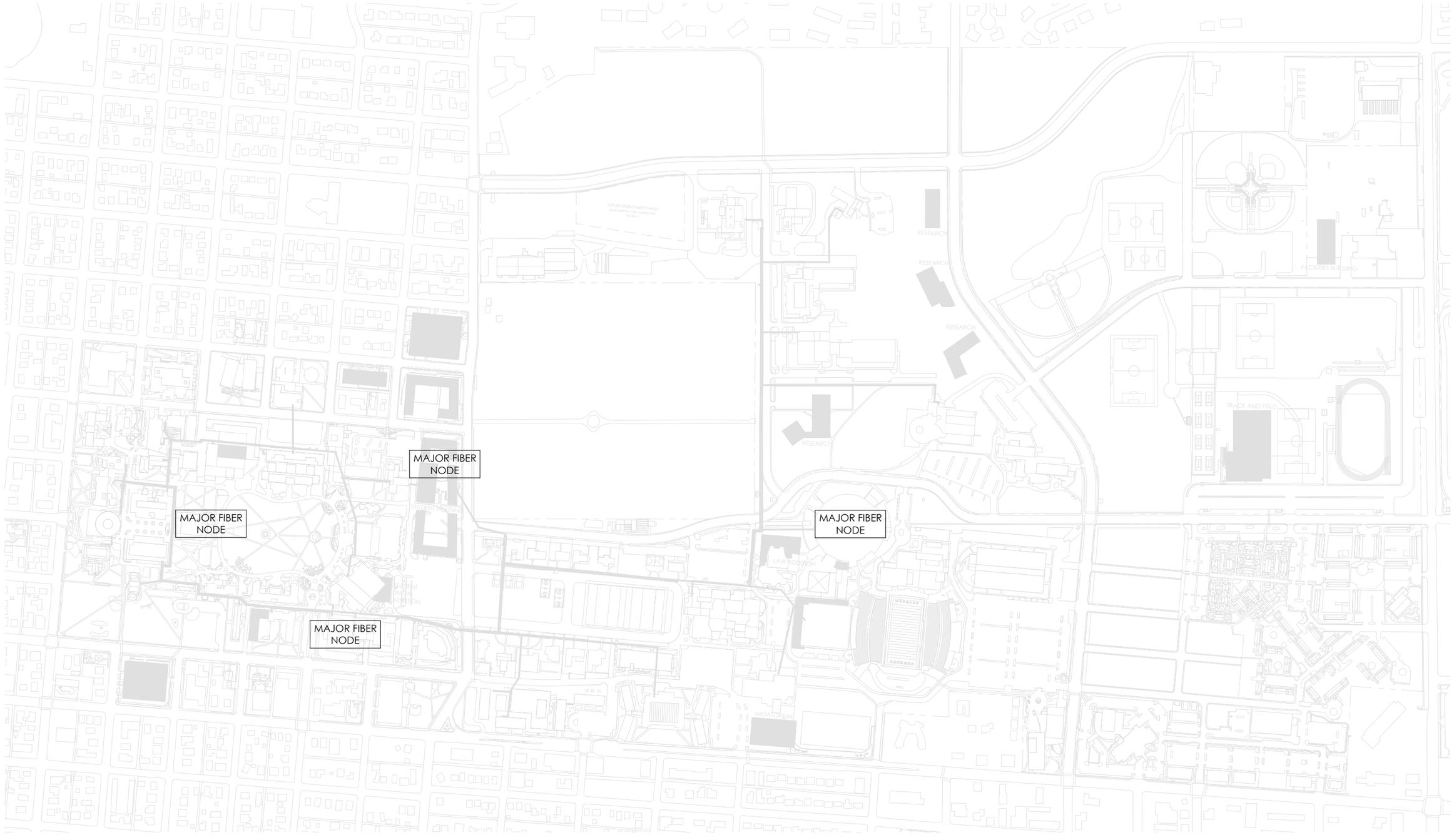
UNIVERSITY OF WYOMING

SOUTH CAMPUS

UW BUILDING NAME	UW BUILDING #	Building (sqft)	Building Function	Heated Building Area (sqft)	Local Building Heating Backup	Heating Source (CEP or HW Plant)	Heating Diversity Factor	Heating Density (Btu/sqft)	Diversified Heating Density (Btu/sqft)	Estimated Diversified Heating Load (MBH)	CEP Steam Flow (lb/hr)	HW Plant Flow (GPM)	Minimum HW Pipe Size (in)	Cooled Building Area (sqft)	Local Building Cooling Capacity (Tons)	Cooling Diversity Factor	Cooling Density (sqft/ton)	Diversified Cooling Density (sqft/ton)	Estimated Diversified Cooling Load (Tons)	Corresponding CHW Building Flow (GPM)	Minimum CHW Pipe Size (in)
				HEATING INFORMATION										COOLING INFORMATION							
Existing Connected Buildings-South Campus																					
Memorial Fieldhouse	16	195,855	Athletics/Gymnasium	195,855	(1) STEAM	CEP	0.65	40	26	5,092	4,629	0	-		30						
Fieldhouse North Addition	17	71,694	Athletics/Gymnasium	71,694	(2) HOT WATER	CEP	0.65	40	26	1,864	1,695	0	-	71,694		0.40	750	1,875	38	92	3
Orr Hall	48	85,361	Student Housing/Life	85,361		CEP	0.70	35	25	2,091	1,901	0	-								0
Crane Hall	40	88,935	Student Housing/Life	88,935		CEP	0.70	35	25	2,179	1,981	0	-								0
Crane Hill Cafeteria	41	20,791	Food Service/Restaurant	20,791		CEP	0.70	40	28	582	529	0	-								0
Downey Hall	42	85,361	Student Housing/Life	85,361		CEP	0.70	35	25	2,091	1,901	0	-								0
Hill Hall	43	85,361	Student Housing/Life	85,361		CEP	0.70	35	25	2,091	1,901	0	-								0
McIntyre Hall	46	134,518	Student Housing/Life	134,518		CEP	0.70	35	25	3,296	2,996	0	-								0
Washakie Center	51	81,516	Food Service/Restaurant	81,516		CEP	0.70	40	28	2,282	2,075	0	-								0
White Hall	52	132,054	Student Housing/Life	132,054		CEP	0.70	35	25	3,235	2,941	0	-								0
War Memorial Stadium		59,411	Athletics/Gymnasium	59,411		CEP	0.65	40	26	1,545	1,404	0	-								
Honors House (Kappa sigma w/addn)	55	12,345	Student Housing/Life	12,345		CEP	0.70	35	25	302	275	0	-								0
Sigma Phi Epsilon House (old Kappa Delta)	56	16,634	Student Housing/Life	16,634		CEP	0.70	35	25	408	370	0	-								0
Health Sciences Living House (ΦΔΘ, ΔΓ, HS, PM)	57	5,247	Student Housing/Life	5,247		CEP	0.70	35	25	129	117	0	-								0
Beta House	61	12,567	Academic/Classroom	12,567		CEP	0.65	40	26	327	297	0	-		16						0
Rochelle Athletics Center	73	47,450	Athletics/Gymnasium	47,450		CEP	0.65	40	26	1,234	1,122	0	-	126,872		0.40	750	1,875	68	162	4
Indoor Practice Facility	74	88,759	Athletics/Gymnasium	88,759		CEP	0.65	40	26	2,308	2,098	0	-								0
Arena Auditorium	89	260,990	Athletics/Gymnasium	260,990		CEP	0.65	40	26	6,786	6,169	0	-		16						0
Alpha Tau Omega Fraternity	902	9,154	Student Housing/Life	9,154		CEP	0.70	35	25	224	204	0	-								0
Sigma Alpha Epsilon Fraternity	905	10,557	Student Housing/Life	10,557		CEP	0.70	35	25	259	235	0	-								0
Sigma Chi Fraternity	906	10,881	Student Housing/Life	10,881		CEP	0.70	35	25	267	242	0	-								0
Sigma Nu Fraternity	907	10,226	Student Housing/Life	10,226		CEP	0.70	35	25	251	228	0	-								0
Pi Kappa Alpha Fraternity (old Alpha Chi Omega)	908	16,750	Student Housing/Life	16,750		CEP	0.70	35	25	410	373	0	-								0
Delta Delta Delta Sorority	909	6,007	Student Housing/Life	6,007		CEP	0.70	35	25	147	134	0	-								0
Kappa Kappa Gamma Sorority	911	20,082	Student Housing/Life	20,082		CEP	0.70	35	25	492	447	0	-								0
Tobin House (Old Pi Beta Phi Sorority w/ 1994 addn)	912	15,758	Student Housing/Life	15,758		CEP	0.70	35	25	386	351	0	-								0
Existing South Campus Subtotals		**1,584,264**		**1,584,264**						**40,278**	**36,616**	**0**		**198,566**	**62**				**106**	**254**	
Near Term Plan-South Campus																					
Demolish White Hall	52	-132,054		-132,054						-3,235	-2,941										0
Demolish Downey Hall	42	-85,361		-85,361						-2,091	-1,901										0
Demolish Washakie Center	51	-81,516		-81,516						-2,282	-2,075										0
Demolish McIntyre Hall	46	-134,518		-134,518						-3,296	-2,996										0
Demolish Orr Hall	48	-85,361		-85,361						-2,091	-1,901										0
Renovate Hill Hall	43	85,361	Office	85,361		HW Plant	0.70	40	28	2,390	-1,901	159	-	85,361		0	750	1,875	46	109	3
Renovate Crane Hall	40	88,935	Office	88,935		HW Plant	0.70	40	28	2,490	-1,981	166	-	88,935		0	750	1,875	47	114	3
Renovate Crane Hill Cafeteria	41	88,935	Office	88,935		HW Plant	0.70	40	28	2,490	-529	166	-	88,935		0	750	1,875	47	114	3
Near Term Plan-South Campus Subtotals		**1,239,750**		**1,239,750**						**27,281**	**20,390**	**491**		**461,797**	**62**				**246**	**591**	
Mid Term Plan-South Campus																					0
Honors House HW Conversion	55	12,345	Student Housing/Life	12,345		HW Plant	0.70	35	25	302	-275	20	-								0
Sigma Phi Epsilon House-Convert to NG	56	16,634	Student Housing/Life	16,634		NG Conversion	0.70	35	25		-370	0	-								0
Health Sciences Living House-Convert to NG	57	5,247	Student Housing/Life	5,247		NG Conversion	0.70	35	25		-117	0	-								0
Arena Auditorium HW Conversion	89	260,990	Athletics/Gymnasium	260,990		HW Plant	0.65	40	26	6,786	-6,169	452	-								0
Alpha Tau Omega HW Conversion	902	9,154	Student Housing/Life	9,154		HW Plant	0.70	35	25	224	-204	15	-								0
Beta House	61	12,567	Academic/Classroom	12,567		HW Plant	0.65	40	26	327	-297	22	-								
Sigma Alpha Epsilon-Convert to NG	905	10,557	Student Housing/Life	10,557		NG Conversion	0.70	35	25		-235	0	-								0
Sigma Chi-Convert to NG	906	10,881	Student Housing/Life	10,881		NG Conversion	0.70	35	25		-242	0	-								0
Sigma Nu-Convert to NG	907	10,226	Student Housing/Life	10,226		NG Conversion	0.70	35	25		-228	0	-								0
Pi Kappa Alpha-Convert to NG	908	16,750	Student Housing/Life	16,750		NG Conversion	0.70	35	25		-373	0	-								0
Delta Delta Delta-Convert to NG	909	6,007	Student Housing/Life	6,007		NG Conversion	0.70	35	25		-134	0	-								0
Kappa Kappa Gamma-Convert to NG	911	20,082	Student Housing/Life	20,082		NG Conversion	0.70	35	25		-447	0	-								0
Tobin House (Old Pi Beta Phi) HW Conversion	912	15,758	Student Housing/Life	15,758		HW Plant	0.70	35	25	386	-351	26	-								0
Mid Term Plan-South Campus Subtotals		**1,239,750**		**1,239,750**						**24,920**	**10,948**	**1,026**		**461,797**	**62**				**246**	**591**	
Long Term Plan-South Campus																					
Demolition of Fieldhouse North Addition	17	-71,694	Athletics/Gymnasium	-71,694						-1,864	-1,695	0	-								0
Renovation of Memorial Fieldhouse	16	195,855	Athletics/Gymnasium	195,855		HW Plant	0.65	40	26	5,092	-4,629	339	-	195,855		0.40	750	1,875	104	251	4
War Memorial Stadium		59,411	Athletics/Gymnasium	59,411		HW Plant	0.65	40	26	1,545	-1,404	103	-	59,411		0.40	750	1,875	32	76	3
Rochelle Athletics Center HW Conversion	73	47,450	Athletics/Gymnasium	47,450		HW Plant	0.65	40	26	1,234	-1,122	82	-								0
Indoor Practice Facility HW Conversion	74	88,759	Athletics/Gymnasium	88,759		HW Plant	0.65	40	26	2,308	-2,098	154	-								0
New Memorial Fieldhouse Addition	N/A	2,688	Athletics/Gymnasium	2,688		HW Plant	0.65	40	26	70	0	5	-	2,688		0.40	750	1,875	3	3	1
Long Term Plan-South Campus Subtotals		**1,170,744**		**1,170,744**						**23,126**	**0**	**1,710**		**719,751**	**62**				**384**	**921**	



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UTILITY MASTER PLAN

FIBER OPTIC

APRIL 2020

FO-01

APPENDIX 2.1-DOMESTIC WATER/FIRE MODELING CALCULATIONS

Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Date	Units (1 unit = 1000 gallons)	Avg Daily Demand (GPM)
2319-37122	**University of Wyoming**				**1010 Lewis Master**					**Master**		**Meter**	**15912744**	1.65
1/13	109	1/14	60	1/15	37	1/16	133	1/17	39	1/18	76	1/19	110	
2/13	93	2/14	32	2/15	63	2/16	21	2/17	38	2/18	41	2/19	58	
3/13	9	3/14	50	3/15	47	3/16	31	3/17	48	3/18	460	3/19	69	
4/13	24	4/14	147	4/15	46	4/16	31	4/17	68	4/18	65	4/19	72	
5/13	34	5/14	49	5/15	72	5/16	77	5/17	79	5/18	57	5/19	82	
6/13	52	6/14	27	6/15	46	6/16	26	6/17	57	6/18	43	6/19	97	
7/13	48	7/14	32	7/15	50	7/16	33	7/17	57	7/18	104	7/19	80	
8/13	51	8/14	55	8/15	57	8/16	276	8/17	53	8/18	55	8/19		
9/13	81	9/14	96	9/15	42	9/16	30	9/17	64	9/18	57	9/19		
10/13	85	10/14	40	10/15	62	10/16	44	10/17	74	10/18	74	10/19		
11/13	62	11/14	78	11/15	59	11/16	462	11/17	75	11/18	75	11/19		
12/13	48	12/14	98	12/15	35	12/16	50	12/17	79	12/18	88	12/19		
Annual Total	696		764		616		1214		731		1195		568	
2319-45920	**University of Wyoming**				**9 1/2 Lewis - Barry Center Rd**					**Master**		**Meter**	**167517**	0.45
1/13	9	1/14	7	1/15	7	1/16	15	1/17	13	1/18	24	1/19	15	
2/13	29	2/14	10	2/15	6	2/16	14	2/17	14	2/18	19	2/19	17	
3/13	20	3/14	8	3/15	11	3/16	22	3/17	14	3/18	21	3/19	18	
4/13	12	4/14	9	4/15	9	4/16	24	4/17	15	4/18	22	4/19	18	
5/13	13	5/14	10	5/15	11	5/16	24	5/17	12	5/18	22	5/19	20	
6/13	20	6/14	12	6/15	9	6/16	22	6/17	11	6/18	21	6/19	18	
7/13	47	7/14	17	7/15	18	7/16	42	7/17	27	7/18	36	7/19	26	
8/13	40	8/14	27	8/15	12	8/16	32	8/17	31	8/18	33	8/19		
9/13	44	9/14	29	9/15	12	9/16	26	9/17	23	9/18	33	9/19		
10/13	2	10/14	32	10/15	15	10/16	24	10/17	24	10/18	43	10/19		
11/13	23	11/14	11	11/15	13	11/16	22	11/17	20	11/18	22	11/19		
12/13	12	12/14	8	12/15	15	12/16	13	12/17	28	12/18	19	12/19		
Annual Total	271		180		138		280		232		315		132	
2319-55382	**University of Wyoming**				**2301 Willett Dr Irrig - UW Bld 7006**					**Master**		**Meter**	**9917552**	9.95
				finalled 8/2017 - turned on 7/2018										
1/13		1/14		1/15		1/16		1/17		1/18		1/19		
2/13		2/14		2/15		2/16		2/17		2/18		2/19		
3/13		3/14		3/15		3/16		3/17		3/18		3/19		
4/13		4/14		4/15		4/16		4/17		4/18		4/19		
5/13	1	5/14	0	5/15	0	5/16	0	5/17	0	5/18		5/19	134	
6/13	349	6/14	9	6/15	49	6/16	0	6/17	0	6/18	on 7/17/18	6/19	2219	
7/13	2136	7/14	379	7/15	475	7/16	558	7/17	0	7/18	0	7/19	4625	
8/13	2952	8/14	2857	8/15	593	8/16	3	8/17	0	8/18	2374	8/19		
9/13	2911	9/14	929	9/15	1168	9/16	0	9/17	**finalled**	9/18	3500	9/19		
10/13	203	10/14	16	10/15	774	10/16	0	10/17		10/18	3923	10/19		
11/13		11/14		11/15		11/16		11/17		11/18		11/19		
12/13		12/14		12/15		12/16		12/17		12/18		12/19		
Annual Total	8552		4190		3059		561		0		9797		6978	
2319-57150	**University of Wyoming**				**1012 Bradley - UW Bldg 130 Enzi Stem Bldg**					**Master**		**Meter**	**1715962**	1.47
1/13		1/14		1/15		1/16	12	1/17	22	1/18	13	1/19	13	
2/13		2/14		2/15		2/16	12	2/17	17	2/18	15	2/19	7	
3/13		3/14		3/15	starts 4/8/15	3/16	32	3/17	75	3/18	48	3/19	29	
4/13		4/14		4/15		4/16	35	4/17	196	4/18	54	4/19	25	
5/13		5/14		5/15	0	5/16	53	5/17	197	5/18	64	5/19	79	
6/13		6/14		6/15	26	6/16	43	6/17	42	6/18	122	6/19	162	
7/13		7/14		7/15	10	7/16	189	7/17	208	7/18	190	7/19	329	
8/13		8/14		8/15	11	8/16	362	8/17	169	8/18	280	8/19		
9/13		9/14		9/15	81	9/16	186	9/17	165	9/18	260	9/19		
10/13		10/14		10/15	182	10/16	142	10/17	206	10/18	362	10/19		
11/13		11/14		11/15	132	11/16	69	11/17	53	11/18	50	11/19		
12/13		12/14		12/15	104	12/16	76	12/17	36	12/18	24	12/19		
Annual Total	0		0		546		1211		1386		1482		644	
Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	
2321-37124	**University of Wyoming**				**UW 11th & Lewis - Master**							**meter**	**1918530**	7.64
1/13	173	1/14	188	1/15	277	1/16	192	1/17	127	1/18	244	1/19	101	
2/13	385	2/14	221	2/15	228	2/16	150	2/17	145	2/18	170	2/19	89	
3/13	305	3/14	317	3/15	378	3/16	264	3/17	284	3/18	278	3/19	264	
4/13	315	4/14	484	4/15	382	4/16	235	4/17	289	4/18	271	4/19	182	
5/13	514	5/14	587	5/15	420	5/16	287	5/17	270	5/18	403	5/19	249	
6/13	382	6/14	240	6/15	257	6/16	201	6/17	184	6/18	407	6/19	231	
7/13	418	7/14	258	7/15	464	7/16	181	7/17	237	7/18	305	7/19	144	
8/13	456	8/14	292	8/15	533	8/16	133	8/17	203	8/18	316	8/19		
9/13	374	9/14	492	9/15	315	9/16	218	9/17	163	9/18	266	9/19		
10/13	1003	10/14	566	10/15	513	10/16	387	10/17	334	10/18	554	10/19		
11/13	934	11/14	687	11/15	371	11/16	355	11/17	309	11/18	279	11/19		
12/13	442	12/14	345	12/15	266	12/16	257	12/17	243	12/18	185	12/19		
Annual Total	5701		4677		4404		2860		2788		3678		1260	
2323-37126	**University of Wyoming**				**1300 Lewis**					**Master**		**Meter**	**1918534**	4.39
1/13	77	1/14	70	1/15	95	1/16	199	1/17	60	1/18	64	1/19	77	
2/13	152	2/14	93	2/15	14	2/16	264	2/17	65	2/18	59	2/19	82	
3/13	148	3/14	127	3/15	205	3/16	444	3/17	111	3/18	82	3/19	209	
4/13	129	4/14	182	4/15	131	4/16	331	4/17	104	4/18	84	4/19	133	
5/13	190	5/14	183	5/15	135	5/16	420	5/17	102	5/18	105	5/19	166	
6/13	173	6/14	96	6/15	131	6/16	436	6/17	82	6/18	175	6/19	131	
7/13	147	7/14	97	7/15	133	7/16	588	7/17	98	7/18	216	7/19	136	
8/13	160	8/14	103	8/15	251	8/16	565	8/17	79	8/18	436	8/19		
9/13	136	9/14	108	9/15	824	9/16	96	9/17	67	9/18	235	9/19		
10/13	263	10/14	211	10/15	635	10/16	134	10/17	105	10/18	381	10/19		
11/13	269	11/14	191	11/15	467	11/16	131	11/17	110	11/18	204	11/19		
12/13	165	12/14	114	12/15	268	12/16	108	12/17	91	12/18	138	12/19		
Annual Total	2009		1575		3289		3716		1074		2179		934	
2325-37128	**University of Wyoming**				**567 N 19th Animal Science**					**Master**		**Meter**	**912617**	0.49

1/13	1	1/14	0	1/15	2	1/16	5	1/17	5	1/18	4	1/19	175
2/13	0	2/14	0	2/15	1	2/16	5	2/17	6	2/18	4	2/19	232
3/13	0	3/14	2	3/15	0	3/16	9	3/17	7	3/18	3	3/19	241
4/13	0	4/14	3	4/15	0	4/16	8	4/17	8	4/18	250	4/19	301
5/13	0	5/14	2	5/15	0	5/16	9	5/17	8	5/18	213	5/19	241
6/13	0	6/14	0	6/15	1	6/16	12	6/17	5	6/18	157	6/19	137
7/13	0	7/14	2	7/15	1	7/16	4	7/17	4	7/18	126	7/19	120
8/13	0	8/14	0	8/15	2	8/16	3	8/17	3	8/18	110	8/19	
9/13	3	9/14	2	9/15	2	9/16	4	9/17	4	9/18	64	9/19	
10/13	4	10/14	1	10/15	6	10/16	7	10/17	23	10/18	102	10/19	
11/13	0	11/14	2	11/15	1	11/16	5	11/17	8	11/18	113	11/19	
12/13	0	12/14	5	12/15	5	12/16	6	12/17	7	12/18	185	12/19	
Annual Total	8		19		21		77		88		1331		1447

1.67

2325-55990	**University of Wyoming**				**567 N 19th Animal Science 2**					**Master**		**Meter**	**213631**
1/13	140	1/14	93	1/15	51	1/16	10	1/17	9	1/18	5	1/19	241
2/13	123	2/14	74	2/15	56	2/16	9	2/17	10	2/18	5	2/19	154
3/13	95	3/14	83	3/15	70	3/16	27	3/17	14	3/18	11	3/19	339
4/13	95	4/14	104	4/15	59	4/16	22	4/17	12	4/18	146	4/19	306
5/13	88	5/14	125	5/15	17	5/16	26	5/17	14	5/18	274	5/19	277
6/13	147	6/14	117	6/15	15	6/16	21	6/17	17	6/18	135	6/19	243
7/13	161	7/14	143	7/15	27	7/16	10	7/17	10	7/18	155	7/19	vice order pend
8/13	132	8/14	162	8/15	24	8/16	11	8/17	6	8/18	153	8/19	
9/13	139	9/14	129	9/15	16	9/16	9	9/17	7	9/18	151	9/19	
10/13	134	10/14	139	10/15	16	10/16	17	10/17	57	10/18	148	10/19	
11/13	134	11/14	174	11/15	12	11/16	14	11/17	5	11/18	173	11/19	
12/13	101	12/14	115	12/15	13	12/16	13	12/17	47	12/18	197	12/19	
Annual Total	1489		1458		376		189		208		1553		1560

Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**

3.00

2335-37138	**University of Wyoming**				**UW N 1/2 University**					**Master**		**Meter**	**835431**
1/13	90	1/14	57	1/15	140	1/16	80	1/17	64	1/18	97	1/19	56
2/13	182	2/14	86	2/15	63	2/16	79	2/17	74	2/18	91	2/19	60
3/13	176	3/14	114	3/15	159	3/16	125	3/17	136	3/18	119	3/19	132
4/13	145	4/14	122	4/15	166	4/16	107	4/17	127	4/18	135	4/19	96
5/13	206	5/14	204	5/15	168	5/16	128	5/17	121	5/18	180	5/19	115
6/13	167	6/14	128	6/15	117	6/16	85	6/17	94	6/18	184	6/19	86
7/13	137	7/14	106	7/15	165	7/16	126	7/17	122	7/18	119	7/19	80
8/13	124	8/14	142	8/15	161	8/16	96	8/17	76	8/18	159	8/19	
9/13	158	9/14	128	9/15	101	9/16	80	9/17	103	9/18	102	9/19	
10/13	152	10/14	264	10/15	152	10/16	144	10/17	129	10/18	192	10/19	
11/13	192	11/14	251	11/15	127	11/16	135	11/17	122	11/18	118	11/19	
12/13	126	12/14	143	12/15	153	12/16	133	12/17	119	12/18	86	12/19	
Annual Total	1855		1745		1672		1318		1287		1582		625

1.30

2337-37140	**University of Wyoming**				**UW S 1/2 University**					**Master**		**Meter**	**838308**
1/13	12	1/14	40	1/15	91	1/16	50	1/17	39	1/18	30	1/19	30
2/13	18	2/14	45	2/15	7	2/16	24	2/17	25	2/18	31	2/19	16
3/13	16	3/14	62	3/15	70	3/16	62	3/17	58	3/18	48	3/19	50
4/13	14	4/14	90	4/15	67	4/16	53	4/17	55	4/18	44	4/19	41
5/13	58	5/14	178	5/15	77	5/16	69	5/17	59	5/18	56	5/19	54
6/13	29	6/14	49	6/15	58	6/16	43	6/17	37	6/18	36	6/19	40
7/13	18	7/14	40	7/15	28	7/16	33	7/17	24	7/18	22	7/19	23
8/13	16	8/14	44	8/15	25	8/16	25	8/17	18	8/18	17	8/19	
9/13	13	9/14	30	9/15	30	9/16	31	9/17	31	9/18	23	9/19	
10/13	7	10/14	112	10/15	71	10/16	65	10/17	52	10/18	71	10/19	
11/13	53	11/14	116	11/15	86	11/16	66	11/17	67	11/18	61	11/19	
12/13	720	12/14	82	12/15	56	12/16	56	12/17	52	12/18	47	12/19	
Annual Total	974		888		666		577		517		486		254

1.72

2339-37142	**University of Wyoming**				**1405 Ivinson - UW Business**					**Master**		**Meter**	**124619**
1/13	32	1/14	14	1/15	26	1/16	76	1/17	35	1/18	22	1/19	25
2/13	33	2/14	31	2/15	23	2/16	70	2/17	28	2/18	27	2/19	16
3/13	41	3/14	38	3/15	41	3/16	96	3/17	58	3/18	48	3/19	47
4/13	37	4/14	39	4/15	35	4/16	91	4/17	43	4/18	47	4/19	45
5/13	54	5/14	35	5/15	42	5/16	109	5/17	66	5/18	67	5/19	55
6/13	151	6/14	137	6/15	26	6/16	104	6/17	58	6/18	60	6/19	33
7/13	173	7/14	239	7/15	97	7/16	125	7/17	76	7/18	78	7/19	62
8/13	152	8/14	177	8/15	107	8/16	132	8/17	63	8/18	71	8/19	
9/13	144	9/14	119	9/15	105	9/16	127	9/17	60	9/18	63	9/19	
10/13	92	10/14	117	10/15	138	10/16	86	10/17	88	10/18	101	10/19	
11/13	56	11/14	72	11/15	118	11/16	75	11/17	66	11/18	70	11/19	
12/13	36	12/14	35	12/15	81	12/16	57	12/17	47	12/18	47	12/19	
Annual Total	1001		1053		839		1148		688		701		283

1.26

2341-37144	**University of Wyoming**				**UW 13th & Ivinson - Master**					**Master**		**Meter**	**1917436**
1/13	24	1/14	23	1/15	47	1/16	39	1/17	3	1/18	55	1/19	23
2/13	45	2/14	36	2/15	29	2/16	27	2/17	273	2/18	34	2/19	18
3/13	59	3/14	42	3/15	60	3/16	51	3/17	51	3/18	45	3/19	47
4/13	57	4/14	41	4/15	54	4/16	14	4/17	48	4/18	45	4/19	38
5/13	60	5/14	670	5/15	64	5/16	86	5/17	51	5/18	58	5/19	50
6/13	45	6/14	33	6/15	48	6/16	47	6/17	37	6/18	38	6/19	37
7/13	36	7/14	43	7/15	37	7/16	31	7/17	39	7/18	32	7/19	33
8/13	32	8/14	46	8/15	41	8/16	3	8/17	40	8/18	23	8/19	
9/13	52	9/14	45	9/15	41	9/16	3	9/17	46	9/18	29	9/19	
10/13	44	10/14	69	10/15	59	10/16	7	10/17	57	10/18	77	10/19	
11/13	74	11/14	98	11/15	68	11/16	5	11/17	66	11/18	62	11/19	
12/13	38	12/14	54	12/15	47	12/16	5	12/17	52	12/18	45	12/19	
Annual Total	566		1200		595		318		763		543		246

Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**

3.06

2349-37152	**University of Wyoming**				**UW 15th & Ivinson - Master**					**Master**		**Meter**	**1917440**
1/13	31	1/14	23	1/15	108	1/16	161	1/17	175	1/18	125	1/19	1
2/13	54	2/14	37	2/15	112	2/16	128	2/17	108	2/18	158	2/19	0
3/13	70	3/14	56	3/15	183	3/16	233	3/17	198	3/18	205	3/19	3

4/13	54	4/14	95	4/15	158	4/16	194	4/17	169	4/18	174	4/19	0
5/13	85	5/14	397	5/15	184	5/16	255	5/17	128	5/18	167	5/19	0
6/13	25	6/14	71	6/15	113	6/16	122	6/17	107	6/18	8	6/19	3
7/13	14	7/14	38	7/15	37	7/16	98	7/17	152	7/18	44	7/19	17
8/13	11	8/14	14	8/15	36	8/16	99	8/17	118	8/18	29	8/19	
9/13	39	9/14	1	9/15	74	9/16	146	9/17	152	9/18	60	9/19	
10/13	140	10/14	325	10/15	245	10/16	285	10/17	282	10/18	199	10/19	
11/13	199	11/14	281	11/15	273	11/16	258	11/17	263	11/18	26	11/19	
12/13	108	12/14	243	12/15	203	12/16	237	12/17	252	12/18	1	12/19	
Annual Total	830		1581		1726		2216		2104		1196		24

1.00

2357-37160	**University of Wyoming**				**UW Downey Dorm**					**Master**		**Meter**	**1914141**
1/13	105	1/14	79	1/15	6	1/16	9	1/17	16	1/18	13	1/19	3
2/13	172	2/14	132	2/15	2	2/16	8	2/17	9	2/18	13	2/19	4
3/13	204	3/14	168	3/15	7	3/16	12	3/17	13	3/18	11	3/19	11
4/13	152	4/14	124	4/15	9	4/16	11	4/17	11	4/18	12	4/19	6
5/13	283	5/14	0	5/15	11	5/16	13	5/17	7	5/18	11	5/19	6
6/13	76	6/14	0	6/15	11	6/16	7	6/17	8	6/18	5	6/19	5
7/13	122	7/14	2	7/15	2	7/16	7	7/17	12	7/18	8	7/19	5
8/13	26	8/14	0	8/15	5	8/16	8	8/17	15	8/18	3	8/19	
9/13	46	9/14	3	9/15	5	9/16	11	9/17	18	9/18	4	9/19	
10/13	278	10/14	14	10/15	14	10/16	25	10/17	29	10/18	17	10/19	
11/13	375	11/14	11	11/15	17	11/16	17	11/17	20	11/18	7	11/19	
12/13	228	12/14	7	12/15	13	12/16	20	12/17	18	12/18	8	12/19	
Annual Total	2067		540		102		148		176		112		40

0.27

2359-37162	**University of Wyoming**				**UW McIntyre Dorm**					**Master**		**Meter**	**939225**
1/13	31	1/14	19	1/15	1	1/16	2	1/17	6	1/18	5	1/19	1
2/13	64	2/14	33	2/15	0	2/16	4	2/17	3	2/18	3	2/19	1
3/13	61	3/14	34	3/15	1	3/16	3	3/17	5	3/18	4	3/19	2
4/13	61	4/14	31	4/15	1	4/16	3	4/17	2	4/18	3	4/19	0
5/13	71	5/14	0	5/15	2	5/16	4	5/17	1	5/18	2	5/19	1
6/13	24	6/14	0	6/15	2	6/16	3	6/17	3	6/18	2	6/19	0
7/13	18	7/14	0	7/15	1	7/16	3	7/17	7	7/18	1	7/19	0
8/13	8	8/14	0	8/15	1	8/16	4	8/17	5	8/18	1	8/19	
9/13	41	9/14	1	9/15	1	9/16	5	9/17	7	9/18	1	9/19	
10/13	63	10/14	2	10/15	2	10/16	6	10/17	7	10/18	4	10/19	
11/13	75	11/14	3	11/15	3	11/16	6	11/17	5	11/18	0	11/19	
12/13	47	12/14	0	12/15	4	12/16	6	12/17	5	12/18	1	12/19	
Annual Total	564		123		19		49		56		27		5

1.50

2361-37164	**University of Wyoming**				**UW Crane Hall East - Master**					**Master**		**Meter**	**1715940**
1/13	108	1/14	83	1/15	15	1/16	17	1/17	10	1/18	4	1/19	3
2/13	217	2/14	158	2/15	7	2/16	14	2/17	7	2/18	4	2/19	2
3/13	240	3/14	178	3/15	9	3/16	27	3/17	12	3/18	6	3/19	5
4/13	214	4/14	160	4/15	2	4/16	23	4/17	12	4/18	4	4/19	4
5/13	265	5/14	208	5/15	19	5/16	25	5/17	11	5/18	5	5/19	5
6/13	155	6/14	70	6/15	125	6/16	18	6/17	8	6/18	2	6/19	4
7/13	217	7/14	93	7/15	21	7/16	106	7/17	7	7/18	2	7/19	2
8/13	195	8/14	129	8/15	79	8/16	113	8/17	6	8/18	2	8/19	
9/13	170	9/14	49	9/15	73	9/16	11	9/17	6	9/18	2	9/19	
10/13	184	10/14	49	10/15	184	10/16	16	10/17	11	10/18	5	10/19	
11/13	225	11/14	14	11/15	28	11/16	15	11/17	6	11/18	6	11/19	
12/13	190	12/14	13	12/15	22	12/16	17	12/17	6	12/18	5	12/19	
Annual Total	2380		1204		584		402		102		47		25

Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**

77.44

2363-37166	**University of Wyoming**				**UW Crane Hall**					**Master**		**Meter**	**1914125 & 1918538**
1/13	1912	1/14	3297	1/15	3103	1/16	2744	1/17	2659	1/18	2347	1/19	2472
2/13	3256	2/14	3849	2/15	3087	2/16	2493	2/17	2330	2/18	2236	2/19	1863
3/13	2822	3/14	3564	3/15	3453	3/16	3217	3/17	3176	3/18	2976	3/19	3589
4/13	2633	4/14	1447	4/15	3330	4/16	2838	4/17	3371	4/18	3382	4/19	3161
5/13	2380	5/14	1805	5/15	3740	5/16	3404	5/17	3267	5/18	3736	5/19	3608
6/13	1832	6/14	3509	6/15	3156	6/16	2423	6/17	2685	6/18	3399	6/19	3545
7/13	3196	7/14	3906	7/15	4083	7/16	3100	7/17	4251	7/18	3627	7/19	3216
8/13	4681	8/14	4095	8/15	3937	8/16	2989	8/17	4319	8/18	3654	8/19	
9/13	7376	9/14	4086	9/15	3617	9/16	3119	9/17	3766	9/18	4435	9/19	
10/13	414	10/14	4517	10/15	4650	10/16	4102	10/17	4812	10/18	5652	10/19	
11/13	0	11/14	4939	11/15	4492	11/16	3845	11/17	3432	11/18	5575	11/19	
12/13	2674	12/14	3491	12/15	3845	12/16	3500	12/17	3660	12/18	3535	12/19	
Annual Total	33176		42505		44493		37774		41728		44554		21454

2.58

2365-37168	**University of Wyoming**				**UW Hill Hall West**					**Master**		**Meter**	**2196417**
1/13	164	1/14	15	1/15	98	1/16	137	1/17	114	1/18	6	1/19	5
2/13	283	2/14	22	2/15	71	2/16	88	2/17	83	2/18	5	2/19	5
3/13	344	3/14	29	3/15	138	3/16	209	3/17	186	3/18	9	3/19	9
4/13	264	4/14	42	4/15	120	4/16	167	4/17	178	4/18	8	4/19	10
5/13	369	5/14	64	5/15	133	5/16	208	5/17	175	5/18	8	5/19	11
6/13	155	6/14	53	6/15	104	6/16	108	6/17	100	6/18	28	6/19	10
7/13	148	7/14	94	7/15	114	7/16	117	7/17	133	7/18	33	7/19	29
8/13	87	8/14	149	8/15	120	8/16	174	8/17	100	8/18	40	8/19	
9/13	59	9/14	113	9/15	129	9/16	170	9/17	98	9/18	35	9/19	
10/13	29	10/14	166	10/15	244	10/16	249	10/17	30	10/18	46	10/19	
11/13	30	11/14	172	11/15	228	11/16	196	11/17	10	11/18	11	11/19	
12/13	27	12/14	134	12/15	182	12/16	177	12/17	10	12/18	9	12/19	
Annual Total	1959		1053		1681		2000		1217		238		79

2.82

2367-37170	**University of Wyoming**				**1801 Grand Bldg 41 Crane Hill Caf**					**Master**		**Meter**	**1917437**
1/13	106	1/14	278	1/15	142	1/16	90	1/17	92	1/18	114	1/19	1
2/13	115	2/14	133	2/15	93	2/16	53	2/17	89	2/18	137	2/19	0
3/13	101	3/14	151	3/15	111	3/16	77	3/17	149	3/18	98	3/19	1
4/13	85	4/14	77	4/15	109	4/16	71	4/17	86	4/18	124	4/19	0
5/13	96	5/14	146	5/15	127	5/16	100	5/17	157	5/18	26	5/19	1
6/13	41	6/14	144	6/15	125	6/16	91	6/17	146	6/18	0	6/19	18
7/13	143	7/14	219	7/15	149	7/16	114	7/17	181	7/18	1	7/19	1
8/13	174	8/14	287	8/15	145	8/16	115	8/17	110	8/18	0	8/19	
9/13	204	9/14	191	9/15	142	9/16	137	9/17	182	9/18	1	9/19	
10/13	164	10/14	150	10/15	172	10/16	177	10/17	223	10/18	0	10/19	

11/13	225	11/14	167	11/15	125	11/16	120	11/17	182	11/18	2	11/19	
12/13	335	12/14	126	12/15	80	12/16	120	12/17	163	12/18	0	12/19	
Annual Total	1789		2069		1520		1265		1760		503		22
2369-37172	**University of Wyoming**				**UW Apartments - 22nd & Willett**					**Master**		**Meter**	**1917451**
1/13	520	1/14	401	1/15	408	1/16	396	1/17	446	1/18	266	1/19	327
2/13	666	2/14	544	2/15	448	2/16	437	2/17	379	2/18	0	2/19	270
3/13	498	3/14	496	3/15	402	3/16	438	3/17	531	3/18	0	3/19	386
4/13	482	4/14	434	4/15	408	4/16	400	4/17	550	4/18	0	4/19	431
5/13	507	5/14	489	5/15	428	5/16	479	5/17	326	5/18	0	5/19	413
6/13	830	6/14	631	6/15	758	6/16	700	6/17	376	6/18	0	6/19	596
7/13	1116	7/14	1206	7/15	937	7/16	1215	7/17	1427	7/18	1377	7/19	997
8/13	1216	8/14	1076	8/15	929	8/16	1566	8/17	1356	8/18	1182	8/19	
9/13	1067	9/14	1252	9/15	1210	9/16	1518	9/17	1247	9/18	852	9/19	
10/13	603	10/14	691	10/15	705	10/16	1426	10/17	1126	10/18	1289	10/19	
11/13	429	11/14	506	11/15	785	11/16	435	11/17	421	11/18	483	11/19	
12/13	485	12/14	397	12/15	358	12/16	487	12/17	435	12/18	405	12/19	
Annual Total	8419		8123		7776		9497		8620		5854		3420
Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**
2381-37184	**University of Wyoming**				**UW River Village Apt - 2902 Willett**					**Master**		**Meter**	**803386**
1/13	527	1/14	383	1/15	368	1/16	294	1/17	311	1/18	207	1/19	176
2/13	749	2/14	505	2/15	348	2/16	307	2/17	272	2/18	659	2/19	139
3/13	546	3/14	493	3/15	354	3/16	393	3/17	446	3/18	757	3/19	284
4/13	542	4/14	404	4/15	347	4/16	353	4/17	427	4/18	742	4/19	267
5/13	531	5/14	500	5/15	385	5/16	440	5/17	195	5/18	770	5/19	276
6/13	1073	6/14	721	6/15	837	6/16	775	6/17	281	6/18	2536	6/19	584
7/13	2309	7/14	2268	7/15	1735	7/16	2345	7/17	2905	7/18	3161	7/19	1598
8/13	2211	8/14	2213	8/15	1681	8/16	3518	8/17	2881	8/18	2302	8/19	
9/13	1904	9/14	2136	9/15	1589	9/16	3238	9/17	2360	9/18	2089	9/19	
10/13	895	10/14	950	10/15	1652	10/16	2630	10/17	1744	10/18	2524	10/19	
11/13	436	11/14	485	11/15	831	11/16	465	11/17	534	11/18	432	11/19	
12/13	423	12/14	367	12/15	318	12/16	385	12/17	416	12/18	287	12/19	
Annual Total	12146		11425		10445		15143		12772		16466		3324
2383-37186	**University of Wyoming**				**2111 Willett Cent Cmplx**					**Master**		**Meter**	**3100350**
1/13	14	1/14	18	1/15	146	1/16	54	1/17	232	1/18	208	1/19	31
2/13	21	2/14	16	2/15	126	2/16	54	2/17	237	2/18	289	2/19	33
3/13	26	3/14	18	3/15	137	3/16	112	3/17	233	3/18	270	3/19	34
4/13	21	4/14	14	4/15	105	4/16	154	4/17	249	4/18	38	4/19	35
5/13	31	5/14	17	5/15	121	5/16	219	5/17	190	5/18	36	5/19	48
6/13	23	6/14	17	6/15	96	6/16	178	6/17	157	6/18	21	6/19	51
7/13	25	7/14	29	7/15	131	7/16	205	7/17	144	7/18	24	7/19	33
8/13	38	8/14	21	8/15	163	8/16	221	8/17	106	8/18	18	8/19	
9/13	29	9/14	20	9/15	178	9/16	232	9/17	101	9/18	17	9/19	
10/13	34	10/14	56	10/15	190	10/16	296	10/17	131	10/18	35	10/19	
11/13	62	11/14	234	11/15	113	11/16	325	11/17	173	11/18	41	11/19	
12/13	39	12/14	178	12/15	77	12/16	233	12/17	206	12/18	41	12/19	
Annual Total	363		638		1583		2283		2159		1038		265
2383-55994	**University of Wyoming**				**2111 Willett Mtr 2**					**Master**		**Meter**	**3118554**
1/13	17	1/14	24	1/15	132	1/16	2	1/17	196	1/18	179	1/19	25
2/13	23	2/14	24	2/15	81	2/16	51	2/17	212	2/18	264	2/19	25
3/13	27	3/14	27	3/15	96	3/16	52	3/17	209	3/18	239	3/19	25
4/13	22	4/14	23	4/15	84	4/16	32	4/17	218	4/18	32	4/19	27
5/13	33	5/14	30	5/15	91	5/16	8	5/17	158	5/18	30	5/19	36
6/13	25	6/14	31	6/15	65	6/16	15	6/17	127	6/18	19	6/19	39
7/13	31	7/14	44	7/15	101	7/16	6	7/17	117	7/18	22	7/19	28
8/13	51	8/14	30	8/15	117	8/16	66	8/17	86	8/18	15	8/19	
9/13	35	9/14	25	9/15	85	9/16	188	9/17	81	9/18	15	9/19	
10/13	41	10/14	46	10/15	129	10/16	260	10/17	110	10/18	31	10/19	
11/13	71	11/14	214	11/15	83	11/16	299	11/17	132	11/18	33	11/19	
12/13	51	12/14	154	12/15	1	12/16	199	12/17	169	12/18	32	12/19	
Annual Total	427		672		1065		1178		1815		911		205
2385-37188	**University of Wyoming**				**UW Stadium - Willett**					**Master**		**Meter**	**2113166**
1/13	26	1/14	14	1/15	21	1/16	20	1/17	30	1/18	17	1/19	15
2/13	47	2/14	24	2/15	28	2/16	28	2/17	66	2/18	12	2/19	24
3/13	44	3/14	27	3/15	36	3/16	30	3/17	111	3/18	17	3/19	27
4/13	37	4/14	82	4/15	19	4/16	22	4/17	226	4/18	12	4/19	24
5/13	195	5/14	132	5/15	21	5/16	29	5/17	53	5/18	16	5/19	25
6/13	32	6/14	13	6/15	19	6/16	17	6/17	197	6/18	8	6/19	21
7/13	57	7/14	17	7/15	16	7/16	20	7/17	100	7/18	17	7/19	20
8/13	44	8/14	9	8/15	14	8/16	16	8/17	140	8/18	12	8/19	
9/13	-141	9/14	22	9/15	17	9/16	24	9/17	202	9/18	21	9/19	
10/13	168	10/14	35	10/15	37	10/16	36	10/17	179	10/18	42	10/19	
11/13	120	11/14	34	11/15	34	11/16	33	11/17	23	11/18	36	11/19	
12/13	62	12/14	35	12/15	32	12/16	31	12/17	20	12/18	33	12/19	
Annual Total	691		444		294		306		1347		243		156
Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**
2389-37192	**University of Wyoming**				**UW Power Plant - 654 N 19th**					**Master**		**Meter**	**7920627**
1/13	1346	1/14	974	1/15	1325	1/16	751	1/17	677	1/18	742	1/19	603
2/13	1341	2/14	944	2/15	1737	2/16	874	2/17	526	2/18	714	2/19	563
3/13	1093	3/14	855	3/15	544	3/16	767	3/17	580	3/18	678	3/19	675
4/13	718	4/14	809	4/15	721	4/16	788	4/17	725	4/18	644	4/19	541
5/13	678	5/14	1173	5/15	758	5/16	1109	5/17	620	5/18	733	5/19	636
6/13	1588	6/14	1271	6/15	1043	6/16	995	6/17	901	6/18	1093	6/19	805
7/13	1827	7/14	1473	7/15	1418	7/16	1875	7/17	1505	7/18	1738	7/19	vice order pend
8/13	1800	8/14	1739	8/15	1452	8/16	1553	8/17	1595	8/18	1502	8/19	
9/13	1603	9/14	1193	9/15	1183	9/16	1269	9/17	1401	9/18	1271	9/19	
10/13	1419	10/14	1634	10/15	1313	10/16	1158	10/17	1309	10/18	1160	10/19	
11/13	914	11/14	1619	11/15	979	11/16	770	11/17	858	11/18	1072	11/19	
12/13	848	12/14	1264	12/15	771	12/16	866	12/17	961	12/18	862	12/19	
Annual Total	15175		14948		13244		12775		11658		12209		3823

15.31

24.86

2.56

1.92

1.05

25.37

2391-37194	**University of Wyoming**				**UW Arena Auditorium**					**Master**		**Meter**	**1917441**
1/13	612	1/14	232	1/15	877	1/16	922	1/17	738	1/18	414	1/19	504
2/13	1000	2/14	344	2/15	584	2/16	678	2/17	563	2/18	437	2/19	418
3/13	1066	3/14	403	3/15	1026	3/16	885	3/17	1032	3/18	952	3/19	815
4/13	900	4/14	2299	4/15	935	4/16	777	4/17	590	4/18	814	4/19	595
5/13	1462	5/14	2781	5/15	931	5/16	1006	5/17	768	5/18	908	5/19	675
6/13	1210	6/14	325	6/15	711	6/16	620	6/17	643	6/18	951	6/19	540
7/13	1327	7/14	507	7/15	811	7/16	718	7/17	746	7/18	949	7/19	494
8/13	1690	8/14	460	8/15	686	8/16	904	8/17	356	8/18	958	8/19	
9/13	1055	9/14	1254	9/15	764	9/16	1151	9/17	441	9/18	775	9/19	
10/13	4650	10/14	1320	10/15	1229	10/16	1327	10/17	744	10/18	1234	10/19	
11/13	4438	11/14	817	11/15	1190	11/16	1152	11/17	883	11/18	1142	11/19	
12/13	2076	12/14	1108	12/15	916	12/16	1004	12/17	780	12/18	826	12/19	
Annual Total	21486		11850		10660		11144		8284		10360		4041

23.40

25665-37118	**University of Wyoming**				**365 N 9th - WRI**					**Master**		**Meter**	**7045084**
1/13	94	1/14	9	1/15	65	1/16	36	1/17	11	1/18	88	1/19	73
2/13	25	2/14	11	2/15	52	2/16	30	2/17	31	2/18	91	2/19	33
3/13	18	3/14	24	3/15	47	3/16	20	3/17	9	3/18	75	3/19	14
4/13	26	4/14	41	4/15	77	4/16	23	4/17	36	4/18	20	4/19	16
5/13	28	5/14	55	5/15	139	5/16	22	5/17	39	5/18	23	5/19	18
6/13	31	6/14	123	6/15	65	6/16	14	6/17	36	6/18	47	6/19	14
7/13	44	7/14	132	7/15	57	7/16	12	7/17	10	7/18	18	7/19	12
8/13	45	8/14	97	8/15	56	8/16	10	8/17	22	8/18	34	8/19	
9/13	32	9/14	95	9/15	55	9/16	15	9/17	11	9/18	47	9/19	
10/13	47	10/14	94	10/15	137	10/16	12	10/17	81	10/18	60	10/19	
11/13	51	11/14	92	11/15	103	11/16	10	11/17	21	11/18	86	11/19	
12/13	15	12/14	82	12/15	50	12/16	12	12/17	79	12/18	120	12/19	
Annual Total	456		855		903		216		386		709		180

1.12

25665-55992	**University of Wyoming**				**365 N 9th Mtr 2**					**Master**		**Meter**	**1918535**
1/13	93	1/14	3	1/15	69	1/16	47	1/17	45	1/18	46	1/19	67
2/13	23	2/14	11	2/15	52	2/16	31	2/17	62	2/18	81	2/19	32
3/13	16	3/14	24	3/15	38	3/16	18	3/17	54	3/18	67	3/19	12
4/13	26	4/14	45	4/15	92	4/16	24	4/17	58	4/18	17	4/19	14
5/13	25	5/14	67	5/15	133	5/16	19	5/17	50	5/18	26	5/19	14
6/13	31	6/14	135	6/15	30	6/16	20	6/17	50	6/18	31	6/19	12
7/13	51	7/14	137	7/15	46	7/16	11	7/17	13	7/18	12	7/19	9
8/13	43	8/14	86	8/15	62	8/16	12	8/17	32	8/18	23	8/19	
9/13	30	9/14	108	9/15	84	9/16	17	9/17	8	9/18	37	9/19	
10/13	44	10/14	92	10/15	77	10/16	14	10/17	39	10/18	49	10/19	
11/13	44	11/14	94	11/15	44	11/16	15	11/17	60	11/18	74	11/19	
12/13	20	12/14	86	12/15	35	12/16	18	12/17	48	12/18	103	12/19	
Annual Total	446		888		762		246		519		566		160

1.09

Date	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**	**Date**	**Units (1 unit = 1000 gallons)**

220.36

28943-45258	**University of Wyoming**				**UW Jacoby Agreement**				Master	**Irrigation**		**Meter**	**1918531**
1/13		1/14		1/15		1/16		1/17	0	1/18	0	1/19	off
2/13		2/14		2/15		2/16		2/17	0	2/18	75	2/19	off
3/13		3/14		3/15		3/16	0	3/17	0	3/18	0	3/19	0
4/13		4/14	33	4/15	1133	4/16	0	4/17	289	4/18	17	4/19	0
5/13	704	5/14	901	5/15	2038	5/16	1	5/17	2428	5/18	2984	5/19	1557
6/13	7782	6/14	6619	6/15	3853	6/16	3631	6/17	9686	6/18	4225	6/19	6496
7/13	18641	7/14	13930	7/15	14762	7/16	12737	7/17	34320	7/18	15575	7/19	7600
8/13	15152	8/14	15846	8/15	10736	8/16	19125	8/17	22355	8/18	13516	8/19	
9/13	15058	9/14	11779	9/15	13440	9/16	14826	9/17	2368	9/18	14752	9/19	
10/13	4167	10/14	7561	10/15	10205	10/16	8560	10/17	201	10/18	16409	10/19	
11/13	369	11/14	1290	11/15	2618	11/16	1953	11/17	18	11/18	2119	11/19	
12/13		12/14		12/15	50	12/16	146	12/17	98	12/18	7	12/19	
Annual Total	61873		57959		58835		60979		71763		69679		15653

120.84

	Irrigation
	Master Meter

APPENDIX 3.0-ELECTRICAL EQUIPMENT EXPECTED LIFESPAN

Emergency Standby Generators:	qty	time (hrs)	Hours
Weekly Exercise Time	52	0.5	**26**
Annual Load Test	1	4	**4**
Total for Outages	12	6	**72**
Annual Estimated Run Hours:			**102**

Estimated Generator Life:	**3000**
Anticipated Years of Service:	**29**

Industry Standard Service Life is estimated at 3000 hrs (30 years).

Electrical Switchgear:

There are no set limits per standards of the life of an equipment. The components, like a circuit breaker have a limited performance (10,000 mechanical operations, 10,000 load current and 50 maximum short circuit operations). After that the breaker can be replaced. The enclosure, bussing, etc. has a 15-30 year life span, but that is not a mandatory requirement. It is not uncommon to have 50 years and older switchgear in service and working well.

Industry Standard Service Life is estimated at 30 years.
(Generally accepted Industry Standard)

MV Electrical Switchgear:

The expected life of distribution transformers is about 25 years.

The lifetime of switchgear equipment is dependent on several variables and could be 9 to 36 years.

An underground, insulated power line will last from 20 to 40 years, depending on the cable technology

Industry Standard Service Life is estimated at 25 years.
(Generally accepted Industry Standard)

Electrical Panelboards:

As a general statement we can state that panelboard useful life is dependent upon the following factors: 1) the environment in which it is installed, 2) the manner in which it has been used (it must be used in the manner in which it was designed to be used), 3) the degree of maintenance provided, and 4) the number of operations the devices installed have experienced.

Panelboards useful life can range from 15 to 40+ years.

Industry Standard Service Life is estimated at 30 years.
(Generally accepted Industry Standard)

Transformers:

When a Transformer is operated under ANSI / IEEE basic loading conditions (ANSI C57.96), its normal life
expectancy is about 20 years. The ANSI / IEEE basic loading conditions for Transformer are:

i. The Transformer is continuously loaded at rated kVA (kilo Volt Ampere) and rated Voltages (Transformer must be operated at the rated Voltage and kVA)

ii. The average temperature of the ambient air during any 24-hour period is equal to 30°C (86 °F) and at no time exceeds 40°C (104 °F).

iii. The height where the transformer is installed,
is not above 3300 feet or 1000 meters.

Industry Standard Service Life is estimated at 20 years.
(Generally accepted Industry Standard)

MV Power Cables:

MV power cables are qualified by various manufacturers to provide a specified life of anywhere from 20 to 30 years of continued service in optimal environmental and operating conditions. Many of the MV power cables operating in commercial, electric utility, and industrial locations can be exposed to a variety of environmental and operational stressors, including elevated temperature, high UV radiation, high humidity, water submersion, and exposure to dust, dirt, and corrosive contaminants.

Additional stress on power cables, such as high ambient environments, water submersion, mechanical stresses from system faults, high-voltage stress from lightning strikes can degrade the dielectric strength of the cables and reduce life. In general the majority of the MV power cables in service in the United States have been in service for over forty years.

Industry Standard Service Life is estimated at 25 years.
(Generally accepted Industry Standard)

***THE ABOVE ESTIMATES ARE BASED ON INFORMATION FROM INDUSTRY MANUFACTURERS SUCH AS KOHLER, CATERPILLAR, SQUARE D, EATON CUTLER HAMMER, SOUTHWIRE, ETC.**

APPENDIX 4.0-CAPITAL COST SUMMARY BY UTILITY AND PROJECT

University of Wyoming: 2019 Campus Master Plan Implementation Matrix

UTILITY MASTER PLAN COST SUMMARY

Design Contingency	10.0%
G.C. Markups	15.0%
CM Fee	5.0%
Construction Contingency	10.0%
Soft Cost	10.0%
Annual Escalation	3.0%
Calculation Baseline Date	1/1/2020

$123,025,269

As of *4/9/2020*

PROJECT OVERVIEW								PROJECT COST ESTIMATE							PROJECT COST ESTIMATE							
Phase	Project # (PPT)	Project Name	Description	Type	Quantity	Unit	Utility	Size	Unit Cost	Direct Cost	Design Contingency	G.C. Markups	CM Fee	Construction Contingency	Construction Cost	Soft Cost	Total Cost	Inflation Cost	Date of Construction Start	Inflation Year	Inflation %	Adjusted Total Cost
Hot Water Distribution																						
Near-Term		Prexy's HW Loop	Extend HW Loop Around Prexy's.	Utility Extension	2,400	LF	Heating Water	14	$840	$2,016,000	$201,600	$332,640	$127,512	$267,775	$2,945,527	$294,553	$3,240,080	$0	01/01/2020	-	0.0%	$3,240,080
Near-Term		West Campus Prexy's HW Loop Laterals	Extend HW Loop from Prexy's Loop to Sciances Tunnels and 15th St	Utility Extension	2,250	LF	Heating Water	14	$840	$1,890,000	$189,000	$311,850	$119,543	$251,039	$2,761,432	$276,143	$3,037,575	$0	01/01/2020	-	0.0%	$3,037,575
Near-Term		Sciences Tunnels HW Distribution	Extension of HW loop throughout Sciences Tunnels	Utility Extension	950	LF	Heating Water	10	$600	$570,000	$57,000	$94,050	$36,053	$75,710	$832,813	$83,281	$916,094	$0	01/01/2020	-	0.0%	$916,094
Near-Term		Bradley HW Extension	Bradley Extension of HW to 15th St	Utility Extension	950	LF	Heating Water	10	$600	$570,000	$57,000	$94,050	$36,053	$75,710	$832,813	$83,281	$916,094	$0	01/01/2020	-	0.0%	$916,094
Near-Term		Lewis HW Extension	HW Extension south of Science Initiative across Lewis to Sciences Tunnels	Utility Extension	1,500	LF	Heating Water	10	$600	$900,000	$90,000	$148,500	$56,925	$119,543	$1,314,968	$131,497	$1,446,464	$0	01/01/2020	-	0.0%	$1,446,464
Near-Term		15th Street HW Loop	Completion of 15th St. HW Loop along Business, north along 15th and connection to Dorm extension	Utility Extension	700	LF	Heating Water	14	$840	$588,000	$58,800	$97,020	$37,191	$78,101	$859,112	$85,911	$945,023	$0	01/01/2020	-	0.0%	$945,023
Near-Term		15th Street HW Line	HW extension along 15th from new dorms to North of Greenhill	Utility Extension	1,500	LF	Heating Water	10	$600	$900,000	$90,000	$148,500	$56,925	$119,543	$1,314,968	$131,497	$1,446,464	$0	01/01/2020	-	0.0%	$1,446,464
Near-Term		North Cemetary HW Run	Extension of HW loop along the north end of cemetary between 15th St and 19th St	Utility Extension	1,700	LF	Heating Water	10	$600	$1,020,000	$102,000	$168,300	$64,515	$135,482	$1,490,297	$149,030	$1,639,326	$0	01/01/2020	-	0.0%	$1,639,326
Near-Term		CEP HW Line	HW extension from CEP to 19th St and south to High Bay	Utility Extension	400	LF	Heating Water	16	$960	$384,000	$38,400	$63,360	$24,288	$51,005	$561,053	$56,105	$617,158	$0	01/01/2020	-	0.0%	$617,158
Near-Term		Wyoming Technology HW Extension	HW Extension from 19th St to Regulated materials and Wyoming Tech Business Center	Utility Extension	500	LF	Heating Water	8	$480	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		19th St. HW Line	HW Routing along 19th St from High Bay to Performing Arts	Utility Extension	2,000	LF	Heating Water	14	$840	$1,680,000	$168,000	$277,200	$106,260	$223,146	$2,454,606	$245,461	$2,700,067	$0	01/01/2020	-	0.0%	$2,700,067
Near-Term		Visual Arts Lateral	HW Extension from 19th St to Visual Arts	Utility Extension	1,800	LF	Heating Water	10	$600	$1,080,000	$108,000	$178,200	$68,310	$143,451	$1,577,961	$157,796	$1,735,757	$0	01/01/2020	-	0.0%	$1,735,757
Near-Term		Indoor Practice Facility Lateral	HW Extension from Visual Arts Lateral to IPF	Utility Extension	2,400	LF	Heating Water	8	$480	$1,152,000	$115,200	$190,080	$72,864	$153,014	$1,683,158	$168,316	$1,851,474	$0	01/01/2020	-	0.0%	$1,851,474
Near-Term		Fraternity/Sorority Row HW Line	HW Extension through Fraternity/Sorority Row and connecting to the 19th Street Line	Utility Extension	1,900	LF	Heating Water	14	$840	$1,596,000	$159,600	$263,340	$100,947	$211,989	$2,331,876	$233,188	$2,565,063	$0	01/01/2020	-	0.0%	$2,565,063
Near-Term		Fieldhouse/Corbet HW Lines	HW Estension from Fraternity/Sorority Row line to the Fieldhouse and Corbett	Utility Extension	1,400	LF	Heating Water	6	$360	$504,000	$50,400	$83,160	$31,878	$66,944	$736,382	$73,638	$810,020	$0	01/01/2020	-	0.0%	$810,020
Near-Term		HW Laterals to Greek houses	Individual HW Laterals to the Greek houses	Utility Extension	1,800	LF	Heating Water	4	$240	$432,000	$43,200	$71,280	$27,324	$57,380	$631,184	$63,118	$694,303	$0	01/01/2020	-	0.0%	$694,303
Near-Term		HW Lateral to Education	Extend HW Lateral from area north of Agriculture to Education	Utility Extension	130	LF	Heating Water	10	$600	$78,000	$7,800	$12,870	$4,934	$10,360	$113,964	$11,396	$125,360	$0	01/01/2020	-	0.0%	$125,360
Mid-Term		19th Street Research HW Loop	HW Loop extension around the 19th Street Research areas	Utility Extension	2,800	LF	Heating Water	8	$480	$1,344,000	$134,400	$221,760	$85,008	$178,517	$1,963,685	$196,368	$2,160,053	$175	01/02/2020	0.00	0.0%	$2,160,228
Near-Term		HW Lateral to Old Main	HW extension from Biological Sciences to Old Main	Utility Extension	300	LF	Heating Water	4	$240	$72,000	$7,200	$11,880	$4,554	$9,563	$105,197	$10,520	$115,717	$0	01/01/2020	-	0.0%	$115,717
Chilled Water Distribution																						
Near-Term		McWhinnie Hall Chilled Water Utility	Includes CHW Lateral into Mechanical Room.	Utility Extension	200	LF	Chilled Water	4	$240	$48,000	$4,800	$7,920	$3,036	$6,376	$70,132	$7,013	$77,145	$0	01/01/2020	-	0.0%	$77,145
Near-Term		Bradley CHW Extension	Bradley Extension of CHW to New Student Houseing	Utility Extension	750	LF	Chilled Water	12	$780	$585,000	$58,500	$96,525	$37,001	$77,703	$854,729	$85,473	$940,202	$0	01/01/2020	-	0.0%	$940,202
Near-Term		South-West Campus CHW Interconnect	Complete CHW loop between Biological Sciences and Merica Hall	Utility Extension	300	LF	Chilled Water	8	$480	$144,000	$14,400	$23,760	$9,108	$19,127	$210,395	$21,039	$231,434	$0	01/01/2020	-	0.0%	$231,434
Near-Term		CHW to Old Main	Chilled Water Extension from Biologicla Sciences to Old Main	Utility Extension	300	LF	Chilled Water	4	$240	$72,000	$7,200	$11,880	$4,554	$9,563	$105,197	$10,520	$115,717	$0	01/01/2020	-	0.0%	$115,717
Near-Term		CHW Lateral to Education	Extend CHW Lateral from area north of Agriculture to Education	Utility Extension	130	LF	Chilled Water	6	$360	$46,800	$4,680	$7,722	$2,960	$6,216	$68,378	$6,838	$75,216	$0	01/01/2020	-	0.0%	$75,216
Near-Term		Fieldhouse/Corbet CHW Lines	HW Estension from 19th St line to the Fieldhouse and Corbett	Utility Extension	1,200	LF	Chilled Water	4	$240	$288,000	$28,800	$47,520	$18,216	$38,254	$420,790	$42,079	$462,869	$0	01/01/2020	-	0.0%	$462,869
Near-Term		CHW to Aven Nelson	Extend CHW from Sciences Tunnel to Aven Nelson	Utility Extension	320	LF	Chilled Water	4	$240	$76,800	$7,680	$12,672	$4,858	$10,201	$112,211	$11,221	$123,432	$0	01/01/2020	-	0.0%	$123,432
Near-Term		CHW to Animal Sciences/Molecular Biology	Extend CHW from Centenial Lateral to Animal Sciences/Molecular Biology	Utility Extension	260	LF	Chilled Water	4	$240	$62,400	$6,240	$10,296	$3,947	$8,288	$91,171	$9,117	$100,288	$0	01/01/2020	-	0.0%	$100,288
Mid-Term		19th Street Research CHW Loop	CHW Loop extension around the 19th Street Research areas	Utility Extension	2,800	Lf	Chilled Water	8	$480	$1,344,000	$134,400	$221,760	$85,008	$178,517	$1,963,685	$196,368	$2,160,053	$0	01/01/2020	-	0.0%	$2,160,053
Building Mechanical Room Conversion from Steam to HW																						
Near-Term		McWhinnie Hall HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		College of Law HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Centennial Complex HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Wyoming Tech Business Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Visual Arts HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		High Bay Research Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Earth Sciences HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Berry Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Energy Innovation Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		College of Business HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Geology HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		COE Library HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Buchanan Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		IT Center HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Honors House HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Rochelle Athletics HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Indoor Practice Facility HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796
Near-Term		Arena Auditorium HW Conversion	Includes HW lateral into Mechancial Room and replacement of heat exchangers and pumps within	Utility Replacement	1	Allowance	Heating Water	1	$250,000	$250,000	$25,000	$41,250	$15,813	$33,206	$365,269	$36,527	$401,796	$0	01/01/2020	-	0.0%	$401,796

PROJECT OVERVIEW								PROJECT COST ESTIMATE						PROJECT COST ESTIMATE						
Phase	Project # (PPT)	Project Name	Description	Type	Quantity	Unit	Utility	Size	Unit Cost	Direct Cost	Design Contingency	G.C. Markups	CM Fee	Construction Contingency	Construction Cost	Soft Cost	Total Cost	Inflation Cost	Date of Construction Start	Inflation Year	Inflation %	Adjusted Total Cost
Hot Water Production Expansion																						
Near-Term		2nd Campus Hot Water Plant-Student Union Area (50MMBTU)		New Construction	1	Allowance	Heating Water		$10,000,000	$10,000,000	$1,000,000	$1,650,000	$632,500	$1,328,250	$14,610,750	$1,461,075	$16,071,825	$0	01/01/2020	-	0.0%	$16,071,825
Long-Term		3rd Campus Hot Water Plant-CEP (50MMBTU)		New Construction	1	Allowance	Heating Water		$5,000,000	$5,000,000	$500,000	$825,000	$316,250	$664,125	$7,305,375	$730,538	$8,035,913	$0	01/01/2020	-	0.0%	$8,035,913
Natural Gas																						
Near-Term		NG to New Service Building	Extend NG from 15th St, along Harney, and provide service connectoin to new Service Building	Utility Extension	100	LF	Natural Gas	2	$48	$4,800	$480	$792	$304	$638	$7,013	$701	$7,714	$0	01/01/2020	-	0.0%	$7,714
Mid-Term		NG to 19th Street Research Facilities	Extend NG to Research buildings	Utility Extension	1,500	LF	Natural Gas	2	$48	$72,000	$7,200	$11,880	$4,554	$9,563	$105,197	$10,520	$115,717	$9	01/02/2020	0.00	0.0%	$115,727
Near-Term		NG Along Lewis	Extend NG from 15th St, along Bradley	Utility Extension	2,500	LF	Natural Gas	4	$60	$150,000	$15,000	$24,750	$9,488	$19,924	$219,161	$21,916	$241,077	$0	01/01/2020	-	0.0%	$241,077
Near-Term		NG to New Fieldhouse	Extend NG from 15th St, along Bradley	Utility Extension	100	LF	Natural Gas	5	#N/A	$0	$0	$0	$0	$0	$0	$0	$0	$0	01/02/2020	0.00	0.0%	$0
Near-Term		NG to New Student Housing	Extend NG from 15th St. in multiple locations to Student Housing	Utility Extension	1,000	LF	Natural Gas	2	$48	$48,000	$4,800	$7,920	$3,036	$6,376	$70,132	$7,013	$77,145	$0	01/01/2020	-	0.0%	$77,145
Near-Term		NG to 2nd Campus Hot Water Plant	Extend NG from Ivinson to New HW Plant	Utility Extension	700	LF	Natural Gas	6	$96	$67,200	$6,720	$11,088	$4,250	$8,926	$98,184	$9,818	$108,003	$0	01/01/2020	-	0.0%	$108,003
Near-Term		NG to new Natatorium	Extend NG from Grand to New Natatorium	Utility Extension	600	LF	Natural Gas	4	$60	$36,000	$3,600	$5,940	$2,277	$4,782	$52,599	$5,260	$57,859	$0	01/01/2020	-	0.0%	$57,859
Mid-Term		Greek Housing NG Extension	Remove Greek Housing from campus steam and place on NG	Utility Extension	8	Allowance	Natural Gas	1	$125,000	$1,000,000	$100,000	$165,000	$63,250	$132,825	$1,461,075	$146,108	$1,607,183	$0	01/01/2020	-	0.0%	$1,607,183
Domestic/Fire Water									#N/A													
Near-Term		Upsizing of Prexy's DW Mains	Upsizing and Replacement of water piping around Prexy's	Utility Replacement	4,100	LF	Domestic/Fire Water	8	$72	$295,200	$29,520	$48,708	$18,671	$39,210	$431,309	$43,131	$474,440	$0	01/01/2020	-	0.0%	$474,440
Near-Term		Ivinson Replacement of DW Mains	Upsizing and Replacement of water piping along Ivinson	Utility Replacement	2,400	LF	Domestic/Fire Water	10	$90	$216,000	$21,600	$35,640	$13,662	$28,690	$315,592	$31,559	$347,151	$0	01/01/2020	-	0.0%	$347,151
Near-Term		9th St Replacement of DW Mains	Upsizing and Replacement of water piping along 9th St	Utility Replacement	2,100	LF	Domestic/Fire Water	10	$90	$189,000	$18,900	$31,185	$11,954	$25,104	$276,143	$27,614	$303,757	$0	01/01/2020	-	0.0%	$303,757
Near-Term		Flint St Replacement of DW Mains	Upsizing and Replacement of water piping along Flint St	Utility Replacement	2,400	LF	Domestic/Fire Water	12	$106	$253,440	$25,344	$41,818	$16,030	$33,663	$370,295	$37,029	$407,324	$0	01/01/2020	-	0.0%	$407,324
Near-Term		15th St Replacement of DW Mains	Upsizing and Replacement of water piping along 15th St	Utility Replacement	2,100	LF	Domestic/Fire Water	12	$106	$221,760	$22,176	$36,590	$14,026	$29,455	$324,008	$32,401	$356,409	$0	01/01/2020	-	0.0%	$356,409
Near-Term		Fraternity/Sorority Row DW Mains	Replacement of water piping along Fraternity and Sorority Rows between 15th and the Stadium	Utility Replacement	3,200	LF	Domestic/Fire Water	8	$72	$230,400	$23,040	$38,016	$14,573	$30,603	$336,632	$33,663	$370,295	$0	01/01/2020	-	0.0%	$370,295
Near-Term		19th St Replacement of DW Mains	Replacement of water piping along 19th St	Utility Replacement	2,800	LF	Domestic/Fire Water	8	$72	$201,600	$20,160	$33,264	$12,751	$26,778	$294,553	$29,455	$324,008	$0	01/01/2020	-	0.0%	$324,008
Near-Term		East Campus DW Extension	Extension of water piping to the Athletic areas on campus	Utility Replacement	2,500	LF	Domestic/Fire Water	12	$106	$264,000	$26,400	$43,560	$16,698	$35,066	$385,724	$38,572	$424,296	$0	01/01/2020	-	0.0%	$424,296
Irrigation																						
Near-Term		New Irrigation Well	Development of a new Irrigation Well on far east campus	New Construction	1	Allowance			$40,000	$40,000	$4,000	$6,600	$2,530	$5,313	$58,443	$5,844	$64,287	$0	01/01/2020	-	0.0%	$64,287
Near-Term		West Campus Irrigation Main	New Irrigation Main between 15th and 9th St	Utility Extension	5,000	LF	Irrigation Main	6	$48	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Willett to Harney Irrigation Main	New Irrigation Main between Willett and Harney, east campus	Utility Extension	2,300	LF	Irrigation Main	6	$48	$110,400	$11,040	$18,216	$6,983	$14,664	$161,303	$16,130	$177,433	$0	01/01/2020	-	0.0%	$177,433
Near-Term		New Well Piping	New Irrigation Main from new well to Willett and 30th	Utility Extension	9,600	LF	Irrigation Main	6	$48	$460,800	$46,080	$76,032	$29,146	$61,206	$673,263	$67,326	$740,590	$0	01/01/2020	-	0.0%	$740,590
Sanitary Sewer																						
Near-Term		Ivinson Sewer Replacement	Replacement of Sewer piping between 9th and 15th Streets along Ivinson	Utility Replacement	2,300	LF	Sanitary Sewer	12	$48	$110,400	$11,040	$18,216	$6,983	$14,664	$161,303	$16,130	$177,433	$0	01/01/2020	-	0.0%	$177,433
Near-Term		15th Street Sewer Replacement	Replacement of Sewer piping along 15th Street	Utility Replacement	3,200	LF	Sanitary Sewer	12	$48	$153,600	$15,360	$25,344	$9,715	$20,402	$224,421	$22,442	$246,863	$0	01/01/2020	-	0.0%	$246,863
Near-Term		Bradley/Lewis Street Sewer Replacement	Replacement of Sewer piping along Bradley and Lewis Streets	Utility Replacement	4,400	LF	Sanitary Sewer	12	$48	$211,200	$21,120	$34,848	$13,358	$28,053	$308,579	$30,858	$339,437	$0	01/01/2020	-	0.0%	$339,437
Near-Term		Fraternity/Sorority Row Sewer Main Replacement	Replacement of sewer piping along Fraternity and Sorority Rows between 15th and the Stadium	Utility Replacement	3,400	LF	Sanitary Sewer	10	$42	$142,800	$14,280	$23,562	$9,032	$18,967	$208,642	$20,864	$229,506	$0	01/01/2020	-	0.0%	$229,506
Near-Term		East Campus Sewer Extension	Extension of New Sewer Pipng between 19th and 22nd Streets for campus growth	Utility Extension	2,400	LF	Sanitary Sewer	10	$42	$100,800	$10,080	$16,632	$6,376	$13,389	$147,276	$14,728	$162,004	$0	01/01/2020	-	0.0%	$162,004
Storm Sewer																						
Near-Term		Bradley St Storm Sewer Improvements	Enhancement/Extension of stormwater along Bradley	Utility Extension	2,200	LF	Storm Sewer	24	$156	$343,200	$34,320	$56,628	$21,707	$45,586	$501,441	$50,144	$551,585	$0	01/01/2020	-	0.0%	$551,585
Near-Term		Flint St Storm Sewer Improvements	Enhancement/Extension of stormwater along Flint	Utility Extension	2,200	LF	Storm Sewer	24	$156	$343,200	$34,320	$56,628	$21,707	$45,586	$501,441	$50,144	$551,585	$0	01/01/2020	-	0.0%	$551,585
Near-Term		9th St Storm Sewer Improvements	Enhancement/Extension of stormwater along 9th Street	Utility Extension	1,500	LF	Storm Sewer	24	$156	$234,000	$23,400	$38,610	$14,801	$31,081	$341,892	$34,189	$376,081	$0	01/01/2020	-	0.0%	$376,081
Near-Term		15th St Storm Sewer Improvements	Enhancement/Extension of stormwater along 15th Street	Utility Extension	1,500	LF	Storm Sewer	24	$156	$234,000	$23,400	$38,610	$14,801	$31,081	$341,892	$34,189	$376,081	$0	01/01/2020	-	0.0%	$376,081
Near-Term		Fraternity/Sorority Row Storm Water Improvements	New Storm Mains along Fraternity/Sorority Rows to create new corridor for conveyance of stormwater	Utility Extension	4,400	LF	Storm Sewer	20	$108	$475,200	$47,520	$78,408	$30,056	$63,118	$694,303	$69,430	$763,733	$0	01/01/2020	-	0.0%	$763,733
Near-Term		Campus Runoff Detention Areas	Installatoin of Storm Detention Areas on Campus	Utility Extension	1	Allowance			$200,000	$200,000	$20,000	$33,000	$12,650	$26,565	$292,215	$29,222	$321,437	$0	01/01/2020	-	0.0%	$321,437
Near-Term		East Campus Storm Sewer Extension	Extension of New Storm Sewer Pipng between 19th and 22nd Streets for campus growth	Utility Extension	1,500	LF	Storm Sewer	20	$108	$162,000	$16,200	$26,730	$10,247	$21,518	$236,694	$23,669	$260,364	$0	01/01/2020	-	0.0%	$260,364

PROJECT OVERVIEW								PROJECT COST ESTIMATE							PROJECT COST ESTIMATE						
Phase	Project # (PPT)	Project Name	Description	Type	Quantity	Unit	Utility	Size	Unit Cost	Direct Cost	Design Contingency	G.C. Markups	CM Fee	Construction Contingency	Construction Cost	Soft Cost	Total Cost	Inflation Cost	Date of Construction Start	Inflation Year	Inflation %	Adjusted Total Cost
Electrical Power																						
Near-Term		Arts and Sciences renovation new electrical switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Arts and Sciences renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Arts and Sciences renovation Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Biological Sciences renovation new electrical switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Biological Sciences renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Crane Hall renovation new electrical switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Crane Hall renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Student Union renovation new electrical switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Student Union renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Student Union Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Student Union Emergency Power	Equipent Infrastructure for building renovation	Renovation	2	Allowance	Generator Installation	1	$240,000	$480,000	$48,000	$79,200	$30,360	$63,756	$701,316	$70,132	$771,448	$0	01/01/2020	-	0.0%	$771,448
Near-Term		Ivinson Parking Garage	Infrastructure for new building	Site	650	LF	Primary Power	1	$360	$234,000	$23,400	$38,610	$14,801	$31,081	$341,892	$34,189	$376,081	$0	01/01/2020	-	0.0%	$376,081
Near-Term		Ivinson Parking Garage	Infrastructure for new building	New Construction	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Corbet renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Corbet renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Bradley Street Parking Garage power	Infrastructure for new building	Site	250	LF	Primary Power	1	$360	$90,000	$9,000	$14,850	$5,693	$11,954	$131,497	$13,150	$144,646	$0	01/01/2020	-	0.0%	$144,646
Near-Term		Bradley Street Parking Garage Switch	Infrastructure for new building	New Construction	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Lab School	Infrastructure for new building	Site	250	LF	Primary Power	1	$360	$90,000	$9,000	$14,850	$5,693	$11,954	$131,497	$13,150	$144,646	$0	01/01/2020	-	0.0%	$144,646
Near-Term		Lab School	Infrastructure for new building	New Construction	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Natatorium power	Infrastructure for new building	Site	250	LF	Primary Power	1	$360	$90,000	$9,000	$14,850	$5,693	$11,954	$131,497	$13,150	$144,646	$0	01/01/2020	-	0.0%	$144,646
Near-Term		Natatorium switch	Infrastructure for new building	New Construction	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		McWhinnie Hall renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		McWhinnie Hall renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		McWhinnie Hall Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Ross Hall renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Ross Hall renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Ross Hall Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Knight Hall renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Knight Hall renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Knight Hall Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Bureau of Mines Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Law School renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Law School renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Law School Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Agriculture C Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Engineering Building Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Engineering Building Fire Pump Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Animal Science/Molecular Biology Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Centennial Complex Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Red Buttes Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		RMMC Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Earth Sciences Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Crane Hill Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		RLDS Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Vet Labs Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		West Campus Electrical Substation Replacement	Replacement of Substation	Utility Replacement	1	Allowance	Substation Replacement	1	$1,500,000	$1,500,000	$150,000	$247,500	$94,875	$199,238	$2,191,613	$219,161	$2,410,774	$0	01/01/2020	-	0.0%	$2,410,774
Near-Term		Bureau of Mines renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Bureau of Mines renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Engineering Building renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Engineering Building renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Agriculture Building renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Agriculture Building renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Education Building renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Education Building renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Education Building new generator	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Physical Sciences Building renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Physical Sciences Building renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431

PROJECT OVERVIEW								PROJECT COST ESTIMATE							PROJECT COST ESTIMATE						
Phase	Project # (PPT)	Project Name	Description	Type	Quantity	Unit	Utility	Size	Unit Cost	Direct Cost	Design Contingency	G.C. Markups	CM Fee	Construction Contingency	Construction Cost	Soft Cost	Total Cost	Inflation Cost	Date of Construction Start	Inflation Year	Inflation %	Adjusted Total Cost
Near-Term		Aven Nelson Building renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Aven Nelson Building renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Aven Nelsonl Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Merica Hall renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Merica Hall renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Animal Sciences renovation new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Animal Sciences renovation new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Rochelle Athletic Center Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		General Primary Power Cabling Replacement	Medium Voltage Cabling replacement	Site	15,000	LF	Primary Power	1	$150	$2,250,000	$225,000	$371,250	$142,313	$298,856	$3,287,419	$328,742	$3,616,161	$0	01/01/2020	-	0.0%	$3,616,161
Near-Term		ITC Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Memorial Fieldhouse addition new switch	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Memorial Fieldhouse addition new transformer	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Transformer	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Memorial Fieldhouse new generator	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		(4) New Laboratory Building Power	Infrastructure for new building	Site	1,400	LF	Primary Power	1	$360	$504,000	$50,400	$83,160	$31,878	$66,944	$736,382	$73,638	$810,020	$0	01/01/2020	-	0.0%	$810,020
Near-Term		(4) New Laboratory Building Switches	Infrastructure for new building	Site	4	Allowance	Electrical Switch	1	$60,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		New Heating Plant Power	Infrastructure for new building	Site	250	LF	Primary Power	1	$360	$90,000	$9,000	$14,850	$5,693	$11,954	$131,497	$13,150	$144,646	$0	01/01/2020	-	0.0%	$144,646
Near-Term		New Heating Plant Switch	Infrastructure for new building	Site	1	Allowance	Electrical Switch	1	$60,000	$60,000	$6,000	$9,900	$3,795	$7,970	$87,665	$8,766	$96,431	$0	01/01/2020	-	0.0%	$96,431
Near-Term		Anthropology Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Science Greenhouse Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Vet Lab Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		ENZI/STEM Emergency Power Generator Replacement (Damaged)	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		UW Conference Center Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Visual Arts Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		EIC Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Coe Library Generator #1 Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Coe Library Generator #2 Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Wildcatter Suites Generator Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Buchanan Center Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		WTBC Emergency Power	Equipent Infrastructure for building renovation	Renovation	1	Allowance	Generator Installation	1	$240,000	$240,000	$24,000	$39,600	$15,180	$31,878	$350,658	$35,066	$385,724	$0	01/01/2020	-	0.0%	$385,724
Near-Term		Fire Pump power backup	Equipent Infrastructure for building renovation	Building Improvemen	12	Allowance	Emergency Power	1	$55,000	$660,000	$66,000	$108,900	$41,745	$87,665	$964,310	$96,431	$1,060,740	$86	01/02/2020	0.00	0.0%	$1,060,826
Near-Term		East Campus Electrical Substation Replacement	Replacement of Substation	Utility Replacement	1	Allowance	Substation Replacement	1	$1,500,000	$1,500,000	$150,000	$247,500	$94,875	$199,238	$2,191,613	$219,161	$2,410,774	$0	01/01/2020	-	0.0%	$2,410,774
Communications																					
Near-Term		Campus Fiber routing	Extension of campus fiber infrastructure	Utility Extension	9,500	LF	Communications	1	$60	$570,000	$57,000	$94,050	$36,053	$75,710	$832,813	$83,281	$916,094	$0	01/01/2020	-	0.0%	$916,094
Near-Term		Communication Hub Upgrades	Misc. Upgrades to communication nodes and hubs	Utility Replacement	1	Allowance	Communications	1	$500,000	$500,000	$50,000	$82,500	$31,625	$66,413	$730,538	$73,054	$803,591	$0	01/01/2020	-	0.0%	$803,591
Roadway and Areaway Lighting																					
Near-Term		Exterior Lighting Upgrade	Replacement of metal halide exterior lighting to LED	Site	1	Allowance	Roadway/ Areaway Lighting	1	$650,000	$650,000	$65,000	$107,250	$41,113	$86,336	$949,699	$94,970	$1,044,669	$0	01/01/2020	-	0.0%	$1,044,669
Near-Term		Grounding of Exterior Lighting around Athletics	Grounding of Exterior Lighting Tennis Courts and Baseball Field	Site	1,000	LF	Primary Power	1	$360	$360,000	$36,000	$59,400	$22,770	$47,817	$525,987	$52,599	$578,586	$0	01/01/2020	-	0.0%	$578,586
Near-Term		West Campus Exterior Lighting Grounding	Grounding of Exterior Lighting around Physcial and Biological Sciences, and Healther and Arts Buildings	Site	1,000	LF	Primary Power	1	$360	$360,000	$36,000	$59,400	$22,770	$47,817	$525,987	$52,599	$578,586	$0	01/01/2020	-	0.0%	$578,586
Tunnel Upgrades																					
Near-Term		Coe Condensate Pump Station Improvements	Replacement of (2) Condensate pump stations	Utility Replacement	1	Allowance	Steam/ Condensate	1	$500,000	$500,000	$50,000	$82,500	$31,625	$66,413	$730,538	$73,054	$803,591	$0	01/01/2020	-	0.0%	$803,591
Near-Term		Abatement/Infill of North-WestUtility Tunnel around Education	Relocation of Utilities and abandonment of tunnel section	Demolition	660	LF	Tunnel Demo	1	$2,000	$1,320,000	$132,000	$217,800	$83,490	$175,329	$1,928,619	$192,862	$2,121,481	$0	01/01/2020	-	0.0%	$2,121,481
Near-Term		Abatement/Infill of South-West Utility Tunnel around Merica	Abatement/Infill of Utility Tunnel between Biological Sciences and Ross Hall	Demolition	850	LF	Tunnel Demo	1	$2,000	$1,700,000	$170,000	$280,500	$107,525	$225,803	$2,483,828	$248,383	$2,732,210	$0	01/01/2020	-	0.0%	$2,732,210
Near-Term		Repair of CEP Tunnel grade joints	Repair metal joints at grade to prevent further damage to snow removal equipent	Site	300	LF		1	$100	$30,000	$3,000	$4,950	$1,898	$3,985	$43,832	$4,383	$48,215	$0	01/01/2020	-	0.0%	$48,215
Central Energy Plant Upgrades																					
Long-Term		Cooling Tower Replacement	Replacement of CEP Cooling Towers	New Construction	1	Allowance	Chilled Water	1	$2,500,000	$2,500,000	$250,000	$412,500	$158,125	$332,063	$3,652,688	$365,269	$4,017,956	$0	01/01/2020	-	0.0%	$4,017,956
Near-Term		Chiller Replacement	Replacement of CEP Chiller	New Construction	1	Allowance	Chilled Water	1	$750,000	$750,000	$75,000	$123,750	$47,438	$99,619	$1,095,806	$109,581	$1,205,387	$0	01/01/2020	-	0.0%	$1,205,387
Near-Term		Coal Boiler Induced Draft Fan Repair	Repair of Draft Fans on (3) coal boilers	Utility Replacement	1	Allowance	Steam/ Condensate	1	$350,000	$350,000	$35,000	$57,750	$22,138	$46,489	$511,376	$51,138	$562,514	$0	01/01/2020	-	0.0%	$562,514
Near-Term		Coal Boiler Retube	Retube of (1) coal fired boiler	Utility Replacement	1	Allowance	Steam/ Condensate	1	$450,000	$450,000	$45,000	$74,250	$28,463	$59,771	$657,484	$65,748	$723,232	$0	01/01/2020	-	0.0%	$723,232
Near-Term		Coal Boiler Stoker Replacement	Stoker Replacement	Utility Replacement	1	Allowance	Steam/ Condensate	1	$975,000	$975,000	$97,500	$160,875	$61,669	$129,504	$1,424,548	$142,455	$1,567,003	$0	01/01/2020	-	0.0%	$1,567,003
Near-Term		Feedwater Pump Replacement	Pump replacement	Utility Replacement	1	Allowance	Steam/ Condensate	1	$200,000	$200,000	$20,000	$33,000	$12,650	$26,565	$292,215	$29,222	$321,437	$0	01/01/2020	-	0.0%	$321,437
Near-Term		Decommissioning of underground fuel tank	Removal of underground fuel storage and piping	Site	1	Allowance		1	$350,000	$350,000	$35,000	$57,750	$22,138	$46,489	$511,376	$51,138	$562,514	$0	01/01/2020	-	0.0%	$562,514
Near-Term		New fueling improvements	New above ground storage tank and piping	Site	1	Allowance		1	$400,000	$400,000	$40,000	$66,000	$25,300	$53,130	$584,430	$58,443	$642,873	$0	01/01/2020	-	0.0%	$642,873