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Task 3



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Appendix G	JBPU-PA-2021 Latest NYGATs Report

Acronyms and Abbreviations

ACEEE	American Council for an Energy Efficient Economy
2GDH	2nd Generation District Heating network ($>212^{\circ}\text{F}$)
4GDH	4th Generation District Heating network ($\leq 170^{\circ}\text{F}$)
5GDH	5th Generation District Heating network (Ambient)
ACEE	American Council for an Energy Efficient Economy
ACET	Agricultural and Clean Energy Technology Center
ASHP	air-source heat pump
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ATES	aquifer thermal energy storage
BAS	building automation system
BAU	business-as-usual
BH	borehole
BHW	building hot water
BTES	borehole thermal energy storage
Btu	British thermal units
CAPEX	capital expenditures
CBECS	Commercial Buildings Energy Consumption Survey
CEMP	Clean Energy Master Plan
CHP	central heating plant
CLCPA	New York State Climate Leadership and Community Protection Act
CM	critical maintenance
CO ₂ e	carbon dioxide equivalent
DH&C	district heating & cooling
DHW	domestic hot water
EEMs	energy efficiency measures
EO 22	Executive Order 22
ETS	energy transfer station
EUI	energy use intensity
GDH	generation district heating
GHG	greenhouse gas
GSF	gross square feet
GSHP	ground-source heat pump
HRC	heat recovery chiller
HVAC	heating, ventilation, and air conditioning
BPU	Jamestown Board of Public Utilities
LCOE	levelized cost of energy
LTW	low temperature water
MTW	medium temperature water
NPV	net present value
NYSDEC	New York State Department of Environmental Conservation
O&M	operations & maintenance
OPEX	operating expenses
Psig	pounds per square inch gauge
SH	supply heat
TTES	tank thermal energy storage
WWTP	wastewater treatment plant

1. Summary

With New York State's move to cleaner forms of energy well underway as part of the Climate Leadership and Community Protection Act (CLCPA), New York State is taking proactive steps to assist communities such as Jamestown, in their planning for the transition away from conventional energy infrastructure.

Ramboll completed a district heating (DH) study to create a vision for low carbon and renewable technologies and operational strategies that reduce fossil fuel use, increase electrification, and maintain resiliency and reliability. This study provides a roadmap for near-term actions and a decision-making framework for the long-term vision of Jamestown BPU's district heating system. A key focus was identifying a pragmatic and cost-effective approach to achieving the long-term goals of electrification-based energy production technologies while also bridging the short-term needs of critical capital improvements that would ultimately support Jamestown's long-term goals.

A suit of scenarios was developed collaboratively with the BPU and NYSERDA to assess centralized and decentralized scenarios. A clear strategy was provided for each scenario that established dedicated heating technologies to support baseload, peaking, and backup operations¹. All scenarios are based on proven technologies that can be implemented with equipment currently available.

The following is a brief summary of all scenarios considered. Scenarios B, C, D & F are electrification-based scenarios. Scenarios BAU and E, indicated in grey font, are fossil-fuel alternatives that were modeled for comparison purposes.

- **Scenario BAU** includes the business-as-usual model by replacing the piping network and gas-fired boilers in kind
- **Scenario B** includes a fourth-generation district heating (4GDH) network serving all buildings on the current system
 - B1: Ground source heat pump (GSHP) w/natural gas (NG) peaking boiler @ existing plant
 - B2: GSHP w/electric peaking boiler @ existing plant
 - B3: Cascading Air source heat pump (ASHP) to water source heat pump (WSHP) w/NG peaking boiler @ existing plant
 - B4: WSHP w/NG peaking boiler @ wastewater treatment plant (WWTP) & existing plant
 - B5: WSHP w/NG peaking boiler @ WWTP & existing plant – w/additional loads²
- **Scenario C** includes a 4GDH network that serves all buildings south of 6th street and includes decentralizing the buildings north of 6th street with local heat pumps.
 - C1: GSHP w/NG peaking boiler @ existing plant
 - C2: GSHP w/electric peaking boiler @ existing plant
 - C3: ASHP/WSHP w/NG peaking boiler @ existing plant
- **Scenario D** includes an ambient temperature fifth generation district heating (5GDH) network that serves all buildings on the current system.
 - D1: Ambient loop and building level WSHP's for base load and peaking
 - D2: Ambient loop and building level WSHP's w/building level NG peaking boilers

¹ See Section 5.1 for a detailed description of recommended baseload, peaking and backup strategies.

² See Appendix B: Additional Potential Heating Load Map for location of WWTP and additional loads.

- **Scenario E** includes full decentralization of all buildings on the current system with natural gas-fired boilers
 - E1: Fully decentralized buildings w/NG boilers
- **Scenario F** includes full decentralization of all buildings on the current system with heat pumps.
 - F1: Fully decentralized buildings w/cascading ASHP's to WSHP's w/building level NG peaking boilers
 - F2: Fully decentralized buildings w/cascading ASHP's to WSHP's for base load and peaking.

A techno-economic analysis of these scenarios was performed to identify the most cost-efficient mix of technologies for future supply of heating. The analysis provides the levelized cost of energy (LCOE) in dollars per million British thermal unit (\$/MMBtu) including capital expense (CAPEX), operating expense (OPEX), residual value, and the social cost of carbon³ over a 20 year period. Figure 1 illustrates the forecasted LCOE for all electrification-based scenarios⁴ as well as provides each scenario's heating load, network type, and its baseload, peaking, and backup technology.

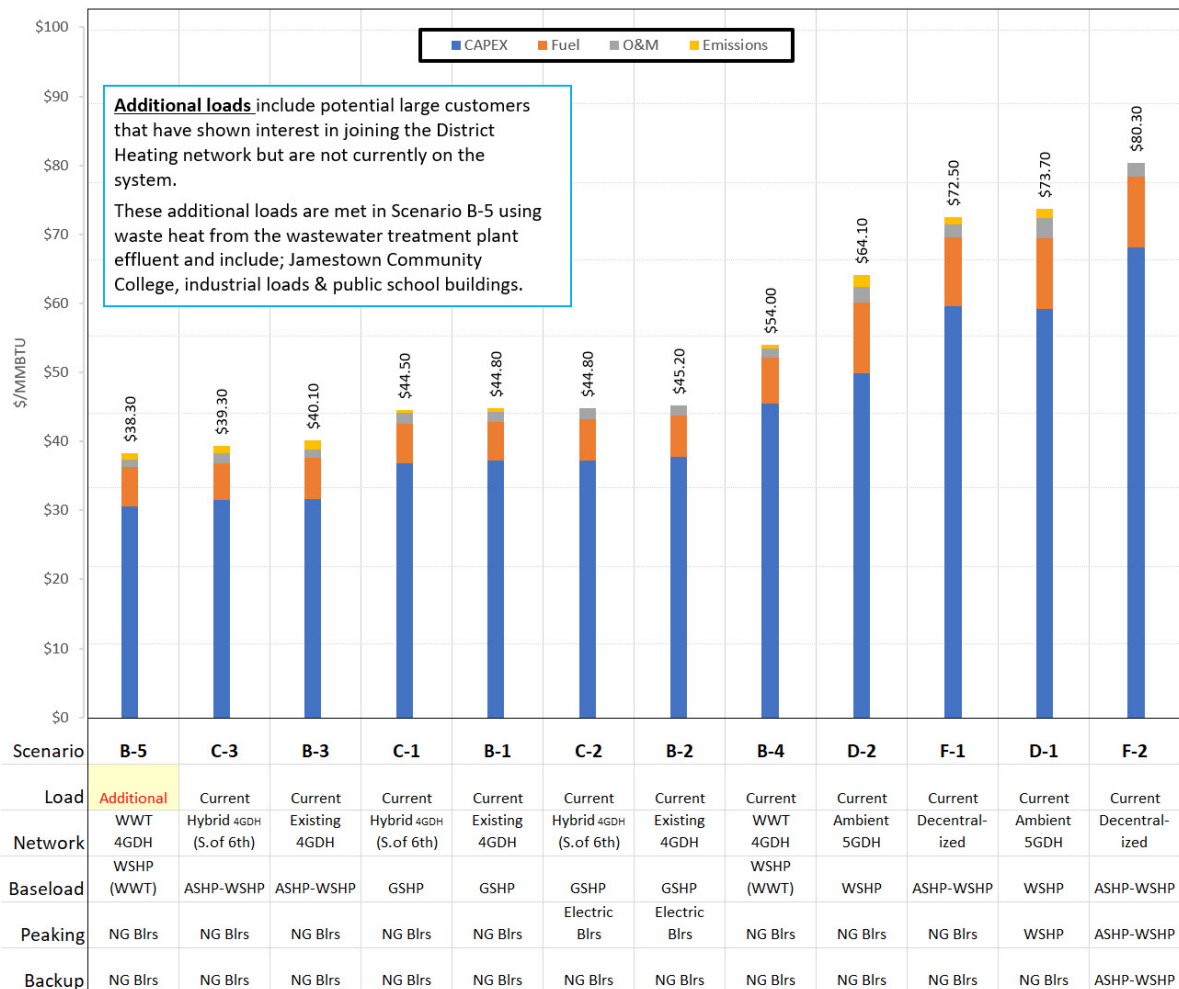


Figure 1. LCOE comparison of electrification-based scenarios

³ The social cost of carbon, or CO₂e emissions, is referenced in NYSDEC guidance.

⁴ All scenarios are discussed in detail in Sections 6, 8 & 9 of this report.

LCOE Results

Scenario B-5 provides the lowest cost of energy for all electrification-based scenarios. B-5 models waste heat from the BPU's WWTP in conjunction with WSHP's that provide hot-water to an expanded customer base. B-5 is the only scenario modeled with additional customers since the distribution piping must be routed 5 miles from the WWTP to the existing network. This extended route provides an opportunity to connect many new customers along its path including Jamestown Community College (JCC), large industrial customers, and public school buildings. Scenario B-4 represents the LCOE without the additional customers, but still requires the long distribution piping network from the WWTP to the existing DH network. The comparison between scenarios B-4 and B-5 illustrates the benefits that an increased customer base has on overall energy pricing and, in this case, reduces the LCOE approximately 30%. The location of the WWTP, the existing Central Plant, and the location of potential new customers are shown on the map provided in Appendix B: Additional Potential Heating Load Map. Considering New York State's interest in broad development of thermal energy networks, it is likely that even more customers than modeled could be added along the network distribution route further improving the LCOE for Scenario B-5.

Scenarios B and C are similar and both based on distributing hot water in a 4GDH network from a central plant. The difference between these scenarios is that Scenario B includes supplying all currently connected buildings from the central plant; whereas Scenario C only supplies the buildings south of 6th street from the central plant and all buildings north are decentralized with building-level heat pumps. Scenario C was developed as a hybrid approach since more than 12% of the piping network is located north of 6th street and only connects to 4 buildings (5% of the total heating load). Figure 1 indicates a slight reduction in LCOE for Scenario C variations by decentralizing the area of lowest heat-demand-density (proximity of buildings connected to the heating network).

Scenarios D and F have the highest LCOE mainly due to the large capital investment required to furnish and install local heat pumps as well as the reinvestment required for the shorter life expectancy of this equipment when compared to centralized solutions⁵. In addition, Scenario F will require electrical distribution upgrades throughout Jamestown and Scenario D requires large diameter direct-buried piping for the ambient water loop for which buildings would connect to. Furthermore, Scenario D also requires expensive borefields as its heat source.

Scenarios BAU and E are not included in Figure 1 since they rely on fossil fuels and do not align with the long-term goals of NYS's Climate Leadership and Community Protection Act (CLCPA) and Jamestown BPU. However, Figure 2 does include the BAU and E scenarios compared to the lowest-cost electrification-based scenario B-5. This figure illustrates that the cost of converting to electrification-based energy production technologies will be more expensive than fossil fuel alternatives even after considering the social cost of carbon using New York State Department of Environmental Conservation (NYSDEC) guidelines.

The BAU does include CAPEX costs associated with replacing the existing district-heating piping network since it is at the end of its useful life as well as replacement of the central plant NG boilers.

⁵ Section 9.5 includes a list of assets and their technical lifetime in years.



Figure 2. LCOE comparison (fossil fuel alternatives vs lowest cost electric scenario)

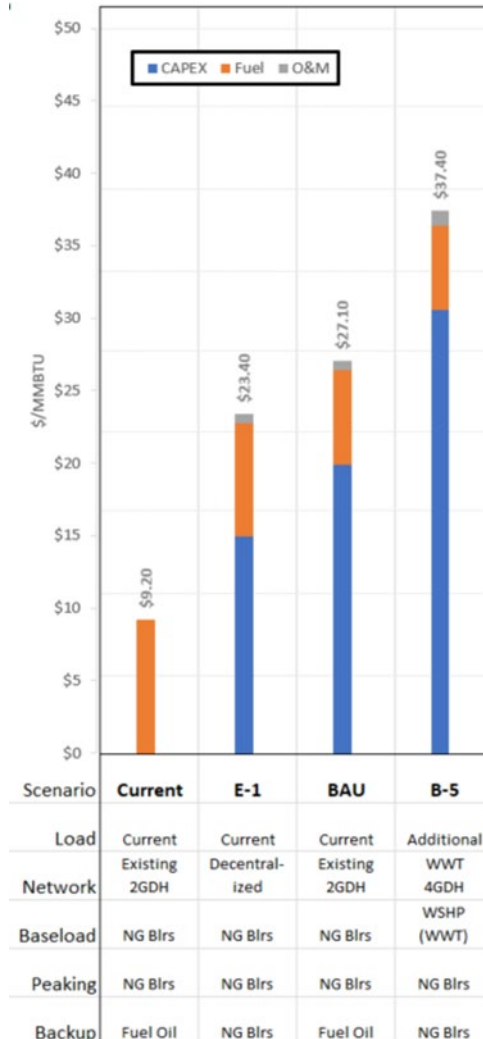


Figure 3. LCOE comparison of current rates not including the cost of emissions

Figure 3 is provided to compare the fossil-fuel alternatives and the lowest cost electrification-based scenario to the current rates excluding the cost of emissions. The difference between the BAU and the current rates is that the BAU includes the total cost of fuel, operations, maintenance, and CAPEX required to replace end-of-life system components including the network piping and central plant boilers. Since the current rates are approximately one-third that of the BAU, the current rates are not sustainable and do not include costs such as repair, replacement, maintenance, personnel, and in some months do not even cover the cost of fuel.

To maintain and continue to operate the existing system for long-term operation, current rates are expected to triple. To convert to electrification-based technology, current rates are expected to increase by more than four times. Although the cost to install electrification-based technology is more than its fossil-fuel alternative, low current rates have an even greater affect on the total difference.

GHG Emissions

When comparing the greenhouse gas (GHG) emissions of the scenarios listed in Figure 1, it is important to include the emissions that would be produced by the additional customers if their heating loads continue to be met using fossil fuel technology. Figure 4 compares the GHG emissions produced over a 20-year period of the electrification-based scenarios and includes the emissions that would be generated to meet the total heating load of the current and additional customers. The evaluation assumes that the additional customers would continue to meet their heating loads using natural gas-fired boilers if they are not connected to BPU's DH network.

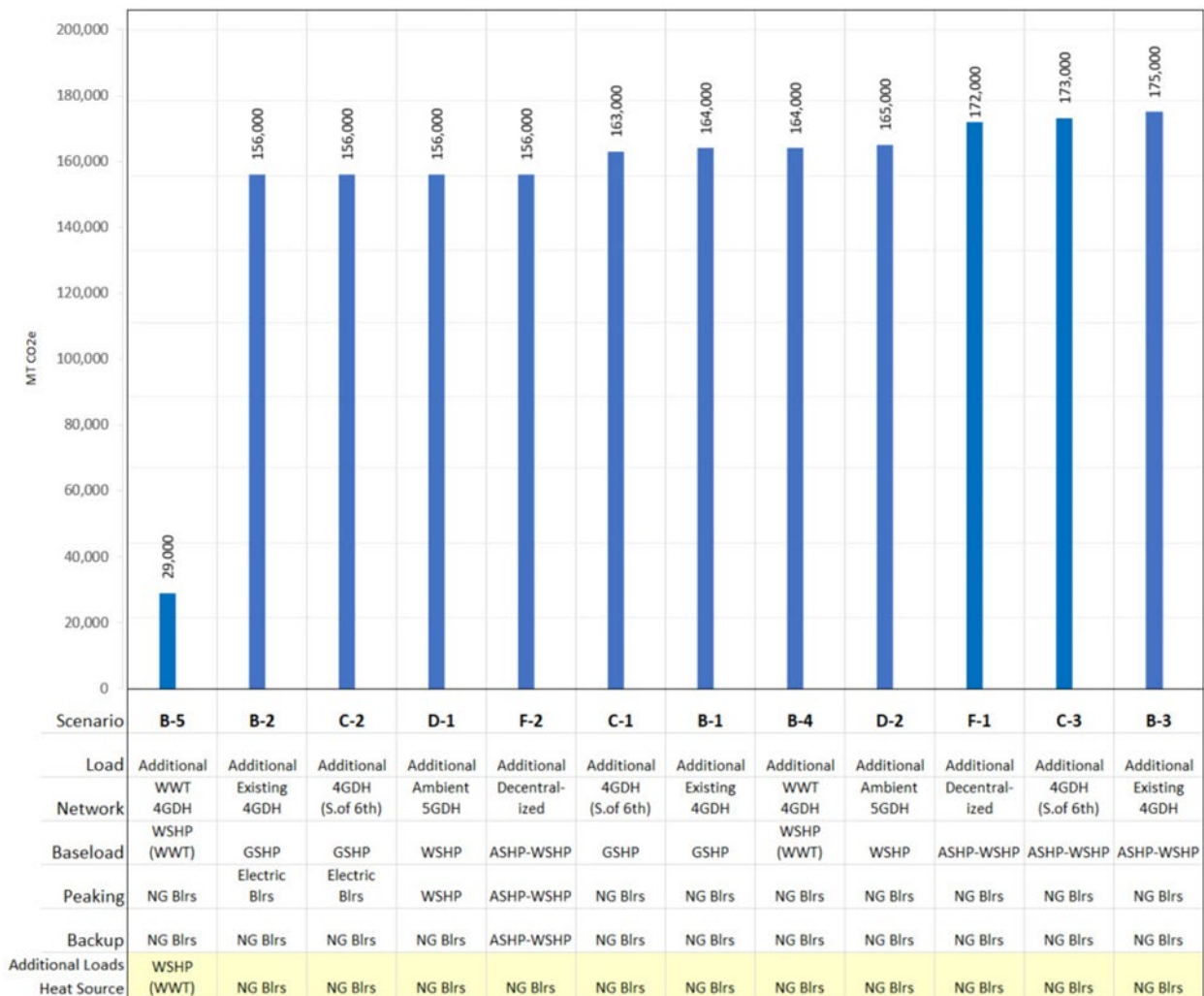


Figure 4. GHG emissions (comparison of electrification-based scenarios)

Scenario B-5 not only offers the lowest cost of energy, but also provides the greatest potential reduction in GHG emissions. In fact, when comparing the total estimated GHG emissions with fossil fuel alternatives such as decentralizing all customers with natural gas-fired boilers or continuing to operate BAU, the total reduction of CO₂e emissions over a 20-year period is estimated to be almost 300,000 MT. Figure 5 is provided to illustrate the potential reduction in GHG emissions between Scenario B-5 and fossil fuel alternatives.

The City of Jamestown is uniquely positioned to reduce carbon emissions in NYS by approximately 300,000 MT of CO₂e over the next 20 years. The BPU currently operates a DH hot-water system, an electric grid powered from 100% renewable sources⁶, and a WWTP that discharges more energy in effluent than is required to meet the current heating load for an entire year. Combining this infrastructure with electrification-based heat producing technology, as well as expanding the current DH system, could provide the City of Jamestown and NYS a cost-effective solution to greatly reducing GHG emissions and reliance on fossil fuel technology.



Figure 5. GHG emissions (B-5 and fossil fuel scenarios)

CAPEX

The analysis and results shown in Figure 1 highlight capital expense (CAPEX) costs that account for a significantly higher percentage than all other costs and the importance these costs play in quantifying scenarios to support decision making and planning. For reference, the CAPEX costs shown in Figure 1 include a reduction in CAPEX to account for residual value of all components with life expectancies that exceed the twenty-year evaluation period.

Figure 6 is provided to compare the up-front capital cost required for each scenario. The figure includes various colors that represent the percentage of each major component that make up the total cost. Detailed cost estimates for each scenario were performed and are included in Appendix A in this report. All estimates have the following contingencies:

- 15% for general conditions
- 10% overhead and profit
- 20% design contingency⁷
- 5% bid contingency
- 10% for phasing

⁶ BPU purchases 100% renewable power from NYPA. See Appendix G: JBPU-PA-2021 Latest NYGATS Report.

⁷ Design contingency is related to the progress of the project. In early stages before details have been defined, the contingency is higher and typically decreases as the project progresses.

The two fossil-fuel alternatives, decentralizing with natural gas-fired boilers and the BAU are included in Figure 6 for comparison purposes. The BAU includes costs to replace the boilers within the existing plant and the distribution pipe since it is at the end of its useful life.

It is noted that Figure 6 identifies the funding required to construct each scenario; it does not include consideration of O&M, fuel, or the residual value of components with an extended life expectancy. In addition, the CAPEX does not include the social cost of carbon or economic impact of GHG emissions.

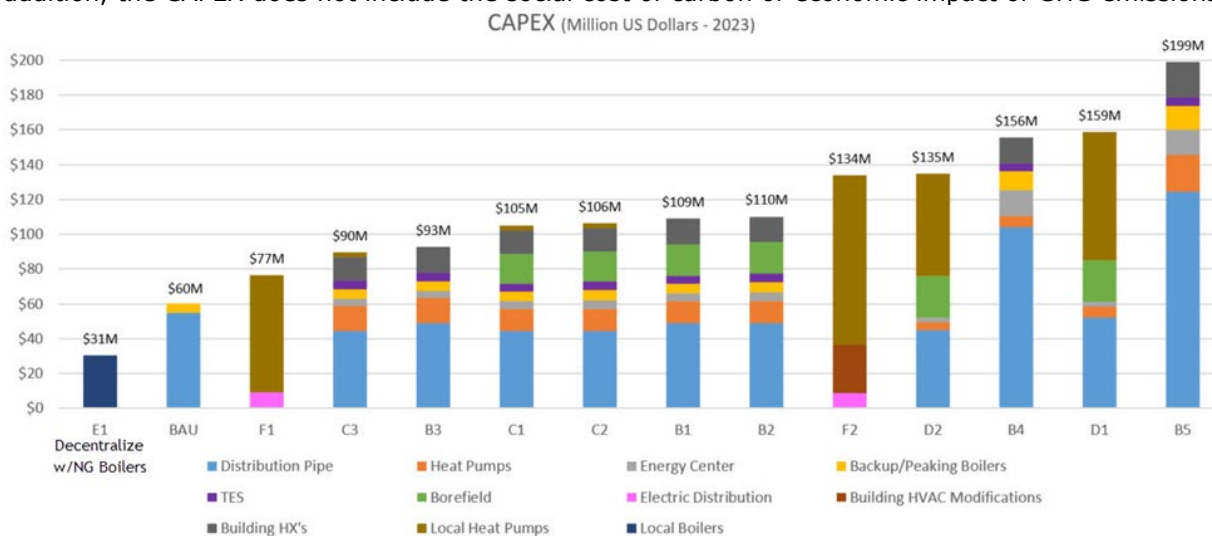


Figure 6. CAPEX comparison

Scenario B-5 offers the greatest value to its customers (see Figure 1) but has the highest up-front capital cost (see Figure 6). The high capital cost is predominantly from the large amount of direct-buried pipe required and greater equipment capacity necessary to meet the additional heating load.

Key Planning Aspects

As part of the planning process and analysis, a number of key aspects were identified to transition Jamestown from fossil-fuel to electrification-based energy producing technology for district heating. These aspects intersect to influence and balance carbon reduction, energy efficiency, flexibility, resiliency, and redundancy in a pragmatic and cost-effective manner. They include:

- Baseload Technology
- Peaking Technology
- Backup Technology
- Emission Reduction
- System Design
- Flexibility
- Cost of Renewable Heat Sources
- Necessary Building Modifications
- Hazardous Materials

Baseload, Peaking, and Backup Strategy: Ramboll recommends a clear strategy for establishing heating and cooling technologies that will support baseload, peaking, and backup (emergency) operations. The rationale for serving the annual load with both baseload and peaking technologies is that the peak load occurs in limited hours annually, and it is less cost-efficient to size the relatively

expensive baseload technology to meet the peak load when it can effectively meet most of the annual load when it is sized much smaller than the peak.

Establishing how much a baseload technology should cover of the total annual heat demand is an optimization exercise. However, as a rule of thumb, if the baseload covers 50% to 60% of the peak heating load, then it will cover approximately 90% of the annual heating load. This is illustrated in Figure 7 for the Jamestown DH system heat load. Distinguishing between baseload and peak load will be more cost efficient and allow financial resources to be allocated for other projects with greater economic and environmental impact.

Additional considerations and benefits of using gas-fired equipment for backup and peaking are:

- Reduces CAPEX by using existing assets that have remaining life.
- Maintains equipment connected to a potential future renewable gas distribution network.
- Cover peak heating load when peak electric demand exceeds the utilities electric capacity.
- An alternate fuel source for backup heating will increase overall reliability and serve as a buffer for resiliency purposes under a future grid with more intermittent renewable energy.
- Requires much less emergency power to operate in the event of a power outage.
- Backup technology is well known to the operational staff.
- Backup fuel supply is reliable and available.
- Maintain heat pump operation at conditions with greatest efficiency.
- Greatly reduce the electric load during peak heating conditions to minimize the electric distribution upgrades that would otherwise be required.
- Can produce the higher temperatures required during peak heating conditions to eliminate costly up-front building modifications that would be necessary to adequately heat a space under peak conditions with lower temperatures provided by renewable equipment.

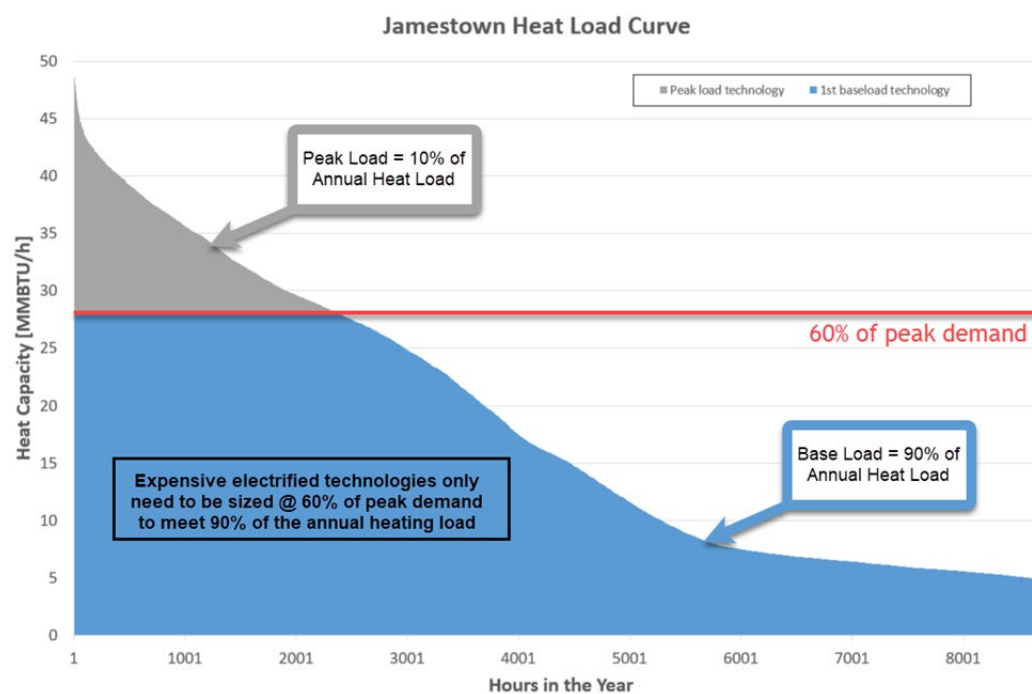


Figure 7. Baseload and peak load illustration

Emission Reduction: The CLCPA's target for an 85% reduction in carbon emissions is achievable without 100% electrification. Scenarios with electric boilers for peaking have higher costs due to electrical upgrades that are required compared to gas-fired peaking boiler counterparts.

System Design: Of the scenarios modeled, a centralized system operated at 4GDH temperatures provides the most economical approach for electrification-based energy producing technologies in Jamestown.

Flexibility: In addition, a 4GDH will provide the most flexibility when compared with a 5GDH or decentralized system in a future electrical grid primarily based on renewable sources with intermittent production. As heat loads throughout NYS continue to be electrified, the demand for electricity will increase significantly. As more wind and solar electric production units are placed online, the existing share of renewable energy in the system, mainly based on hydro, will comprise an increasingly smaller portion of the total renewable energy expected to be developed under the CLCPA. The large thermal storage capacities available in centralized 4GDH low temperature district heating systems would help to meet the NYS goal of a carbon free grid quicker and more cost-effectively than other options by decoupling intermittent renewable electricity output from instantaneous demand. In addition, the ability of transferring heat producing technologies from heat pumps to boilers based on the amount of green electricity in the grid mix, is far superior in a 4GDH system since they are not characterized with heat pumps and boilers in every building.

Due to the intermittency of green electricity, there will be large variations in production, and when it is available, electrification technologies such as heat pumps should be used. At times, production may become so significant that the grid will need to be balanced by either curtailing renewable sources or using the excess power to charge thermal energy storage. A flexible energy system with storage, can use much of the excess electricity instead of it being wasted, and therefore, flexible heating networks will reduce the costs for the transition.

Heating systems that are being designed now will be in operation for many decades and should be designed for maximum support to the power grid and the most cost-effective transition costs.

Cost of Renewable Heat Sources: Scenarios with GSHP have higher CAPEX costs than scenarios with ASHP or that use waste heat from wastewater due to the high cost of geothermal borefields. Capturing and repurposing rejected waste heat from the BPU's WWTP is a cost-effective heat recovery solution.

Additional Cost Considerations

As part of the planning process and analysis these additional items were identified and their costs will need to be considered but were not included in the analysis since they will not affect the results of the study between electrification-based scenarios.

Necessary Building Modifications: The UPMC Chautauqua Hospital is the only building that operates on steam directly and would require a full building HVAC gut and renovation to convert to a hydronic heating system. The estimated cost to renovate the Hospital is expected to exceed \$50M. Since the steam and condensate piping is coming to the end of its useful life throughout the building, costs for pipe replacement are expected to be funded by the Hospital and is therefore not included in the CAPEX values as part of the evaluation. Pipe replacement should consider the conversion from steam

to hydronic over time as pipe is replacement to slowly convert from steam to hydronic. In addition, UPMC may have energy and emission reduction goals that would require a conversion from an inefficient 1st generation steam heating system to a more efficient low temperature hydronic system. Since the Hospital accounts for almost 8% of the annual heating load, it is critical that the Hospital remain a Jamestown BPU DH customer.

Hazardous Materials: Hazardous material abatement and removal costs are not included and may increase project costs. Although it is difficult to estimate the cost of abatement without an environmental survey, based on the average building age of 85 years, it is anticipated that abatement will be required for building work. Abatement costs are expected to be similar across all scenarios and not affect the result of this comparison.

Recommended Next Steps

Ramboll has identified the following recommended next steps to help Jamestown BPU prioritize projects that can influence future system design and demonstrate progress.

- **Heat Mapping** – Assess buildings that should be connected to the district heating network initially and identify buildings and areas that have the potential to be connected in the future.
- **Building Assessment** – Evaluate, investigate, and perform testing of the heating system within each of the currently connected buildings as well as buildings identified during heat mapping for connection. Evaluation, investigation and testing are defined in Section 5.3 of the report. The investigative work in current and potential buildings will also determine if additional heat sources are available to feed into the district heating network such as cooling loads that can easily be served with heat recovery chillers.
- **UPMC Hospital Steam Conversion** – Develop a strategy to convert the Hospital from steam to hot-water and to meter, for greater accuracy, heat rejected from its year-round cooling load. Ramboll met with UPMC Hospital staff to discuss and review this study and its purpose.
- **Pipe Replacement Phasing Strategy** – Develop a strategy to replace approximately 70,000 LF of pipe in a phased approach that addresses age, condition, and capacity in relation to the project's needs. In addition, the strategy will define all phasing requirements such as temporary heating units, structures, and investment needs by year.
- **Customer Education Campaign** – Educate and inform the community about the project, opportunities, and to help identify potential take rates and interest of new and existing customers should the new system be constructed. Educate customers on cost effective energy efficiency measures that can typically be performed at buildings to reduce overall energy consumption.
- **Geothermal Testing** – Since the geothermal borefield size, depths and cost in this report are based on conservative industry standards, subsurface testing as well as evaluation of various borefield heat exchangers should be conducted. Test results could identify much higher heat extraction rates with shallower drill depths.
- **Monitor Market Development** – Monitor advances in heat pump technology and US market availability.

Some of the preceding recommendations should be completed to help Jamestown BPU select a preferred scenario, or variation thereof, prior to beginning preliminary design.

Conclusion

To greatly reduce the consumption of fossil fuels in a cost-effective manner while still maintaining resiliency, reliability, and maximum support to the power grid, it is recommended that a centralized district heating system using a 4GDH network and waste heat recovery from the Jamestown WWT plant (Scenario B-5) be further developed. Particularly with consideration to NYSERDA's current study of Statewide Thermal Energy Networks (TENs) potential, where larger heat sources, like wastewater heat, could have a significant contribution to broader implementation of district energy systems.

The City of Jamestown is uniquely positioned to reduce carbon emissions in NYS by approximately 300,000 MT of CO₂e over the next 20 years. The BPU currently operates a DH system and a WWTP that discharges more energy in heat from effluent than is required to meet the current heating load for an entire year. In addition, the electric distribution grid is powered from 100% renewable sources and Jamestown's heat production would only require a fuel shift from natural gas to "net zero" electricity to reduce carbon emissions. Combining this infrastructure with heat pumps, as well as expanding the current DH system, provides the lowest energy cost of all electrification-based scenarios modeled. Scenario B-5 incorporates the combining of Jamestown BPU's infrastructure with additional customers and has the greatest potential for expansion of all scenarios evaluated.

A total of 12 electrification-based scenarios were analyzed and include comparing 4GDH networks, 5GDH networks, hybrid solutions with mixed decentralized and centralized buildings, fully decentralized, and with various heat pumps and heat sources such as ASHP's, WSHP's, borefields, and wastewater. The results of this study indicate Scenario B-5 provides the City of Jamestown and NYS the most cost-effective solution to greatly reducing GHG emissions and reliance on fossil fuel technology and has the greatest potential for expanding its customer base. It is recommended that the next steps described in this report be employed to further develop Scenario B-5.

Although scenario B-5 provides the greatest benefit, it does not come without challenges. Scenario B-5 has the highest up-front cost at almost \$200M and this cost does not include the building modifications needed to convert the hospital from steam to hydronic or environmental abatement costs. Although these costs are expected to be the same for all scenarios and not affect the results, they will increase the CAPEX and LCOE.

In addition, the current energy rates of Jamestown's DH customers are extremely low and not sustainable since the rates do not include costs such as repair, replacement, maintenance, personnel, and in some months not even the cost of fuel. Because of this, the BPU does not have the necessary funding to replace end-of-life systems or even make repairs to keep the system operational. Rates must be increased to fund repairs and as a result will likely drive customers towards installing their own local natural gas-fired boilers since it is the least expensive alternative to DH. If this occurs, current emissions generated at the central plant will not improve and instead be dispersed throughout the city and will not contribute towards NYS CLCPA goals that address climate change. If the NYSDEC was to impose a social cost of carbon, it could influence the shift to individual natural gas-fired boilers.

Jamestown BPU has taken the first step towards overcoming these challenges by securing funding through NYSERDA and, along with Ramboll, developing this study to help identify a preferred solution to transition away from fossil fuel technology. Although significant funding would be required to implement Scenario B-5, new funding opportunities are released each month and many new

programs are expected to be written. Studies like this can help guide program design and be used to develop applicable funding opportunities for investment in waste heat recovery and centralized district heating networks that have the potential for widespread deployment. Scenario B-5 embodies the full intent and purpose of the large investments in clean energy Federal and State Governments are offering.

An opportunity exists in Jamestown NY to convert an existing district heating system, one that serves a multitude of building types such as offices, restaurants, various businesses, residential, a hospital, and an ice arena, from fossil-fuel to renewable sources. In addition to converting the existing customer base, the system has the potential and local support if economically feasible, for great expansion including nearby industrial and manufacturing facilities, as well as the entire campus of Jamestown Community College. For all of these reasons, Jamestown should continue to pursue State and Federal funding at the scale required to adequately support this project.

2. Purpose, Drivers, and Approach

2.1 Purpose

With New York State's move to cleaner forms of energy well underway as part of the Climate Leadership and Community Protection Act (CLCPA), New York State is taking proactive steps to assist communities in their planning for the transition away from conventional energy infrastructure they have hosted over the past several decades, specifically fossil-fuel. The purpose of the project was to develop a strategy that aligns with New York State directives and create a vision for low carbon and renewable technologies that reduce fossil fuel use and dependency and increase electrification of utility operations while still maintaining resiliency and reliability. This study provides a roadmap for near-term actions and a decision-making framework for the long-term vision to achieve NYS energy efficiency and GHG reduction mandates and set a path for carbon neutrality.

2.2 Drivers

A high-level summary of the NYS mandates, energy and carbon reduction targets, and directives includes the following:

Table 1. List of NYS mandates

New York State Mandate	Goals/Targets
The Climate Leadership and Community Protection Act (CLCPA)	• Reduce statewide GHG 40% by 2023 and 85% by 2050 (1990 baseline) • 70% renewable energy grid by 2030 • 100% carbon free electricity by 2040 • By 2030, 100% electricity from Clean Energy Standard ("Eligible Systems")
Executive Order 22 (EO 22)	• Beginning Jan 1, 2024, new permitted construction shall avoid infrastructure, building systems, or equipment that can used to combust fossil fuels • Reduce energy consumption by 11 TBtu by State Agencies by 2025
BuildSmart 2025 (ties to New Efficiency New York and CLCPA)	• Energy Master Plan every 5 years if annual utility bill is over \$300k • ASHRAE Level 2 audits for state-owned buildings over 5,000 gross square feet (GSF)

2.3 Approach

A key strategy was identifying a pragmatic and cost-effective approach to achieving the long-term goals of electrification-based energy production technologies while also bridging the short-term needs of critical capital improvements ultimately supporting the long-term goals. Key steps to development are illustrated in Figure 8 below. Completing these steps allowed critical discussion around strategic focus areas including energy efficiency, resiliency, renewable energy, stewardship and engagement.

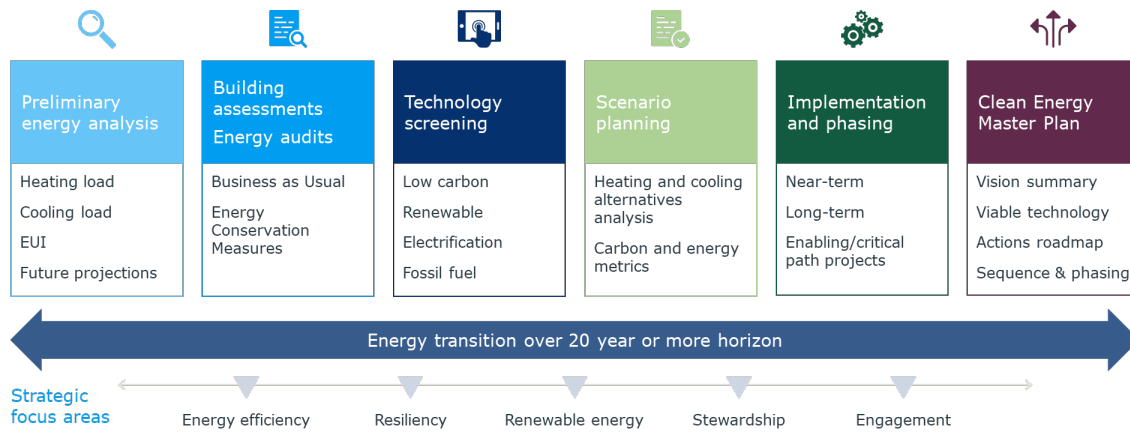


Figure 8. Clean energy master planning key steps

3. Existing System

The space heating and domestic hot-water-production needs of 69 buildings within the City of Jamestown are met via a centralized district heating hot-water system. These buildings include schools, hospitals, commercial, residence, and public types. The district heating system was initially established as a steam system in 1948 and was ultimately abandoned in 1969 when building owners decided to install their own local boilers⁸. The central system was reestablished to 4 buildings as a hot-water network in 1984. Since then, the system had grown to supply over 70 customers. However, approximately 85% (~60,000') of the networks direct-buried piping system has been in operation over 35 years and is beyond its useful life. Replacing the piping network will require extensive capital investment and increase utility rates. Some customers have already left the district heating network and installed their own local gas-fired boilers.

Hot water from the central plant is distributed to customers which is then mostly used for space heating and domestic hot water (DHW). Both the ice rink and the Hospital have additional process loads including humidification, sanitizing, ice melt, and dehumidification. All of the connected buildings are currently equipped with hot water heat exchangers that use hot water from the district heating system to produce hot water for hydronic building heat and domestic-hot-water.

⁸ Second Quarter 2005, Twenty Years Later: Revisiting the growing Jamestown system, District Energy, pages 7-9

4. Heating Load Analysis

4.1 Annual heating load

Three full years of customer monthly metered data was provided under Task 2A by Jamestown BPU. The average annual heating load of each customer was determined using the metered data provided. Table 2 is a list of the annual heating load of each building and the percentage that building represents of the thermal district.

4.2 Hourly heating load

Nine years of hourly energy supply data was provided by BPU and used to determine peak and annual energy usage. Additional analysis was performed to determine the peak heating load of each individual building since heat load diversity, domestic hot water and plant process loads, and thermal losses are included in the energy supply data provided by BPU. In addition to using trend data from the central plant, a cursory heat analysis was performed to estimate peak loads.

A heat-load analysis determines the heat that must be supplied to the building to overcome convective/conductive heat transfer from the warm inside to the cold outside through walls, windows, roofs, and floors. The analysis also considers the losses associated with infiltration of cold air into the building through small openings in the building walls, or cracks around doors and windows. Building characteristics including location, size and shape, number of floors, % fenestration, and occupancy type were determined for each building. A summary of the peak heating building loads, along with the percentage that building represents of the thermal district system's peak load, is included in Table 3:

Table 2. Annual heating loads

Building	Annual Htg Load (MMBtu/yr)	EUI kBtu/SF	% of Total Load
15 E 5th St LLC (Burgett & Robbins)	460	62.87	0.3%
200 Harrison St LLC (Chataqua IDA)	1,471	12.27	1.0%
3644 Holdings LLC (Priscilla)	1,460	70.27	1.0%
3644 Holdings LLC 2 (Cameo)	1,370	71.01	0.9%
3644 Holdings LLC 3 Jefferson St Apts)	444	71.26	0.3%
3644 Holdings LLC 4 (Parkview Apts)	734	46.60	0.5%
Agnes Home	432	81.69	0.3%
Anderson Manor LB	1,170	53.60	0.8%
Anderson Tower LP	1,132	34.12	0.8%
Best Western Hotel	480	14.22	0.3%
Board Of Education - JHS	11,977	47.44	8.3%
Board Of Education - LOVE	2,586	43.23	1.8%
Board Of Education (Tech Cntr)	416	23.98	0.3%
BPU - DH-carlson	2,350	69.52	1.6%
BPU - low pres gas heat	936	-	0.6%
BPU - monitor building	2,003	33.39	1.4%
Carlson Tower LP	1,002	35.06	0.7%
Chautauqua Brick, Inc	415	17.31	0.3%
Chautauqua Opportunities	1,543	21.08	1.1%
City of Jamestown (City Hall)	6,155	104.49	4.2%
City Of Jamestown 3 (Main St. Parking)	1,259	27.80	0.9%
CODE Euclid Gardens	1,964	66.11	1.4%
Covenant Manor Apartments, LLC	5,119	46.79	3.5%
DPW	588	41.98	0.4%
DPW 2	4,255	151.95	2.9%
Duncan Olesnak	143	33.21	0.1%
Eliz W Marvin House	206	31.80	0.1%
E-Z Clean Car Wash	827	296.25	0.6%
First Covenant Church	768	46.23	0.5%
First Lutheran Church	1,763	56.80	1.2%
Fourth St Housing	759	58.41	0.5%
Gregory J Buzzanco (Foote Ave Church)	133	17.51	0.1%
Herbert A Duke II	295	9.82	0.2%
Heritage Ministries (Heritage Park)	7,735	122.62	5.3%

Notes:

1) JHA = Jamestown Housing Authority

2) JRP = Jamestown Rental Properties

3) Only approximately 33% of 200 Harrison St. LLC is heated for office use.

Building	Annual Htg Load (MMBtu/yr)	EUI kBtu/SF	% of Total Load
Heritage Ministries 2 (Childcare)	284	61.75	0.2%
HH Jamestown, LLC (Cherry St. Parking)	1,137	11.66	0.8%
Inter'n Ordinance Tech	747	22.25	0.5%
Jamestown Boys & Girls Club	1,936	65.51	1.3%
Jamestown City (Ice Arena)	4,294	62.66	3.0%
Jamestown Newspaper Corp	1,293	19.79	0.9%
JHA (5th St. High Rise)	2,387	33.06	1.6%
JHA (Chadakoin Bldg)	2,562	46.14	1.8%
JHA (Hotel Jamestown)	5,699	40.71	3.9%
JRP (Jody Peterson)	651	67.81	0.4%
JRP (South County Office Bldg)	1,069	19.24	0.7%
Kaleida Health	2,339	71.19	1.6%
Krog Corp (BWB Center)	641	17.88	0.4%
Legal Assistance of WNY	451	56.33	0.3%
Lewis & Lewis P C (.001) (.1)	435	96.67	0.3%
Lewis and Lewis	583	89.75	0.4%
Little Theater Jamestown	2,058	35.70	1.4%
National Comedy Center, Inc.	1,386	61.72	1.0%
Northwest Bank	711	30.91	0.5%
Prendergast Library	1,544	45.99	1.1%
REALiFE Church Inc.	526	43.80	0.4%
Reg Lenna Center for the Arts	1,949	40.66	1.3%
Riverwalk Properties (JAMA)	5,100	61.73	3.5%
Robert H Jackson Inc, The	723	37.72	0.5%
St James Church	1,093	36.43	0.8%
St Susan Center	366	3.28	0.3%
Time Warner Cable	473	27.86	0.3%
Triple R, LLC	306	40.94	0.2%
UPMC Chautauqua at WCA (Jones Hill)	8,420	74.40	5.8%
UPMC Chautauque at WCA (Physicians)	4,246	114.75	2.9%
UPMC Chautauque at WCA (Hospital)	10,838	31.88	7.5%
Westerberg Tower LP	775	23.10	0.5%
Windstream Corp A/P	1,295	18.28	0.9%
YMCA (main)	2,999	38.01	2.1%
YWCA	606	32.82	0.4%

Table 3. Peak heating loads

Building	Estimated Peak Load (Btuh)	Btu/Sq-Ft	% of Total Load
15 E 5th St LLC (Burgett & Robbins)	118,280	16	0.2%
200 Harrison St LLC (Chataqua IDA)	919,619	8	1.4%
3644 Holdings LLC (Priscilla)	298,669	14	0.4%
3644 Holdings LLC 2 (Cameo)	284,310	15	0.4%
3644 Holdings LLC 3 Jefferson St Apts)	138,717	22	0.2%
3644 Holdings LLC 4 (Parkview Apts)	248,697	16	0.4%
Agnes Home	94,650	18	0.1%
Anderson Manor LB	287,912	13	0.4%
Anderson Tower LP	410,833	12	0.6%
Best Western Hotel	391,842	12	0.6%
Board Of Education - JHS	5,506,083	22	8.1%
Board Of Education - LOVE	1,452,504	24	2.1%
Board Of Education (Tech Cntr)	211,505	12	0.3%
BPU - DH-carlson	481,520	14	0.7%
BPU - low pres gas heat	59,593	18	0.1%
BPU - monitor building	562,335	9	0.8%
Carlson Tower LP	348,013	12	0.5%
Chautauqua Brick, Inc	444,098	19	0.7%
Chautauqua Opportunities	1,630,625	22	2.4%
City of Jamestown (City Hall)	952,014	16	1.4%
City Of Jamestown 3 (Main St. Parking)	583,239	13	0.9%
CODE Euclid Gardens	722,802	24	1.1%
Covenant Manor Apartments, LLC	1,089,861	10	1.6%
DPW	265,639	19	0.4%
DPW 2	376,705	13	0.6%
Duncan Olesnak	61,336	14	0.1%
Eliz W Marvin House	108,401	17	0.2%
E-Z Clean Car Wash	51,769	19	0.1%
First Covenant Church	658,075	40	1.0%
First Lutheran Church	1,135,995	37	1.7%
Fourth St Housing	207,896	16	0.3%
Gregory J Buzzanco (Foote Ave Church)	320,103	42	0.5%
Herbert A Duke II	333,071	11	0.5%
Heritage Ministries (Heritage Park)	593,642	9	0.9%

Notes:

1) JHA = Jamestown Housing Authority

2) JRP = Jamestown Rental Properties

3) Only approximately 33% of 200 Harrison St. LLC is heated for office use.

Building	Estimated Peak Load (Btuh)	Btu/Sq-Ft	% of Total Load
Heritage Ministries 2 (Childcare)	140,636	31	0.2%
HH Jamestown, LLC (Cherry St. Parking)	1,198,498	12	1.8%
Inter'n Ordinance Tech	346,259	10	0.5%
Jamestown Boys & Girls Club	1,081,424	37	1.6%
Jamestown City (Ice Arena)	2,372,321	35	3.5%
Jamestown Newspaper Corp	429,734	7	0.6%
JHA (5th St. High Rise)	868,188	12	1.3%
JHA (Chadakoin Bldg)	755,391	14	1.1%
JHA (Hotel Jamestown)	1,380,786	10	2.0%
JRP (Jody Peterson)	155,580	16	0.2%
JRP (South County Office Bldg)	629,498	11	0.9%
Kaleida Health	1,438,077	44	2.1%
Krog Corp (BWB Center)	437,465	12	0.6%
Legal Assistance of WNY	113,994	14	0.2%
Lewis & Lewis P C (.001) (.1)	98,876	22	0.1%
Lewis and Lewis	109,620	17	0.2%
Little Theater Jamestown	1,882,513	33	2.8%
National Comedy Center, Inc.	500,610	22	0.7%
Northwest Bank	258,119	11	0.4%
Prendergast Library	483,026	14	0.7%
REALIFE Church Inc.	467,616	39	0.7%
Reg Lenna Center for the Arts	1,715,887	36	2.5%
Riverwalk Properties (JAMA)	3,464,705	42	5.1%
Robert H Jackson Inc, The	226,823	12	0.3%
St James Church	1,051,474	35	1.6%
St Susan Center	898,362	8	1.3%
Time Warner Cable	246,071	14	0.4%
Triple R, LLC	92,505	12	0.1%
UPMC Chautauqua at WCA (Jones Hill)	4,603,592	41	6.8%
UPMC Chautauque at WCA (Physicians)	1,605,585	43	2.4%
UPMC Chautauque at WCA (Hospital)	13,344,745	39	19.7%
Westerberg Tower LP	390,091	12	0.6%
Windstream Corp A/P	701,571	10	1.0%
YMCA (main)	2,936,395	37	4.3%
YWCA	239,944	0	0.4%

4.3 Utility prices

Electricity and gas pricing was provided as part of Task 2A RFI response from Jamestown BPU. The values used are as follows:

Table 4. Annual utility prices

Fuel	Supply + Delivery
CEP Electricity	0.0527 \$/kWh
CEP Natural Gas	0.5098 \$/Therm
Consumer Electricity	0.0961 \$/kWh
Consumer Natural Gas	0.7003 \$/Therm

4.4 CO₂ emissions

The CO₂ emission factors are shown in Table 5.

Table 5. Emissions factors

CO ₂ Emissions	2020	2030	2040
Electricity ⁹	0 lbCO ₂ e/MWh	0 lbCO ₂ e/MWh	0 lbCO ₂ e/MWh
Natural Gas	0.053 MTCO ₂ e/MMBtu	0.053 MTCO ₂ e/MMBtu	0.053 MTCO ₂ e/MMBtu
	11.7 lbCO ₂ e/Therm	11.7 lbCO ₂ e/Therm	11.7 lbCO ₂ e/Therm
	117.1 lb/MMBtu	117.1 lb/MMBtu	117.1 lb/MMBtu

4.5 Heating values

The heating values for natural gas, fuel oil and propane are stated in Table 6.

Table 6. Heating values

Fuel	Heating Values
Natural Gas	100,000 Btu/Therm

4.6 Heat demand density

Heat demand density is the heat demand divided by the area of the district. The most recent map ([Pan-European Thermal Atlas 5.2](#)) starts identifying potential areas within the 14 EU Member States when the heat density reaches 50 TJ/km² (4.4MBtu/ft²). The maps provide three ranges of heat density with higher values having a greater potential for centralized district heating networks.

- 50 TJ/km² (4.4MBtu/ft²) – 120 TJ/km² (10.5MBtu/ft²)
- 120 TJ/km² (10.5MBtu/ft²) – 300 TJ/km² (26.3MBtu/ft²)
- Greater than 300 TJ/km² (26.3MBtu/ft²)

The heat demand density of the currently connected Jamestown customers is approximately 55 TJ/km² (4.8MBtu/ft²) which is near the low end when identifying potential areas for district heat. However, the 55 TJ/km² only considers the current load. Since there are over 2,000 structures within the City of Jamestown, heat mapping as indicated in the recommended next steps, should be performed to determine the actual heat demand density in Jamestown, which will be much greater than what is shown in Figure 9 below.

⁹ Jamestown's electric utility grid is currently supplied from 100% renewable sources: Appendix G: JBPU-PA-2021 Latest NYGATS Report

Scenarios B-4 and B-5 require network piping installed over 5 miles from the Jamestown WWTP requiring more than double the amount of direct-buried pipe than the current system. This not only significantly increases infrastructure but also drastically reduces the heat demand density. Even after adding all potential future loads, including industrial, Jamestown Community College, and local schools along the route, which almost double the current load, the heat demand density is still significantly less. Figure 9 illustrates the heat demand density of the current network compared with Scenario C (south of 6th street) and Scenario B-4 B-5 at the WWTP with both the current load and potential future load. To

improve the LCOE, Jamestown should focus on expanding its customer base. Extensive piping from the WWTP facility has the greatest potential of all scenarios modeled for this expansion.

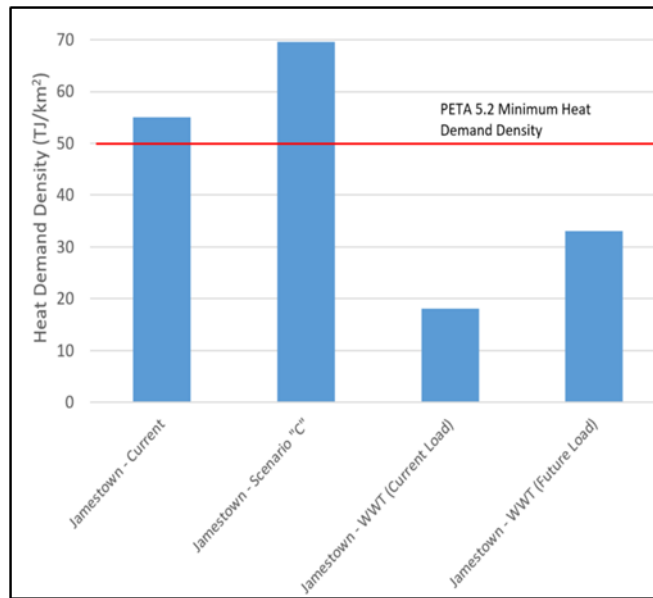


Figure 9. Heat demand density scenario comparison

cost

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5. Energy Master Planning – Design Considerations

This section articulates and categorizes conceptual strategies that cover a range of technical approaches to reduce GHG emissions and/or phase out fossil fuel use while maintaining reliable utility services to Jamestown. Summarized below are completed steps and activities that identify the most suited technologies that could cover the heating demands for the city of Jamestown’s district heating system and using that information to develop scenarios for consideration.

5.1 Baseload, peaking, and backup considerations

Ideally, a thermal heating solution would be able to serve the customers, through all demand conditions, and would have a low installed cost, low cost to operate, and emissions free. However, no such technology exists today that meets all these needs simultaneously. Therefore, a combined approach is employed to maximize the environmental impact, minimize the installed capital requirements and operational costs, and ensure reliability. The combined approach establishes dedicated baseload technologies and peaking technologies to optimize the installed costs and operational costs. Peaking technologies are only relevant in limited annual hours but require a high capacity (see Figure 10) while baseload technologies are operated most of the time. From experience, if the baseload covers 50% to 60% of the peak heating load, then it will cover approximately 90% of the annual heating load.

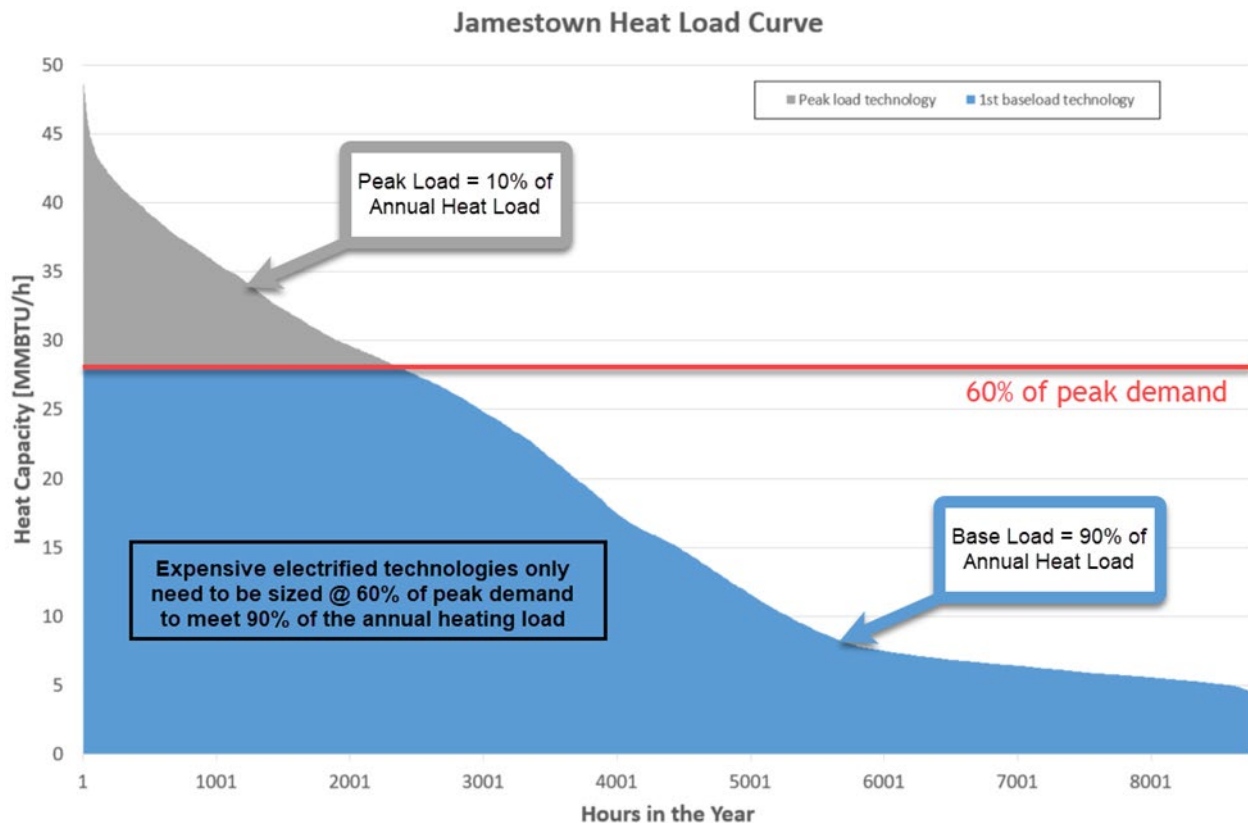


Figure 10. Baseload and peaking information

Since a peaking technology would have limited annual operating hours, the potentially higher operational costs will only have limited impact on the overall economy and emissions. For example, peak technologies could be existing boilers, which are established assets and often have long remaining lifetime. If they are operated as a peak technology, the annual operating hours will occur in the coldest times of winter and will be limited in relative comparison to total annual operating hours and the technical lifetime for existing boilers will be extended. However, if a baseload technology was leveraged to cover the peak hours, much of the capacity would be unused for most of the year at a much higher installed price. For example, if the baseload technology was a ground heat source system, it would be necessary to nearly double the number of boreholes in the ground to go from approximately 90% to 100% load, at a significantly high cost than utilizing existing assets or lower cost peaking technologies like natural gas boilers.

In addition, the future energy system will increasingly be using sources that are more intermittent in nature (i.e., wind and solar) and, therefore, will move from being very stable to being more unstable increasing the need for backup electricity and backup heat production resources.

Therefore, distinguishing between baseload and peak load resources will result is the most cost-efficient, low emission, and reliable solution while also allowing additional financial resources to be allocated to other projects that maximize the overall environmental benefit.

Here are some aspects for planning purposes:

Baseload technology

- Low cost to operate
- Reliable for continuous operations
- Low emissions

Peaking/backup technology

- Leverage alternate energy source than baseload
- Highly reliable, low maintenance, low installation costs
- Energy supply should be reliable
- Maintenance and operation should be simple and easy for operational staff

A summary of the benefits of using gas-fired equipment for peaking include:

- Reduces CAPEX by using existing assets that have remaining life
 - Maintains equipment connected to a potential future gas distribution system supplied by renewable natural gas
 - Can be used to cover peak heating needs when future peak electric demand exceeds the utilities electric supply capacity
 - Will also serve as the backup heat source
 - An alternate fuel source for backup heating will increase overall reliability and will serve as an economic buffer for resiliency purposes under a future condition of more intermittent renewable energy.
 - Requires much less emergency generator power to operate in case of a power outage
- Baseline Building Thermal Energy Demands

5.2 Supply temperature considerations

To introduce low carbon heating technologies like heat pumps, it is typically necessary to reduce the supply temperature to the systems/buildings since heat pumps have operating temperature limits. Furthermore, the lower the supply temperature of a heat pump, the higher the efficiency of the heat pump. At this time, industrial heat pumps commonly available in the US can typically only produce district HW temperatures as high as 170°F. There are exceptions, and the market is also developing rapidly to include more multi-stage heat pumps and other refrigerant options that are more common in other parts of the world. High temperature heat pump offerings also tend to be available in larger sizes that are more applicable to centralized solutions rather than individual building scale; although expanded size offerings are a likely future development as well. Market offerings should be monitored within the timeframe for implementation of this study.

There are many benefits of reducing hot water temperatures, including:

- Greater long-term economic benefits of lower temperature systems
- Ability to employ a diversified portfolio of low carbon or renewable technologies including heat pumps, geothermal, waste heat, solar thermal, and thermal storage
- Reduction in heat distribution losses due to a lower temperature difference between the circulating fluid in the distribution pipe and its surrounding
- Reduction in the overall temperature drop from the heat source to the most hydraulically remote building
- Ability to use different piping systems such as PEX or HDPE once the network is completely converted to lower temperature. Steel piping may be required initially to bridge the current high temperature and future low temperature systems
- Increased efficiency of heat pumps by reducing the amount of temperature lift required
- Reduced reliance on fossil fuel technology by limiting annual peaking operation even further
- Longer life expectancy of steel pipes from reduced thermal stresses
- Increased safety and lower risk of scalding injuries

Heat supplied from the central plant will target 170°F or lower on the long-term and operate based on an outdoor air temperature reset schedule to reduce distribution temperatures as outdoor temperature rises, increasing overall seasonal efficiency. This approach will transition the current district heating system from a 2nd generation operating at a maximum temperature of 240°F to a 4th generation district heating (4GDH) system.

In addition to a 4GDH system, a 5GDH system is also evaluated as part of this study. A 5GDH system circulates ambient temperature water throughout a district piping network. The low temperature is not suitable for direct heating, however, is the source water supply for individual water source heat pumps (WSHP's) installed at each building. The requirement for heat pumps located at each building is the fundamental difference between 4GDH and 5GDH systems.

Some considerations for a 5GDH system as compared to a 4GDH system are as follows:

- Lower deltaT between supply and return lines require higher flow rates and larger pipe diameters when compared to a 4GDH system.
 - Also results in higher pumping costs.

- Building electricity rates may be higher than central plant utility rates that are large consumers at higher connection voltages.
- Building electrical system upgrades may be required to support decentralized heat pumps.
- Individual thermal storage tanks installed at each building are expected to cost more and may not even be economically feasible as compared to a large single tank at a central plant.

In addition to these considerations, operating a 5GDH system will have limited flexibility when compared with a 4GDH system in a future electrical grid with increasing reliance on intermittent renewable sources such as wind and solar. As other sectors such as heat and transport are being electrified, the demand for electricity will increase significantly and impact demand load shapes as well. Due to the intermittency of green electricity, there will be large variations in production to deal with. An electrified heating and cooling system that is capable of storing thermal energy will help support a decarbonized grid in maintaining the balance between grid supply and demand.

The large thermal storage capacities available in centralized 4GDH low temperature district heating systems will help to meet the NYS goal of a carbon free grid quicker and more cost-effectively than other options by decoupling intermittent renewable electricity output from instantaneous demand. This is not the case with 5GDH ambient loop systems since they employ heat pumps in every building. If it is not specifically required to design the ambient systems with flexibility, it is not possible to control the consumption of electricity since heat will be produced from the heat pumps, regardless of the amount of green electricity in the grid mix. In addition, operation of the heat pumps at times when there is limited renewable energy available means that the most inefficient power plants are operating with significant emissions as a result. Furthermore, owners will experience higher prices for electricity without the ability to shift heating and cooling production to hours when rates are lower.

In a future electric grid with extensive PV and wind generated electricity, there will be times when the supply and demand will need to be balanced by either curtailing renewable sources or diverting the excess power to storage (including thermal energy storage). Curtailing electricity is costly from a society perspective since increased intermittent renewable generation capacity will have limited annual hours of operation. A flexible energy system with storage can use much of the excess electricity instead of it being wasted. In this way, flexible heating networks that include storage will reduce the costs of grid decarbonization.

The heating systems designed now will be in operation for many decades and should be designed to support to the power grid and reduce the overall transition costs. The consumer also benefits from reduced electricity rates by charging storage when rates are low and discharging storage when rates are high. The flexibility of 5GDH can be increased by including adequately sized thermal storage and/or peaking boilers. The costs associated with the 5GDH systems evaluated here include the additional costs of peaking natural gas-fired boilers and thermal energy storage in each building.

5.3 Building-side heating system modifications

At a supply temperature of 170°F from the central plant and allowing for distribution losses and losses at building heat exchangers, building operating temperatures will be approximately 165°F. Most building-side heating systems on the Jamestown DH network are designed to meet the peak load with 180°F BHW or higher. However, these temperatures are only required during peak design conditions when the outside air temperature is low and occurs for a small percentage of the total

heating season. For example, Jamestown BPU weather data in 2022 shows only 596 annual hours (6.8%) below 20°F outside temperature. Hot water supply temperatures are typically reset to lower temperatures when the outside temperature is higher, which reduces distribution losses and improves temperature control; and in the case of heat pumps, increases efficiency. An example reset schedule is shown in Figure 11 and illustrates that a typical schedule might call for 180°F supply temperature for outside air temperature below 20°F and then decrease that setpoint linearly down to a supply temperature of 120°F at outside air temperatures above 50°F. The figure shows an OAT of 27°F would require 165°F building hot-water temperature. Jamestown BPU weather data in 2022 recorded approximately 1,200 hours, or less than 14% of year, at or below this OAT.

An important point made by this example is that for most buildings, available heat pumps can meet the heating requirements most of the time without the costly and time-consuming building upgrades that would be required to operate at much lower design supply temperatures (e.g., 140°F). For the few hours per year where higher supply temperatures may be required, peaking technologies can fill this gap. Electric and fossil-fuel fired boilers are considered as peaking technologies in this study.

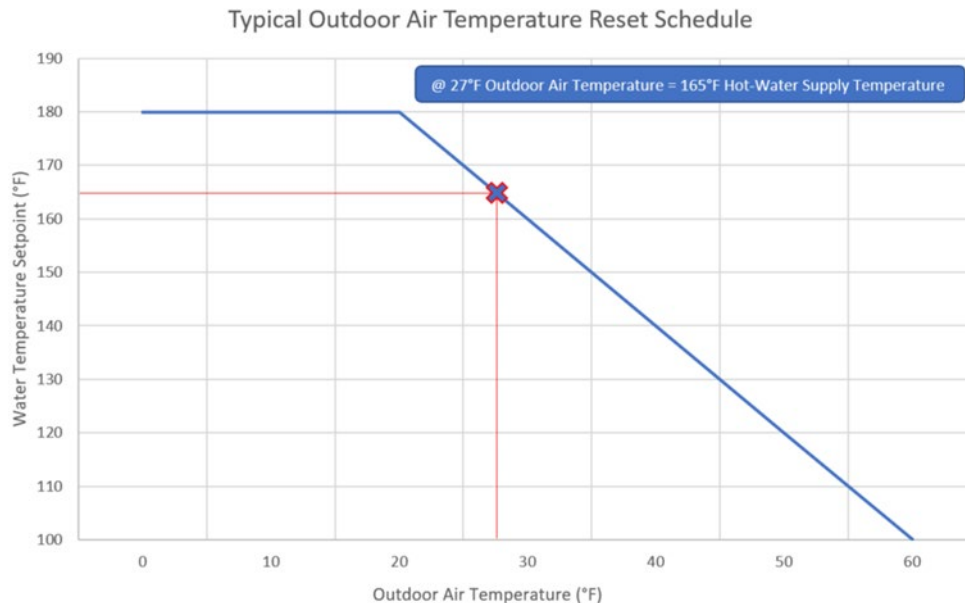


Figure 11. Example outdoor air temperature reset schedule

The overall capacity of a distribution network is dependent on the supply and the return temperature in the distribution system. Among buildings, there are differences in the required heat to each building and each building's ability to reduce the temperature of that supplied heat (ΔT). Buildings with a low heat demand and a higher ΔT will have a low influence on the overall ΔT in the distribution network, whereas buildings with a high heat demand and low ΔT will have a high influence on the overall ΔT . When building renovations are planned, focus should be on the buildings with a high influence on the overall distribution system ΔT . Often it may only be necessary to concentrate on a limited number of buildings. This could be assessed through hydraulic modeling. There should be focus on increasing the ΔT in the buildings, which will increase the overall energy system efficiency. In a district heating system where the utility does not own or control customer side improvements, this is typically incentivized in rate structure as discussed in Optimization of Rate Structures in Section 9.1.

Furthermore, high return temperatures can limit the contribution heat pumps can make to the heating load at higher supply temperatures. If the return temperature at design conditions exceeds the maximum heat pump supply temperature, then the heat pump could not operate and the peaking technology would need to meet the design load independently. This would have a major impact on peaking technology design capacity and, for electric peaking, required electrical infrastructure requirements. It is possible that NYISO Class Year limits¹⁰ or regional capacity limits may become an issue. Further evaluation, investigation and testing are recommended for buildings which have a high influence on the deltaT.

Evaluation: Building-level temperature monitoring is an important action to help inform future design and to help determine and prioritize which buildings need renovations to support the further reduction of hot water supply temperatures. If a building owner can monitor building hot water supply and return temperatures over the course of at least one heating season, then that data would be very useful in defining the design parameters of the proposed heat pump solutions and also identify locations that require retrofits and modifications. Monitored temperature data would also indicate the system temperature difference (delta T; hot water supply temperature minus return temperature) throughout the season. Knowing the delta-T will help define the design parameters and also identify buildings with a low delta T that may benefit from a retrofit. A low delta T can reduce heating capacity, increase pumping power, and/or require larger pipes in the distribution system.

Jamestown BPU has installed hot water supply and return temperatures in the buildings, but interval trend data is not collected. As part of the evaluation effort, all building hot water supply and return points should be verified for accuracy and set up for trend data collection. It is important that the BHW setpoints be set up for OAT reset functionality as well, because for a majority of the heating season, the BHW temperature can be lower than the design point and heat pump capacity and efficiency will improve significantly. Additional discussion regarding OAT reset is provided in the Task 2B report.

In addition to temperature, the position of BHW control valves also provides important operational information and can help to optimize OAT reset schedules for each building.

Investigation: The investigation should include identifying existing issues such as leaking or failed control valves, bypasses left open between supply and return lines, lack of or bypassed pump controls, terminal units with bypassed thermostatic controls, failed sensors, fouled heat exchangers, incorrect OAT reset settings, air handler unit temperature settings, and an unbalanced system.

Testing: After the investigation is complete, deficiencies corrected, and the hydronic system balanced, testing of the system should be performed by lowering the BHW temperature on peak days. This will help to determine if and how much the BHW temperature can be lowered while still meeting peak loads. It is important to note that lowering the BHW temperature at peak temperature will also lower the operating BHW temperature across the entire OAT reset operating range.

¹⁰ The Class Year study is performed annually by NYISO to evaluate the cumulative impact a group of large projects will have on the NYS transmission system. The process identifies specific system upgrades required at a transmission level and allocates cost. As a result, unpredictable transmission system upgrade costs may be required in addition to the expected high costs to modify the electrical distribution.

The Hospital is the only building that operates on steam directly and is expected that approximately 75% of the building would require a full building HVAC gut and renovation to accept low temperature hot water supply. A building extension was performed since the original construction and is heated hydronically accounting for approximately 25% of the buildings area. The estimated cost to renovate the Hospital is expected to be greater than \$50M, funded by the Hospital, and is therefore not included in the CAPEX values as part of the evaluation. In addition, this cost would be required for all scenarios evaluated except E1 decentralizing with natural gas boilers.

The Hospital also requires high pressure steam for sanitizing needs which are currently met using the Hospital's local high-pressure firetube boilers and not with district heat. It is assumed that the high-pressure steam loads will continue to be met this way until future replacement with potential electric steam generators.

For the buildings that currently operate with hydronic systems, early replacement of HVAC equipment is not assumed. High temperature heat pump applications and peaking technologies can avoid the associated cost and time delay while realizing the vast majority of energy and GHG savings. As the HVAC systems in these buildings come due for replacement, low temperature replacements should be installed to improve heat pump performance and further reduce the need for fossil fuel.

5.4 Piping materials considerations

With lower supply temperatures in the heating network, it is possible to use polymeric materials in the heating network. However, many aspects of the final choice of using a polymeric material should be carefully considered.

- How will the network transition from the higher temperature to the lower temperature? Will it be necessary to maintain the higher temperature for any extended periods, even if that is only to certain portions of the city?
- What system pressure is necessary? A polymeric material cannot withstand high temperature and high pressure for extended time periods. Are there elevations in the city which increases the pressure in the system?
- Pipe service life. How long time is the service life of the pipe and how is it affected by shorter exceedances in the temperature / pressure gradients?
- Pipes should be insulated, and regardless of material choice, the pipes should be pre-insulated
- Pipes should have leak detection to allow for quick identification and repair of potential issues

Final material choice would be selected in subsequent design phases where the above considerations and costs are further assessed. For purposes of this study, EN253 piping was considered for all applications.

5.5 Energy transfer stations in buildings

It is proposed to connect each individual building through an indirect connection. A new heat exchanger would be installed in each building to separate the distribution network from the internal building installations. This is typically referred to as an Energy Transfer Station (ETS), meaning there is hydraulic separation between the two systems.

This has the advantage of being a more secure system than a direct connection in the event of an internal leak where there is risk of getting a large amount of water from the distribution network into

the building, potentially causing significant damage. A hydraulically separated indirect connection thus removes this risk. The hydraulic separation also makes it possible to use higher pressures in the distribution network if necessary.

The ETS itself would come as a prefabricated packaged unit solution and depending on the heating demand, will for example look like the image in Figure 12. A skid mounted unit is suitable for larger demands; for smaller demands, a wall mounted ETS will be more suited.



Figure 12. Typical ETS Installation (source: Danfoss)

In the techno-economic modeling, CAPEX is included for the installation of energy transfer stations for all buildings connected to the centralized system. In addition, CAPEX is included for the Carlson Plant to convert its unit heaters to low temperature units.

5.6 Future resiliency posture

With an increased focus on electrification, it is advised to have full heating backup from a secondary fuel. Diversified fuel use can support flexibility and cost resiliency.

For buildings connected to a centralized system, the heating backup would be established in the central plant through the use of boilers. Backup boilers may be supplied from either natural gas or from a liquid fuel. For buildings not connected to the centralized system, it would be necessary to install separate backup boilers within each building. These would be the same boilers used for peaking, as described in Section 5.1.

5.7 Borehole design considerations

Number of Boreholes: To estimate the number of boreholes needed to serve the city's heating load, an average heat extraction rate is needed. The scope for this project did not include test bore installation and analysis, but Ramboll did review previous investigation results from Sheila Johnson

Design Center geothermal project, as well as other campuses. Conservatively, Ramboll applied a value of 40 Btu/h/ft (corresponding to approximately 300 feet/ton) to estimate the number of boreholes. With that assumption, approximately 476 boreholes would be needed to cover baseload heating for buildings that would be on a centralized district. 450 boreholes would be needed to cover all buildings south of 6th street.

Borehole Balancing: Using the subsoil as BTES (borehole thermal energy storage) means that the ground temperature for the entire area of the BTES field varies in temperature. Since the city of Jamestown is heating dominant (a higher demand for heating than for cooling), the demand for cooling is not adequate enough to re-balance the boreholes and, therefore, the subsoil would eventually get cooler from season to season unless the boreholes are balanced. A higher temperature source can be used for this balancing purpose, as for instance solar thermal panels, heat injection from heat pumps, the ambient air in the summer season or other sources.

For Jamestown, it is envisioned that the air source heat pumps whose primary purpose is to meet baseload, will also be used for balancing boreholes.

5.8 Tank thermal energy storage

Tank thermal energy storage (TTES) is an important component in an energy system with fluctuating energy prices. TTES involves storing hot or cold water in insulated tanks to help balance energy demand and supply while ultimately reducing peak demand, energy consumption, carbon emissions and costs. The storage makes it possible to disconnect consumption of electricity from the supply of heat. Thereby, it is possible to capture heat when renewable energy when is available and supply heat from the TTES when renewable energy is scarce.

5.9 Battery storage

Current battery technology is far more advanced than in the past and some demonstration battery storage systems are currently in use on college campuses. An example of this is the Tesla battery system currently installed at UMass Dartmouth. Battery storage can provide an uninterruptable power supply when the grid power is lost, but the capacity of a battery storage system is limited and often only a few hours of power supply is available. Scale needs to be considered and battery storage would not be cost-effective at municipal scale. Often a building or a data center is backed up with an uninterrupted power supply to allow enough time for a generator to be started.

6. Technology Screening – Energy Generation

The objective of the technology screening process is to identify suited technologies and storage options for the future production of heating that support Jamestown BPU's alignment with the carbon reduction goals of the CLCPA. Technologies evaluated considered centralized and distributed (decentralized) solutions.

The process was conducted through a series of meetings where Ramboll presented descriptions of fossil fuel, renewable and electrification technologies and their ability to produce either baseload and/or peak load production. Ramboll also discussed the technology's ability to increase energy system flexibility and resiliency for the city.

Technologies that were considered relevant and viable continue into the scenario planning phase that is described further below.

A technology screening conference was held with Jamestown BPU and NYSEDA on April 14, 2023. Presentations and meeting minutes were distributed to Jamestown BPU and NYSEDA.

6.1 Fossil fuel technologies

Table 7 shows the relevant fossil fuel technologies and the result from the screening process:

Table 7. Technology screening process, fossil fuel technologies

Fossil technologies / fuels

Fossil technologies / fuels

1

2

3

4

5

1= poorest performance5= highest performance

Technology	Output	Type	Notes	CO2 neutrality	CAPEX	OPEX	System integration
Gas turbine (simple cycle), Gas turbine combined cycle, rankine steam turbine, gas engines	- Electricity	Fossil fuel	- Base load technology, well proven - Not carbon neutral if NG is used - High CAPEX	1	2	4	5
Solid oxide fuel cell CHP	- Heat - Electricity	Fossil fuel	- High CAPEX - Base load technology - Not carbon neutral if NG is used - Local use of biogas seems unrealistic - Long start up times, high minimum load %	2	1	4	4
Gas boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	2	5	3	5
Oil boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	1	5	2	4
Grey Hydrogen	Fuel	Fossil fuel	- Derived from n-gas and produced from fossil fuels - CO2 is released into the air	1	1	2	3

The technologies are mentioned in the left column and the upper horizontal row are different characteristics of the technologies. To qualitatively assist in the evaluation of the technologies, color coding is used where red is a "low score" and green is a "high score". For example, in all technologies have a low score for "CO2 neutrality" since they are fossil based. The technology "Gas Boilers" has a score high on CAPEX since the CAPEX for establishing a gas boiler system is relatively low in comparison to some other technologies. The column titled "system integration" considers different characteristics for the technologies (e.g., support to local energy system (e.g., peak / backup),

integration with electricity market, space requirements, potential regulatory impact). All scores are based on a qualitative evaluation.

Only the gas boiler will continue to the subsequent phase mainly due to its ability to act as peaking and backup technology for the primary technologies.

6.2 Renewable source technologies

Table 8 shows the relevant renewable source technologies and the result from the screening process:

Table 8. Technology screening process, renewable sources

Renewable sources / technologies



Technology	Output	Type	Notes	CO2 neutral	CAPEX	OPEX	System integration
Bio-oil fired turbine (simple cycle)	- Heat - Electricity	Renewable fuel	- Base load technology - High CAPEX - Very high OPEX	4	2	1	3
Bio-oil engines	- Heat - Electricity	Renewable fuel	- Base load technology - Very high OPEX	4	2	1	4
Biomass ORC CHP, wood chips	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - Low OPEX	4	1	4	3
Biomass ORC, wood pellets	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - High OPEX	4	1	2	3
Biomass HOB, wood chips	- Heat	Renewable fuel	- Low CAPEX - Low OPEX	4	4	4	5
Biomass HOB, wood pellets	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	4	2	5
Bio oil boiler	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	5	2	5
Photovoltaics	- Electricity	Renewable source	- Intermittent source / need backup from grid - Limited production winter / high in summer	5	2	5	3
Wind turbine	- Electricity	Renewable source	- Low CAPEX - Need backup from grid	5	2	5	3
Bio gas production - anaerobic digester	- Gas	Renewable fuel	- High CAPEX / OPEX	5	1	2	2
Large Solar Thermal	- Heat	Renewable source	- Limited production in winter / high in summer	5	1	5	3
HOB - conversion from n-gas to bio-oil	- Heat	Renewable fuel	- Very low CAPEX - High OPEX if used in baseload	4	5	2	5
Boiler, hydrogen	- Heat	Renewable fuel	- High CAPEX / OPEX	4	1	1	1
Cogeneration, hydrogen	- Heat - Electricity	Renewable fuel	- High CAPEX / OPEX	3	1	1	1
Blue Hydrogen	Fuel	Renewable source	- Derived from n-gas and produced from fossil fuels - CO2 is captured in a CCS process and stored	4	1	1	2
Green Hydrogen	Fuel	Renewable source	- Produced from electrolyzes - Electricity is based on renewable electricity	5	2	1	2

Although the technologies listed in Table 8 mostly have a high-performance regarding CO2 neutralization, their CAPEX, OPEX, and system integration concerns keep them from advancing to a subsequent phase of evaluation. These concerns include:

- Large CAPEX technologies, some requiring significant available space
- Challenges associated with sourcing and delivery of large quantities of biomass.
- Sourcing of large quantities of biooil is dependent on local availability
- Actual environmental impact of sourcing and delivering biomass/biooil

- Large scale solar thermal production is mainly in the summer season, where there is a very limited demand for heat and will not lead to reduced CAPEX for other technologies since they would be designed for full capacity considering potential for limited sun in the winter months
- Although onsite installation of photovoltaics would reduce the amount of renewable electricity purchased, it is typically not economical when evaluated using current electric rates and the cost of installation. In addition, available space within the city of Jamestown should be used for city purposes or more cost effective renewable technologies. NYS utility companies are required to meet CLCPA goals and provide renewable electricity. Although NYS is required to meet 100% renewable electricity by 2030, for purposes of this report, 100% carbon free electricity is modeled for all years since Jamestown is provided with 100% hydro power.
- Hydrogen and other synthetic fuels are expected to play an important role in the decarbonization of future renewable energy systems. However, the heating sector requiring low temperatures and having well-established and efficient alternatives should not compete for the use of hydrogen, which should be left to those sectors which are difficult to decarbonize such as heavy transport, industrial, air, and the maritime industries.

6.3 Electrification technologies

Table 9 shows the relevant electrification technologies and the result from the screening process. Most are heat pumps with different capacities (single building or central) and different heat sources (wastewater, air, or ground).

Table 9. Technology screening process, electrification technologies

Electrification technologies					1	2	3	4	5
					1= poorest performance 5= highest performance				
Technology	Output	Type	Notes	CO2 neutral	CAPEX	OPEX	System integration		
Electric boiler	- Heat	Electrification	- Base load or peak load - Very low CAPEX for boiler - High requirement for electric load. Potentially need for larger upgrade of electric feeders - High OPEX	4	5	1	5		
HP (air-to-water) - large scale	- Heat - Cooling	Electrification	- Air as secondary heat source - Low efficiency in winter period - Reduction in load in winter season	5	3	3	4		
HP (air-to-water) - small scale	- Heat - Cooling	Electrification	- Standardized product, low CAPEX - Low efficiency in winter period	5	2	3	3		
GSHP open-loop, deep geothermal	- Heat - Cooling	Electrification	- Base load technology - High risk and high CAPEX	5	1	3	3		
GSHP closed-loop, horiz, individual	- Heat - Cooling	Electrification	- Closed loop, base load technology - Requires high available area	5	1	3	3		
GSHP closed-loop, vert	- Heat - Cooling	Electrification	- Closed loop, base load technology - Requires much available space - High CAPEX - Boreholes would require balancing in summer periode	5	2	3	4		
HP (sewage water-to water)	- Heat - Cooling	Electrification	- Base load technology - Often, relatively low CAPEX compared to benefits	5	3	3	4		
Heat recovery chillers, electric	- Heating - Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - higher CAPEX compared to conventional chiller	4	3	4	4		
Chillers, electric	- Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - lower CAPEX compared to heat recovery chillers	4	3	3	5		

Although an open-loop deep geothermal could reduce CAPEX if conditions are favorable, the Jamestown plant sits on top of a drinking water aquifer and an open loop system will not likely be approved by the local authority. In addition, costly and significant front-end investigative work is required to determine soil conditions and since this location is next to the Chadokoin river, it is

anticipated that fouling of the injection screens are more likely and would result in increased OPEX. Therefore, this technology was not regarded as relevant for Jamestown BPU and was excluded from further analysis.

Ground-source heat pumps (GSHP) using closed-loop horizontal boreholes to extract heat from shallow depths require large areas of land for heat transfer. GSHP with shallow horizontal boreholes was excluded from further analysis since Jamestown does not have the available space required to employ this technology. Additionally, the shallow soil has much less stable temperatures compared to deep soil, therefore the efficiency of a GSHP using horizontal boreholes would be lower compared to a GSHP using deep vertical boreholes.

All of the remaining electrification technologies were deemed as relevant at this stage of the project and were carried on for further analysis.

6.4 Air source heat pumps

Air-source heat pumps use ambient air as heat source for their operation. Both the heat output and the efficiency (COP) of a heat pump decrease at lower ambient temperatures. An example of this correlation is shown in Figure 13 below.

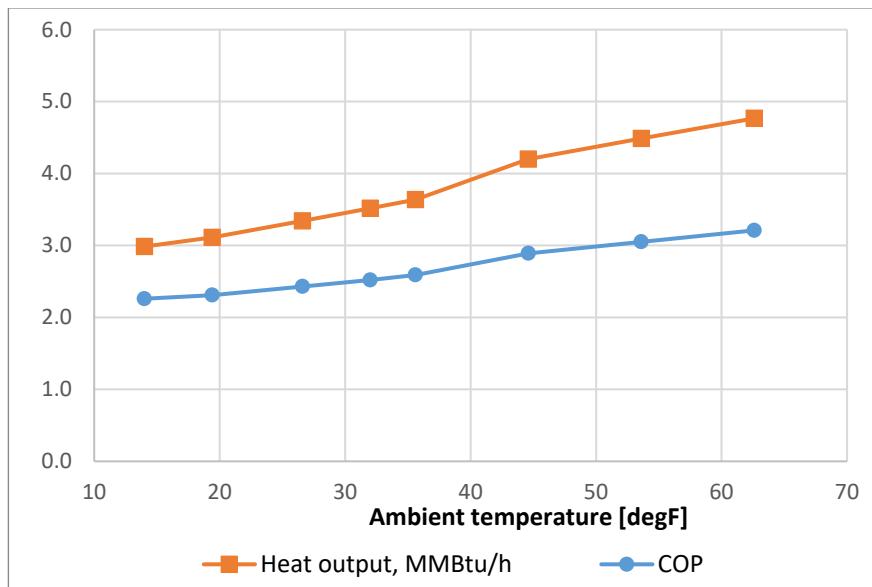


Figure 13. Example of heat output and COP of an ASHP as a function of ambient temperatures

This is one of the main disadvantages of an air-source heat pump. Heat output and COP are lower at lower outdoor temperature, which typically corresponds to higher heat demands.

Other disadvantages include:

- The low specific heat of air results in large air flows
- Noise from the fans of the air-cooling units. Noise calculations should be carried out to ensure the respect of local requirements
- Water vapor in the air results in condensate and frost when the temperature approached the freezing point

Advantages of using air as a heat source include:

- Free and unlimited heat source
- Always accessible
- Less expensive to install compared to geothermal boreholes

Based on the above, air-source heat pump technology was carried on to the scenario planning phase.

6.5 Underground closed-loop vertical boreholes

Heat from the underground can also be exploited via closed-loop boreholes. In closed-loop boreholes a heat transfer fluid (typically a mix of water and antifreeze fluid like glycol) is circulated in U-pipes embedded in vertical boreholes.

Because the temperature of the soil at deep depth is much more stable than the ambient air, ground-source heat pump (and chillers) typically has a better efficiency than their air-source counterparts.

Due to the poor thermal properties of the soil, many boreholes are needed to extract significant amount of heat.

To increase the heat extraction capacity from the boreholes, these must be installed at some distance from one another, resulting in quite large areas occupied by the borehole field. The boreholes and manifolds are installed underground, the space occupied by the borehole field can still be used as green area, parking space, athletic fields, but no future buildings will be possible due to the foundations typically required for building construction. Therefore, the future plans of the city should be considered when deciding the location of a borehole field.

In lack of on-site thermal response test investigating the thermal response of the soil, the following estimates can be preliminary used for sizing:

- Heat extraction rate from the borehole: ~40 Btu/h/ft borehole
- Maximum depth of borehole: 499 ft (stricter regulation applies at deeper depths)
- Distance between boreholes: ~20 ft

Other considerations to be kept in mind in the context of a closed-loop geothermal heat pump system are the following:

- The borehole field should be ideally located as close as possible to the energy center, to avoid long pipe connection between the two. These pipes will have quite large diameters given the small temperature difference across the borehole field, therefore keeping their length short will reduce their installation costs.
- To maintain a good performance of the ground-source heat pump in the long run, the borehole field should be balanced as much as possible. Balancing a borehole field means that on a yearly basis the heat extracted from the ground (typically in winter) should be similar to the heat reinjected back into the ground (in summer), so to keep the average temperature of the underground roughly at its natural level. If a borehole field was not balanced, this would progressively get colder and colder over the years, deteriorating the efficiency of the heat pump.

Based on the above considerations, closed-loop vertical boreholes feeding a geothermal heat pump was considered a viable technology for the city of Jamestown and was brought on for the scenario planning. Regarding the balancing of the borehole field, air source heat pumps were chosen as the most relevant option.

Figure 14 was provided by Brightcore and shows the proposed locations of borefields and their approximate area in acres required.



Figure 14. Proposed location of borefields (image developed and provided by Brightcore)

Table 10. Estimated quantity of boreholes per scenario

Scenario	Load (MMBtu)	# of Boreholes	Depth (ft)	Area Required (Acres)
B1	11.0	476	499	4.23
B2	11.0	476	499	4.23
C1	10.4	450	499	4.00
C2	10.4	450	499	4.00
D1	15.4	667	499	5.93
D2	15.4	667	499	5.93

6.6 Conceptual scenario selection and initial screening

Based on the technology screening, the qualitative screening and inputs from Jamestown BPU, the scenarios listed in Table 11 below were identified as relevant for Jamestown BPU.

Table 11. Selected scenarios

TWO Scenario Description ->	Business As Usual	Centralized Option & Centralized Hybrid Option			Centralized Option from WWT Plant		Ambient Loop		Dentralized Option 1	Decentralized Option 2	
TWO Scenario ->	Scenario A	Scenario's B&C			Scenario B		Scenario D		Scenario E	Scenario F	
Scenario Variation ->	1	B&C-1	B&C-2	B&C-3	B4	B5	1	2	1	1	2
Heat Demand	Current	Current	Current	Current	Current	Additional	Current	Current	Current	Current	Current
Network Configuration	Centralized HTW	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized	Centralized	Ambient Loop	Ambient Loop	None	None	None
Baseload Technology	NG	GSHP (Closed Loop), ASHP	GSHP (Closed Loop), ASHP	ASHP in cascade w/W-W HP	WSHP (Waste Water)	WSHP (Waste Water)	Individual HP's	Individual HP's	NG Blrs	Individual HP's	Individual HP's
Peaking Technology	NG	NG Blrs	Electric Blrs	NG Blrs	NG Blrs	NG Blrs	Individual HP's	NG Blrs	NG Blrs	NG Blrs	Individual HP's
Borefield Balancing	N/A	ASHP	ASHP	N/A	N/A	N/A	ASHP	ASHP	N/A	N/A	N/A
DHW (Summer)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local	Local
DHW (Winter)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local	Local
Space Cooling	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec
Thermal Energy Storage	None	Yes	Yes	Yes	Yes	Yes	Yes-Local	Yes-Local	No	Yes-Local	Yes-Local
Backup Heat (Emergency)	Fuel Oil	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	Individual HP's
Network	2Pipe/2G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/5G	2Pipe/5G	N/A	N/A	N/A

The column headers contain the scenario name, its letter designation, and the number of variations. The first column of the table contains various characteristics by which the scenarios can differ from one another.

"B" scenarios denote scenarios which include centralized supply to buildings north of 6th Street, whereas "C" scenarios denote scenarios with decentralized supply to buildings north of 6th Street.

Except for scenario variation B5, all scenarios will have the same annual demand. Additional heat load in scenario B5 include potential large customers that have shown interest in joining the District Heating network but are not currently connected. These additional loads include Jamestown Community College, industrial loads, and public school buildings.

"D" scenarios include Ambient Loop (5GDH) networks where WSHP's are installed locally at each building and are served by an ambient piping network.

The "E" scenario is fully decentralized using natural gas boilers, relies completely on 100% fossil fuel technology and is included for comparison purposes only.

"F" scenarios are fully decentralized heat pump solutions.

Demand denotes which energy demand is used in the scenario (either current demand or estimated future demand). All scenarios (including the Business-As-Usual) use the current demand, in order to allow for a fair comparison between them.

Network Configuration denotes the type of network supplying (Centralized = hot water, Hybrid = hot water up to 6th street, ambient loop).

Baseload Technology and *Peaking Technology* denote the technologies used for heat production in baseload and peak-load, respectively (ASHP=air-source heat pump; GSHP=ground source heat pump; WSHP=water-source heat pump; NG=natural gas boiler; Electric=electric boiler).

Borefield Balancing denotes (where applicable) how the borehole field is balanced.

DHW (Summer) and *DHW (Winter)* denote how domestic hot water is produced in summer (i.e., when there is no space heating demand) and in winter (when there is space heating demand), respectively.

Space Cooling denotes how cooling is provided.

Thermal Energy Storage denotes whether thermal energy storage is present.

Backup Heat (Emergency) denotes how backup heat is provided in case of failure of the main heat production units.

Network denotes the DH generation the system belongs to.

6.7 Additional scenario variants

In addition to the scenarios and their variants listed in Table 11, other scenarios and variants were discussed during the planning process. It is important to note that one of these variants included an ambient loop (5GDH) network from the WWTP. The main difference between Scenario D and an ambient loop from the WWTP, is the heat source. In Scenario D, the heat source is a geothermal borefield with an estimated cost of \$24M to establish. Using wastewater as the heat source would require an additional 31,000 linear feet of trench (62,000 feet of pipe) almost doubling the amount of pipe required in Scenario D. The estimated cost to install the additional pipe from the WWTP, which is located approximately 5 miles from the existing DH network, is \$60M. Since CAPEX has the largest effect on LCOE, improving the OPEX to overcome the \$36M difference is not likely and therefore this scenario was not considered further. Furthermore, the pumping power would be much greater from the WWTP only increasing the OPEX when compared to scenario D.

7. Thermal Energy Storage

7.1 Tank Thermal Energy Storage (TTES)

Tank thermal energy storage (TTES) is an important component to overall efficiency of energy systems, particularly district heating. TTES involves storing hot water in insulated tanks to help balance energy demand and supply while ultimately reducing peak demand, energy consumption, carbon emissions and costs.

TTES is designed as a day-to-day storage, being able to utilize either high electricity prices (if the district heating network is supplied from a cogeneration plant) or low electricity prices (if the district heating network is supplied from a heat pump). The total storage volume depends on system needs and desired function. TTES helps to level out daily fluctuations, whereas other types of storage are more suited for seasonal fluctuations (as for example, borehole thermal energy storage). When the heating network works as a cooling network in the summer season, the TTES will work as a cooling storage.

The benefits of TTES include the following:

- Lowers energy system operating costs, since the storage enables operation in off-peak hours for electricity
- Reduces the requirements for peak production since the storage can help provide peak. If peak is produced from fossil fuels, it will thereby reduce the GHG emissions
- Integrates many different fluctuating heat sources such as surplus production of heat from wastewater
- Avoids installing special equipment for summer production. With a tank storage it will not be necessary to install "summer" equipment to account for the low loads in the summer season. A variable flow pump will adjust according to the demand
- Can, to a certain extent, provide backup for the system provided that pumps and ancillary equipment are on a secured electrical supply or emergency generator backup
- Functions as a "virtual battery" in energy systems dominated by intermittent renewable energy production and variability of hourly electrical prices. TTES has similar characteristics as a chemical battery (using electricity at low electricity prices and curtailing consumption of electricity when prices for electricity are high), but provides significantly higher energy content than a chemical battery and at a lower overall cost

7.2 TTES design

TTES typically can be in the form of cylindrical steel tanks (typically located above ground level) or concrete tanks (which can be partially buried if necessary). The tanks are insulated in both cases. In most installations, the temperature supplied to the storage is the supply temperature in the district heating network. Temperature stratification (i.e., having distinct layers of water at different temperatures within the storage tank rather than a fully mixed tank with a uniform temperature) can be achieved through multiple inlets, which increase the performance of the storage. Figure 15 shows the principles of a TTES:

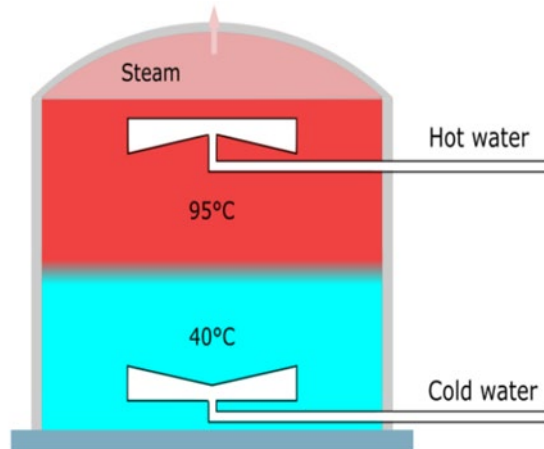


Figure 15. Principle of a TTES

There is not a physical separation between the warm and the cold water. The separation is handled by the difference in density between warm and cold water. Since the temperature in the separation layer is in between the supply and return temperatures, it is desired to keep it as thin as possible and often within 6-8 ft. Therefore, to avoid disturbances of the separation layer the inlet and outlet velocities are kept low with diffusers in the top and bottom of the tank. A tall and slim tank is preferred, since it will limit the unusable volume in the separation layer.

To avoid corrosion of the tank (in the case of a steel tank), steam is sometimes used in the space between the water level and the tank structure. More often, nitrogen is used instead of steam, and the nitrogen is produced from a small nearby nitrogen generator. If necessary, tanks can be slightly pressurized, but that will increase the costs for the construction. Most often, the water temperature will not exceed 212F (100C) in new low temperature heating systems, and therefore, the tank will be unpressurized. The temperatures in the example shown are 95C (203F) as supply temperature, and 40C (104F) as return temperature.

A pressure-less tank storage will work as a pressure holder for a district heating network always keeping minimum required system pressure in case of pump failure on circulating pumps. Therefore, it is recommended that the water level in the tank is always above the highest point in the district heating system. If the water level is below the highest point, it would be necessary to separate the systems, which will complicate the installation and increase the risk of failures.

The basic structure of connecting the heat storage tank to the district heating system, as a pressure holding vessel, is shown in Figure 16 below. The load for district heating system flow pump is in principle adjusted according to the consumption in the heating network, and the pump load before the energy center is in principle adjusted according to the heat production.

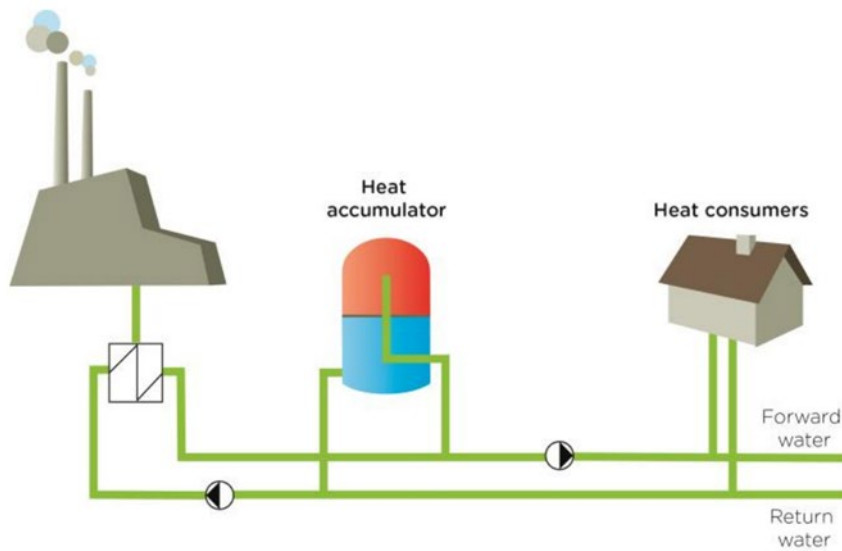


Figure 16. Connection of a TTES – Heat Storage

7.3 Preliminary sizing of TTES

The TTES should be able to provide heating or cooling to the energy system when there is limited renewable electricity in the electric grid. Therefore, in principle, it should be designed based on a thorough analysis of the prices for electricity and their fluctuations. However, since the further build out of intermittent renewable energy in NY will occur over many years to meet the goals of CLCPA, for purpose of this analysis, Ramboll assumed that TTES would cover 8 hours of base load operation.

From the load curve described in Section 5.1, it is estimated that the 56% of the peak heating demand covers approximately 90% of the heat demand. This load has been used as basis for the preliminary design. The peak heating demand is approximately 68 MMBtu/h.

Ramboll as assumed a ΔT of 36°F between supply and return temperatures in the district heating network. In TTES, it is desired to keep the stratification layer between the warmer (supply) and the colder (return) water as thin as possible and at a maximum thickness of 3 to 4 feet, but thicker layers could be site specific. The larger the diameter of the tank storage compared to the height of the tank storage, the more volume there will be in the 3 to 4 feet stratification layer thickness. Therefore, a higher and slimmer tank storage is generally preferred.

For this assessment, Ramboll has estimated a gross tank volume of 530,000 gallons. Based on a diameter/height ratio of 0.6, the water level height is estimate at 110 ft with a diameter of 30 ft (excluding insulation).

7.4 Aquifer thermal energy storage (ATES)

Aquifer Thermal Energy Storage (ATES) system is an innovative open-loop geothermal technology that relies on seasonal storage of cold and/or warm groundwater in an aquifer. It is different from Borehole Thermal Energy Storage (BTES) that is designed and operated to store or abstract heat seasonally, using the Earth as a thermal battery.

The main benefits of an ATES system compared to a GSHP system with a BTES, is that significantly less boreholes are needed due to higher capacity per borehole. Therefore, the entire system has significantly lower CAPEX than a traditional ATES system, should it be a viable application of technology. An ATES system requires that the geological formations are suited for ATES and that a high-water flow can be extracted from the borings.

Based on current limited subsurface data, ATES was not selected for potential scenario incorporation.

8. Hydraulic Modeling

In a hydraulic model, it is possible to simulate the behavior of flow directions, pressure and thermal conditions in a distribution network. Through interpreting the results, the model helps to guide/recommend/target investments in equipment and the distribution network.

Hydraulic modeling is an efficient way to evaluate the present situation and the impact of changes to the distribution network. For example, changing pipe sizes, network sectioning (opening/closing valves), or expanding the distribution network by connecting more consumers. Further the hydraulic model can be used to evaluate different production strategies with multiple heat sources operating with different temperatures, as well as determine maximum throughput, optimal pipe sizing and pump requirements.

Termis software, by Schneider Electric, was used by Ramboll to model the proposed low-temperature (LT) Jamestown distribution network. Termis is a hydraulic modeling tool that simulates flow, pressure and thermal behavior in a distribution piping network. The program was used to determine the most cost-effective piping arrangement as well as pipe sizing under various conditions. The model was also used to verify system pressure losses at peak conditions to size the distribution pumps more accurately at the Central Energy Plant.

The following inputs were used to generate the model:

- Temperature difference between supply and return at peak load conditions: 36°F
 - Minimum pressure difference at each building: 7.25 psi
 - Minimum system pressure: 21.8 psi(g)
 - Sizing criteria:
 - Maximum pressure gradient: 0.0053 psi/ft
 - Maximum flow velocity: 8.2 ft/s
 - Pipes sized at 85% of full flow conditions.
 - It is typical to model large central distribution networks using a diversity factor.
 - If a plant trips offline during peak load conditions, and 100% load is experienced, a higher flow rate at a larger pressure drop is acceptable under these temporary conditions.
- Alternatively, higher temperatures can be supplied short-term until the loads are stable.

For this project, hydraulic modeling was used to evaluate the feasibility of converting the district heating system from high-temperature hot water (2GDH) to low temperature hot-water (4GDH), ambient temperature (5GDH) and from two different supply locations including the existing central plant and from the wastewater treatment plant.

8.1 Hydraulic model Scenarios B-1 through B-3

The DH network was evaluated for the distribution of lower temperature hot water within a 4GDH network at 170°F from the existing central energy plant. The model includes a large diameter direct-buried pipe loop that connects the north and south discharge points from the plant. The pipe runs east and west along Harrison St. and 4th St. and north and south along Jefferson St., Institute St. and Prendergast Ave. to enable full flow from either location and to accommodate phasing and increase reliability and resiliency.

Table 12 indicates the assumptions made, flow, temperatures, pressures, and a list of the quantities of trench piping and the associated pipe size. Trench length represents a supply and return pipe of the same size within a single trench for a total of 74,138ft of pipe (37,069LF of trench x 2 pipes).

Figure 17. Hydraulic model Scenario B: fully centralized network configuration illustrates the location and sizes of pipes within the network. For clarity, piping north of 6th street is not shown but is included in the model and Table 12 data.

Table 12. Hydraulic model Scenario B: fully centralized network parameters

Production			Pipe Type	Trench [Ft]
Load	[MMbtu/h]	68.1		
Flow	[GPM]	5,396	a) 1"	147
Temp. Supply	[F]	170	b) 1.25"	1,277
Temp. Return	[F]	144	c) 1.5"	113
Pressure, Supply	[psig]	109.5	d) 2"	1,300
Pressure, Return	[psig]	65.5	e) 2.5"	3,881
ΔP	[psi]	44.0*	f) 3"	5,400
Assumptions: ➤ Supply Temp.: 170 °E ➤ Return Temp.: 145°F ➤ ΔT: 25 °E ➤ Ambient Temp: 46.4 °E ➤ Min. ΔP: 14.5 psi ➤ Min. Pressure: 14.5 psi(g) ➤ Max. Pressure: 150 psi(g)			g) 4"	4,513
			i) 6"	6,150
			j) 8"	2,617
			k) 10"	1,421
			l) 12"	1,433
			m) 14"	1,705
			n) 16"	3,839
			o) 18"	3,274
			p) 20"	0
			SUM	37,069

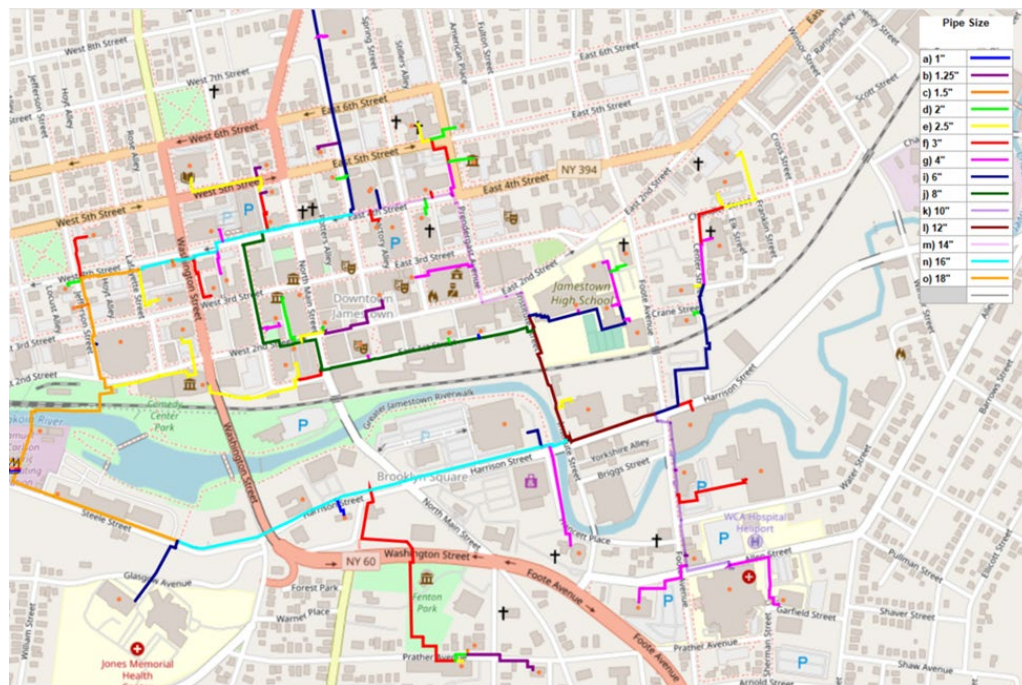


Figure 17. Hydraulic model Scenario B: fully centralized network configuration

In addition, the overall elevation changes and static pressure were considered in the model due to an elevation change of nearly 100 ft as is illustrated in Figure 18. This is important to consider when placing a TTES as well as additional static pressure pumps that will maintain overall system pressure when another external pressure source is not employed such as a nitrogen or steam blanket.

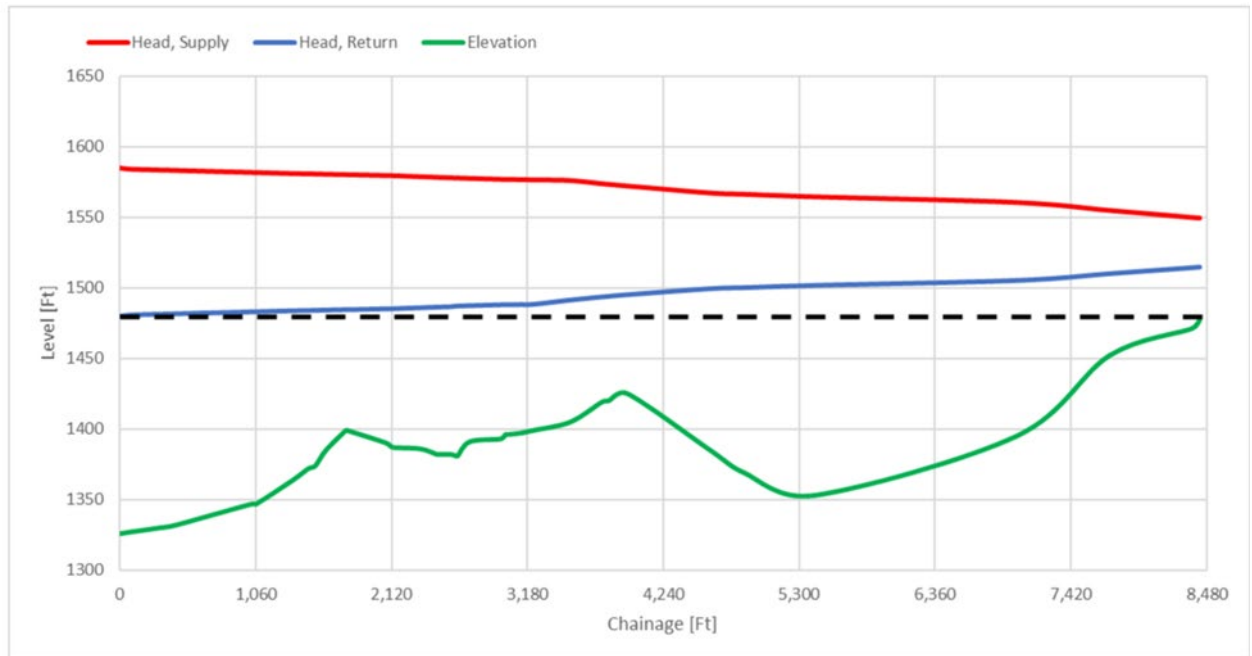


Figure 18. Hydraulic model Scenario B: elevation and head pressure

8.2 Hydraulic model WWT plant Scenario B-4

The DH network with all buildings connected and supplied with DH from the Jamestown WWT facility located approximately 5 miles from the central energy plant was evaluated for the distribution of lower temperature hot water within a 4GDH network at 170°F from the existing central energy plant. The model includes two large headers for redundancy and consideration of future potential loads in the area. One loop extends down 2nd street towards the existing DH network and a second loop travels along Buffalo St. to serve the DH network from the north end.

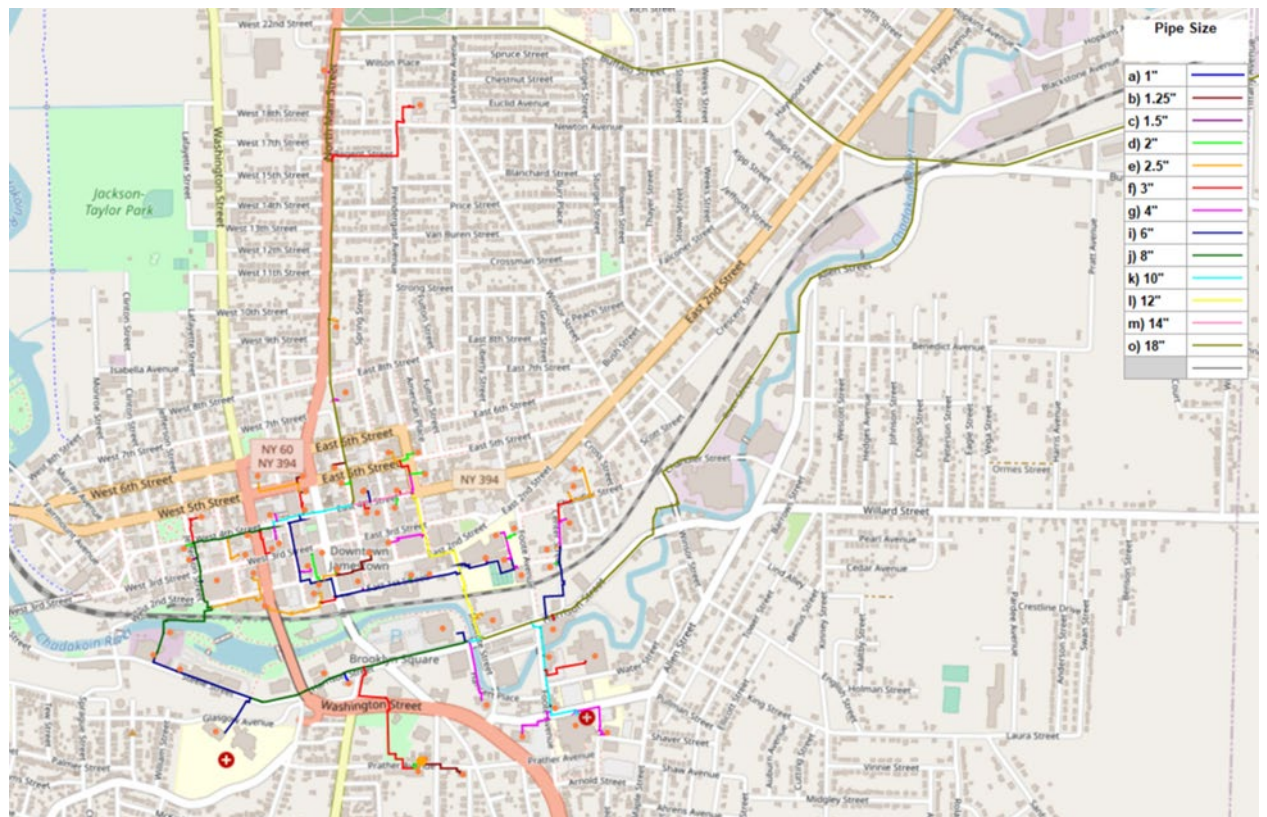
A number of large potential customers were contacted during the course of this study and all seem interested in connecting at some point in the future. A map of potential loads is included in Appendix B: Additional Potential Heating Load Map of this report.

Table 13 indicates the assumptions made, flow, temperatures, pressures, and a list of the quantities of trench piping and the associated pipe size. Trench length represents a supply and return pipe of the same size within a single trench for a total of 135,916 ft of pipe (67,958LF of trench x 2 pipes). There is a substantial increase in the amount of piping required from the WWT facility.

Table 13. Hydraulic model scenario WWT: fully centralized network parameters

Production			Pipe Type	Trench [Ft]
Load	[MMbtu/h]	70.2		
Flow	[GPM]	5,394	a) 1"	147
Temp. Supply	[F]	170	b) 1.25"	1,578
Temp. Return	[F]	144	c) 1.5"	113
Pressure, Supply	[psig]	209.9	d) 2"	2,606
Pressure, Return	[psig]	46.2	e) 2.5"	3,889
ΔP	[psi]	163.7*	f) 3"	6,460
Assumptions:			g) 4"	4,517
➤ Supply Temp.:	170 °F		i) 6"	5,961
➤ Return Temp.:	145°F		j) 8"	2,478
➤ ΔT:	25 °F		k) 10"	1,373
➤ Ambient Temp:	46.4 °F		l) 12"	1,892
➤ Min. ΔP:	14.5 psi		m) 14"	627
➤ Min. Pressure:	14.5 psi(g)		n) 16"	0
➤ Max. Pressure:	210 psi(g)		o) 18"	36,316
			p) 20"	0
			SUM	67,958

Figure 19 illustrates the location and sizes of pipes within the network.

**Figure 19. Hydraulic model scenario WWT: fully centralized network configuration**

In addition, the overall elevation changes and static pressure were considered and are shown in Figure 20. The illustration shows the largest elevation change of all scenarios considered and has a change of approximately 250'. For this scenario, two pumps in series were considered to reduce the amount of head required from each pump. In addition, the TTES would be located at the current central energy plant and piped accordingly.

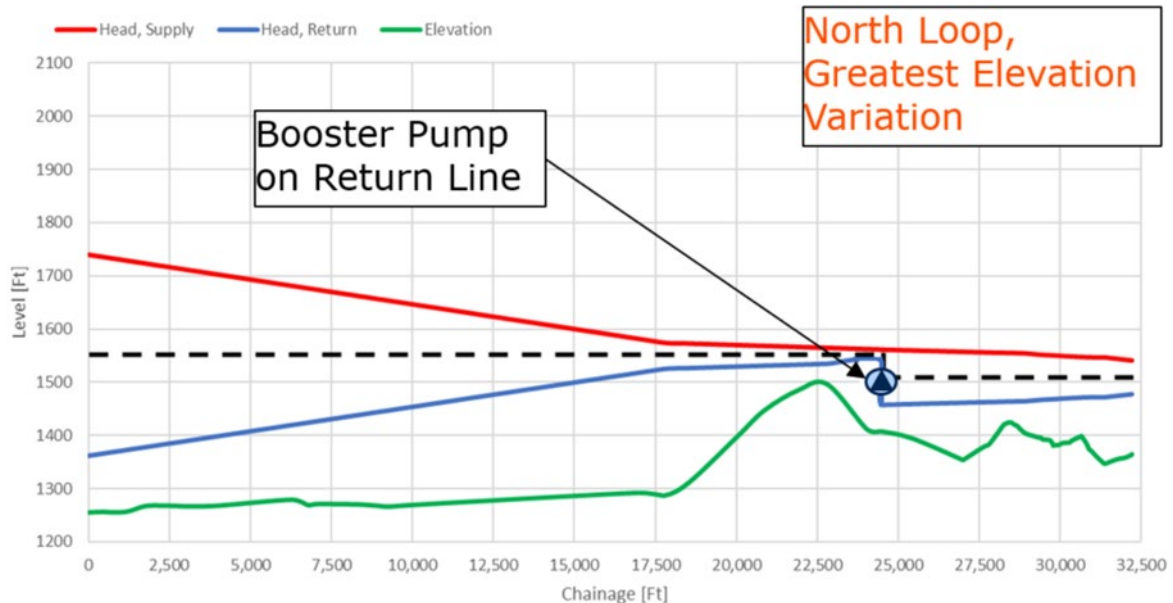


Figure 20. Hydraulic model scenario WWT: elevation and head pressure

8.3 Hydraulic model WWT plant Scenario B-5

In scenario B5 the network is supplied from the WWTP, and the Jamestown City demand is supplemented with demand from SUNY Jamestown, the industrial area etc. Since the pipe length from the WWTP to the first larger consumers would be approximately 3 miles, the peaking strategy is important. On the one hand the peaking could be served from gas boilers located at the WWTP facility. The consequence would however be, that the pipe should be able to carry the full capacity, which is costly. An alternative approach would be to produce the peak load from the existing central energy plant (CEP) in addition with boilers at SUNY Jamestown. Thereby, in both situations, the existing assets would be reused, and it is possible to reduce the CAPEX significantly.

In wintertime when there is a requirement for peak production, the heat will partly be produced from the WWTP and from the CEP / SUNY Jamestown. When the requirement for peak production is limited, then the WWTP will produce the highest proportion of the heat. The higher the requirement for peak production the more heat will be produced from the CEP / SUNY Jamestown.

The loads and their approximate locations for scenario B-5 are shown in Figure 21.

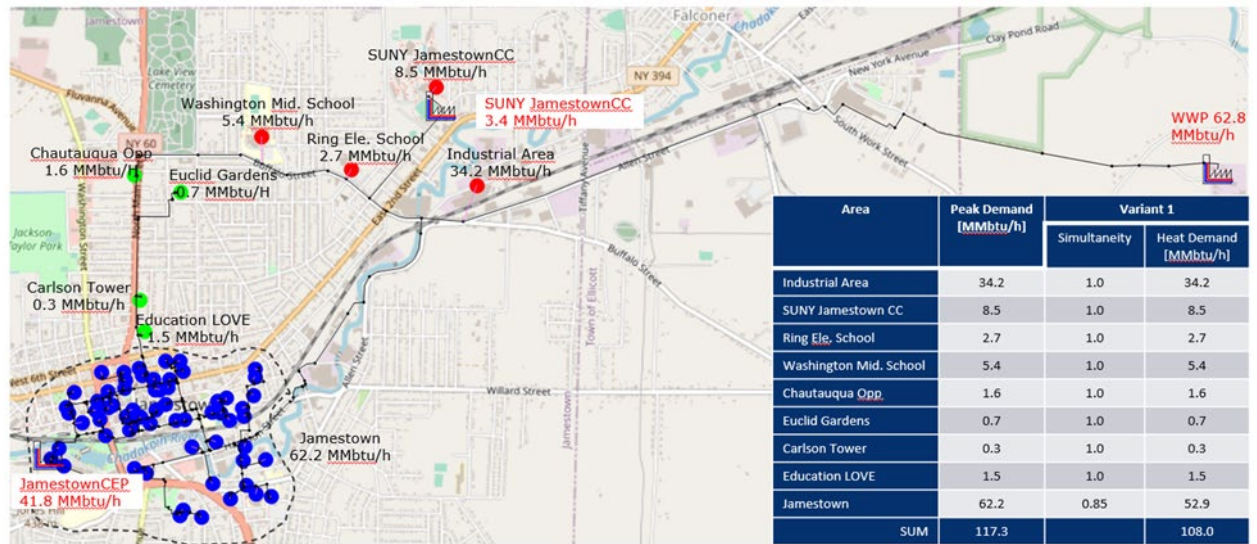


Figure 21. Scenario B-5 hydraulic model loads

The resulting pipe dimensions from hydraulic estimates are shown in Figure 22

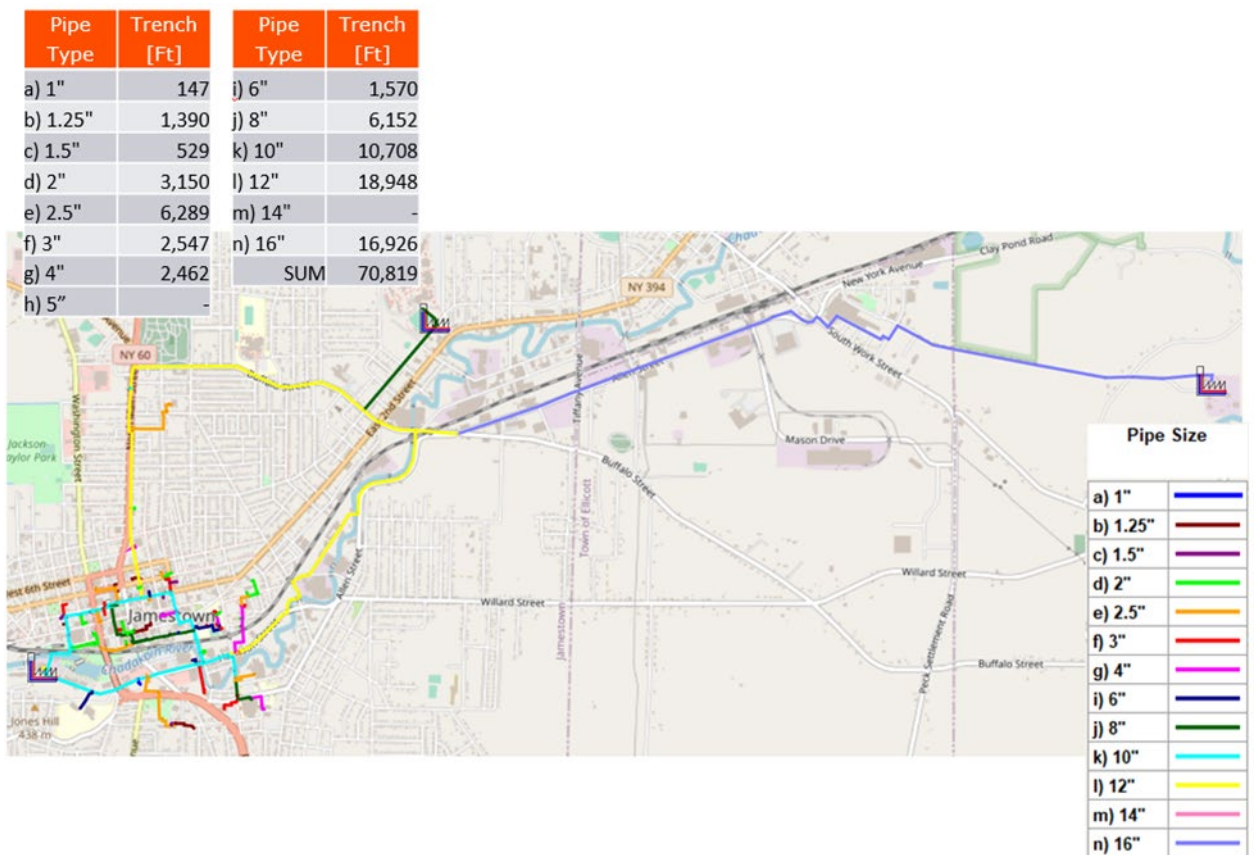


Figure 22. Scenario B-5 hydraulic model pipe dimensions and locations

The main pipe dimensions in the figure above are the 16-inch pipe (in blue) from the WWTP, and the 12-inch pipe (in yellow) partly going into the City and north of the City.

8.4 Hydraulic model Scenario C-1 through C-3

The DH network with all buildings north of 6th street decentralized was evaluated for the distribution of lower temperature hot water within a 4GDH network at 170°F from the existing central energy plant. The model included larger loop piping from the south and north discharge points to accommodate full flow conditions from either location to accommodate phasing and future failure and repair to increase overall system reliability similar to the scenario B models. Table 14 indicates the assumptions made, flow, temperatures, pressures, and a list of the quantities of trench piping and the associated pipe size. Trench length represents a supply and return pipe of the same size within a single trench for a total of 65,328 ft of pipe (32,664LF of trench x 2 pipes). There is a substantial reduction in piping of approximately 8,800 ft representing 12% of the system piping which only serves 5% of the load.

Table 14. Hydraulic Model Scenario C: partially centralized network parameters

Production			Pipe Type	Trench [Ft]
Load	[MMbtu/h]	63.7		
Flow	[GPM]	5,059	a) 1"	147
Temp. Supply	[F]	170	b) 1.25"	1,476
Temp. Return	[F]	144	c) 1.5"	113
Pressure, Supply	[psig]	93.2	d) 2"	1,303
Pressure, Return	[psig]	50	e) 2.5"	4,093
ΔP	[psi]	43.2*	f) 3"	3,973
Assumptions:			g) 4"	3,789
➤ Supply Temp.:	170 °F		i) 6"	3,342
➤ Return Temp.:	145°F		j) 8"	2,749
➤ ΔT:	25 °F		k) 10"	1,424
➤ Ambient Temp:	46.4 °F		l) 12"	1,438
➤ Min. ΔP:	14.5 psi		m) 14"	2,215
➤ Min. Pressure:	14.5 psi(g)		n) 16"	6,604
➤ Max. Pressure:	150 psi(g)		o) 18"	0
			p) 20"	0
			SUM	32,664

Figure 23 illustrates the location and sizes of pipes within the network.

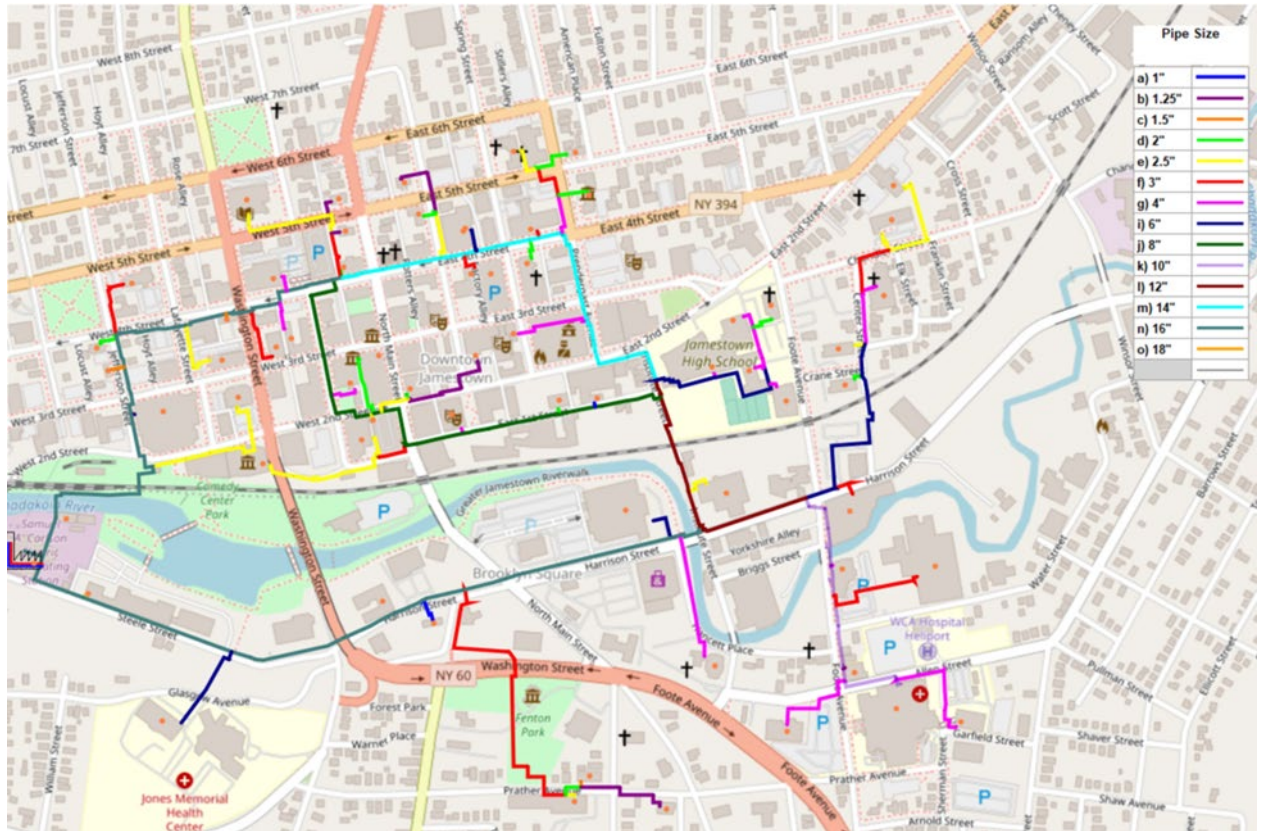


Figure 23. Hydraulic Model Scenario C: partially centralized network configuration

In addition, the overall elevation changes and static pressure were considered and are shown in Figure 24. The illustration shows very little change in elevation as compared to Scenario B indicating that the large elevation change occurs north of 6th street.

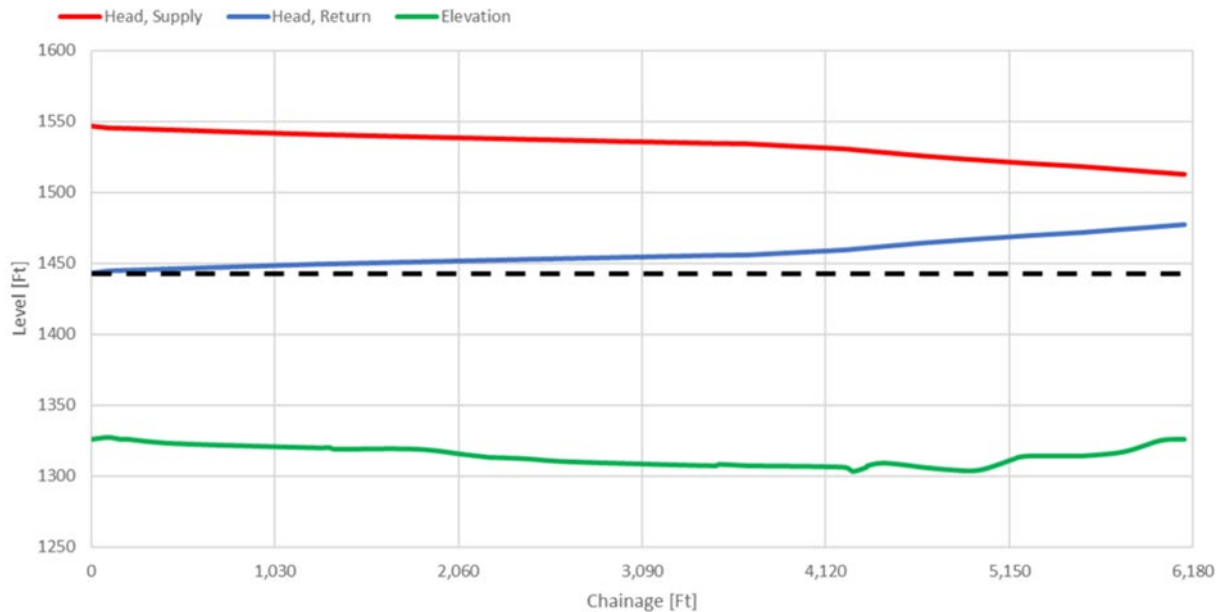


Figure 24. Hydraulic Model Scenario C: elevation and head pressure

8.5 Hydraulic model Scenarios D-1 and D-2

A 5GDH loop was evaluated for the distribution of ambient temperature water between 44°F and 51°F from the existing central energy plant. The system was modeled for two different scenarios as follows:

Scenario D-1 (HP's @ 100%):

In this scenario, the ambient loop was modeled to handle the full load (with a diversity factor) using the ambient loop piping network. The heat pumps are used to meet the heating load and the local NG boilers are only used for backup purposes. This scenario can be compared with scenario B (4GDH) where the full load (with a diversity factor) is supplied through the piping network.

- Scenario B: 74,138 ft of pipe = 261,781 gallons
- Scenario D (HP's @ 100%): 74,138 ft of pipe = 526,989 gallons

Ambient loops have a much lower deltaT and in these scenario's, the models were based on a 7°F deltaT which is typical for these types of systems. The lower deltaT requires higher flow rates resulting in larger pipe sizes. Although the length of piping is the same as Scenario B, the total volume is much greater due to these larger pipes.

Scenario D-2 (HP's @ 56%):

The second ambient loop model uses the local NG boilers for backup and peaking purposes and therefore the heat pumps were only sized to meet 56% of the peak load. In this case, the ambient piping network was only sized to meet 56% of the load and results in a reduction of total volume of approximately 30% as compared to the first ambient loop model.

- Scenario D (HP's @ 56%): 74,138 ft of pipe = 360,367 gallons

Table 15 indicates the assumptions made, flow, temperatures, pressures, and a list of the quantities of trench piping and the associated pipe size.

Table 15. Hydraulic Model Scenario D (NP's @100%): fully centralized network parameters

Production			Pipe Type	Trench [Ft]
Load	[MMbtu/h]	47.5	a) 1"	0
Flow	[GPM]	13,363	b) 1.25"	0
Temp. Supply	[F]	51	c) 1.5"	147
Temp. Return	[F]	44	d) 2"	1,277
Pressure, Supply	[psig]	124.1	e) 2.5"	949
Pressure, Return	[psig]	67	f) 3"	1,132
ΔP	[psi]	57.1*	g) 4"	5,328
Assumptions: ➤ Supply Temp.: 51 °F ➤ Return Temp.: 44 °F ➤ ΔT: 7 °F ➤ Ambient Temp: 46.4 °F ➤ Min. ΔP: 14.5 psi ➤ Min. Pressure: 14.5 psi(g) ➤ Max. Pressure: 150 psi(g)			i) 6"	7,798
			j) 8"	5,794
			k) 10"	3,019
			l) 12"	131
			m) 14"	891
			n) 16"	973
			o) 18"	0
			p) 20"	2,405
			q) 24"	7,224
			SUM	37,069

Figure 25 illustrates the location and sizes of pipes within the network

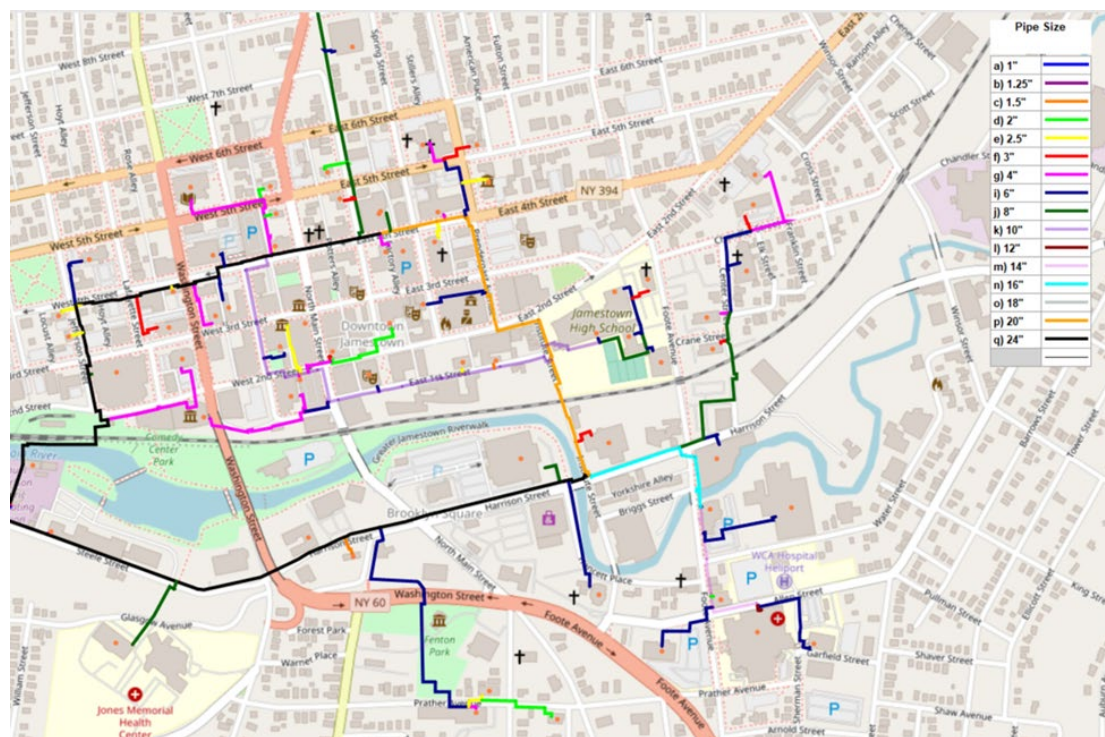


Figure 25. Hydraulic Model Scenario D (HP's @ 100%): fully centralized network configuration

The elevation change is the same as the change shown in Scenario B Figure 18.

Scenario D was also modeled using peaking boilers where the heat pumps and district network were sized for 56% of the load as described in Sections 5.1 and 5.2 of this report. Table 16 indicates the assumptions made, flow, temperatures, pressures, and a list of the quantities of trench piping and the associated pipe size.

Table 16. Hydraulic Model Scenario (HP's @ 56%): fully centralized network parameters

Production			Pipe Type	Trench [Ft]
Load	[MMbtu/h]	28.5	a) 1"	0
Flow	[GPM]	8,022	b) 1.25"	147
Temp. Supply	[F]	51	c) 1.5"	1,127
Temp. Return	[F]	44	d) 2"	368
Pressure, Supply	[psig]	111.6	e) 2.5"	2,208
Pressure, Return	[psig]	67	f) 3"	2,868
ΔP	[psi]	44.6*	g) 4"	7,062
Assumptions:			i) 6"	6,699
➤ Supply Temp.:	51 °F		j) 8"	4,919
➤ Return Temp.:	44 °F		k) 10"	95
➤ ΔT:	7 °F		l) 12"	1,944
➤ Ambient Temp:	46.4 °F		m) 14"	18
➤ Min. ΔP:	14.5 psi		n) 16"	2,328
➤ Min. Pressure:	14.5 psi(g)		o) 18"	63
➤ Max. Pressure:	150 psi(g)		p) 20"	7,224
			SUM	37,069

Figure 26 illustrates the location and sizes of pipes within the network.

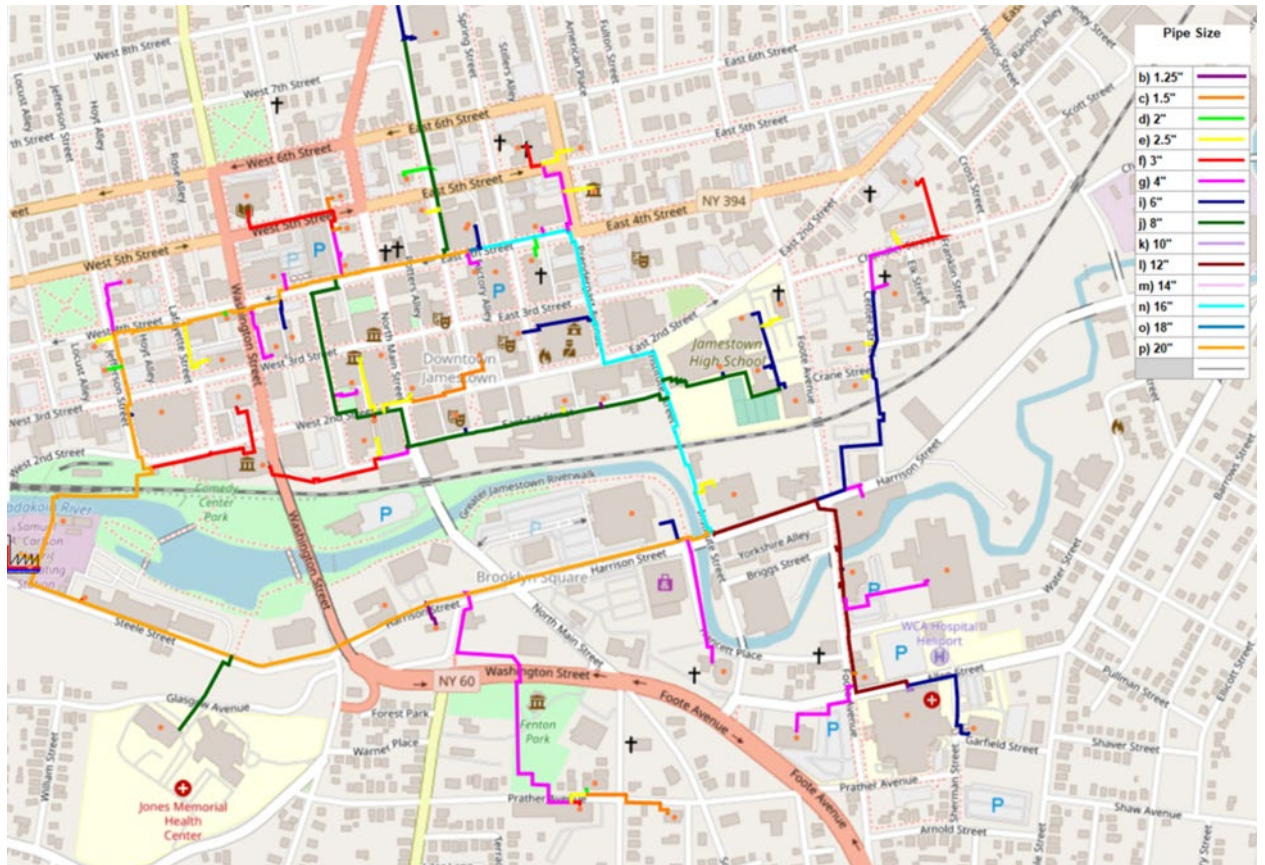


Figure 26. Hydraulic Model Scenario D (HP's @56%): fully centralized network configuration

The elevation change is the same as the change shown in Scenario B Figure 18.

9. Techno-Economic Analysis

The objective of techno-economic analysis is to identify the most cost-efficient mix of technologies for future heating.

9.1 Existing tariff analysis (high-level evaluation) for Jamestown district heating

The most crucial prerequisite towards continuous development of the district heating network is a continuous effort on maintaining tariffs below the consumers alternative costs. With tariffs lower than the alternative, consumers will not have an incentive to leave the district heating system and convert to their own production. In addition, new consumers will be more willing to connect to the district heating network. Today, the alternative production for most consumers will be a natural gas-fired boiler. However, if the overall goal for New York State is to achieve full decarbonization through electrification of sectors, then the alternative on the longer term will be individual heat pumps.

If existing consumers should determine to establish their own production, it would be necessary for them to invest in a new heating unit and assume responsibility to pay all fuel costs, maintenance and repairs. The amount of fuel will depend on the efficiency of the heating unit and the level of maintenance it receives.

We have made a comparison of the current district heating tariffs with the alternative costs for a gas boiler. Since the technical lifetime of the components are different, we compare the annualized costs of purchasing heat from Jamestown district heating to producing heat from a gas boiler. Future district heating tariffs determined as part of this study include associated OPEX and CAPEX. The main assumptions are as follows:

- Natural gas tariffs: Based on the first six months of data in 2023, the average variable gas rate is approximately \$7 per MMBtu. The gas tariffs for January to June from the following: [Summary of New York Rates | Business Partners | National Fuel](#)
- The local building hx's associated with district heat will have a technical lifetime of 30 years.
- Natural gas-fired boilers have a technical lifetime of 20 years
- Average efficiency of a condensing gas-fired boiler = 90%
- Initial investment costs are converted to an annual payment at 4% interest rate

The total annual costs for district heating and a gas boiler are compared in the following table. For district heating, the following items are included: Basic service charge, meter charge, delivery charge, fuel cost adjustment (FCA) charge, and in addition it is assumed that the customer must invest in a district heating unit. For a gas furnace the following items are included: The variable rate for natural gas, investment in a gas furnace¹¹, and an annual service fee.

¹¹ Refer to Appendix E: TASK 2D Converting Customer Buildings To Alternate Sources for local gas-fired boilers detailed cost estimates.

Table 17. Annual costs of DH vs NG boilers

Annual heat consumption (MMBtu/yr)	Annual costs district heating (\$)	Annual costs from gas boiler installation (\$)	Difference (\$)
200	2,250	14,448	12,198
400	4,272	20,444	16,172
600	6,294	25,313	19,019
800	8,360	29,620	21,261
1000	10,382	33,577	23,196
1200	12,404	37,290	24,887
1400	14,426	40,821	26,396
1600	16,533	44,210	27,676
1800	18,555	47,483	28,927
2000	20,577	50,661	30,083

As seen from Table 17, the customer has a significant benefit of connecting to district heating based on the current rates.

Optimization of rate structure as heat pumps are phased in

If the main heat supply is changed from gas boilers / gas-based co-generation to heat pumps, it should be considered to update the rate structure. In contrary to gas boilers, the efficiency of a heat pump is highly dependent of the supply temperature of district heating, which should therefore be kept as low as possible. The reason for the high supply temperature is often, that a higher deltaT can be achieved on the distribution side. The achievable deltaT on the distribution side is dependent on the installations in the buildings, and their ability to reduce the incoming temperature. The building owners would normally not have an incentive to improve the deltaT. Therefore, a **cooling tariff** should be considered, to incentivize a higher deltaT.

An alternative to a cooling tariff, could be a **temperature tariff**, where the consumers return temperature should be below a certain threshold.

Jamestown should continuously have a focus on the deltaT from the connected buildings. If there are buildings connected to the system with a high demand for heat, and at a same time a low deltaT, these buildings have a high impact on the district heating network performance and the thermal losses from the network, since it will be necessary to supply at a higher temperature.

Adding new customers to the network

In the following we will evaluate the potential economic benefit of connecting new consumers to the network. The methodology is to compare the production costs in a future situation, where most of the heat is based on heat pumps, with the revenue for Jamestown based on the existing district heating rate structure. The profit should be able to pay for the connection of the consumer.

The production costs for Jamestown are evaluated from the model which is established in EnergyPro and are mainly dependent on the hourly prices for electricity, the efficiency of the heat pumps, and other variable production costs such as variable maintenance.

The price for natural gas is approximately \$7 per MMBtu for 2023. The hourly price for electricity which is used in the modeling is shown in Figure 27.

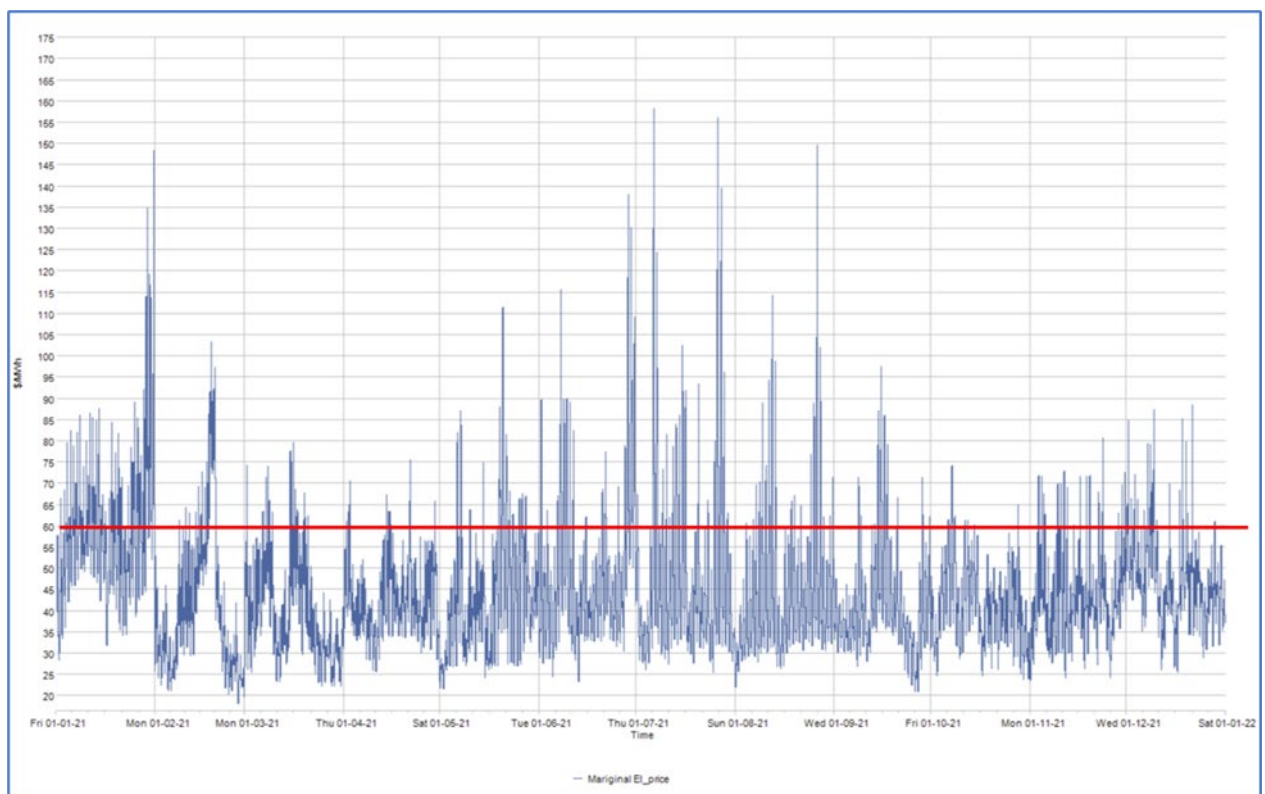


Figure 27. Hourly electric prices (2021)

As expected, there is considerable fluctuation in hourly electric prices. An order of magnitude in heat production costs can be evaluated from the following: If we roughly assume that the average electricity price is \$60/MWh (red line in the figure), then the electricity costs can be converted to a heat cost (main components of the variable heat cost is fuel) of $\$60/3/3.41$ (COP of 3, and a factor of 3.41 between MWh and MMBtu) which would be \$5.9/MMBtu. Based on the current low cost of natural gas compared to current electricity rates, the overall heat production costs from a boiler and from a heat pump are similar.

Estimates assuming a fixed heat pump capacity

We did an evaluation of the variable costs for increasing the heat demand with one larger residential building, which was assumed to add 500 MWh (1,700 MMBtu) per year to the existing heat demand. The marginal heating costs was evaluated from (increase in costs / increase in heat demand).

If the capacity of a heat pump installation is fixed, and new consumers are added to the network, then the additional heat demand will be produced at a higher cost, since the hours with the low electricity prices are already utilized to produce to the existing consumers. The more consumers are connected without increasing the capacity of the heat pumps, the lower the overall profit of connecting new consumers.

The results can be seen in the following table, and are under the assumption of a fixed HP capacity:

Table 18. Additional revenue when adding a consumer – fixed HP capacity

Text	Unit	Basis demand	Increased demand	Difference
Heat production (Sc. B4)	MWh/yr	45,058	45,558	500
Heat production, converted	MMBtu/yr	153,648	155,353	1,705
Production costs evaluated in EPRO ¹⁾	USD	966,819	979,934	13,115
Costs per MMBtu	\$/MMBtu	6.3	6.3	
Tariff per MMBtu ²⁾	\$/MMBtu	10.11	10.11	
Revenue, USD	\$/yr	1,553,383	1,570,620	17,238
Revenue minus costs	\$/yr			4,123

¹⁾Based on hourly electricity rates and utilization of thermal storage

²⁾Delivery charge 7.11 \$/MMBtu, FCA charge 3.00 \$/MMBtu, Total: 10.11 \$/MMBtu

The tariffs for 2023 will result in a variable heat tariff of \$10.11/MMBtu when adding 1,700 MMBtu to the demand.

From Table 18 above, it is seen that the incremental costs are \$13,115, and the incremental revenue is \$17,238 – an increase in revenue of \$4,123/year. In addition, the consumer will pay a connection fee of \$2,000 (estimated) for connecting a new consumer with a demand of 1,700 MMBtu per year.

If the consumer chooses district heating instead of a boiler, he will not have to invest in a gas boiler. However, our understanding is that the consumer will have to invest in their own district heating unit installation.

Estimates assuming an increase in HP capacity

Estimates in the following table are showing the revenue if the heat pump capacity is increased to reflect the increased demand. The increased heat demand is, as above, still 1,700 MMBtu/yr, and we have added 0.68 MMBtu/h in capacity to the heat pump.

Table 19. Additional revenue adding a new customer

Text	Unit	Base demand	Increased demand	Increase
Heat production (sc. B4)	MWh/yr	45,058	45,558	500
Conversion	MMBtu/yr	153,648	155,353	1700
Production costs evaluated in EPro ¹⁾	\$/yr	966,819	977,855	11,036
Tariff per MMBtu ²⁾	\$/MMBtu	10.11	10.11	
Revenue	\$/yr	1,553,383	1,570,619	17,236
Revenue minus costs	\$/yr			6,200

¹⁾Based on hourly electricity rates and utilization of thermal storage

²⁾Delivery charge 7.11 \$/MMBtu, FCA charge 3.00 \$/MMBtu, Total: 10.11 \$/MMBtu

Conclusion is that by connecting a building with 1,700 MMBtu, and simultaneously increasing the heat pump capacity with 0.68 MMBtu/h, the variable profit will be increased by \$6,200/year (17,236 – 11,036) excluding the connection fee of \$2,000.

Obviously, the heat pump capacity cannot be changed once the HP is installed. Therefore, a thorough energy planning phase is necessary as indicated in the recommended next steps of this report.

The above estimate on economic benefit of connecting a new consumer is based on natural gas prices from the first six months of 2023 and can be different for other years.

9.2 Social cost of carbon

The social cost of carbon was estimated based on the NYSDEC document “Establishing a value of carbon”¹². Table 20 presents the values used to calculate the social cost of carbon over the life of the project. The NYSDEC guidance document expresses the values in 2020 dollars. Ramboll calculated the social cost of carbon expressed in 2022 dollars based on historical consumer price index (CPI) published by the United States Bureau of Labor Statistics¹³.

Table 20. 2% average (central rate) social cost of carbon

Emissions Year	Carbon	
	2020\$ per metric ton of CO2	2022\$ per metric ton of CO2
2020	\$121	\$137
2021	\$123	\$139
2022	\$124	\$140
2023	\$126	\$142
2024	\$128	\$145
2025	\$129	\$146
2026	\$131	\$148
2027	\$132	\$149
2028	\$134	\$152

¹² https://www.dec.ny.gov/docs/administration_pdf/vocapp22.pdf

¹³ https://www.bls.gov/regions/mid-atlantic/data/consumerpriceindexhistorical_us_table.htm

2020 average CPI = 258.8; 2022 average CPI = 292.7; 13.1% inflation rate from 2020 to 2022

Emissions Year	Carbon	
	2020\$ per metric ton of CO2	2022\$ per metric ton of CO2
2029	\$136	\$154
2030	\$137	\$155
2031	\$139	\$157
2032	\$141	\$159
2033	\$142	\$161
2034	\$144	\$163
2035	\$146	\$165
2036	\$147	\$166
2037	\$149	\$168
2038	\$151	\$171
2039	\$152	\$172
2040	\$154	\$174
2041	\$156	\$176
2042	\$158	\$179
2043	\$160	\$181
2044	\$162	\$183
2045	\$164	\$185
2046	\$166	\$188
2047	\$167	\$189
2048	\$169	\$191
2049	\$170	\$192
2050	\$172	\$194

9.3 Shadow price of carbon

The shadow price of carbon is estimated as part of the techno-/economic modeling. The unit of the number is dollar per metric ton of carbon. It can be perceived as a number indicating the cost-effectiveness of each of the scenarios when it comes to reducing carbon emissions. The number indicates the required cost of carbon emissions if the business-as-usual scenario and the actual scenario, should have identical costs overall.

The social cost of carbon is based on values provided by NYS DEC, whereas the shadow price of carbon indicates the difference in the LCOE between the BAU and the alternative renewable scenarios. Figure 28 illustrates the difference between the shadow price of carbon and the social cost of carbon.

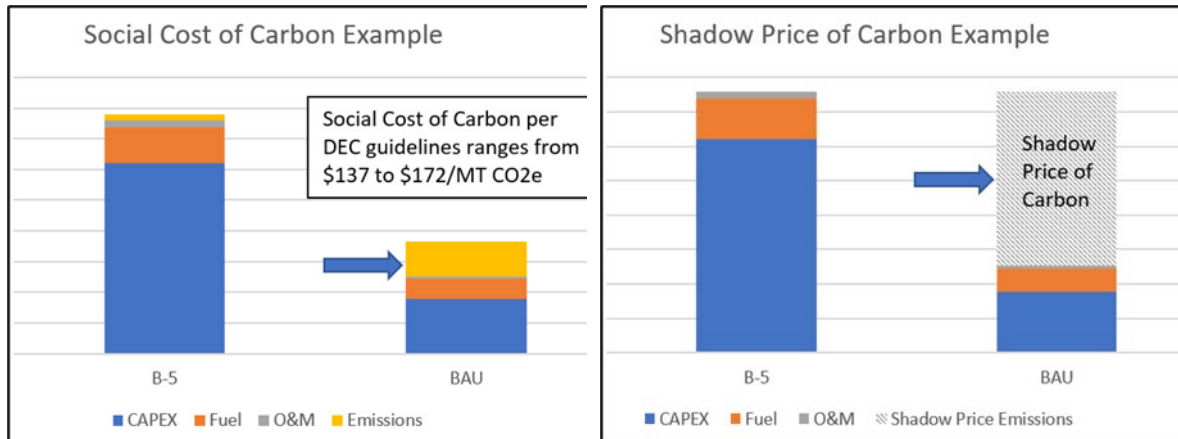


Figure 28. Social cost of carbon vs shadow price of carbon comparison

The prerequisite for estimating the shadow price of carbon is that the heat demand is the same in the business as usual and in the scenario for which the shadow price is estimated. In scenario B5, the heat demand is higher than in the business as usual. Therefore, to estimate the number, the business-as-usual scenario is adjusted to get to a result which is comparable with the other scenarios.

As mentioned, the number indicates the cost-effectiveness of reducing carbon. However, there can be other reasons not to choose the scenario with the lowest shadow cost. As for instance the expectation of how the different scenarios are suited for future changes to the system, and potentially changes in the heat demand.

Table 21 indicates the shadow price of carbon for the different scenarios:

Table 21. Shadow price of carbon

	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	D-1	D-2	F-1	F-2
Shadow price in \$ per ton	302	302	223	464	313	296	297	207	757	622	822	890

In the table above, the shadow price is estimated based on the costs in the business-as-usual scenario. From the table it is seen that C-3 has the lowest shadow price and is therefore immediately the most cost-efficient scenario. The C-3 scenario is where the customers north of 6th Street are disconnected from district heating and are supplied from gas boilers instead. The B-5 scenario is not directly comparable with the other scenarios since a district heating ring connection is assumed to increase the resiliency of the system. Therefore, to make a direct comparison, either parts of the ring connection should be removed together with a downsizing of parts of the network, or additional boiler capacity should be included in the other scenarios. This will improve the scenario B-5 compared to the other scenarios.

The B-5 scenario is considered the most futureproof scenario due to its connection to the wastewater treatment facility and thereby access to low-cost heat once the connection is established. Thereafter, connection of new consumers to the system will predominantly be supplied with wastewater heat without any changes to the system.

The levelized cost of heat includes all long-term CAPEX and OPEX for the district heating network and is therefore comparable with the tariff that the consumers should pay (excluding certain cost elements as for instance staffing costs, and any existing loans for Jamestown District heating). When comparing the levelized cost of energy, the B-5 scenario has the lowest costs.

9.4 Staffing needs and workforce development

The need for staffing is dependent on the complexity of the local energy system. The energy system will transition over time from a fossil fueled steam-based combustion system to a low temperature hot water system with heat pump technology, where combustion fuels are only used for peaking and backup purposes. The operation of the plant will, to a high extent, be automated.

Future operations are expected to be more complicated than today's. With the CLCPA goal of a carbon free grid by 2040, there will be a broad build out of wind (off-shore, on-shore) and solar. This will result in more intermittent renewable energy as part of the electric grid and a heightened attention to shifting demand away during hours of limited intermittent renewable electricity in the grid. Daily strategies will include operating the heat pumps at the lowest wholesale day ahead prices for electricity and produce to thermal storage. In situations with potential very high prices for electricity, it may be more optimal to produce from boilers.

In the techno-economic evaluation we have not considered the impact to workforce and staffing needs. Therefore, it is explicitly assumed that some staffing is trained for other purposes. In the initial years of operation, when the operational staff are still learning, there will likely be need for a few more staffing in the operation and maintenance.

9.5 Technical lifetime of assets

Table 22 includes equipment lifetime that have been assumed for estimating CAPEX.

Table 22. Technical lifetime of assets

Item	Technical Life time, Years
Building level installations	
Heat Pumps	16
Fossil-fuel boilers	20
Energy Transfer Station (ETS)	25
Distribution system	
2GDH	30
4GDH/5GDH	50
Energy center	
Building for energy center	50
TTES	50
GSHP	25
GeoThermal Wellfield	40

Item	Technical Life time, Years
WWHP	25
ASHP	25
Electric boilers	25
Gas boilers for LTW production	20
BTES	40
Dry coolers for BTES	25

9.6 EnergyPro modeling tool

A techno-economic assessment (TEA) of the proposed central energy plant was performed using EnergyPRO, a modeling software package specifically designed to analyze the economic performance of a centralized district heating system. The model accounts for all financial aspects including fuel prices, investment costs, operation and maintenance costs as well as environmental costs. The EnergyPRO model is shown in Figure 29 below. The model includes all fuel pricing, heating loads, and technologies within each scenario as follows:

- ASHP – Scenarios B3, C3, D1, & D2
- ASHP (Modeled as Dry Cooler) – Scenarios B1, B2, C1, & C2
- GSHP – Scenarios B1, B2, C1, & C2
- GSHP (Modeled as WSHP) – Scenario B4
- BTES Discharge – Scenarios B1, B2, C1, & C2
- BTES Discharge (Modeled as Wastewater) – Scenario B4
- Electric peaking boilers – Scenarios B2 & C2
- NG peaking boilers – Scenarios B1, B3, B4, C1 & C3
- Thermal energy storage (TES) – All scenarios
- NG fired backup boilers – All scenarios

Although all technologies are shown in Figure 29, they are either turned on or off when evaluating individual scenarios.

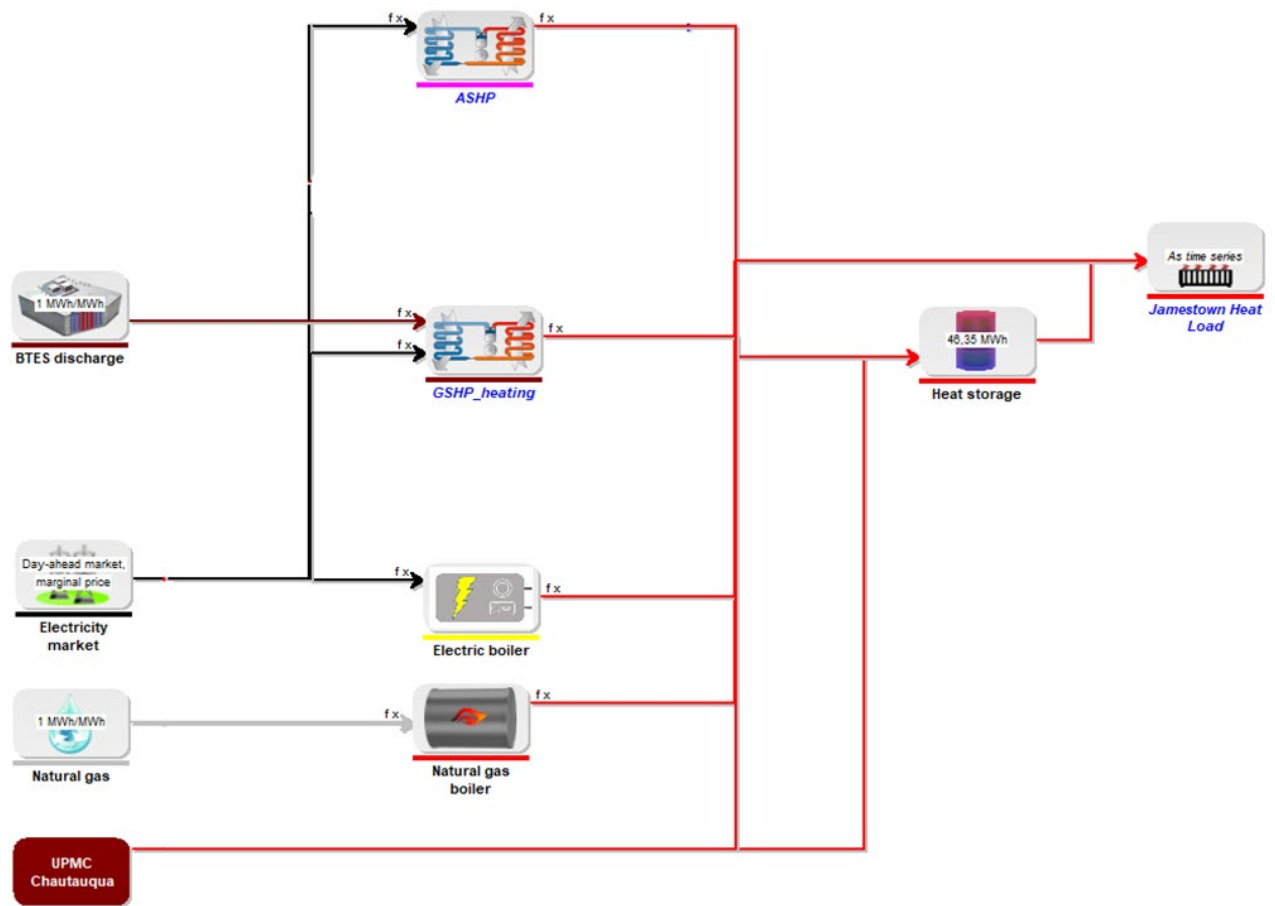


Figure 29. EnergyPRO model of central energy plant(s)

EnergyPRO assigns different color connecting lines to denote different types of energy flow:

- Red: "heating energy"
- Black: electricity
- Maroon: "heating energy" at a low temperature
- Grey: natural gas

The loads within the model are shown on the right-hand side of Figure 29 and include Jamestown's heating load. The left side lists the energy sources used, such as electricity, fuel oil, and geothermal energy. Aligned vertically in the center of the figure, are the different production units included in all scenarios.

Between production units and the load blocks is a short-term tank energy storage ("Heat storage") that works as a buffer between energy supply and energy demand. The presence of thermal storage allows the system to take advantage of lower electricity prices by running electric-driven equipment when electric prices are down to charge the storage tank and by turning off electric-driven equipment and using the stored energy when electric prices are high.

Figure 30 below includes the load required to recharge the borehole thermal energy storage (BTES) which is included in Scenarios B1, B2, C1, & C2. The additional “BTES Recharge” heat load is present during the summer months due to the need for balancing the BTES.

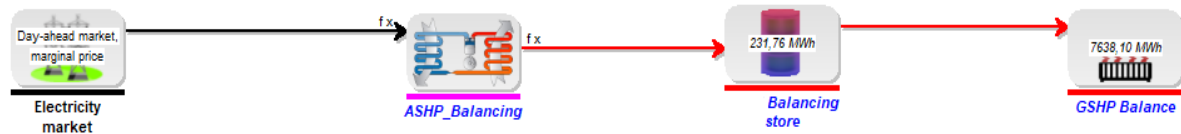


Figure 30. EnergyPRO model of GSHP balancing

EnergyPRO optimizes the operation of the production units so that the energy demands are met at the lowest annual operating cost. Since each technology employed within the model is tied to an operating efficiency as well as a cost per unit of energy input (natural gas or electricity) for each hour of the year, the program is able to accurately determine the sequencing of each production unit. In addition, the model considers outdoor air temperatures and how the system load and production unit efficiency is affected by it. The units with the lowest marginal cost of production will be called in operation first. If more production capacity is required to cover demand, units with progressively higher marginal costs of production are called in operation. Charging and discharging of thermal energy storage is also determined as part of the optimization process. In periods with low electricity prices, the heat pumps operate to cover the demand and to charge the storage. Conversely, in hours with higher electricity prices, these stop or limit their production and the demand is covered by discharging the storage.

One of the outputs of an EnergyPRO simulation is the hour-by-hour production schedule of the different energy-production units. As an example, the production schedule and the state of charge of the thermal energy storage for Scenario B1 is shown in Figure 31. A legend of each color is as follows:

■ HRC_UPMC	A baseload from a heat recovery unit at the UPMC Hospital is considered
■ GSHP_heating	Heat extracted from the GSHP
■ ASHP	Air Source Heat Pump in operation for heating purposes
■ ASHP_Balancing	Air Source Heat Pump in operation to balance the borefield during the summer months
■ Natural gas boiler	Natural gas boiler in operation for peaking purposes
— Total demand	Indicates total heating demand, TTES is charged when production is above the line

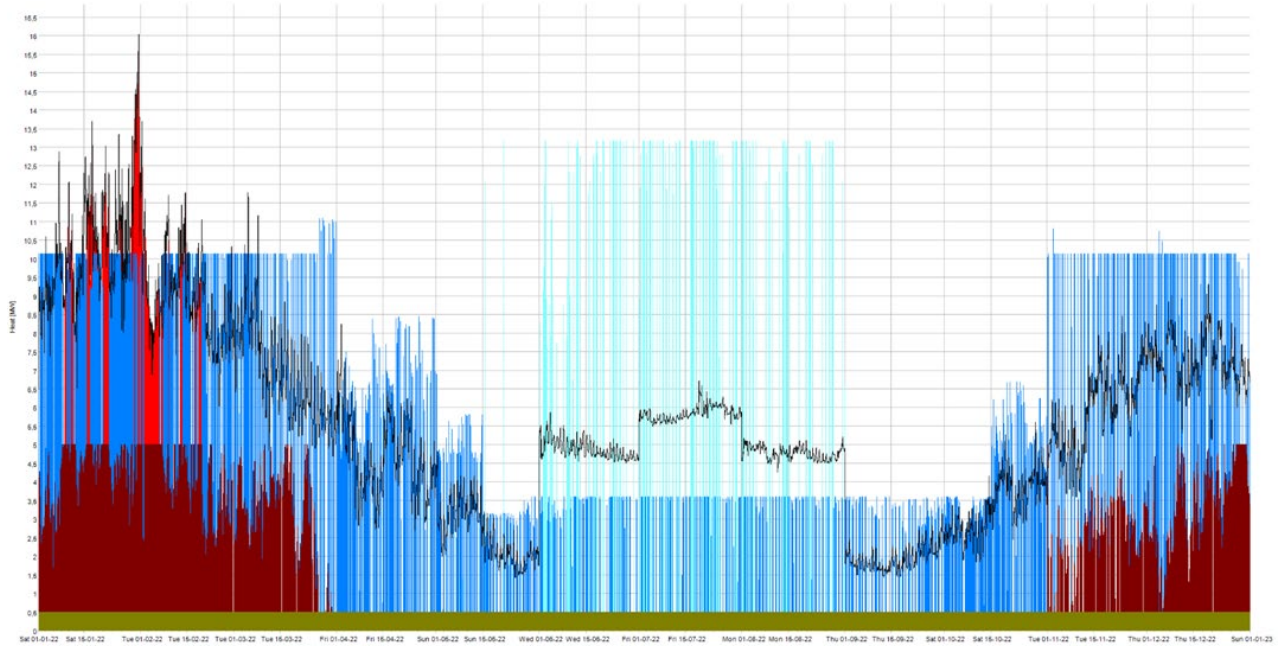


Figure 31. Hour-by-hour production schedule of the different production units over one year in Scenario B1

Note that energy and power units are in MWh and MW, respectively. These values can be multiplied by a factor of 3.41 to convert them to MMBtu/h and MMBtu, respectively. The thin gaps between heat production shown above in Figure 31, represent thermal energy storage output. Figure 32 better illustrates the total output from thermal energy storage throughout an entire year.

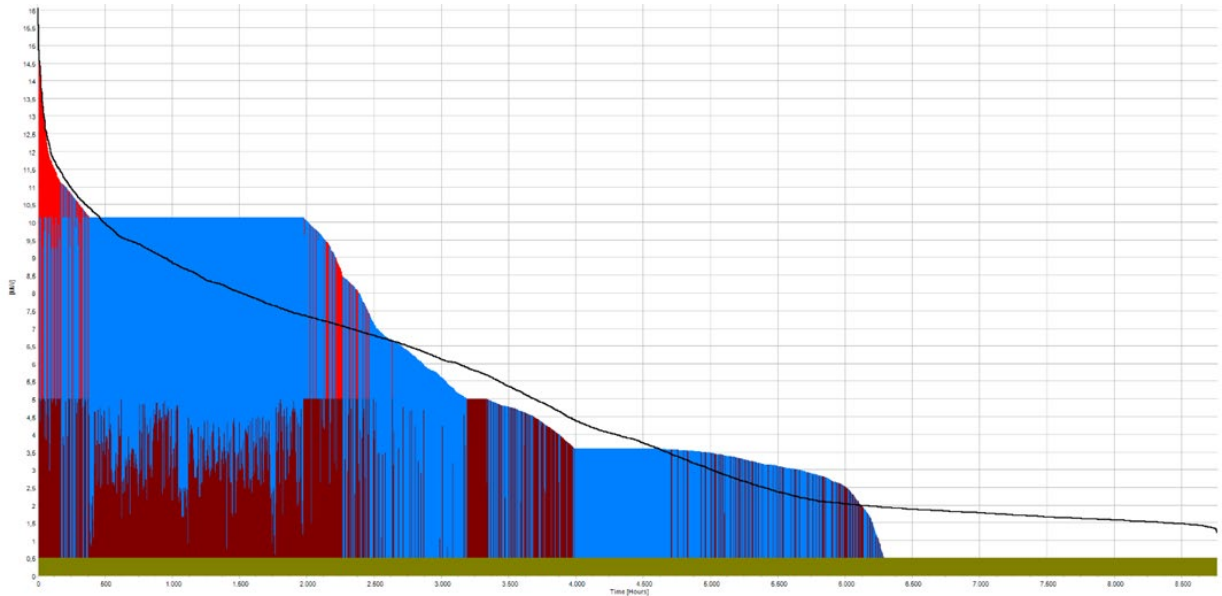


Figure 32. Annual production schedule of different production units over one year in Scenario B1

9.7 Modeling: technical results

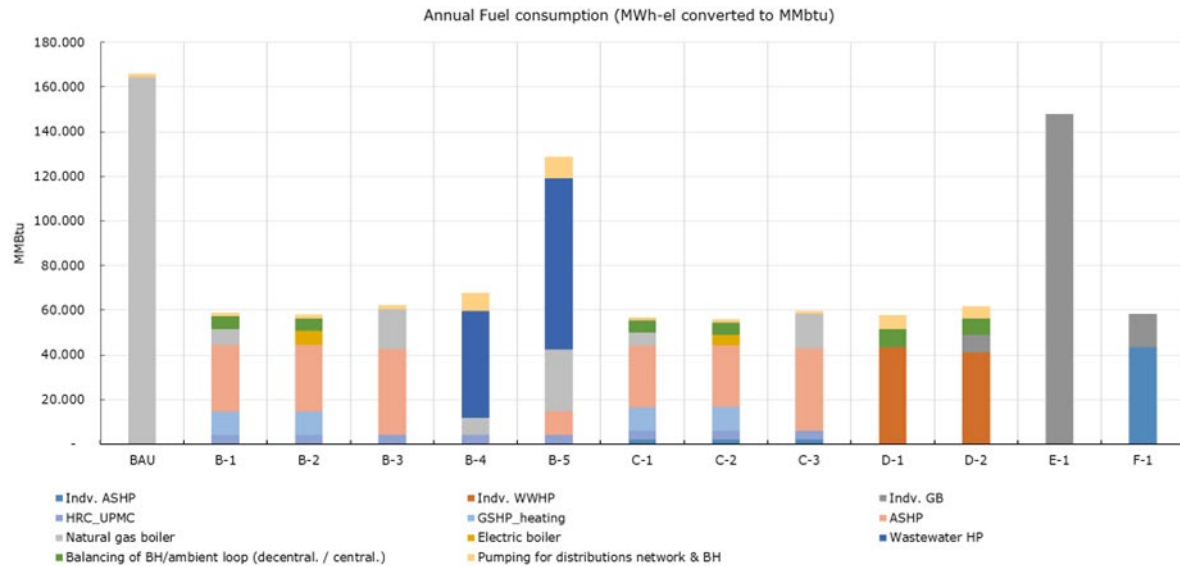


Figure 33. Annual fuel consumption from the main technologies of each scenario

Figure 33 lists the yearly fuel/electricity consumption from the main technologies in the different scenarios. The end-user's heating and cooling demand that is to be covered is the same in all scenarios except B-5 which has almost double the load of all other scenarios. The fuel/electricity consumption is different due to different conversion efficiencies of the different production units, as well as the different distribution losses for the centralized solutions.

The total fuel consumption for centralized and building level production is estimated. To present the results in the same units, electricity in MWh/yr is converted to MMBtu/yr. It is seen that total fuel consumption is reduced significantly due to the high efficiency in the heat pump solutions. The total fuel consumption of the fossil-fuel based scenarios BAU and E-1 are highest, with the BaU estimated to consume approximately 166,000 MMBtu per year, whereas the fuel consumption for a majority of the electrification-based scenarios is less than 60,000 MMBtu per year.

It is important to note that Scenario B-5 has almost double the load of all other scenarios and its ratio of fuel consumption per heating load is much less than all other scenarios.

9.8 Capital expenditures (CAPEX)

Figure 34 denotes the CAPEX for the BaU and the scenario variants divided into respectively CAPEX for building level installations, distribution system, centralized system and other. For improving the overview in the table, the cells containing numbers different from zero are marked with blue. As expected, the CAPEX in the BaU and decentralizing with natural gas-fired boilers is limited, whereas the CAPEX for scenario B5, a new energy plant at the wastewater treatment facility with added customers is the most CAPEX intensive and is approximately \$200 million.

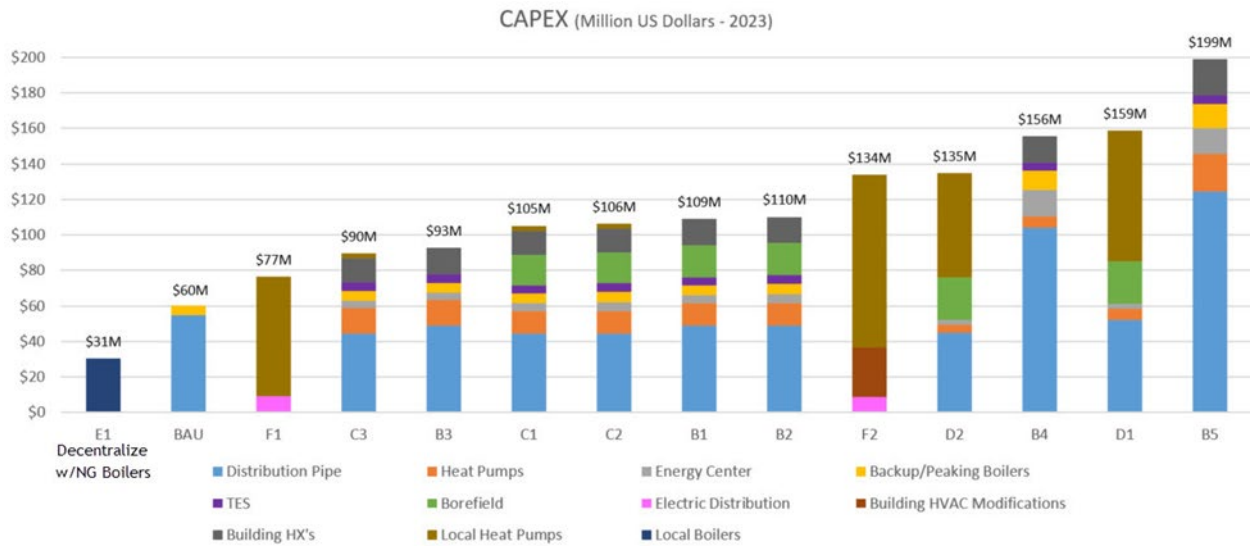


Figure 34. CAPEX comparison

9.9 Modeling: economic results

The economic results can be expressed in either the net present value of costs (NPV), or alternatively the levelized cost of energy (LCOE). The NPV method requires that the demand for heat is the same across all scenarios, which is not the case since scenario B-5 has a higher heat demand than the other scenarios. Therefore, the scenarios are compared using the LCOE methodology.

The LCOE method accounts for all CAPEX and OPEX in the project and assumes constant reinvestments in equipment. It is estimated from the NPV of the costs divided by the NPV of the demand for heat.

Figure 35 shows the economic performance of the scenarios measured by the LCOE in \$ per MMBtu of heat:

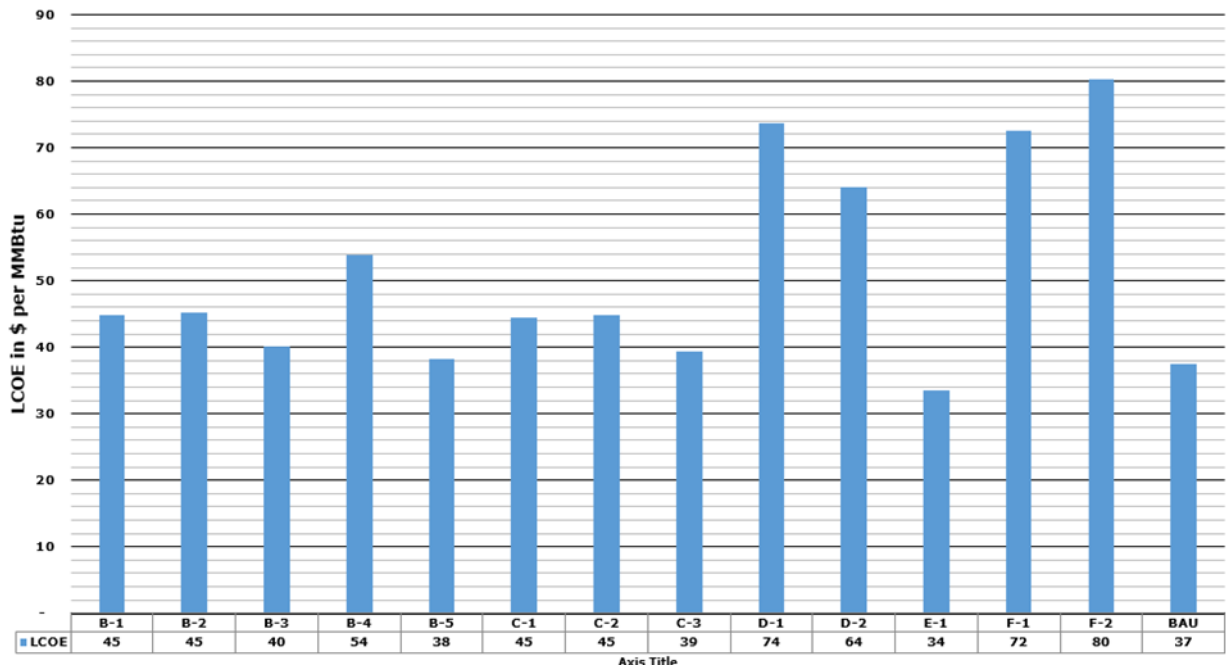


Figure 35. LCOE of the assessed scenarios including carbon emission

Figure 35 includes costs for carbon emissions, which has a significant influence on scenario E-1 and BaU. Without including emissions, the LCOE for E-1 is \$23/MMBtu, and LCOE for BaU is \$27/MMBtu. Since the emissions in the other scenarios are limited, there is only very limited difference whether the calculation are with/without carbon emissions.

Figure 32 provides an overview of the economic performance of each of the scenarios in terms of levelized cost of energy. The numbers can be perceived as the long-term heating tariff for the system, but excluding staffing costs, remaining payments on existing assets etc.

The scenario with the lowest LCOE is scenario E-1, which assumes disconnection from the district heating system and installation of local gas boilers in every building. Continued use of gas boilers will not enable Jamestown to reach the required reduction in carbon emissions.

In general, the centralized scenarios B and C have significantly lower costs than the decentralized scenarios D and F. Based exclusively on economy, scenario B-5 appears to be the most favorable among the centralized scenarios. However, the scenarios using a gas boiler for peaking purposes (B1 and C1) have less capital investment needs than their equivalent scenarios (B2 and C2) using an electric boiler for peaking purposes.

The most cost-efficient centralized scenario seems to be scenario B-5, but due to uncertainties in the assumptions, the scenarios B-3, C-3, and B-5 can all be considered equal. These scenarios are close to and in the same order of magnitude as scenario E-1. However, scenario B-5 includes utilization of wastewater and costs for connection to the wastewater treatment facility is included. Utilizing wastewater means that new customers can be connected with limited additional costs, and where wastewater can cover the majority of the additional heat demand. Scenario B-5 opens for connection of additional customers, further reducing the LCOE.

It is also clear from the LCOE assessments, that the individual heat pump scenarios (scenario F), and the ambient loop scenarios (scenario D-1 and D-2), all have significantly higher costs than the scenarios with centralized production.

The suggested district heating network has a lot of room for expansion, and a subsequent study should map out the most feasible connections. The study should also assess the connectable zones and buildings in Jamestown, estimate the key indicators, and suggest how to rank the potential areas. Buildings in the city center that are close to the existing network should get the highest priority, and potentially receive a discounted rate for connecting to the network.

The difference between the B and the C scenarios is that in the C scenarios, the buildings north of 6th Street are disconnected from the network and have local heat pumps installed instead. Disconnection of the buildings will have the consequence that connectable buildings in proximity to this part of the network cannot be connected.

9.10 Modeling: environmental results

The CO₂e emissions for the different scenarios together with the LCOE, is shown in Figure 36 below. The LCOE is shown with respectively a green triangle and a yellow dot for each of the scenarios. The yellow dots include a cost for CO₂e emissions of \$125 per ton metric, while the green triangles exclude a cost of CO₂e. It is seen, that the LCOE in the BaU and the E1 scenario (both with high CO₂e emissions) increases significantly when including the cost of carbon.

It can be seen that all alternatives achieve a significant reduction in CO₂e emissions compared to BaU and Scenario E1. This is due to:

- A significant reduction in the share of natural gas use towards the overall energy production in the alternative scenarios
- The progressive decarbonization of the grid electricity over time, which entails a lower environmental impact of the alternative scenarios, which are all based on electrification of the energy supply and alignment with the CLCPA goals of at 100% carbon free electric grid by 2040.

By comparing the NPV and the CO₂e emissions of the alternatives to the BaU and Scenario E1, it is seen that other scenarios, in general, have lower CO₂e emissions and higher NPV of costs.

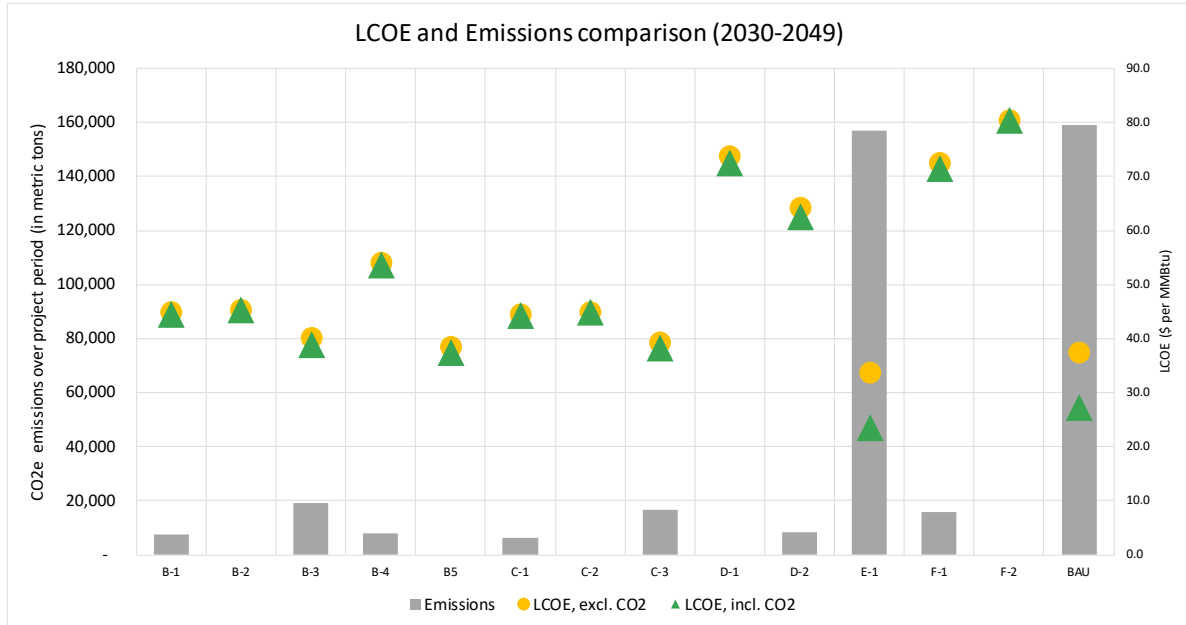


Figure 36. Overview, LCOE and emissions

It is clear from Figure 36 that when including a cost of carbon emissions, the centralized scenario is in the same order of magnitude as the decentralized scenarios E-1 and BAU.

9.11 Modeling: conclusions

Several conclusions can be drawn from the techno-economic analysis:

1. Centralized scenarios (Scenarios B & C) are in general more favorable than individual scenarios (Scenarios D & F)
2. Scenarios D & F, in which the entire city is equipped with building level heat pumps, has significantly higher costs compared to the centralized scenarios.
3. By applying a social cost of carbon as indicated in Section 9.2, the difference in costs between the BaU and E1 scenarios and the centralized scenarios is reduced significantly, but E1 remains the least expensive scenario.
4. Adding a social cost of carbon of between approximately \$200 and \$450 per ton metric, would balance the economy between the BaU and the centralized scenarios.
5. If centralized scenarios that include a gas boiler for peaking (B1 & C1) are compared with identical scenarios, but with an electric boiler for peaking (B2 & C2), the scenarios with electric boilers have higher costs due to electrical upgrades that would be needed.
6. Scenarios with electric boilers would require electrical distribution upgrades and could trigger the need to perform a NYISO Class Year study.

10. Electrical Distribution

Electrification of Jamestown DH will result in increased electricity use for heating purposes, as well as will increase the necessary peak electrical load. It is noted that peak electrical demands typically occur in January/February and the new electric heating sources will only increase the current peak. The BPU provides electric power to more than 18,000 customers across multiple service territories including the City of Jamestown, the Villages of Falconer and Celoron, and the Town of Ellicott. In 2022, the peak recorded electric load was 81.5 MW and occurred on January 27th with an OAT of 3°F.

The electric distribution system was evaluated based on a review of the existing distribution network using ARC GIS mapping, JBPU Easy Power Electrical Model, and the hourly load data of the affected transformers. All data was provided by Jamestown BPU. Based on Ramboll's review, a number of constraints were identified where the existing distribution system would not support the future loads and upgrades are necessary if the district is decentralized with heat pumps as described in this report. The electrical load curve for one years' worth of electrical data is shown in Figure 37 and indicates a current peak electrical load in February.

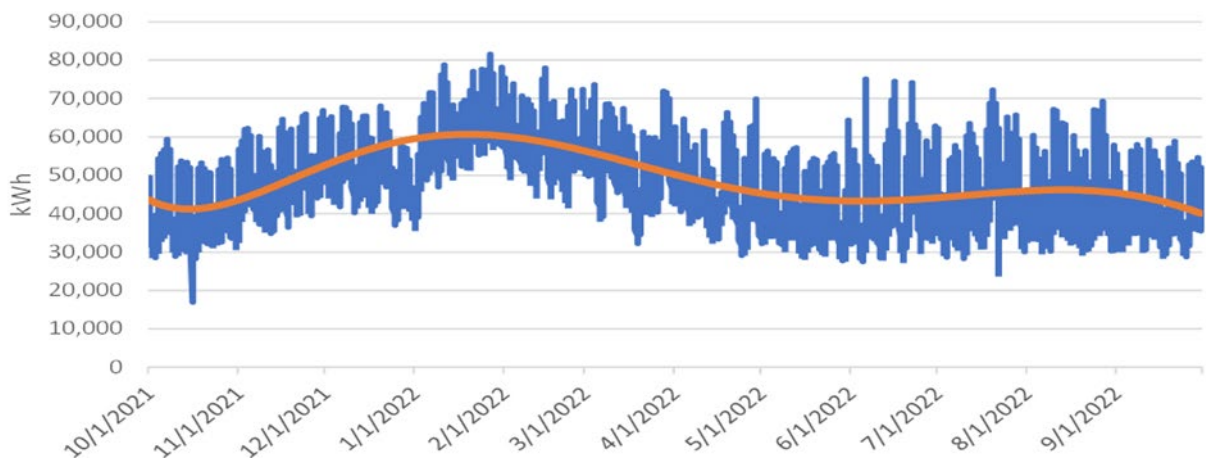


Figure 37. Jamestown BPU hourly electric load (2022)

Table 23 summarizes the peak electrical demand impact of each scenario in February and the electrical capacity shortfall when compared to the existing electric distribution grid capacity. Any electrical shortfall shaded in red indicates that the current local distribution system operated by Jamestown BPU does not currently support the estimated electrical peak increase.

Additional costs for transmission system upgrades are also possible for scenarios peaking with electric boilers since the increase in load is estimated to be greater than 10MW and trigger NYISO Class Year study limits. The Class Year study is performed annually by NYISO to evaluate the cumulative impact a group of large projects will have on the NYS transmission system. The process identifies specific system upgrades required at a transmission level and allocates cost. NYISO's main concern is grid reliability, and their evaluation includes dispatchable power sources. As a result, unpredictable transmission system upgrade costs may be required in addition to the expected high costs to modify the electrical distribution.

In addition, a Class Year study is also anticipated in a decentralized scenario where peaking with heat pumps is performed. A decentralized approach peaking with heat pumps is not recommended and has not been modeled as part of this study but is evaluated and discussed in the Task 2D report.

Table 23. Estimated electrical peak increase per scenario

Scenario	Approach	Baseload	Peaking	Estimated Current Peak Electrical Demand in February (MW)	Estimated Maximum Electrical Load per Scenario (MW)	Estimated Electrical Peak in February (MW)	J.BPU Electrical Upgrades Estimated	NYISO Class Year Limit Study Estimated
BAU	Centralized	NG Boilers	NG Boilers	81.5	No Change	81.5		
B1	Centralized	GSHP	NG Boilers	81.5	4.4	85.9		
B2	Centralized	GSHP	Electric Boiler	81.5	10.69	92.19		X
B3	Centralized	ASHP/WSHP	NG Boilers	81.5	4.09	85.59		
B4	Centralized	WWT	NG Boilers	81.5	4.18	85.68		
C1	Centralized	GSHP	NG Boilers	81.5	4.4	85.9		
C2	Centralized	GSHP	Electric Boiler	81.5	10.69	92.19		X
C3	Centralized	ASHP/WSHP	NG Boilers	81.5	4.08	85.58		
D1	Ambient	GSHP/ASHP/WSHP	GSHP/ASHP/WSHP	81.5	7.13	88.63	X	
D2	Ambient	GSHP&ASHP	NG Blrs	81.5	3.77	85.27	X	
E1	Decentralized	NG Boilers	NG Blrs	81.5	No Change	81.5		
F1	Decentralized	ASHP/WSHP	NG Blrs	81.5	9.78	91.28	X	
F2	Decentralized	ASHP/WSHP	ASHP/WSHP	81.5	18	99.5	X	X

10.1.1 Electrical capacity assessment – centralized Scenarios B & C

There is enough capacity at existing Transformer T7-GSU to support the future anticipated peak electrical load for new equipment. For estimating purposes, a new high voltage switch, transformer, and switchgear are anticipated to supply the new equipment.

10.2 Electrical capacity assessment – decentralized Scenarios D & F

Electrification of the Jamestown district heating system will result in increased electricity use for heating purposes. A map of the electric distribution system and expected upgrades is provided in Appendix C. The upgrades include replacing 35 transformers and their associated secondary feeds to the buildings as well as electric metering. The upgrades also include the replacement of approximately 10,000-feet of primary cables. The estimated cost to perform these upgrades is \$15.6M.

Furthermore, the increase in electrical consumption by decentralizing with local heat pumps is expected to exceed the 100MW interconnection limit between JBPU and National Grid. Although National Grid has indicated that they could likely support up to a 120MW with the existing transmission level equipment, changes to the current contract as well as relays, settings, and other modifications will be necessary. Additional costs associated with relay programming and modifications is included in the estimate.

10.3 Electrical capacity assessment – WWT Facility Scenario B4

For estimating purposes, a new above ground feeder using existing poles and extending approximately 15,000 ft from the Dow St. substation is included to supply the new equipment.

11. Key Takeaways and Recommended Next Steps

11.1 Key takeaways from the Clean Energy Master Planning Process

Table 24 provides a summary of important topics and associated aspects that surfaced during the planning process. These inform the complexities and challenges that will need to be considered and managed as part of the energy transition. These aspects intersect to influence and balance carbon reduction, energy efficiency, flexibility, resiliency and redundancy in a pragmatic and cost-effective manner.

Table 24. Key takeaways from the Clean Energy Master Planning Process

Electrical Demand Impact	Natural Gas Peaking Benefits	Building Improvements	Infrastructure Scenarios	Emission Reduction
Scenarios with decentralized heat pumps installed locally at each building as in Scenarios D and F will require electrical distribution system upgrades.	Flexibility Redundancy for emergency Bridging fuel –while utility infrastructure catches up Manages capital spend	Address direct steam uses by hot water conversion or point-of-use steam generation Retrofit or replace HVAC systems in buildings with high (>180°F) hot water supply temperature requirements Lower supply water temperatures improve heat pump performance, but early HVAC replacement may not be cost effective	Piping material decisions – temperature and pressure Centralized solution is preferred over decentralized Land area needs for geothermal	85% reduction is achievable without 100% electrification
Decentralizing with heat pumps sized to meet 100% peak load (Scenario F-2) has the largest electrical needs and is expected to exceed the current 100MW interconnection limit.	Future renewable fuels currently under development for transportation industries Reuse of existing infrastructure and backup power assets	Renovation approval and timing Hazardous materials may increase project costs		
Relatively higher added CAPEX to completely eliminate carbon emissions reduction via electrification of peak load				
Peak load electrification more expensive per unit of carbon reduction				

11.2 Recommended next steps

Ramboll has identified the following recommended next steps to help Jamestown BPU prioritize projects that can influence future system design and demonstrate progress.

- Heat Mapping – Assess buildings that should be connected to the district heating network initially and identify buildings and areas which have the potential to be connected in the future.
- Building Assessment – Evaluate, investigate, and perform testing of the heating system within each of the currently connected buildings as well as buildings identified during heat mapping for connection. Evaluation, investigation and testing are defined in Section 5.3 of the report. The investigative work in current and potential buildings will also determine if additional heat sources are available to feed into the district heating network such as cooling loads that can easily be served with heat recovery chillers.
- UPMC Hospital Steam Conversion – Develop a strategy to convert the Hospital from steam to hot-water and to meter, for greater accuracy, heat rejected from its year-round cooling load.
- Pipe Replacement Phasing Strategy – Develop a strategy to replace approximately 70,000 LF of pipe in a phased approach that addresses age, condition, and capacity in relation to the project's needs. In addition, the strategy will define all phasing requirements such as temporary heating units, structures, and investment needs by year.
- Customer Education Campaign – Teach the community about the project, opportunities, and to help identify potential take rates and interest of new and existing customers should the new system be constructed. Educate customers on cost effective energy efficiency measures that can typically be performed at buildings to reduce overall energy consumption.
- Geothermal Testing – Since the geothermal borefield size, depths and cost in this report are based on conservative industry standards, subsurface testing as well as evaluation of various borefield heat exchangers should be provided. Test results could identify much higher heat extraction rates with shallower drill depths.
- Monitor Market Development – Monitor advances in heat pump technology and US market availability.

Some of the preceding recommendations should be completed to help Jamestown BPU select a preferred scenario, or variation thereof, prior to beginning preliminary design.

12. Funding Source and Incentive Program Potential

12.1 Federal funding sources

The Inflation Reduction Act (IRA) and the Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL), were both signed into law over the past two years and are the largest investment in clean energy infrastructure in American history¹⁴. The IIJA alone provides over \$830B in funding for more than 380 programs. These programs fall into 13 different categories and funding is appropriated within each category as follows:

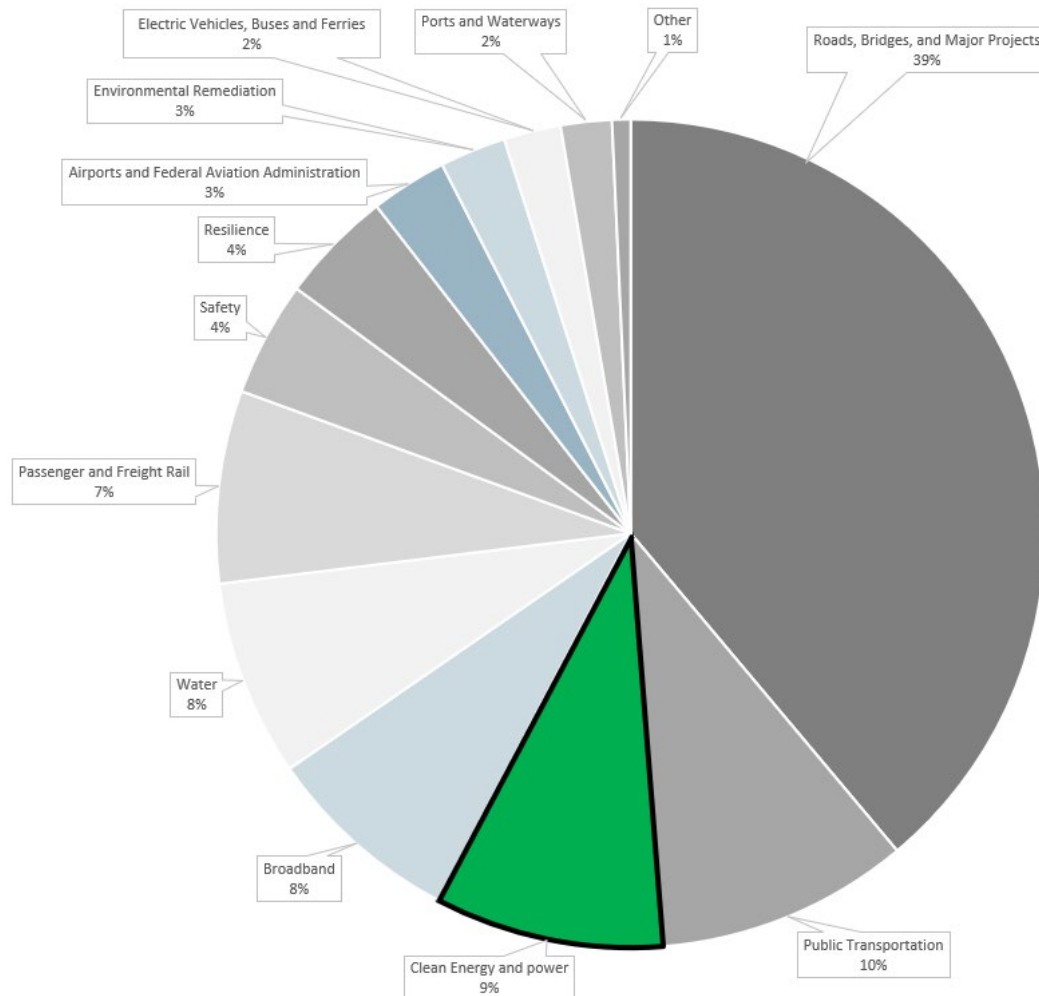


Figure 38. Infrastructure investment and jobs act budgeted appropriations

As illustrated in Figure 38, clean energy and power account for 9% (~\$75B) of the total funding. The funding covers a variety of technologies and is available to potential recipients such as State, local, Tribal governments, clean energy companies, utilities, and others. The types of funding also vary between grants, loans, cooperative agreements, incentive payments, prize, direct federal spending, and others yet to be determined.

¹⁴ [BUILDING-A-BETTER-AMERICA-V2.pdf \(whitehouse.gov\)](https://www.whitehouse.gov/wp-content/uploads/2022/02/BUILDING-A-BETTER-AMERICA-V2.pdf)

The \$75B in clean energy and power funding has been distributed between 13 bureaus as indicated in Figure 39. The green bars represent the two bureaus of the thirteen listed that are most closely related to the work proposed in this study.

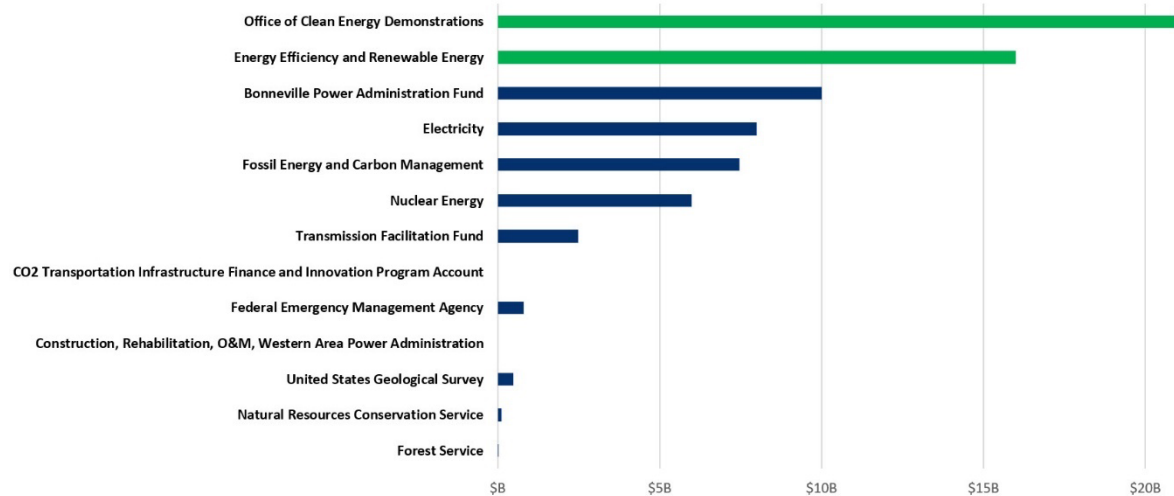


Figure 39. IIJA Clean Energy and Power Funding by Bureau

The Office of Clean Energy Demonstrations and the Energy Efficiency and Renewable Energy bureau's currently offer 44 programs with a total funding of \$37B. Although only about 11% of this funding has been awarded, the programs currently offered do not appear to directly apply to the work proposed in this study; including heat recovery from wastewater, a hydronic piping network to transport the recovered heat, large scale WSHP's, hot-water thermal energy storage, backup and peaking equipment to support the electrification-based technology, and building-side equipment required to connect them to the hot-water network.

The 44 programs were reviewed and placed into types to indicate, at a high level, what each program is generally meant to fund. Figure 40 indicates the various types and level of funding.

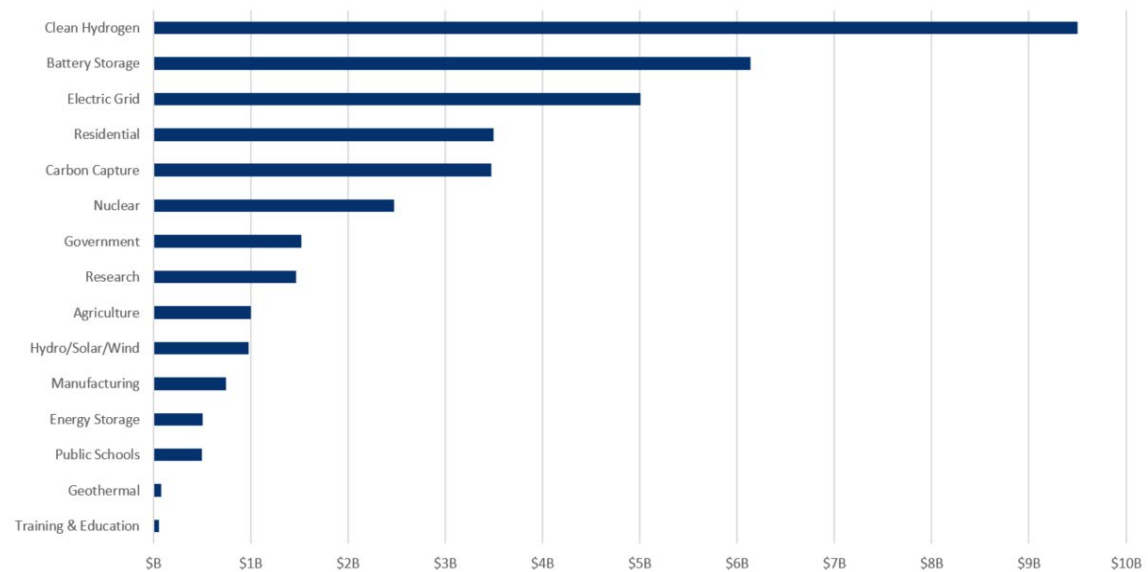


Figure 40. Clean energy demonstrations and energy efficiency and renewable energy bureau program types

Separate from the IIJA, which offers funding mostly in the form of grants and loans, the IRA legislation adds 25 tax credits to the existing tax code for investment (based on eligible investment costs) and production (based on the amount of electricity generated). Similar to the IIJA, the tax credits mostly include provisions for unrelated items such as transportation, manufacturing, nuclear, residential, clean hydrogen, solar, wind, and carbon capture which do not align with the work indicated in this report. However, there are two credits indicated within the red box in Table 25 below that do appear to apply after a cursory review of the detailed code descriptions. RMI developed a list that breaks out IRA programs and incentives. RMI IRA break down by incentive can be found at the following site: [RMI IRA break down by incentive](#). Further evaluation of these credits is recommended if Scenario B-5 is advanced.

Table 25 Summary of Tax Incentives under IRA

Item Name
168(e)(3)(B): Cost Recovery for Qualified Facilities, Qualified Property, and Energy Storage Technology
179D: Energy Efficient Commercial Buildings Deduction
25C: Energy Efficient Home Improvement Credit
25D: Residential Clean Energy Credit
25E: Credit for Previously-Owned Clean Vehicles
30C: Alternative Fuel Vehicle Refueling Property Credit
30D: Clean Vehicle Credit
40: Extension of Second Generation Biofuel Incentives
40A: Tax Credits for Biodiesel and Renewable Diesel
40B: Sustainable Aviation Fuel Credit
45: Production Tax Credit for Electricity from Renewables (placed in service before 2025)
45L: New Energy Efficient Homes Credit
45Q: Credit for Carbon Oxide Sequestration
45U: Zero-Emission Nuclear Power Production Credit
45V: Clean Hydrogen Production Tax Credit
45W: Credit for Qualified Commercial Clean Vehicles
45X: Advanced Manufacturing Production Credit
45Y: Clean Electricity Production Tax Credit (projects placed in service in 2025 or thereafter)
45Z: Clean Fuel Production Credit
48(e): Low-Income Communities Bonus Credit
48: Investment Tax Credit for Energy Property
48C: Advanced Energy Project Credit
48E(h): Low-Income Communities Bonus Credit
48E: Clean Electricity Investment Tax Credit
6426(d), 6426(e), 6427(e): Tax Credits for Alternative Fuels

12.2 State funding

The current NYSERDA funding offered for community heat pump projects is not at the scale necessary to move this project to the next phase of development. NYSERDA has indicated that they will review the results of this study along with their current Statewide Thermal Energy Networks (TENS) pilot submittals to better inform a future funding program for large scale utility-based networks with the potential to greatly reduce GHG emissions. In addition, these projects also have the potential, where larger heat sources, like wastewater heat, could have a significant contribution to broader implementation of district energy systems.

12.3 Funding development

The Office of Clean Energy Demonstrations and the Energy Efficiency and Renewable Energy bureaus have awarded less than 11% of their total funding from the IIJA and still have \$33B remaining. New funding opportunities are released each month and many new programs are expected to be written. Studies like this can help guide program design through DOE and NYSERDA's request for information, notices of intent, various webinars and other stakeholder engagement opportunities where information can be shared. Staying apprised and taking advantage of these opportunities is a crucial step towards creating and securing potential and adequate funding for this project.¹⁵

According to the Building a Better America Guidebook¹⁶ published by the Federal Government, the purpose of these funding opportunities is to invest in energy efficiency and clean energy improvements in homes, schools, businesses, and communities to make them cleaner and more affordable. These funds are also meant to accelerate the transition to zero-emissions while also creating good paying jobs and investing in manufacturing across the country. In addition, demonstration projects that gauge the effectiveness of innovating technologies in real world conditions at scale are encouraged since they have the potential to pave the way towards widespread deployment. Furthermore, much of this funding is designed for large projects that can be significant engines for local and regional economic development and job creation. Scenario B-5, the recommended approach in this report, embodies the full intent and purpose of the largest investment in clean energy infrastructure in American history.

An opportunity exists in Jamestown NY to convert an existing district heating system, one that serves a multitude of building types such as offices, restaurants, various businesses, residential, a hospital, and an ice arena, from fossil-fuel to renewable sources. In addition to converting the existing customer base, the system has the potential and local support if economically feasible, for great expansion including nearby industrial and manufacturing facilities, as well as the entire campus of Jamestown Community College. For all of these reasons, Jamestown should continue to pursue State and Federal funding at the scale required to adequately support this project.

¹⁵ The latest announcements and upcoming engagements are posted by the DOE at [Clean Energy Infrastructure Program and Funding Announcements | Department of Energy](#)

¹⁶ [BUILDING-A-BETTER-AMERICA-V2.pdf \(whitehouse.gov\)](#)

13. Permitting & Regulatory Review

13.1 CEP Boilers

The Jamestown central plant boilers are anticipated to fall under the subpart Dc of the New Source Pollution Standards (NSPS) regulations for generating units with a heat input between 10 and 100 MMBtuh. Opacity monitoring is required for units with a heat input of 30 MMBtuh or greater firing coal, residual oil or wood. Since the boilers fire No. 2 oil and natural gas, opacity monitoring is not required. Similarly, SO₂ monitoring is not required if laboratory analysis of the fuel oil is provided in accordance with Reference Method 6B of 40CFR60, Appendix A to demonstrate that low-sulfur fuel is used. The NSPS regulations would not require a NO_x monitor for the proposed boiler size but require the boilers to be compliant with Part 227-2 of the NYS DEC Rules and Regulations. Part 227-2 classifies the steam generator as a “Mid-Size” boiler since the heat input is more than 50 MMBtuh, but less than 100 MMBtuh. As a mid-size boiler, the generator must comply with NO_x emission limits of 0.10 lbNO_x/MMBtuh while firing natural gas and 0.12 lbNO_x/MMBtuh while firing No. 2 fuel oil.

If the new boilers were to have a heat input capacity greater than 100 MMBtuh on any fuel, they would be subject to the NSPS requirements outlined in Subpart Db, which would require continuous opacity monitoring and continuous emission monitoring of SO₂, and NO_x, respectively.

13.2 Local building-level boilers

The UPMC Hospital is the only building with boilers sized at a capacity that may require permitting. Currently the boilers are used as backup only and do not require posted registration. However, further evaluation is required of the Hospital’s existing air facility registration emission limits and if using local boilers as the main source of heat production will trigger annual limits required to post registration.

13.3 Borefields

In New York State, geothermal wells (including borehole wells) drilled deeper than 500’ were subject to additional state regulations and permitting processes when compared to wells below the 500’ threshold. However, State legislation was recently signed into law on September 22nd, 2023 that would exempt closed-loop GSHP boreholes deeper than 500’ from the additional regulations and permitting requirements that currently apply to boreholes over 500’ in depth. The Governor reached agreement with the legislature to give NYS Department of Environmental Conservation (NYSDEC) authority to create new and appropriate regulations for closed-loop geothermal boreholes deeper than 500 feet. NYSDEC is expected to create these regulations as quickly as possible.

Final decisions on borehole depth should consider updated policies and regulations that follow this new legislation. To avoid these additional regulations and maintain a conservative approach when estimating GSHP potential, Ramboll assumed a borehole well depth of 400’. This depth was used as a basis for both GSHP performance evaluations and for borefield pricing.

13.4 Trench excavation

It is not anticipated that there will be significant dewatering as part of this project. However, a SPEDES permit is required from the New York State Department of Environmental Conservation (DEC) if discharging to navigable waters. The use of the existing settling ponds can be used for discharge of any unforeseen dewatering and would not require a permit. Erosion and sediment control will still be required during construction.

In addition to a SPEDES permit, a Storm Water Pollution Prevention Plan (SWPPP) would be required since the cumulative work for the project will disturb more than an acre of land. The topography of the city will require the use of silt fences to prevent excessive erosion of the soil. The nature of the work will require a Notice of Intent (N.O.I.) be filed with the DEC a minimum of five days before any work commences.

13.5 Asbestos

Much of the piping insulation in the older buildings mechanical rooms is suspected to contain asbestos. In some mechanical rooms, asbestos abatement may have already taken place. However, it will be necessary to conduct asbestos sampling to quantify the extent of abatement required to complete the project. Testing is recommended in all mechanical rooms where work will be performed. Samples should be taken from piping and any other material that could be disturbed during construction such as insulation, gaskets, sealants, ceiling tile and floor tile, and adhesive material. Underground utilities are not expected to contain asbestos. that are disrupted during construction shall be treated as a field condition as well as any other materials that were not accessible at the time of testing.

Appendix A

Cost Estimates

COST SUMMARY

Scenario	BAU	B1	B2	B3	B4	B5	C1
Title	Business as usual	Centralized w/WSHP Borefield/ASHP & Drycoolers	Centralized w/WSHP Borefield/ASHP & Drycoolers	Centralized w/ASHP to WSHP Cascade Arrangement	Centralized @ WWT Facility w/WSHP	Centralized @ WWT Facility w/WSHP & Additional Loads	Centralized S.of 6th w/WSHP Borefield/ASHP & Drycoolers
Peaking	Business as usual	NG Boilers	Electric Boilers	NG Boilers	NG Boilers	NG Boilers	NG Boilers
Cost	\$60,390,980	\$109,059,136	\$110,213,295	\$92,684,367	\$155,638,551	\$199,026,150	\$105,185,836
Notes	- Replace all DH pipe	- Replace all bldg HX's	- Replace all bldg HX's	- Replace all bldg HX's	- Replace all bldg HX's	- Replace all bldg HX's	- Replace bldg HX's S.of 6th
	- Replace CEP DH Boilers	- Replace all DH pipe	- Replace all DH pipe	- Replace all DH pipe	- Replace all DH pipe	- Replace all DH pipe	- Replace DH Pipe S.of 6th
		- Construct Platforms in CEP	- Construct Platforms in CEP	- Construct Platforms in CEP			- Construct Platforms in CEP
		- Remove Coal Tower	- Remove Coal Tower	- Remove Coal Tower	- Remove Coal Tower	- Remove Coal Tower	- Remove Coal Tower
		- Install new TES	- Install new TES	- Install new TES	- Install new TES	- Install new TES	- Install new TES
		- Install WSHP's on Platforms	- Install WSHP's on Platforms	- Install WSHP's on Platforms			- Install WSHP's on Platforms
		- Install Outdoor Drycoolers	- Install Outdoor Drycoolers				- Install Outdoor Drycoolers
		- Install Borefield	- Install Borefield				- Install Borefield
		- Replace CEP DH Boilers	- Replace CEP DH Boilers	- Replace CEP DH Boilers	- Replace CEP DH Boilers	- Replace CEP DH Boilers	- Replace CEP DH Boilers
		- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.
			- Install peaking electric blr.				
			- Provide additional elec equip.				
				- Install Outdoor ASHP's			
					- Install new DH pipe from WWT	- Install new DH pipe from WWT	
					- Install new elec feed to WWT	- Install new elec feed to WWT	
					- Install additional circ pumps	- Install additional circ pumps	
						- DH pipe sized for new loads	- Decentralize 4 bldgs No.of6th w/HP's @ 100% capacity and associated ASHP
							- Elec distribution upgrades associated with HP Decent. at 100% capacity
					- 4 new NG boilers (WWT & CEP)	- 4 new NG boilers (WWT & CEP)	

Scenario	C2	C3	D1	D2	E1	F1	F2
Title	Centralized S.of 6th w/WSHP	Centralized S.of 6th w/ASHP to	Ambient Loop w/Borefield/ASHP	Ambient Loop	Decentralize w/NG Boilers	Decentralize w/Heat Pumps	Decentralize w/Heat Pumps
Peaking	Electric Boilers	NG Boilers	Heat Pumps	NG Boilers	NG Boilers	NG Boilers	Heat Pumps Peaking & Backup
Cost	\$106,342,394	\$89,625,946	\$158,603,951	\$134,619,465	\$30,530,700	\$76,533,138	\$133,717,917
Notes	- Replace bldg HX's S.of 6th	- Replace bldg HX's S.of 6th					
	- Replace DH Pipe S.of 6th	- Replace DH Pipe S.of 6th	- Replace DH Pipe with 5G Pipe	- Replace DH Pipe with 5G Pipe smaller than D1			
	- Construct Platforms in CEP	- Construct Platforms in CEP					
	- Remove Coal Tower	- Remove Coal Tower					
	- Install new TES	- Install new TES					
	- Install WSHP's on Platforms	- Install WSHP's on Platforms					
	- Install Outdoor Drycoolers						
	- Install Borefield		- Install Borefield	- Install Borefield			
	- Replace CEP DH Boilers	- Replace CEP DH Boilers					
	- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.	- Provide new electric equip.			
	- Install peaking electric blr.						
	- Provide additional elec equip.						
		- Install Outdoor ASHP's	- Install Outdoor ASHP's	- Install Outdoor ASHP's smaller than D1			
	- Decentralize 4 bldgs No.of6th w/HP's @ 100% capacity and associated ASHP	- Decentralize 4 bldgs No.of6th w/HP's @ 100% capacity and associated ASHP	- Decentralize all bldgs w/ Heat Pumps @ 100% capacity	- Decentralize all bldgs w/ Heat Pumps @ 60% capacity	- Decentralize all bldgs w/ Boilers @ 100% capacity	- Decentralize all bldgs w/ Heat Pumps @ 60% capacity associated ASHP	- Decentralize all bldgs w/ Heat Pumps @100% capacity associated ASHP
	- Elec distribution upgrades associated with HP Decent. at 100% capacity	- Elec distribution upgrades associated with HP Decent. at 100% capacity	- Elec distribution upgrades associated with HP Decent. at 100% capacity	- Elec distribution upgrades associated with HP Decent. at 60% capacity		- Elec distribution upgrades associated with HP Decent. at 60% capacity	- Elec distribution upgrades associated with HP Decent. at 100% capacity
					- Decommission existing pipe w/concrete mix	- Decommission existing pipe w/concrete mix	- Decommission existing pipe w/concrete mix

SCENARIO A - BUSINESS AS USUAL

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DISTRICT HOT WATER DISTRIBUTION PIPING										
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1424	ft	\$34.00	\$48,416.00	Plumbers	\$85.78	3.38	4,813.41	\$412,908.81	\$461,325
2" Site Distribution Piping DB EN-253 Pipe & Fittings	1413	ft	\$40.00	\$56,520.00	Plumbers	\$85.78	3.59	5,067.89	\$434,738.36	\$491,258
3" Site Distribution Piping DB EN-253 Pipe & Fittings	9281	ft	\$46.00	\$426,926.00	Plumbers	\$85.78	3.79	35,203.07	\$3,019,822.80	\$3,446,749
4" Site Distribution Piping DB EN-253 Pipe & Fittings	4513	ft	\$64.00	\$288,832.00	Plumbers	\$85.78	4.34	19,585.77	\$1,680,124.73	\$1,968,957
6" Site Distribution Piping DB EN-253 Pipe & Fittings	6150	ft	\$94.00	\$578,100.00	Plumbers	\$85.78	5.26	32,369.32	\$2,776,736.01	\$3,354,836
8" Site Distribution Piping DB EN-253 Pipe & Fittings	2617	ft	\$132.00	\$345,444.00	Plumbers	\$85.78	6.38	16,689.92	\$1,431,710.77	\$1,777,155
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1421	ft	\$190.00	\$269,990.00	Plumbers	\$85.78	8.06	11,458.36	\$982,931.77	\$1,252,922
12" Site Distribution Piping DB EN-253 Pipe & Fittings	1433	ft	\$240.00	\$343,920.00	Plumbers	\$85.78	9.54	13,665.84	\$1,172,295.89	\$1,516,216
14" Site Distribution Piping DB EN-253 Pipe & Fittings	1705	ft	\$276.00	\$470,580.00	Plumbers	\$85.78	10.61	18,093.88	\$1,552,146.49	\$2,022,726
16" Site Distribution Piping DB EN-253 Pipe & Fittings	3839	ft	\$380.00	\$1,458,820.00	Plumbers	\$85.78	13.62	52,275.74	\$4,484,367.07	\$5,943,187
18" Site Distribution Piping DB EN-253 Pipe & Fittings	3279	ft	\$492.00	\$1,613,268.00	Plumbers	\$85.78	16.85	55,247.06	\$4,739,255.90	\$6,352,524
Rental boilers, 100 hp (Pipe replacement phasing)	18	MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12	MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$31,381,722
NG BOILERS										
800 HP Firetube Boiler	2	each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work				\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS										\$3,062,654
SUBTOTAL										\$34,444,376
GENERAL CONDITIONS										15% \$39,611,032
OVERHEAD AND PROFIT										10% \$43,572,136
DESIGN CONTINGENCY										20% \$52,286,563
BID CONTINGENCY										5% \$54,900,891
PHASING										10% \$60,390,980
GRAND TOTAL										\$60,390,980

SCENARIO B1 - CENTRALIZED WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chatauqua IDA) (46 gpm)	2 each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2 each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2 each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2 each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	2 each	\$18,801.15	\$37,602.30	Plumbers	\$85.78	125.60	251.1932503	\$21,548.10	\$59,150
Board Of Education (Tech Cntr) (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2 each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2 each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Chatauqua Brick, Inc (23 gpm)	2 each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chatauqua Opportunities (82 gpm)	2 each	\$21,119.10	\$42,238.20	Plumbers	\$85.78	141.08	282.1622811	\$24,204.71	\$66,443
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	2 each	\$9,529.35	\$19,058.70	Plumbers	\$85.78	63.66	127.3171269	\$10,921.64	\$29,980
Covenant Manor Apartments, LLC (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0 each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2 each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2 each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2 each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2 each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0 each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2 each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2 each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2 each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2 each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2 each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2 each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2 each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO B1 - CENTRALIZED WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2	each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2	each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2	each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2	each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2	each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2	each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2	each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2	each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2	each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2	each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2	each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2	each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2	each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	32.00	4,160.00	\$356,857.07	\$421,857
6" Concrete Pad	69	each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	130	each	\$400.00	\$52,000.00	Electrician	\$87.69	8.00	1,040.00	\$91,199.68	\$143,200
Direct digital control of HX's (8 points each)	1,040	each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages for HXs	130	each	\$1,000.00	\$130,000.00	Plumbers	\$85.78	8.00	1,040.00	\$89,214.27	\$219,214
Isolation valves, automatic	260	each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260	each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520	each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260	each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65	buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS										\$8,451,786
DISTRICT HOT WATER DISTRIBUTION PIPING										
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1537	ft	\$34.00	\$52,258.00	Plumbers	\$85.78	3.38	5,195.38	\$445,674.75	\$497,933
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3679	ft	\$40.00	\$147,160.00	Plumbers	\$85.78	3.59	13,195.16	\$1,131,919.64	\$1,279,080
3" Site Distribution Piping DB EN-253 Pipe & Fittings	8919	ft	\$46.00	\$410,274.00	Plumbers	\$85.78	3.79	33,829.99	\$2,902,036.37	\$3,312,310
4" Site Distribution Piping DB EN-253 Pipe & Fittings	5837	ft	\$64.00	\$373,568.00	Plumbers	\$85.78	4.34	25,331.73	\$2,173,030.81	\$2,546,599
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5426	ft	\$94.00	\$510,044.00	Plumbers	\$85.78	5.26	28,558.69	\$2,449,848.71	\$2,959,893
8" Site Distribution Piping DB EN-253 Pipe & Fittings	763	ft	\$132.00	\$100,716.00	Plumbers	\$85.78	6.38	4,866.03	\$417,422.74	\$518,139
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193	ft	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	2600	ft	\$240.00	\$624,000.00	Plumbers	\$85.78	9.54	24,794.96	\$2,126,984.87	\$2,750,985
14" Site Distribution Piping DB EN-253 Pipe & Fittings	2482	ft	\$276.00	\$685,032.00	Plumbers	\$85.78	10.61	26,339.60	\$2,259,488.33	\$2,944,520
16" Site Distribution Piping DB EN-253 Pipe & Fittings	4634	ft	\$380.00	\$1,760,920.00	Plumbers	\$85.78	13.62	63,101.27	\$5,413,013.03	\$7,173,933
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0	ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18	MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12	MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317

SCENARIO B1 - CENTRALIZED WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$27,829,148
WORK INSIDE CENTRAL ENERGY PLANT										
Construct 50'x20' 2nd story 15' above 1st story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT										\$466,952
THERMAL ENERGY STORAGE TANK										
520,000 gallon TES	1	LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1	LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1	LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1	each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1	each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100	ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4	each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK										\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)										
WSHP - Trane CVHH (17,500 Mbh)	2	each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8	each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400	ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400	ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5	each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5	each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10	each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100	ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10	each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10	each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5	each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5	each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2	each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1	each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)										\$3,190,654
DRY COOLER										
250 ton Dry Cooler	16	each	\$204,500.00	\$3,272,000.00	Plumbers	\$85.78	50.794	812.70	\$69,716.15	\$3,341,716
Direct digital control of Dry Cooler	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving Dry Cooler, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Dry Cooler Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Dry Cooler Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Dry Cooler Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Dry Cooler Circ. Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
Dry Cooler Circ. Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
Dry Cooler Circ. Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Dry Cooler Circ. Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Dry Cooler Circ. Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000	ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077

SCENARIO B1 - CENTRALIZED WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Concrete foundation	1000	SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115	CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300	ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24	each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2	each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
				\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - DRY COOLER										\$4,155,117
GEOHERMAL WELLFIELD										
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 476 bore holes, 499' depth	476	each	\$13,473.00	\$6,413,148.00	Plumbers	\$85.78	51.325	24,430.70	\$2,095,737.52	\$8,508,886
Direct digital control of wellfield (est 100 pts each)	100	points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913
Wellfield Circulating Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000	ft-Trench	\$308.40	\$616,800.00	Plumbers	\$87.69	4.59	9,179.03	\$804,927.69	\$1,421,728
TOTAL - GEOHERMAL WELLFIELD										\$10,271,809
NG BOILERS										
800 HP Firetube Boiler	2	each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work				\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS										\$3,062,654
ELECTRIC										
13.8kV - cable (500 kcmil)	2000	ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100	ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3	each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6	each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12	each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1	each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	1	each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
160A-4,160 Feed to ASHP (inside plant)	200	ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500	ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer	1	each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100	ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1	each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046

SCENARIO B1 - CENTRALIZED WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$2,041,038
SUBTOTAL									\$62,202,565
GENERAL CONDITIONS									15%
OVERHEAD AND PROFIT									10%
DESIGN CONTINGENCY									20%
BID CONTINGENCY									5%
PHASING									10%
GRAND TOTAL									\$109,059,136

SCENARIO B2 - CENTRALIZED ASHP/WSHP/BOREFIELD & W/ELECTRIC PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chataqua IDA) (46 gpm)	2 each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2 each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2 each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2 each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	2 each	\$18,801.15	\$37,602.30	Plumbers	\$85.78	125.60	251.1932503	\$21,548.10	\$59,150
Board Of Education (Tech Cntr) (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2 each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2 each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Chatauqua Brick, Inc (23 gpm)	2 each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chatauqua Opportunities (82 gpm)	2 each	\$21,119.10	\$42,238.20	Plumbers	\$85.78	141.08	282.1622811	\$24,204.71	\$66,443
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	2 each	\$9,529.35	\$19,058.70	Plumbers	\$85.78	63.66	127.3171269	\$10,921.64	\$29,980
Covenant Manor Apartments, LLC (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0 each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2 each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2 each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2 each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2 each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0 each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2 each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2 each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2 each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2 each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2 each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2 each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2 each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO B2 - CENTRALIZED ASHP/WSHP/BOREFIELD & W/ELECTRIC PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2	each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2	each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2	each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2	each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2	each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2	each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2	each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2	each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2	each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2	each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2	each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2	each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2	each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	32.00	4,160.00	\$356,857.07	\$421,857
6" Concrete Pad	69	each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	130	each	\$400.00	\$52,000.00	Electrician	\$87.69	8.00	1,040.00	\$91,199.68	\$143,200
Direct digital control of HX's (8 points each)	1,040	each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages for HXs	130	each	\$1,000.00	\$130,000.00	Plumbers	\$85.78	8.00	1,040.00	\$89,214.27	\$219,214
Isolation valves, automatic	260	each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260	each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520	each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260	each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65	buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS										\$8,451,786
DISTRICT HOT WATER DISTRIBUTION PIPING										
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1537	ft	\$34.00	\$52,258.00	Plumbers	\$85.78	3.38	5,195.38	\$445,674.75	\$497,933
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3679	ft	\$40.00	\$147,160.00	Plumbers	\$85.78	3.59	13,195.16	\$1,131,919.64	\$1,279,080
3" Site Distribution Piping DB EN-253 Pipe & Fittings	8919	ft	\$46.00	\$410,274.00	Plumbers	\$85.78	3.79	33,829.99	\$2,902,036.37	\$3,312,310
4" Site Distribution Piping DB EN-253 Pipe & Fittings	5837	ft	\$64.00	\$373,568.00	Plumbers	\$85.78	4.34	25,331.73	\$2,173,030.81	\$2,546,599
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5426	ft	\$94.00	\$510,044.00	Plumbers	\$85.78	5.26	28,558.69	\$2,449,848.71	\$2,959,893
8" Site Distribution Piping DB EN-253 Pipe & Fittings	763	ft	\$132.00	\$100,716.00	Plumbers	\$85.78	6.38	4,866.03	\$417,422.74	\$518,139
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193	ft	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	2600	ft	\$240.00	\$624,000.00	Plumbers	\$85.78	9.54	24,794.96	\$2,126,984.87	\$2,750,985
14" Site Distribution Piping DB EN-253 Pipe & Fittings	2482	ft	\$276.00	\$685,032.00	Plumbers	\$85.78	10.61	26,339.60	\$2,259,488.33	\$2,944,520
16" Site Distribution Piping DB EN-253 Pipe & Fittings	4634	ft	\$380.00	\$1,760,920.00	Plumbers	\$85.78	13.62	63,101.27	\$5,413,013.03	\$7,173,933
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0	ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18	MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12	MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317

SCENARIO B2 - CENTRALIZED ASHP/WSHP/BOREFIELD & W/ELECTRIC PEAKING BOILERS

Description	Quantity		Material		Labor Type	Rate	Labor			Total
			Unit Price	Total			Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$27,829,148
WORK INSIDE CENTRAL ENERGY PLANT										
Construct 50'x20' 2nd story 15' above 1st story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT										\$466,952
THERMAL ENERGY STORAGE TANK										
520,000 gallon TES	1	LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1	LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1	LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1	each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1	each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100	ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4	each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK										\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)										
WSHP - Trane CVHH (17,500 Mbh)	2	each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8	each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400	ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400	ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5	each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5	each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10	each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100	ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10	each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10	each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5	each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5	each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2	each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1	each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)										\$3,190,654
DRY COOLER										
250 ton Dry Cooler	16	each	\$204,500.00	\$3,272,000.00	Plumbers	\$85.78	50.794	812.70	\$69,716.15	\$3,341,716
Direct digital control of Dry Cooler	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving Dry Cooler, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Dry Cooler Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Dry Cooler Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Dry Cooler Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Dry Cooler Circ. Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
Dry Cooler Circ. Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
Dry Cooler Circ. Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Dry Cooler Circ. Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Dry Cooler Circ. Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000	ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077

SCENARIO B2 - CENTRALIZED ASHP/WSHP/BOREFIELD & W/ELECTRIC PEAKING BOILERS

Description	Quantity		Material		Labor Type	Rate	Labor			Total
			Unit Price	Total			Labor Unit	Total Labor Hours	Total Labor Cost	
Concrete foundation	1000	SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115	CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300	ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24	each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2	each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
				\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - DRY COOLER										\$4,155,117
GEOHERMAL WELLFIELD										
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 476 bore holes, 499' depth	476	each	\$13,473.00	\$6,413,148.00	Plumbers	\$85.78	51.325	24,430.70	\$2,095,737.52	\$8,508,886
Direct digital control of wellfield (est 100 pts each)	100	points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913
Wellfield Circulating Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000	ft-Trench	\$308.40	\$616,800.00	Plumbers	\$87.69	4.59	9,179.03	\$804,927.69	\$1,421,728
TOTAL - GEOHERMAL WELLFIELD										\$10,271,809
NG BOILERS										
800 HP Firetube Boiler	2	each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work				\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS										\$3,062,654
ELECTRIC BOILER										
Electric Boiler (17,000 MBH) 5MW	2	each	\$90,000.00	\$180,000.00	Plumbers	\$85.78	200	400.00	\$34,313.18	\$214,313
Direct digital control of boilers (est 15 pts each)	2	each	\$15,000.00	\$30,000.00	Electrician	\$87.69	128.57	257.14	\$22,549.12	\$52,549
Heating hot water system components	2	LS	\$50,000.00	\$100,000.00	Plumbers	\$85.78	146.29	292.58	\$25,098.38	\$125,098
4" concrete slab, vapor barrier, 6x6 6/6 welded wire mesh, 6" stone base, bulkheads and edge forms, finish, cure and protect	400	SF	\$5.50	\$2,200.00	Plumbers	\$85.78	0.06	24.00	\$2,058.79	\$4,259
TOTAL - ELECTRIC BOILER										\$396,219
ELECTRIC										
13.8kV - cable (500 kcmil)	2000	ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100	ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3	each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	9	each	\$4.45	\$40.05	Electrician	\$87.69	1.143	10.29	\$902.09	\$942
13.8kV - Terminations	24	each	\$395.00	\$9,480.00	Electrician	\$87.69	1.739	41.74	\$3,659.91	\$13,140
13.8kV - Switch	1	each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
13.8kV/4.16kV Transformer	1	each	\$145,500.00	\$145,500.00	Electrician	\$87.69	105	105.00	\$9,207.66	\$154,708
4,160V - cable from Xfmr to E.Blr Switch to Boiler (500 kcmil)	4500	ft	\$10.25	\$46,125.00	Electrician	\$87.69	0.06667	300.02	\$26,308.92	\$72,434
4,160V E.Blr Switch	1	each	\$21,800.00	\$21,800.00	Electrician	\$87.69	52.632	52.63	\$4,615.41	\$26,415
4,160 Terminations	8	each	\$115.00	\$920.00	Electrician	\$87.69	1	8.00	\$701.54	\$1,622
4,000A 480V double ended switchgear w/xfmr	1	each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574

SCENARIO B2 - CENTRALIZED ASHP/WSHP/BOREFIELD & W/ELECTRIC PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
160A-4,160 Feed to ASHP (inside plant)	200	ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500	ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer	1	each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100	ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1	each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1	each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1	each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200	ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC										\$2,303,101
SUBTOTAL										\$62,860,847
GENERAL CONDITIONS										15%
OVERHEAD AND PROFIT										10%
DESIGN CONTINGENCY										20%
BID CONTINGENCY										5%
PHASING										10%
GRAND TOTAL										\$110,213,295

SCENARIO B3 - CENTRALIZED WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chataqua IDA) (46 gpm)	2	each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2	each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2	each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2	each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	2	each	\$18,801.15	\$37,602.30	Plumbers	\$85.78	125.60	251.1932503	\$21,548.10	\$59,150
Board Of Education (Tech Cntr) (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2	each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2	each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	2	each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Chautauqua Brick, Inc (23 gpm)	2	each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chautauqua Opportunities (82 gpm)	2	each	\$21,119.10	\$42,238.20	Plumbers	\$85.78	141.08	282.1622811	\$24,204.71	\$66,443
City of Jamestown (City Hall) (48 gpm) Not Connected	0	each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	2	each	\$9,529.35	\$19,058.70	Plumbers	\$85.78	63.66	127.3171269	\$10,921.64	\$29,980
Covenant Manor Apartments, LLC (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0	each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0	each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2	each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2	each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2	each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2	each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0	each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2	each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2	each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2	each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2	each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2	each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2	each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2	each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2	each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO B3 - CENTRALIZED WSH-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2	each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2	each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2	each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALIFE Church Inc. (24 gpm)	2	each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2	each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2	each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2	each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2	each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2	each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2	each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2	each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2	each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2	each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	32.00	4,160.00	\$356,857.07	\$421,857
6" Concrete Pad	69	each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	130	each	\$400.00	\$52,000.00	Electrician	\$87.69	8.00	1,040.00	\$91,199.68	\$143,200
Direct digital control of HX's (8 points each)	1,040	each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages for HXs	130	each	\$1,000.00	\$130,000.00	Plumbers	\$85.78	8.00	1,040.00	\$89,214.27	\$219,214
Isolation valves, automatic	260	each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260	each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520	each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260	each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65	buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS										\$8,451,786
DISTRICT HOT WATER DISTRIBUTION PIPING										
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1537	ft	\$34.00	\$52,258.00	Plumbers	\$85.78	3.38	5,195.38	\$445,674.75	\$497,933
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3679	ft	\$40.00	\$147,160.00	Plumbers	\$85.78	3.59	13,195.16	\$1,131,919.64	\$1,279,080
3" Site Distribution Piping DB EN-253 Pipe & Fittings	8919	ft	\$46.00	\$410,274.00	Plumbers	\$85.78	3.79	33,829.99	\$2,902,036.37	\$3,312,310
4" Site Distribution Piping DB EN-253 Pipe & Fittings	5837	ft	\$64.00	\$373,568.00	Plumbers	\$85.78	4.34	25,331.73	\$2,173,030.81	\$2,546,599
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5426	ft	\$94.00	\$510,044.00	Plumbers	\$85.78	5.26	28,558.69	\$2,449,848.71	\$2,959,893
8" Site Distribution Piping DB EN-253 Pipe & Fittings	763	ft	\$132.00	\$100,716.00	Plumbers	\$85.78	6.38	4,866.03	\$417,422.74	\$518,139
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193	ft	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	2600	ft	\$240.00	\$624,000.00	Plumbers	\$85.78	9.54	24,794.96	\$2,126,984.87	\$2,750,985
14" Site Distribution Piping DB EN-253 Pipe & Fittings	2482	ft	\$276.00	\$685,032.00	Plumbers	\$85.78	10.61	26,339.60	\$2,259,488.33	\$2,944,520
16" Site Distribution Piping DB EN-253 Pipe & Fittings	4634	ft	\$380.00	\$1,760,920.00	Plumbers	\$85.78	13.62	63,101.27	\$5,413,013.03	\$7,173,933
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0	ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18	MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12	MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317

SCENARIO B3 - CENTRALIZED WSH-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 20 hp, install and breakdown	2 LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING									\$27,829,148
WORK INSIDE CENTRAL ENERGY PLANT									
Construct 50'x20' 2nd story 15' above 1st story	1 each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1 each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT									\$466,952
THERMAL ENERGY STORAGE TANK									
520,000 gallon TES	1 LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1 LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1 LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1 each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1 each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100 ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4 each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK									\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)									
WSHP - Trane CVHH (17,500 Mhb)	2 each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8 each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400 ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400 ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24 points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5 each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5 each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10 each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100 ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10 each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10 each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5 each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5 each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2 each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1 each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)									\$3,190,654
AIR SOURCE HEAT PUMP (ASHP)									
Air Source Heat Pumps ACXA230	17 each	\$247,058.82	\$4,200,000.00	Plumbers	\$85.78	50.794	863.50	\$74,073.41	\$4,274,073
Direct digital control of ASHP	24 points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving ASHP, 2,000 gpm @ 45ft	2 each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
ASHP Circ. Pump - VFD	2 each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
ASHP Circ. Pump - Isolation Valves	4 each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
ASHP Circ. Pump - Nearby Piping	40 ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
ASHP Circ. Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
ASHP Circ. Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
ASHP Circ. Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
ASHP Circ. Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
ASHP Circ. Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000 ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077

SCENARIO B3 - CENTRALIZED WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Concrete foundation	1000	SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115	CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300	ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24	each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2	each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
				\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - AIR SOURCE HEAT PUMP (ASHP)										\$5,087,474
GEOTHERMAL WELLFIELD										
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 476 bore holes, 499' depth	0	each	\$13,473.00	\$0.00	Plumbers	\$85.78	51.325	0.00	\$0.00	\$0
Direct digital control of wellfield (est 100 pts each)	0	points	\$700.00	\$0.00	Electrician	\$87.69	6	0.00	\$0.00	\$0
Pumps serving borefield, 2,000 gpm @ 45ft	0	each	\$48,950.00	\$0.00	Plumbers	\$85.78	73.14	0.00	\$0.00	\$0
Wellfield Circulating Pump - VFD	0	each	\$22,600.00	\$0.00	Plumbers	\$85.78	57.143	0.00	\$0.00	\$0
Wellfield Circulating Pump - Isolation Valves	0	each	\$4,400.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield Circulating Pump - Nearby Piping	0	ft	\$112.50	\$0.00	Plumbers	\$85.78	1.02	0.00	\$0.00	\$0
Wellfield Circulating Pump - Temperature transmitters	0	each	\$150.00	\$0.00	Plumbers	\$85.78	0.91	0.00	\$0.00	\$0
Wellfield Circulating Pump - Pressure transmitters	0	each	\$200.00	\$0.00	Plumbers	\$85.78	0.91	0.00	\$0.00	\$0
Wellfield Circulating Pump - Test and balance	0	LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	0.00	\$0.00	\$0
Wellfield Circulating Pump - Suction Diffuser	0	each	\$2,325.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield Circulating Pump - Check Vlv	0	each	\$4,000.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield piping from borefield to central plant HDPE Piping System	0	ft-Trench	\$308.40	\$0.00	Plumbers	\$87.69	4.59	0.00	\$0.00	\$0
TOTAL - GEOTHERMAL WELLFIELD										\$0
NG BOILERS										
800 HP Firetube Boiler	2	each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work				\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS										\$3,062,654
ELECTRIC										
13.8kV - cable (500 kcmil)	2000	ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100	ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3	each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6	each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12	each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1	each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	1	each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
160A-4,160 Feed to ASHP (inside plant)	200	ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500	ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600	ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kv/480V Transformer	1	each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100	ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1	each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046

SCENARIO B3 - CENTRALIZED WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
480V Feed to District Htg Sys Circulating Pump-3	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1	each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1	each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200	ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC										\$2,041,038
SUBTOTAL										\$52,863,113
GENERAL CONDITIONS										15% \$60,792,580
OVERHEAD AND PROFIT										10% \$66,871,838
DESIGN CONTINGENCY										20% \$80,246,206
BID CONTINGENCY										5% \$84,258,516
PHASING										10% \$92,684,367
GRAND TOTAL										\$92,684,367

SCENARIO B4 - CENTRALIZED WSHW AT WWT FACILITY W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chataqua IDA) (46 gpm)	2 each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2 each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2 each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2 each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	2 each	\$18,801.15	\$37,602.30	Plumbers	\$85.78	125.60	251.1932503	\$21,548.10	\$59,150
Board Of Education (Tech Cntr) (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2 each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2 each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Chautauqua Brick, Inc (23 gpm)	2 each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chautauqua Opportunities (82 gpm)	2 each	\$21,119.10	\$42,238.20	Plumbers	\$85.78	141.08	282.1622811	\$24,204.71	\$66,443
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	2 each	\$9,529.35	\$19,058.70	Plumbers	\$85.78	63.66	127.3171269	\$10,921.64	\$29,980
Covenant Manor Apartments, LLC (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0 each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2 each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2 each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2 each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2 each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0 each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2 each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2 each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2 each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2 each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2 each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2 each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2 each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO B4 - CENTRALIZED WSHW AT WWT FACILITY W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2 each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2 each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2 each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALIFE Church Inc. (24 gpm)	2 each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2 each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2 each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2 each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2 each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2 each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2 each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2 each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2 each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2 each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	32.00	4,160.00	\$356,857.07	\$421,857
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	130 each	\$400.00	\$52,000.00	Electrician	\$87.69	8.00	1,040.00	\$91,199.68	\$143,200
Direct digital control of HX's (8 points each)	1,040 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages for HXs	130 each	\$1,000.00	\$130,000.00	Plumbers	\$85.78	8.00	1,040.00	\$89,214.27	\$219,214
Isolation valves, automatic	260 each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260 each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520 each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260 each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS									\$8,451,786
DISTRICT HOT WATER DISTRIBUTION PIPING									
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1537 ft	\$34.00	\$52,258.00	Plumbers	\$85.78	3.38	5,195.38	\$445,674.75	\$497,933
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3679 ft	\$40.00	\$147,160.00	Plumbers	\$85.78	3.59	13,195.16	\$1,131,919.64	\$1,279,080
3" Site Distribution Piping DB EN-253 Pipe & Fittings	8836 ft	\$46.00	\$406,456.00	Plumbers	\$85.78	3.79	33,515.17	\$2,875,030.09	\$3,281,486
4" Site Distribution Piping DB EN-253 Pipe & Fittings	2490 ft	\$64.00	\$159,360.00	Plumbers	\$85.78	4.34	10,806.24	\$926,991.04	\$1,086,351
6" Site Distribution Piping DB EN-253 Pipe & Fittings	1570 ft	\$94.00	\$147,580.00	Plumbers	\$85.78	5.26	8,263.39	\$708,857.81	\$856,438
8" Site Distribution Piping DB EN-253 Pipe & Fittings	3380 ft	\$132.00	\$446,160.00	Plumbers	\$85.78	6.38	21,555.96	\$1,849,133.51	\$2,295,294
10" Site Distribution Piping DB EN-253 Pipe & Fittings	10771 ft	\$190.00	\$2,046,490.00	Plumbers	\$85.78	8.06	86,852.90	\$7,450,498.29	\$9,496,988
12" Site Distribution Piping DB EN-253 Pipe & Fittings	35784 ft	\$240.00	\$8,588,160.00	Plumbers	\$85.78	9.54	341,254.95	\$29,273,856.41	\$37,862,016
14" Site Distribution Piping DB EN-253 Pipe & Fittings	ft	\$276.00	\$0.00	Plumbers	\$85.78	10.61	0.00	\$0.00	\$0
16" Site Distribution Piping DB EN-253 Pipe & Fittings	ft	\$380.00	\$0.00	Plumbers	\$85.78	13.62	0.00	\$0.00	\$0
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0 ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
20" Site Distribution Piping DB EN-253 Pipe & Fittings	0 ft	\$550.00	\$0.00	Plumbers	\$85.78	18.55	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18 MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12 MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12 MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2 LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244

SCENARIO B4 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$59,449,453
NEW CENTRAL ENERGY CENTER AT WASTEWATER TREATMENT FACILITY										
Central energy plant, block construction, including basic MEP infrastructure needed for personnel operations, mechanical or electrical equipment included in separate lines	10,000	SF	\$350.00	\$3,500,000.00	Ironworker	\$82.54	2.6	26,000.00	\$2,146,029.60	\$5,646,030
TOTAL - NEW CENTRAL ENERGY CENTER AT WASTEWATER TREATMENT FACILITY										\$5,646,030
THERMAL ENERGY STORAGE TANK										
520,000 gallon TES	1	LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1	LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1	LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1	each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1	each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100	ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4	each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK										\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)										
WSHP - Trane CVHH (17,500 Mbh)	2	each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8	each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400	ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400	ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	10	each	\$34,100.00	\$341,000.00	Plumbers	\$85.78	60	600.00	\$51,469.77	\$392,470
Site Distribution Pump - VFD	10	each	\$22,600.00	\$226,000.00	Electrician	\$87.69	57.143	571.43	\$50,109.84	\$276,110
Site Distribution Pump - Isolation Valves	20	each	\$4,400.00	\$88,000.00	Plumbers	\$85.78	9.6	192.00	\$16,470.33	\$104,470
Site Distribution Pump - Nearby Piping	200	ft	\$112.50	\$22,500.00	Plumbers	\$85.78	1.02	204.00	\$17,499.72	\$40,000
Site Distribution Pump - Temperature transmitters	20	each	\$150.00	\$3,000.00	Plumbers	\$85.78	4.00	80.00	\$6,862.64	\$9,863
Site Distribution Pump - Pressure transmitters	20	each	\$200.00	\$4,000.00	Plumbers	\$85.78	4.00	80.00	\$6,862.64	\$10,863
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	10	each	\$2,325.00	\$23,250.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$31,485
Site Distribution Pump - Check Vlv	10	each	\$4,000.00	\$40,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$48,235
Direct digital control of pumps	20	points	\$0.00	\$0.00	Electrician	\$87.69	12	240.00	\$21,046.08	\$21,046
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
TOTAL - WATER SOURCE HEAT PUMP (WSHP)										\$3,590,850
NG BOILERS										
800 HP Firetube Boiler	4	each	\$929,662.00	\$3,718,648.00	Master Mechanic	\$93.84	\$6,411.46	25,645.85	\$2,406,660.26	\$6,125,308
Includes all associated work				\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS										\$6,125,308
ELECTRIC										
13.8kV - cable (500 kcmil)	2000	ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100	ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3	each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6	each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12	each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1	each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
Overhead Feeder from DOW to WWT (750 kcmil)	26	MLF	\$26,904.00	\$686,052.00	Electrician	\$87.69	\$68.74	1,752.87	\$153,713.01	\$839,765
4,000A 480V double ended switchgear w/xfmr	1	each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574

SCENARIO B4 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
120A-4,160V Feed to WSHP-1 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer (3,750 kVA)	1 each	\$165,500.00	\$165,500.00	Electrician	\$87.69	125	125.00	\$10,961.50	\$176,462
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-6	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-7	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-8	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-9	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-10	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$2,772,596
SUBTOTAL									\$88,769,428
GENERAL CONDITIONS									15% \$102,084,843
OVERHEAD AND PROFIT									10% \$112,293,327
DESIGN CONTINGENCY									20% \$134,751,992
BID CONTINGENCY									5% \$141,489,592
PHASING									10% \$155,638,551
GRAND TOTAL									\$155,638,551

SCENARIO B5 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS & ADDITIONAL LOADS

Description	Quantity	Material		Labor					Total	
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost		
BUILDING MER PLATE & FRAME HEAT EXCHANGERS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862	
200 Harrison St LLC (Chataqua IDA) (46 gpm)	2 each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273	
3644 Holdings LLC (Priscilla) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154	
3644 Holdings LLC 2 (Cameo) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154	
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2 each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672	
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534	
Agnes Home (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051	
Anderson Manor LB (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154	
Anderson Tower LP (21 gpm)	2 each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016	
Best Western Hotel (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206	
Board Of Education - JHS (276 gpm)	2 each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637	
Board Of Education - LOVE (73 gpm)	2 each	\$18,801.15	\$37,602.30	Plumbers	\$85.78	125.60	251.1932503	\$21,548.10	\$59,150	
Board Of Education (Tech Cntr) (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913	
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2 each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191	
BPU - low pres gas heat (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431	
BPU - monitor building (29 gpm)	2 each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498	
Carlson Tower LP (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585	
Chatauqua Brick, Inc (23 gpm)	2 each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636	
Chatauqua Opportunities (82 gpm)	2 each	\$21,119.10	\$42,238.20	Plumbers	\$85.78	141.08	282.1622811	\$24,204.71	\$66,443	
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0	
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308	
CODE Euclid Gardens (37 gpm)	2 each	\$9,529.35	\$19,058.70	Plumbers	\$85.78	63.66	127.3171269	\$10,921.64	\$29,980	
Covenant Manor Apartments, LLC (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565	
DPW (14 gpm) Not Connected	0 each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0	
DPW 2 (19 gpm) Not Connected	0 each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0	
Duncan Olesnak (4 gpm)	2 each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241	
Eliz W Marvin House (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862	
E-Z Clean Car Wash (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431	
First Covenant Church (33 gpm)	2 each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739	
First Lutheran Church (57 gpm)	2 each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186	
Fourth St Housing (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913	
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2 each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775	
Herbert A Duke II (17 gpm) Not Connected	0 each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0	
Heritage Ministries (Heritage Park) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308	
Heritage Ministries 2 (Childcare) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482	
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2 each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617	
Inter'n Ordinance Tech (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585	
Jamestown Boys & Girls Club (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565	
Jamestown City (Ice Arena) (119 gpm)	2 each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423	
Jamestown Newspaper Corp (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826	
JHA (5th St. High Rise) (44 gpm)	2 each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652	
JHA (Chadakoin Bldg) (38 gpm)	2 each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791	
JHA (Hotel Jamestown) (70 gpm)	2 each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720	
JRP (Jody Peterson) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482	
JRP (South County Office Bldg) (32 gpm)	2 each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929	
Kaleida Health (72 gpm)	2 each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340	
Krog Corp (BWB Center) (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826	
Legal Assistance of WNY (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862	
Lewis & Lewis P C (.001) (.1) (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051	

SCENARIO B5 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS & ADDITIONAL LOADS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2 each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2 each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2 each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2 each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2 each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2 each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2 each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2 each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2 each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2 each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2 each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2 each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2 each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Rand Machine	2 each	\$17,660.57	\$35,321.14	Plumbers	\$85.78	117.98	235.95	\$20,240.87	\$55,562
Artone MFG	2 each	\$73,585.71	\$147,171.43	Plumbers	\$85.78	491.57	983.14	\$84,336.98	\$231,508
The Forage source	2 each	\$2,295.87	\$4,591.75	Plumbers	\$85.78	15.34	30.67	\$2,631.31	\$7,223
SKF USA	2 each	\$79,472.57	\$158,945.14	Plumbers	\$85.78	530.90	1,061.80	\$91,083.94	\$250,029
Electrovaya	2 each	\$39,694.49	\$79,388.98	Plumbers	\$85.78	265.17	530.34	\$45,494.07	\$124,883
TitanX Engine Cooling	2 each	\$104,021.65	\$208,043.30	Plumbers	\$85.78	694.89	1,389.78	\$119,219.76	\$327,263
Hope's Windows	2 each	\$69,170.57	\$138,341.14	Plumbers	\$85.78	462.08	924.16	\$79,276.76	\$217,618
Bush Industries	2 each	\$117,737.14	\$235,474.29	Plumbers	\$85.78	786.52	1,573.03	\$134,939.17	\$370,413
SUNY JCC	2 each	\$125,562.54	\$251,125.08	Plumbers	\$85.78	838.79	1,677.58	\$143,907.90	\$395,033
Washington MS	2 each	\$80,061.26	\$160,122.51	Plumbers	\$85.78	534.83	1,069.66	\$91,758.63	\$251,881
Ring Elementary School	2 each	\$40,381.33	\$80,762.67	Plumbers	\$85.78	269.76	539.52	\$46,281.26	\$127,044
Removal of existing heat exchangers	152 each	\$500.00	\$76,000.00	Plumbers	\$85.78	32.00	4,864.00	\$417,248.27	\$493,248
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	152 each	\$400.00	\$60,800.00	Electrician	\$87.69	8.00	1,216.00	\$106,633.47	\$167,433
Direct digital control of HX's (8 points each)	1,216 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	14,592.00	\$1,279,601.66	\$1,279,602
Valve packages for HXs	152 each	\$1,000.00	\$152,000.00	Plumbers	\$85.78	8.00	1,216.00	\$104,312.07	\$256,312
Isolation valves, automatic	304 each	\$1,500.00	\$456,000.00	Plumbers	\$85.78	8.00	2,432.00	\$208,624.13	\$664,624
Flow meters, ultrasonic	304 each	\$3,500.00	\$1,064,000.00	Plumbers	\$85.78	8.00	2,432.00	\$208,624.13	\$1,272,624
Temperature transmitters	608 each	\$1,000.00	\$608,000.00	Plumbers	\$85.78	4.00	2,432.00	\$208,624.13	\$816,624
Pressure transmitters	304 each	\$1,000.00	\$304,000.00	Plumbers	\$85.78	4.00	1,216.00	\$104,312.07	\$408,312
Differential pressure switch	152 each	\$500.00	\$76,000.00	Plumbers	\$85.78	2.00	304.00	\$26,078.02	\$102,078
Test and balance	76 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	6,080.00	\$521,560.34	\$521,560
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS									\$11,676,121
DISTRICT HOT WATER DISTRIBUTION PIPING									
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1537 ft	\$34.00	\$52,258.00	Plumbers	\$85.78	3.38	5,195.38	\$445,674.75	\$497,933
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3679 ft	\$40.00	\$147,160.00	Plumbers	\$85.78	3.59	13,195.16	\$1,131,919.64	\$1,279,080
3" Site Distribution Piping DB EN-253 Pipe & Fittings	8836 ft	\$46.00	\$406,456.00	Plumbers	\$85.78	3.79	33,515.17	\$2,875,030.09	\$3,281,486
4" Site Distribution Piping DB EN-253 Pipe & Fittings	2462 ft	\$64.00	\$157,568.00	Plumbers	\$85.78	4.34	10,684.72	\$916,567.05	\$1,074,135
6" Site Distribution Piping DB EN-253 Pipe & Fittings	3770 ft	\$94.00	\$354,380.00	Plumbers	\$85.78	5.26	19,842.66	\$1,702,161.75	\$2,056,542

SCENARIO B5 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS & ADDITIONAL LOADS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
8" Site Distribution Piping DB EN-253 Pipe & Fittings	6152 ft	\$132.00	\$812,064.00	Plumbers	\$85.78	6.38	39,234.39	\$3,365,641.82	\$4,177,706
10" Site Distribution Piping DB EN-253 Pipe & Fittings	10708 ft	\$190.00	\$2,034,520.00	Plumbers	\$85.78	8.06	86,344.90	\$7,406,920.03	\$9,441,440
12" Site Distribution Piping DB EN-253 Pipe & Fittings	18948 ft	\$240.00	\$4,547,520.00	Plumbers	\$85.78	9.54	180,698.04	\$15,500,811.29	\$20,048,331
14" Site Distribution Piping DB EN-253 Pipe & Fittings	1	\$276.00	\$0.00	Plumbers	\$85.78	10.61	0.00	\$0.00	\$0
16" Site Distribution Piping DB EN-253 Pipe & Fittings	16926 ft	\$380.00	\$6,431,880.00	Plumbers	\$85.78	13.62	230,481.68	\$19,771,398.03	\$26,203,278
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0 ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
20" Site Distribution Piping DB EN-253 Pipe & Fittings	0 ft	\$550.00	\$0.00	Plumbers	\$85.78	18.55	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18 MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12 MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882
Rental boilers, 20 hp	12 MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2 LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2 LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2 LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING									\$70,853,798
NEW CENTRAL ENERGY CENTER AT WASTEWATER TREATMENT FACILITY									
Central energy plant, block construction, including basic MEP infrastructure needed for personnel operations, mechanical or electrical equipment included in separate lines	10,000 SF	\$350.00	\$3,500,000.00	Ironworker	\$82.54	2.6	26,000.00	\$2,146,029.60	\$5,646,030
TOTAL - NEW CENTRAL ENERGY CENTER AT WASTEWATER TREATMENT FACILITY									\$5,646,030
THERMAL ENERGY STORAGE TANK									
520,000 gallon TES	1 LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1 LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1 LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1 each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1 each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100 ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4 each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK									\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)									
WSHP - Trane CVHH (17,500 Mbh)	4 each	\$1,150,000.00	\$4,600,000.00	Plumbers	\$85.78	427.00	1,708.00	\$146,517.28	\$4,746,517
WSHP Isolation valves Evap & Cond	16 each	\$5,250.00	\$84,000.00	Plumbers	\$85.78	10.435	166.96	\$14,322.32	\$98,322
WSHP Nearby pipe	800 ft	\$176.00	\$140,800.00	Plumbers	\$85.78	1.6	1,280.00	\$109,802.18	\$250,602
WSHP Pipe Insulation	800 ft	\$15.75	\$12,600.00	Plumbers	\$85.78	0.229	183.20	\$15,715.44	\$28,315
Direct digital control of WSHP	48 points	\$0.00	\$0.00	Electrician	\$87.69	12	576.00	\$50,510.59	\$50,511
Site Distribution Pumps, 2,000 gpm @ 145ft	20 each	\$34,100.00	\$682,000.00	Plumbers	\$85.78	60	1,200.00	\$102,939.54	\$784,940
Site Distribution Pump - VFD	20 each	\$22,600.00	\$452,000.00	Electrician	\$87.69	57.143	1,142.86	\$100,219.68	\$552,220
Site Distribution Pump - Isolation Valves	40 each	\$4,400.00	\$176,000.00	Plumbers	\$85.78	9.6	384.00	\$32,940.65	\$208,941
Site Distribution Pump - Nearby Piping	400 ft	\$112.50	\$45,000.00	Plumbers	\$85.78	1.02	408.00	\$34,999.44	\$79,999
Site Distribution Pump - Temperature transmitters	40 each	\$150.00	\$6,000.00	Plumbers	\$85.78	4.00	160.00	\$13,725.27	\$19,725
Site Distribution Pump - Pressure transmitters	40 each	\$200.00	\$8,000.00	Plumbers	\$85.78	4.00	160.00	\$13,725.27	\$21,725
Site Distribution Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	20 each	\$2,325.00	\$46,500.00	Plumbers	\$85.78	9.6	192.00	\$16,470.33	\$62,970
Site Distribution Pump - Check Vlv	20 each	\$4,000.00	\$80,000.00	Plumbers	\$85.78	9.6	192.00	\$16,470.33	\$96,470
Direct digital control of pumps	40 points	\$0.00	\$0.00	Electrician	\$87.69	12	480.00	\$42,092.16	\$42,092
200' Supply and return piping in plant to header	400 ft	\$184.60	\$73,840.00	Plumbers	\$85.78	1.48	592.00	\$50,783.51	\$124,624
TOTAL - WATER SOURCE HEAT PUMP (WSHP)									\$7,174,837
AIR SOURCE HEAT PUMP (ASHP)									
Air Source Heat Pumps ACXA230	17 each	\$247,058.82	\$4,200,000.00	Plumbers	\$85.78	50.794	863.50	\$74,073.41	\$4,274,073

SCENARIO B5 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS & ADDITIONAL LOADS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Direct digital control of ASHP	24 points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving ASHP, 2,000 gpm @ 45ft	2 each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
ASHP Circ. Pump - VFD	2 each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
ASHP Circ. Pump - Isolation Valves	4 each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
ASHP Circ. Pump - Nearby Piping	40 ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
ASHP Circ. Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
ASHP Circ. Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
ASHP Circ. Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
ASHP Circ. Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
ASHP Circ. Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000 ft	\$0.00	\$0.00	Electrician	\$87.69	0	0.00	\$0.00	\$0
Concrete foundation	1000 SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115 CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300 ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24 each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2 each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
			\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - AIR SOURCE HEAT PUMP (ASHP)									\$5,002,397
NG BOILERS									
800 HP Firetube Boiler	5 each	\$929,662.00	\$4,648,310.00	Master Mechanic	\$93.84	\$6,411.46	32,057.31	\$3,008,325.32	\$7,656,635
Includes all associated work			\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS									\$7,656,635
ELECTRIC									
13.8kV - cable (500 kcmil)	2000 ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100 ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3 each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6 each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12 each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1 each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
Overhead Feeder from DOW to WWT (750 kcmil)	26 MLF	\$26,904.00	\$686,052.00	Electrician	\$87.69	\$68.74	1,752.87	\$153,713.01	\$839,765
4,000A 480V double ended switchgear w/xfmr	1 each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
120A-4,160V Feed to WSHP-1 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer (3,750 kVA)	1 each	\$165,500.00	\$165,500.00	Electrician	\$87.69	125	125.00	\$10,961.50	\$176,462
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-6	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-7	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-8	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-9	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-10	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202

SCENARIO B5 - CENTRALIZED WSHP AT WWT FACILITY W/NG PEAKING BOILERS & ADDITIONAL LOADS									
Description	Quantity		Material		Labor				Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost
20 Amp Circuit Feeds various controls/misc. equip	4200	ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28
TOTAL - ELECTRIC									\$2,772,596
SUBTOTAL									\$113,515,819
GENERAL CONDITIONS									15% \$130,543,192
OVERHEAD AND PROFIT									10% \$143,597,511
DESIGN CONTINGENCY									20% \$172,317,013
BID CONTINGENCY									5% \$180,932,864
PHASING									10% \$199,026,150
GRAND TOTAL									\$199,026,150

SCENARIO C1 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chataqua IDA) (46 gpm)	2	each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2	each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2	each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2	each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	0	each	\$18,801.15	\$0.00	Plumbers	\$85.78	125.60	0	\$0.00	\$0
Board Of Education (Tech Cntr) (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2	each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2	each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	0	each	\$4,635.90	\$0.00	Plumbers	\$85.78	30.97	0	\$0.00	\$0
Chautauqua Brick, Inc (23 gpm)	2	each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chautauqua Opportunities (82 gpm)	0	each	\$21,119.10	\$0.00	Plumbers	\$85.78	141.08	0	\$0.00	\$0
City of Jamestown (City Hall) (48 gpm) Not Connected	0	each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	0	each	\$9,529.35	\$0.00	Plumbers	\$85.78	63.66	0	\$0.00	\$0
Covenant Manor Apartments, LLC (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0	each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0	each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2	each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2	each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2	each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2	each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0	each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2	each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2	each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2	each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2	each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2	each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2	each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2	each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2	each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO C1 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2 each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2 each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2 each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2 each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2 each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2 each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2 each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2 each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2 each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2 each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2 each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2 each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2 each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	114 each	\$500.00	\$57,000.00	Plumbers	\$85.78	32.00	3,648.00	\$312,936.20	\$369,936
6" Concrete Pad	57 each	\$250.00	\$14,250.00	Cement Masons	\$72.62	8.00	456.00	\$33,113.37	\$47,363
Control system upgrades to accommodate low temperature water	114 each	\$400.00	\$45,600.00	Electrician	\$87.69	8.00	912.00	\$79,975.10	\$125,575
Direct digital control of HX's (8 points each)	912 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	10,944.00	\$959,701.25	\$959,701
Valve packages for HXs	114 each	\$1,000.00	\$114,000.00	Plumbers	\$85.78	8.00	912.00	\$78,234.05	\$192,234
Isolation valves, automatic	228 each	\$1,500.00	\$342,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$498,468
Flow meters, ultrasonic	228 each	\$3,500.00	\$798,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$954,468
Temperature transmitters	456 each	\$1,000.00	\$456,000.00	Plumbers	\$85.78	4.00	1,824.00	\$156,468.10	\$612,468
Pressure transmitters	228 each	\$1,000.00	\$228,000.00	Plumbers	\$85.78	4.00	912.00	\$78,234.05	\$306,234
Differential pressure switch	114 each	\$500.00	\$57,000.00	Plumbers	\$85.78	2.00	228.00	\$19,558.51	\$76,559
Test and balance	57 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	4,560.00	\$391,170.25	\$391,170
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS									\$7,641,928
DECENTRALIZE BUILDINGS NORTH OF 6TH STREET									
Chautauqua Opportunities (82 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
CODE Euclid Gardens (37 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Carlson Tower LP (18 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Board Of Education - LOVE (73 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Electrical Distribution Upgrades	1 LS	\$185,616.72	\$185,616.72	Electrician	\$87.69	632.26	632.26	\$55,443.96	\$241,061
TOTAL - DECENTRALIZE BUILDINGS NORTH OF 6TH STREET									\$1,645,809
DISTRICT HOT WATER DISTRIBUTION PIPING									
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1736 ft	\$34.00	\$59,024.00	Plumbers	\$85.78	3.38	5,868.04	\$503,377.59	\$562,402
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3833 ft	\$40.00	\$153,320.00	Plumbers	\$85.78	3.59	13,747.50	\$1,179,300.89	\$1,332,621
3" Site Distribution Piping DB EN-253 Pipe & Fittings	7552 ft	\$46.00	\$347,392.00	Plumbers	\$85.78	3.79	28,644.93	\$2,457,246.18	\$2,804,638
4" Site Distribution Piping DB EN-253 Pipe & Fittings	2721 ft	\$64.00	\$174,144.00	Plumbers	\$85.78	4.34	11,808.75	\$1,012,989.01	\$1,187,133
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5009 ft	\$94.00	\$470,846.00	Plumbers	\$85.78	5.26	26,363.89	\$2,261,572.46	\$2,732,418
8" Site Distribution Piping DB EN-253 Pipe & Fittings	899 ft	\$132.00	\$118,668.00	Plumbers	\$85.78	6.38	5,733.37	\$491,825.75	\$610,494
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193 ft	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	3147 ft	\$240.00	\$755,280.00	Plumbers	\$85.78	9.54	30,011.44	\$2,574,469.77	\$3,329,750
14" Site Distribution Piping DB EN-253 Pipe & Fittings	3223 ft	\$276.00	\$889,548.00	Plumbers	\$85.78	10.61	34,203.27	\$2,934,057.57	\$3,823,606

SCENARIO C1 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
16" Site Distribution Piping DB EN-253 Pipe & Fittings	3351 ft	\$380.00	\$1,273,380.00	Plumbers	\$85.78	13.62	45,630.63	\$3,914,330.31	\$5,187,710
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0 ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	17 MO	\$75,000.00	\$1,275,000.00	Plumbers	\$85.78	30.00	510.00	\$43,749.30	\$1,318,749
Rental boilers, 50 hp	11 MO	\$50,000.00	\$550,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$578,308
Rental boilers, 20 hp	11 MO	\$35,000.00	\$385,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$413,308
Rental boilers, 100 hp, install and breakdown	2 LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2 LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2 LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING									\$25,248,808
WORK INSIDE CENTRAL ENERGY PLANT									
Construct 50'x20' 2nd story 15' above 1st story	1 each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1 each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT									\$466,952
THERMAL ENERGY STORAGE TANK									
520,000 gallon TES	1 LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1 LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1 LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1 each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1 each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100 ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4 each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK									\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)									
WSHP - Trane CVHH (17,500 Mbh)	2 each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8 each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400 ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400 ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24 points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5 each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5 each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10 each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100 ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10 each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10 each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5 each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5 each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2 each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1 each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)									\$3,190,654
DRY COOLER									
250 ton Dry Cooler	16 each	\$204,500.00	\$3,272,000.00	Plumbers	\$85.78	50.794	812.70	\$69,716.15	\$3,341,716
Direct digital control of Dry Cooler	24 points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving Dry Cooler, 2,000 gpm @ 45ft	2 each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Dry Cooler Circ. Pump - VFD	2 each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Dry Cooler Circ. Pump - Isolation Valves	4 each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Dry Cooler Circ. Pump - Nearby Piping	40 ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000

SCENARIO C1 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Dry Cooler Circ. Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
Dry Cooler Circ. Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
Dry Cooler Circ. Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Dry Cooler Circ. Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Dry Cooler Circ. Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000 ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077
Concrete foundation	1000 SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115 CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300 ft-Trench	\$308.40	\$92,520.00	Plumbers	\$87.69	4.59	1,376.85	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24 each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" Isolation valves	2 each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
			\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - DRY COOLER									\$4,155,117
GEOTHERMAL WELLFIELD									
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 450 bor holes, 499' depth	450 each	\$13,473.00	\$6,062,850.00	Plumbers	\$85.78	51.325	23,096.25	\$1,981,264.46	\$8,044,114
Direct digital control of wellfield (est 100 pts each)	100 points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2 each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2 each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4 each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40 ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913
Wellfield Circulating Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000 ft-Trench	\$308.40	\$616,800.00	Plumbers	\$87.69	4.59	9,179.03	\$804,927.69	\$1,421,728
TOTAL - GEOTHERMAL WELLFIELD									\$9,807,038
NG BOILERS									
800 HP Firetube Boiler	2 each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work			\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS									\$3,062,654
ELECTRIC									
13.8kV - cable (500 kcmil)	2000 ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100 ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3 each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6 each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12 each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1 each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	1 each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
160A-4,160 Feed to ASHP (inside plant)	200 ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500 ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer	1 each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023

SCENARIO C1 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
480V (2000A) Switchgear	1 each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$2,041,038
SUBTOTAL									\$59,993,404
GENERAL CONDITIONS									15% \$68,992,415
OVERHEAD AND PROFIT									10% \$75,891,657
DESIGN CONTINGENCY									20% \$91,069,988
BID CONTINGENCY									5% \$95,623,487
PHASING									10% \$105,185,836
GRAND TOTAL									\$105,185,836

SCENARIO C2 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/ELEC PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chatauqua IDA) (46 gpm)	2	each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2	each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2	each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2	each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2	each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	0	each	\$18,801.15	\$0.00	Plumbers	\$85.78	125.60	0	\$0.00	\$0
Board Of Education (Tech Cntr) (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2	each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2	each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	0	each	\$4,635.90	\$0.00	Plumbers	\$85.78	30.97	0	\$0.00	\$0
Chatauqua Brick, Inc (23 gpm)	2	each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chatauqua Opportunities (82 gpm)	0	each	\$21,119.10	\$0.00	Plumbers	\$85.78	141.08	0	\$0.00	\$0
City of Jamestown (City Hall) (48 gpm) Not Connected	0	each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	0	each	\$9,529.35	\$0.00	Plumbers	\$85.78	63.66	0	\$0.00	\$0
Covenant Manor Apartments, LLC (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0	each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0	each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2	each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2	each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2	each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2	each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2	each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2	each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0	each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2	each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2	each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2	each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2	each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2	each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2	each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2	each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2	each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2	each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2	each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2	each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2	each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO C2 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/ELEC PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2 each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2 each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2 each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2 each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2 each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2 each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2 each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2 each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2 each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2 each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2 each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2 each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2 each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2 each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	114 each	\$500.00	\$57,000.00	Plumbers	\$85.78	32.00	3,648.00	\$312,936.20	\$369,936
6" Concrete Pad	57 each	\$250.00	\$14,250.00	Cement Masons	\$72.62	8.00	456.00	\$33,113.37	\$47,363
Control system upgrades to accommodate low temperature water	114 each	\$400.00	\$45,600.00	Electrician	\$87.69	8.00	912.00	\$79,975.10	\$125,575
Direct digital control of HX's (8 points each)	912 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	10,944.00	\$959,701.25	\$959,701
Valve packages for HXs	114 each	\$1,000.00	\$114,000.00	Plumbers	\$85.78	8.00	912.00	\$78,234.05	\$192,234
Isolation valves, automatic	228 each	\$1,500.00	\$342,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$498,468
Flow meters, ultrasonic	228 each	\$3,500.00	\$798,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$954,468
Temperature transmitters	456 each	\$1,000.00	\$456,000.00	Plumbers	\$85.78	4.00	1,824.00	\$156,468.10	\$612,468
Pressure transmitters	228 each	\$1,000.00	\$228,000.00	Plumbers	\$85.78	4.00	912.00	\$78,234.05	\$306,234
Differential pressure switch	114 each	\$500.00	\$57,000.00	Plumbers	\$85.78	2.00	228.00	\$19,558.51	\$76,559
Test and balance	57 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	4,560.00	\$391,170.25	\$391,170
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS									\$7,641,928
DECENTRALIZE BUILDINGS NORTH OF 6TH STREET									
Chautauqua Opportunities (82 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
CODE Euclid Gardens (37 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Carlson Tower LP (18 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Board Of Education - LOVE (73 gpm) - MEDIUM	1 each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Electrical Distribution Upgrades	1 LS	\$185,616.72	\$185,616.72	Electrician	\$87.69	632.26	632.26	\$55,443.96	\$241,061
TOTAL - DECENTRALIZE BUILDINGS NORTH OF 6TH STREET									\$1,645,809
DISTRICT HOT WATER DISTRIBUTION PIPING									
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1736 ft	\$34.00	\$59,024.00	Plumbers	\$85.78	3.38	5,868.04	\$503,377.59	\$562,402
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3833 ft	\$40.00	\$153,320.00	Plumbers	\$85.78	3.59	13,747.50	\$1,179,300.89	\$1,332,621
3" Site Distribution Piping DB EN-253 Pipe & Fittings	7552 ft	\$46.00	\$347,392.00	Plumbers	\$85.78	3.79	28,644.93	\$2,457,246.18	\$2,804,638
4" Site Distribution Piping DB EN-253 Pipe & Fittings	2721 ft	\$64.00	\$174,144.00	Plumbers	\$85.78	4.34	11,808.75	\$1,012,989.01	\$1,187,133
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5009 ft	\$94.00	\$470,846.00	Plumbers	\$85.78	5.26	26,363.89	\$2,261,572.46	\$2,732,418
8" Site Distribution Piping DB EN-253 Pipe & Fittings	899 ft	\$132.00	\$118,668.00	Plumbers	\$85.78	6.38	5,733.37	\$491,825.75	\$610,494
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193 ft	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	3147 ft	\$240.00	\$755,280.00	Plumbers	\$85.78	9.54	30,011.44	\$2,574,469.77	\$3,329,750
14" Site Distribution Piping DB EN-253 Pipe & Fittings	3223 ft	\$276.00	\$889,548.00	Plumbers	\$85.78	10.61	34,203.27	\$2,934,057.57	\$3,823,606

SCENARIO C2 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/ELEC PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
16" Site Distribution Piping DB EN-253 Pipe & Fittings	3351	ft	\$380.00	\$1,273,380.00	Plumbers	\$85.78	13.62	45,630.63	\$3,914,330.31	\$5,187,710
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0	ft	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	17	MO	\$75,000.00	\$1,275,000.00	Plumbers	\$85.78	30.00	510.00	\$43,749.30	\$1,318,749
Rental boilers, 50 hp	11	MO	\$50,000.00	\$550,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$578,308
Rental boilers, 20 hp	11	MO	\$35,000.00	\$385,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$413,308
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$25,248,808
WORK INSIDE CENTRAL ENERGY PLANT										
Construct 50'x20' 2nd story 15' above 1st story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT										\$466,952
THERMAL ENERGY STORAGE TANK										
520,000 gallon TES	1	LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1	LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1	LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1	each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1	each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100	ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" Isolation valves	4	each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK										\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)										
WSHP - Trane CVHH (17,500 Mbh)	2	each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8	each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400	ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400	ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5	each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5	each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10	each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100	ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10	each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10	each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5	each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5	each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2	each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1	each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)										\$3,190,654
DRY COOLER										
250 ton Dry Cooler	16	each	\$204,500.00	\$3,272,000.00	Plumbers	\$85.78	50.794	812.70	\$69,716.15	\$3,341,716
Direct digital control of Dry Cooler	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving Dry Cooler, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Dry Cooler Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Dry Cooler Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Dry Cooler Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000

SCENARIO C2 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/ELEC PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Dry Cooler Circ. Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
Dry Cooler Circ. Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
Dry Cooler Circ. Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Dry Cooler Circ. Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Dry Cooler Circ. Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000 ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077
Concrete foundation	1000 SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115 CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300 ft-Trench	\$308.40	\$92,520.00	Plumbers	\$87.69	4.59	1,376.85	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24 each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" Isolation valves	2 each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
			\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - DRY COOLER									\$4,155,117
GEOHERMAL WELLFIELD									
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 450 bore holes, 499' depth	450 each	\$13,473.00	\$6,062,850.00	Plumbers	\$85.78	51.325	23,096.25	\$1,981,264.46	\$8,044,114
Direct digital control of wellfield (est 100 pts each)	100 points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2 each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2 each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4 each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40 ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913
Wellfield Circulating Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000 ft-Trench	\$308.40	\$616,800.00	Plumbers	\$87.69	4.59	9,179.03	\$804,927.69	\$1,421,728
TOTAL - GEOHERMAL WELLFIELD									\$9,807,038
NG BOILERS									
800 HP Firetube Boiler	2 each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work			\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS									\$3,062,654
ELECTRIC BOILER									
Electric Boiler (17,000 MBH) 5MW	2 each	\$90,000.00	\$180,000.00	Plumbers	\$87.69	200	400.00	\$35,076.80	\$215,077
Direct digital control of boilers (est 15 pts each)	2 each	\$15,000.00	\$30,000.00	Electrician	\$87.69	128.57	257.14	\$22,549.12	\$52,549
Heating hot water system components	2 LS	\$50,000.00	\$100,000.00	Plumbers	\$87.69	146.29	292.58	\$25,656.93	\$125,657
4" concrete slab, vapor barrier, 6x6 6/6 welded wire mesh, 6" stone base, bulkheads and edge forms, finish, cure and protect	400 SF	\$5.50	\$2,200.00	Plumbers	\$87.69	0.06	24.00	\$2,104.61	\$4,305
TOTAL - ELECTRIC BOILER									\$397,587
ELECTRIC									
13.8kV - cable (500 kcmil)	2000 ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100 ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3 each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	9 each	\$4.45	\$40.05	Electrician	\$87.69	1.143	10.29	\$902.09	\$942
13.8kV - Terminations	24 each	\$395.00	\$9,480.00	Electrician	\$87.69	1.739	41.74	\$3,659.91	\$13,140

SCENARIO C2 - CENTRALIZED N.BLDGS REMOVED - WSHP/BOREFIELD/DRY COOLER & W/ELEC PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
13.8kV - Switch	1 each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
13.8kV/4.16kV Transformer	1 each	\$145,500.00	\$145,500.00	Electrician	\$87.69	105	105.00	\$9,207.66	\$154,708
4,160V - cable from Xfmr to E.Blr Switch to Boiler (500 kcmil)	4500 ft	\$10.25	\$46,125.00	Electrician	\$87.69	0.06667	300.02	\$26,308.92	\$72,434
4,160V E.Blr Switch	1 each	\$21,800.00	\$21,800.00	Electrician	\$87.69	52.632	52.63	\$4,615.41	\$26,415
4,160 Terminations	8 each	\$115.00	\$920.00	Electrician	\$87.69	1	8.00	\$701.54	\$1,622
4,000A 480V double ended switchgear w/xfmr	1 each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
160A-4,160 Feed to ASHP (inside plant)	200 ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500 ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer	1 each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1 each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$2,303,101
SUBTOTAL									\$60,653,054
GENERAL CONDITIONS									15%
OVERHEAD AND PROFIT									10%
DESIGN CONTINGENCY									20%
BID CONTINGENCY									5%
PHASING									10%
GRAND TOTAL									\$106,342,394

SCENARIO C3 - CENTRALIZED N.BLDGS REMOVED - WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
BUILDING MER PLATE & FRAME HEAT EXCHANGERS									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
200 Harrison St LLC (Chatauqua IDA) (46 gpm)	2 each	\$11,847.30	\$23,694.60	Plumbers	\$85.78	79.14	158.2861577	\$13,578.25	\$37,273
3644 Holdings LLC (Priscilla) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 2 (Cameo) (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	2 each	\$1,802.85	\$3,605.70	Plumbers	\$85.78	12.04	24.087024	\$2,066.26	\$5,672
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	2 each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73304457	\$3,837.33	\$10,534
Agnes Home (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.20501714	\$1,475.90	\$4,051
Anderson Manor LB (15 gpm)	2 each	\$3,863.25	\$7,726.50	Plumbers	\$85.78	25.81	51.61505143	\$4,427.69	\$12,154
Anderson Tower LP (21 gpm)	2 each	\$5,408.55	\$10,817.10	Plumbers	\$85.78	36.13	72.261072	\$6,198.77	\$17,016
Best Western Hotel (20 gpm)	2 each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82006857	\$5,903.59	\$16,206
Board Of Education - JHS (276 gpm)	2 each	\$71,083.80	\$142,167.60	Plumbers	\$85.78	474.86	949.7169463	\$81,469.52	\$223,637
Board Of Education - LOVE (73 gpm)	0 each	\$18,801.15	\$0.00	Plumbers	\$85.78	125.60	0	\$0.00	\$0
Board Of Education (Tech Cntr) (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
BPU - DH-carlson (25 gpm) +GT Air & Gas Preheat Pipe	2 each	\$130,062.75	\$260,125.50	Plumbers	\$85.78	868.85	1737.706731	\$149,065.61	\$409,191
BPU - low pres gas heat (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
BPU - monitor building (29 gpm)	2 each	\$7,468.95	\$14,937.90	Plumbers	\$85.78	49.89	99.78909943	\$8,560.20	\$23,498
Carlson Tower LP (18 gpm)	0 each	\$4,635.90	\$0.00	Plumbers	\$85.78	30.97	0	\$0.00	\$0
Chautauqua Brick, Inc (23 gpm)	2 each	\$5,923.65	\$11,847.30	Plumbers	\$85.78	39.57	79.14307886	\$6,789.13	\$18,636
Chautauqua Opportunities (82 gpm)	0 each	\$21,119.10	\$0.00	Plumbers	\$85.78	141.08	0	\$0.00	\$0
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$12,362.40	\$0.00	Plumbers	\$85.78	82.58	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
CODE Euclid Gardens (37 gpm)	0 each	\$9,529.35	\$0.00	Plumbers	\$85.78	63.66	0	\$0.00	\$0
Covenant Manor Apartments, LLC (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
DPW (14 gpm) Not Connected	0 each	\$3,605.70	\$0.00	Plumbers	\$85.78	24.09	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$4,893.45	\$0.00	Plumbers	\$85.78	32.69	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	2 each	\$1,030.20	\$2,060.40	Plumbers	\$85.78	6.88	13.76401371	\$1,180.72	\$3,241
Eliz W Marvin House (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.64602057	\$1,771.08	\$4,862
E-Z Clean Car Wash (3 gpm)	2 each	\$772.65	\$1,545.30	Plumbers	\$85.78	5.16	10.32301029	\$885.54	\$2,431
First Covenant Church (33 gpm)	2 each	\$8,499.15	\$16,998.30	Plumbers	\$85.78	56.78	113.5531131	\$9,740.92	\$26,739
First Lutheran Church (57 gpm)	2 each	\$14,680.35	\$29,360.70	Plumbers	\$85.78	98.07	196.1371954	\$16,825.23	\$46,186
Fourth St Housing (11 gpm)	2 each	\$2,833.05	\$5,666.10	Plumbers	\$85.78	18.93	37.85103771	\$3,246.97	\$8,913
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	2 each	\$4,378.35	\$8,756.70	Plumbers	\$85.78	29.25	58.49705829	\$5,018.05	\$13,775
Herbert A Duke II (17 gpm) Not Connected	0 each	\$4,378.35	\$0.00	Plumbers	\$85.78	29.25	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	2 each	\$7,726.50	\$15,453.00	Plumbers	\$85.78	51.62	103.2301029	\$8,855.38	\$24,308
Heritage Ministries 2 (Childcare) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	2 each	\$15,453.00	\$30,906.00	Plumbers	\$85.78	103.23	206.4602057	\$17,710.77	\$48,617
Inter'n Ordinance Tech (18 gpm)	2 each	\$4,635.90	\$9,271.80	Plumbers	\$85.78	30.97	61.93806171	\$5,313.23	\$14,585
Jamestown Boys & Girls Club (55 gpm)	2 each	\$14,165.25	\$28,330.50	Plumbers	\$85.78	94.63	189.2551886	\$16,234.87	\$44,565
Jamestown City (Ice Arena) (119 gpm)	2 each	\$30,648.45	\$61,296.90	Plumbers	\$85.78	204.74	409.479408	\$35,126.35	\$96,423
Jamestown Newspaper Corp (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
JHA (5th St. High Rise) (44 gpm)	2 each	\$11,332.20	\$22,664.40	Plumbers	\$85.78	75.70	151.4041509	\$12,987.89	\$35,652
JHA (Chadakoin Bldg) (38 gpm)	2 each	\$9,786.90	\$19,573.80	Plumbers	\$85.78	65.38	130.7581303	\$11,216.82	\$30,791
JHA (Hotel Jamestown) (70 gpm)	2 each	\$18,028.50	\$36,057.00	Plumbers	\$85.78	120.44	240.87024	\$20,662.56	\$56,720
JRP (Jody Peterson) (8 gpm)	2 each	\$2,060.40	\$4,120.80	Plumbers	\$85.78	13.76	27.52802743	\$2,361.44	\$6,482
JRP (South County Office Bldg) (32 gpm)	2 each	\$8,241.60	\$16,483.20	Plumbers	\$85.78	55.06	110.1121097	\$9,445.74	\$25,929
Kaleida Health (72 gpm)	2 each	\$18,543.60	\$37,087.20	Plumbers	\$85.78	123.88	247.7522469	\$21,252.92	\$58,340
Krog Corp (BWB Center) (22 gpm)	2 each	\$5,666.10	\$11,332.20	Plumbers	\$85.78	37.85	75.70207543	\$6,493.95	\$17,826
Legal Assistance of WNY (6 gpm)	2 each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Lewis & Lewis P C (.001) (.1) (5 gpm)	2 each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051

SCENARIO C3 - CENTRALIZED N.BLDGS REMOVED - WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	2	each	\$1,545.30	\$3,090.60	Plumbers	\$85.78	10.32	20.65	\$1,771.08	\$4,862
Little Theater Jamestown (95 gpm)	2	each	\$24,467.25	\$48,934.50	Plumbers	\$85.78	163.45	326.90	\$28,042.05	\$76,977
National Comedy Center, Inc. (26 gpm)	2	each	\$6,696.30	\$13,392.60	Plumbers	\$85.78	44.73	89.47	\$7,674.67	\$21,067
Northwest Bank (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Prendergast Library (25 gpm)	2	each	\$6,438.75	\$12,877.50	Plumbers	\$85.78	43.01	86.03	\$7,379.49	\$20,257
REALiFE Church Inc. (24 gpm)	2	each	\$6,181.20	\$12,362.40	Plumbers	\$85.78	41.29	82.58	\$7,084.31	\$19,447
Reg Lenna Center for the Arts (86 gpm)	2	each	\$22,149.30	\$44,298.60	Plumbers	\$85.78	147.96	295.93	\$25,385.43	\$69,684
Riverwalk Properties (JAMA) (174 gpm)	2	each	\$44,813.70	\$89,627.40	Plumbers	\$85.78	299.37	598.73	\$51,361.22	\$140,989
Robert H Jackson Inc, The (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
St James Church (53 gpm)	2	each	\$13,650.15	\$27,300.30	Plumbers	\$85.78	91.19	182.37	\$15,644.51	\$42,945
St Susan Center (45 gpm)	2	each	\$11,589.75	\$23,179.50	Plumbers	\$85.78	77.42	154.85	\$13,283.07	\$36,463
Time Warner Cable (13 gpm)	2	each	\$3,348.15	\$6,696.30	Plumbers	\$85.78	22.37	44.73	\$3,837.33	\$10,534
Triple R, LLC (5 gpm)	2	each	\$1,287.75	\$2,575.50	Plumbers	\$85.78	8.60	17.21	\$1,475.90	\$4,051
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	2	each	\$59,494.05	\$118,988.10	Plumbers	\$85.78	397.44	794.87	\$68,186.45	\$187,175
UPMC Chautauque at WCA (Physicians) (81 gpm)	2	each	\$20,861.55	\$41,723.10	Plumbers	\$85.78	139.36	278.72	\$23,909.53	\$65,633
UPMC Chautauque at WCA (Hospital)1 (668 gpm)+HRC	2	each	\$254,543.40	\$509,086.80	Plumbers	\$85.78	1266.30	2,532.59	\$217,253.07	\$726,340
Westerberg Tower LP (20 gpm)	2	each	\$5,151.00	\$10,302.00	Plumbers	\$85.78	34.41	68.82	\$5,903.59	\$16,206
Windstream Corp A/P (36 gpm)	2	each	\$9,271.80	\$18,543.60	Plumbers	\$85.78	61.94	123.88	\$10,626.46	\$29,170
YMCA (main) (147 gpm)	2	each	\$37,859.85	\$75,719.70	Plumbers	\$85.78	252.91	505.83	\$43,391.38	\$119,111
YWCA (12 gpm)	2	each	\$3,090.60	\$6,181.20	Plumbers	\$85.78	20.65	41.29	\$3,542.15	\$9,723
Removal of existing heat exchangers	114	each	\$500.00	\$57,000.00	Plumbers	\$85.78	32.00	3,648.00	\$312,936.20	\$369,936
6" Concrete Pad	57	each	\$250.00	\$14,250.00	Cement Masons	\$72.62	8.00	456.00	\$33,113.37	\$47,363
Control system upgrades to accommodate low temperature water	114	each	\$400.00	\$45,600.00	Electrician	\$87.69	8.00	912.00	\$79,975.10	\$125,575
Direct digital control of HX's (8 points each)	912	each	\$0.00	\$0.00	Electrician	\$87.69	12.00	10,944.00	\$959,701.25	\$959,701
Valve packages for HXs	114	each	\$1,000.00	\$114,000.00	Plumbers	\$85.78	8.00	912.00	\$78,234.05	\$192,234
Isolation valves, automatic	228	each	\$1,500.00	\$342,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$498,468
Flow meters, ultrasonic	228	each	\$3,500.00	\$798,000.00	Plumbers	\$85.78	8.00	1,824.00	\$156,468.10	\$954,468
Temperature transmitters	456	each	\$1,000.00	\$456,000.00	Plumbers	\$85.78	4.00	1,824.00	\$156,468.10	\$612,468
Pressure transmitters	228	each	\$1,000.00	\$228,000.00	Plumbers	\$85.78	4.00	912.00	\$78,234.05	\$306,234
Differential pressure switch	114	each	\$500.00	\$57,000.00	Plumbers	\$85.78	2.00	228.00	\$19,558.51	\$76,559
Test and balance	57	buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	4,560.00	\$391,170.25	\$391,170
TOTAL - BUILDING MER PLATE & FRAME HEAT EXCHANGERS										\$7,641,928
DECENTRALIZE BUILDINGS NORTH OF 6TH STREET										
Chautauqua Opportunities (82 gpm) - MEDIUM	1	each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
CODE Euclid Gardens (37 gpm) - MEDIUM	1	each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Carlson Tower LP (18 gpm) - MEDIUM	1	each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Board Of Education - LOVE (73 gpm) - MEDIUM	1	each	\$295,743.02	\$295,743.02	Plumbers	\$85.78	646.33	646.33	\$55,443.96	\$351,187
Electrical Distribution Upgrades	1	LS	\$185,616.72	\$185,616.72	Electrician	\$87.69	632.26	632.26	\$55,443.96	\$241,061
TOTAL - DECENTRALIZE BUILDINGS NORTH OF 6TH STREET										\$1,645,809
DISTRICT HOT WATER DISTRIBUTION PIPING										
1" Site Distribution Piping DB EN-253 Pipe & Fittings	1736	ft-Trench	\$34.00	\$59,024.00	Plumbers	\$85.78	3.38	5,868.04	\$503,377.59	\$562,402
2" Site Distribution Piping DB EN-253 Pipe & Fittings	3833	ft-Trench	\$40.00	\$153,320.00	Plumbers	\$85.78	3.59	13,747.50	\$1,179,300.89	\$1,332,621
3" Site Distribution Piping DB EN-253 Pipe & Fittings	7552	ft-Trench	\$46.00	\$347,392.00	Plumbers	\$85.78	3.79	28,644.93	\$2,457,246.18	\$2,804,638
4" Site Distribution Piping DB EN-253 Pipe & Fittings	2721	ft-Trench	\$64.00	\$174,144.00	Plumbers	\$85.78	4.34	11,808.75	\$1,012,989.01	\$1,187,133
6" Site Distribution Piping DB EN-253 Pipe & Fittings	5009	ft-Trench	\$94.00	\$470,846.00	Plumbers	\$85.78	5.26	26,363.89	\$2,261,572.46	\$2,732,418
8" Site Distribution Piping DB EN-253 Pipe & Fittings	899	ft-Trench	\$132.00	\$118,668.00	Plumbers	\$85.78	6.38	5,733.37	\$491,825.75	\$610,494
10" Site Distribution Piping DB EN-253 Pipe & Fittings	1193	ft-Trench	\$190.00	\$226,670.00	Plumbers	\$85.78	8.06	9,619.86	\$825,219.98	\$1,051,890
12" Site Distribution Piping DB EN-253 Pipe & Fittings	3147	ft-Trench	\$240.00	\$755,280.00	Plumbers	\$85.78	9.54	30,011.44	\$2,574,469.77	\$3,329,750
14" Site Distribution Piping DB EN-253 Pipe & Fittings	3223	ft-Trench	\$276.00	\$889,548.00	Plumbers	\$85.78	10.61	34,203.27	\$2,934,057.57	\$3,823,606

SCENARIO C3 - CENTRALIZED N.BLDGS REMOVED - WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
16" Site Distribution Piping DB EN-253 Pipe & Fittings	3351	ft-Trench	\$380.00	\$1,273,380.00	Plumbers	\$85.78	13.62	45,630.63	\$3,914,330.31	\$5,187,710
18" Site Distribution Piping DB EN-253 Pipe & Fittings	0	ft-Trench	\$492.00	\$0.00	Plumbers	\$85.78	16.85	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	17	MO	\$75,000.00	\$1,275,000.00	Plumbers	\$85.78	30.00	510.00	\$43,749.30	\$1,318,749
Rental boilers, 50 hp	11	MO	\$50,000.00	\$550,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$578,308
Rental boilers, 20 hp	11	MO	\$35,000.00	\$385,000.00	Plumbers	\$85.78	30.00	330.00	\$28,308.37	\$413,308
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - DISTRICT HOT WATER DISTRIBUTION PIPING										\$25,248,808
WORK INSIDE CENTRAL ENERGY PLANT										
Construct 50'x20' 2nd story 15' above 1st story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
Construct 50'x20' 3rd story 15' above 2nd story	1	each	\$75,000.00	\$75,000.00	Ironworker	\$82.54	1920	1,920.00	\$158,476.03	\$233,476
TOTAL - WORK INSIDE CENTRAL ENERGY PLANT										\$466,952
THERMAL ENERGY STORAGE TANK										
520,000 gallon TES	1	LS	\$1,269,528.45	\$1,269,528.45	Master Mechanic	\$93.84	5120	5,120.00	\$480,471.55	\$1,750,000
Removal of existing coal towers & conveyors	1	LS	\$0.00	\$0.00	Laborer	\$60.32	5,802	5,802.00	\$349,983.89	\$349,984
Removal of existing concrete silo	1	LS	\$25,000.00	\$25,000.00	Ironworker	\$82.54	4160	4,160.00	\$343,364.74	\$368,365
Direct digital control of TES	1	each	\$14,000.00	\$14,000.00	Electrician	\$87.69	120.00	120.00	\$10,523.04	\$24,523
Nitrogen Generator (20 cfm)	1	each	\$20,000.00	\$20,000.00	Plumbers	\$85.78	22	22.00	\$1,887.22	\$21,887
100' Trench 12" Direct Buried EN-253 Pipe	100	ft	\$240.00	\$24,000.00	Plumbers	\$85.78	9.54	953.65	\$81,807.11	\$105,807
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
12" isolation valves	4	each	\$12,632.00	\$50,528.00	Plumbers	\$12.63		0.00	\$0.00	\$50,528
TOTAL - THERMAL ENERGY STORAGE TANK										\$2,733,406
WATER SOURCE HEAT PUMP (WSHP)										
WSHP - Trane CVHH (17,500 Mbh)	2	each	\$1,150,000.00	\$2,300,000.00	Plumbers	\$85.78	427.00	854.00	\$73,258.64	\$2,373,259
WSHP Isolation valves Evap & Cond	8	each	\$5,250.00	\$42,000.00	Plumbers	\$85.78	10.435	83.48	\$7,161.16	\$49,161
WSHP Nearby pipe	400	ft	\$176.00	\$70,400.00	Plumbers	\$85.78	1.6	640.00	\$54,901.09	\$125,301
WSHP Pipe Insulation	400	ft	\$15.75	\$6,300.00	Plumbers	\$85.78	0.229	91.60	\$7,857.72	\$14,158
Direct digital control of WSHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Site Distribution Pumps, 2,000 gpm @ 145ft	5	each	\$34,100.00	\$170,500.00	Plumbers	\$85.78	60	300.00	\$25,734.89	\$196,235
Site Distribution Pump - VFD	5	each	\$22,600.00	\$113,000.00	Electrician	\$87.69	57.143	285.72	\$25,054.92	\$138,055
Site Distribution Pump - Isolation Valves	10	each	\$4,400.00	\$44,000.00	Plumbers	\$85.78	9.6	96.00	\$8,235.16	\$52,235
Site Distribution Pump - Nearby Piping	100	ft	\$112.50	\$11,250.00	Plumbers	\$85.78	1.02	102.00	\$8,749.86	\$20,000
Site Distribution Pump - Temperature transmitters	10	each	\$150.00	\$1,500.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$4,931
Site Distribution Pump - Pressure transmitters	10	each	\$200.00	\$2,000.00	Plumbers	\$85.78	4.00	40.00	\$3,431.32	\$5,431
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	5	each	\$2,325.00	\$11,625.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$15,743
Site Distribution Pump - Check Vlv	5	each	\$4,000.00	\$20,000.00	Plumbers	\$85.78	9.6	48.00	\$4,117.58	\$24,118
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
Rigging to upper elevations	2	each	\$2,325.00	\$4,650.00	Operator (Crane)	\$87.68	16	32.00	\$2,805.83	\$7,456
Remove replace wall sections for rigging operation	1	each	\$20,000.00	\$20,000.00	Ironworker	\$82.54	480	480.00	\$39,619.01	\$59,619
TOTAL - WATER SOURCE HEAT PUMP (WSHP)										\$3,190,654
AIR SOURCE HEAT PUMP (ASHP)										
Air Source Heat Pumps ACXA230	17	each	\$247,058.82	\$4,200,000.00	Plumbers	\$85.78	50.794	863.50	\$74,073.41	\$4,274,073
Direct digital control of ASHP	24	points	\$0.00	\$0.00	Electrician	\$87.69	12	288.00	\$25,255.30	\$25,255
Pumps serving ASHP, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
ASHP Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
ASHP Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
ASHP Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000

SCENARIO C3 - CENTRALIZED N.BLDGS REMOVED - WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
ASHP Circ. Pump - Temperature transmitters	4 each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
ASHP Circ. Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
ASHP Circ. Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
ASHP Circ. Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
ASHP Circ. Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10 points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000 ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077
Concrete foundation	1000 SF	\$12.00	\$12,000.00	Cement Masons	\$72.62	0.12	120.00	\$8,714.05	\$20,714
Earthwork including excavation, backfill, & disposal	115 CY	\$100.00	\$11,500.00	Laborer Foreman	\$61.79	1	115.00	\$7,106.14	\$18,606
Trench 12" Direct Buried HDPE Pipe	300 ft-Trench	\$308.40	\$92,520.00	Plumbers	\$87.69	4.59	1,376.85	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200 ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24 each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2 each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
			\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - AIR SOURCE HEAT PUMP (ASHP)									\$5,087,474
GEOTHERMAL WELLFIELD									
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 450 bore holes, 499' depth	0 each	\$13,473.00	\$0.00	Plumbers	\$85.78	51.325	0.00	\$0.00	\$0
Direct digital control of wellfield (est 100 pts each)	0 points	\$700.00	\$0.00	Electrician	\$87.69	6	0.00	\$0.00	\$0
Pumps serving borefield, 2,000 gpm @ 45ft	0 each	\$48,950.00	\$0.00	Plumbers	\$85.78	73.14	0.00	\$0.00	\$0
Wellfield Circulating Pump - VFD	0 each	\$22,600.00	\$0.00	Plumbers	\$85.78	57.143	0.00	\$0.00	\$0
Wellfield Circulating Pump - Isolation Valves	0 each	\$4,400.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield Circulating Pump - Nearby Piping	0 ft	\$112.50	\$0.00	Plumbers	\$85.78	1.02	0.00	\$0.00	\$0
Wellfield Circulating Pump - Temperature transmitters	0 each	\$150.00	\$0.00	Plumbers	\$85.78	0.91	0.00	\$0.00	\$0
Wellfield Circulating Pump - Pressure transmitters	0 each	\$200.00	\$0.00	Plumbers	\$85.78	0.91	0.00	\$0.00	\$0
Wellfield Circulating Pump - Test and balance	0 LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	0.00	\$0.00	\$0
Wellfield Circulating Pump - Suction Diffuser	0 each	\$2,325.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield Circulating Pump - Check Vlv	0 each	\$4,000.00	\$0.00	Plumbers	\$85.78	9.6	0.00	\$0.00	\$0
Wellfield piping from borefield to central plant									
HDPE Piping System	0 ft-Trench	\$308.40	\$0.00	Plumbers	\$87.69	4.59	0.00	\$0.00	\$0
TOTAL - GEOTHERMAL WELLFIELD									\$0
NG BOILERS									
800 HP Firetube Boiler	2 each	\$929,662.00	\$1,859,324.00	Master Mechanic	\$93.84	\$6,411.46	12,822.92	\$1,203,330.13	\$3,062,654
Includes all associated work			\$0.00				0.00	\$0.00	\$0
TOTAL - NG BOILERS									\$3,062,654
ELECTRIC									
13.8kV - cable (500 kcmil)	2000 ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100 ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3 each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6 each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12 each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1 each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	1 each	\$703,528.00	\$703,528.00	Electrician	\$87.69	240	240.00	\$21,046.08	\$724,574
160A-4,160 Feed to ASHP (inside plant)	200 ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500 ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.8	480.00	\$42,092.16	\$102,092
120A-4,160V Feed to WSHP-2 (inside plant)	600 ft	\$100.00	\$60,000.00	Electrician	\$87.69	0.80	480.00	\$42,092.16	\$102,092
13.8kV/480V Transformer	1 each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023

SCENARIO C3 - CENTRALIZED N.BLDGS REMOVED - WSHP-ASHP CASCADE EQUIPMENT W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
480V (2000A) Switchgear	1 each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$2,041,038
SUBTOTAL									\$51,118,723
GENERAL CONDITIONS									15%
OVERHEAD AND PROFIT									10%
DESIGN CONTINGENCY									20%
BID CONTINGENCY									5%
PHASING									10%
GRAND TOTAL									\$89,625,946

SCENARIO D1 - AMBIENT LOOP W/HEAT PUMP PEAKING UNITS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DECENTRALIZE WITH HEAT PUMPS @ 100% CAPACITY AND NG BOILER BACKUP									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
200 Harrison St LLC (Chatauqua IDA) (46 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
3644 Holdings LLC (Priscilla) (15 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
3644 Holdings LLC 2 (Cameo) (15 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Agnes Home (5 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
Anderson Manor LB (15 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Anderson Tower LP (21 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Best Western Hotel (20 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Board Of Education - JHS (276 gpm)	1 each	\$872,932.87	\$872,932.87	Plumbers	\$85.78	3265.91	3265.905973	\$280,159.05	\$1,153,092
Board Of Education - LOVE (73 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Board Of Education (Tech Cntr) (11 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
BPU - DH-carlson (25 gpm)	1 each	\$1,133,058.37	\$1,133,058.37	Plumbers	\$85.78	4134.76	4134.759339	\$354,691.85	\$1,487,750
BPU - low pres gas heat (3 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
BPU - monitor building (29 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Carlson Tower LP (18 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Chautauqua Brick, Inc (23 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Chautauqua Opportunities (82 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$240,109.23	\$0.00	Plumbers	\$85.78	1178.23	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
CODE Euclid Gardens (37 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Covenant Manor Apartments, LLC (55 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
DPW (14 gpm) Not Connected	0 each	\$240,109.23	\$0.00	Plumbers	\$85.78	1178.23	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$240,109.23	\$0.00	Plumbers	\$85.78	1178.23	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
Eliz W Marvin House (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
E-Z Clean Car Wash (3 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
First Covenant Church (33 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
First Lutheran Church (57 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Fourth St Housing (11 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Herbert A Duke II (17 gpm) Not Connected	0 each	\$240,109.23	\$0.00	Plumbers	\$85.78	1178.23	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Heritage Ministries 2 (Childcare) (8 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Inter'n Ordinance Tech (18 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Jamestown Boys & Girls Club (55 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Jamestown City (Ice Arena) (119 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Jamestown Newspaper Corp (22 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
JHA (5th St. High Rise) (44 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
JHA (Chadakoin Bldg) (38 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
JHA (Hotel Jamestown) (70 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
JRP (Jody Peterson) (8 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
JRP (South County Office Bldg) (32 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Kaleida Health (72 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Krog Corp (BWB Center) (22 gpm)	1 each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1178.231779	\$101,072.20	\$341,181
Legal Assistance of WNY (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
Lewis & Lewis P C (.001) (.1) (5 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077

SCENARIO D1 - AMBIENT LOOP W/HEAT PUMP PEAKING UNITS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	1	each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
Little Theater Jamestown (95 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
National Comedy Center, Inc. (26 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Northwest Bank (13 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Prendergast Library (25 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
REALiFE Church Inc. (24 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Reg Lenna Center for the Arts (86 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Riverwalk Properties (JAMA) (174 gpm)	1	each	\$872,932.87	\$872,932.87	Plumbers	\$85.78	3265.91	3,265.91	\$280,159.05	\$1,153,092
Robert H Jackson Inc, The (12 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
St James Church (53 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
St Susan Center (45 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Time Warner Cable (13 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Triple R, LLC (5 gpm)	1	each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1	each	\$872,932.87	\$872,932.87	Plumbers	\$85.78	3265.91	3,265.91	\$280,159.05	\$1,153,092
UPMC Chautauque at WCA (Physicians) (81 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	1	each	\$3,608,195.07	\$3,608,195.07	Plumbers	\$85.78	7579.16	7,579.16	\$650,162.84	\$4,258,358
Westerberg Tower LP (20 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Windstream Corp A/P (36 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
YMCA (main) (147 gpm)	1	each	\$872,932.87	\$872,932.87	Plumbers	\$85.78	3265.91	3,265.91	\$280,159.05	\$1,153,092
YWCA (12 gpm)	1	each	\$240,109.23	\$240,109.23	Plumbers	\$85.78	1178.23	1,178.23	\$101,072.20	\$341,181
Electrical Distribution Upgrades	1	LS	\$6,875,057.42	\$6,875,057.42	Electrician	\$87.69	23418.20	23,418.20	\$2,053,588.58	\$8,928,646
Removal of existing heat exchangers	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	32.00	4,160.00	\$356,857.07	\$421,857
6" Concrete Pad	69	each	\$250.00	\$17,250.00	Cement Masons	\$72.62	8.00	552.00	\$40,084.61	\$57,335
Control system upgrades to accommodate low temperature water	130	each	\$400.00	\$52,000.00	Electrician	\$87.69	8.00	1,040.00	\$91,199.68	\$143,200
Direct digital control of equipment (8 points each)	1,040	each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages	130	each	\$1,000.00	\$130,000.00	Plumbers	\$85.78	8.00	1,040.00	\$89,214.27	\$219,214
Isolation valves, automatic	260	each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260	each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520	each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260	each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130	each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65	buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
TOTAL - DECENTRALIZE WITH HEAT PUMPS @ 100% CAPACITY AND NG BOILER BACKUP										\$41,898,344
AMBIENT LOOP DISTRIBUTION PIPING										
1" Site Distribution Piping DB HDPE Pipe & Fittings	0	ft-Trench	\$84.07	\$0.00	Plumbers	\$85.78	3.19	0.00	\$0.00	\$0
2" Site Distribution Piping DB HDPE Pipe & Fittings	1424	ft-Trench	\$92.71	\$132,023.53	Plumbers	\$85.78	3.36	4,788.98	\$410,812.50	\$542,836
3" Site Distribution Piping DB HDPE Pipe & Fittings	2081	ft-Trench	\$103.68	\$215,756.09	Plumbers	\$85.78	3.54	7,365.72	\$631,853.07	\$847,609
4" Site Distribution Piping DB HDPE Pipe & Fittings	5030	ft-Trench	\$120.40	\$605,612.00	Plumbers	\$85.78	3.99	20,055.30	\$1,720,402.81	\$2,326,015
6" Site Distribution Piping DB HDPE Pipe & Fittings	8096	ft-Trench	\$145.80	\$1,180,396.80	Plumbers	\$85.78	4.22	34,187.80	\$2,932,730.15	\$4,113,127
8" Site Distribution Piping DB HDPE Pipe & Fittings	5794	ft-Trench	\$190.80	\$1,105,495.20	Plumbers	\$85.78	4.39	25,408.19	\$2,179,589.52	\$3,285,085
10" Site Distribution Piping DB HDPE Pipe & Fittings	3019	ft-Trench	\$250.60	\$756,561.40	Plumbers	\$85.78	4.58	13,822.07	\$1,185,697.96	\$1,942,259
12" Site Distribution Piping DB HDPE Pipe & Fittings	131	ft-Trench	\$308.40	\$40,400.40	Plumbers	\$85.78	4.69	614.61	\$52,722.76	\$93,123
14" Site Distribution Piping DB HDPE Pipe & Fittings	891	ft-Trench	\$375.80	\$334,837.80	Plumbers	\$85.78	4.94	4,405.29	\$377,898.93	\$712,737
16" Site Distribution Piping DB HDPE Pipe & Fittings	973	ft-Trench	\$457.95	\$445,580.84	Plumbers	\$85.78	5.10	4,960.63	\$425,537.42	\$871,118
18" Site Distribution Piping DB HDPE Pipe & Fittings	2516	ft-Trench	\$547.35	\$1,377,120.23	Plumbers	\$85.78	5.27	13,260.63	\$1,137,536.29	\$2,514,657
20" Site Distribution Piping DB HDPE Pipe & Fittings	0	ft-Trench	\$646.05	\$0.00	Plumbers	\$85.78	5.44	0.00	\$0.00	\$0
24" Site Distribution Piping DB HDPE Pipe & Fittings	7113	ft-Trench	\$871.38	\$6,198,124.30	Plumbers	\$85.78	5.76	40,983.69	\$3,515,702.09	\$9,713,826
Rental boilers, 100 hp (Pipe replacement phasing)	18	MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12	MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882

SCENARIO D1 - AMBIENT LOOP W/HEAT PUMP PEAKING UNITS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - AMBIENT LOOP DISTRIBUTION PIPING										\$29,756,259
AMBIENT LOOP SITE DISTRIBUTION PUMPS										
Site Distribution Pumps, 2,000 gpm @ 145ft	4	each	\$34,100.00	\$136,400.00	Plumbers	\$85.78	60	240.00	\$20,587.91	\$156,988
Site Distribution Pump - VFD	4	each	\$22,600.00	\$90,400.00	Electrician	\$87.69	57.143	228.57	\$20,043.94	\$110,444
Site Distribution Pump - Isolation Valves	8	each	\$4,400.00	\$35,200.00	Plumbers	\$85.78	9.6	76.80	\$6,588.13	\$41,788
Site Distribution Pump - Nearby Piping	80	ft	\$112.50	\$9,000.00	Plumbers	\$85.78	1.02	81.60	\$6,999.89	\$16,000
Site Distribution Pump - Temperature transmitters	8	each	\$150.00	\$1,200.00	Plumbers	\$85.78	4.00	32.00	\$2,745.05	\$3,945
Site Distribution Pump - Pressure transmitters	8	each	\$200.00	\$1,600.00	Plumbers	\$85.78	4.00	32.00	\$2,745.05	\$4,345
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	4	each	\$2,325.00	\$9,300.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$12,594
Site Distribution Pump - Check Vlv	4	each	\$4,000.00	\$16,000.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$19,294
Direct digital control of pumps	8	points	\$0.00	\$0.00	Electrician	\$87.69	12	96.00	\$8,418.43	\$8,418
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
TOTAL - AMBIENT LOOP SITE DISTRIBUTION PUMPS										\$442,991
AIR SOURCE HEAT PUMP (ASHP)										
Air Source Heat Pumps ACXA230	11	each	\$247,058.82	\$2,717,647.06	Plumbers	\$85.78	50.794	558.73	\$47,929.85	\$2,765,577
Direct digital control of ASHP	18	points	\$0.00	\$0.00	Electrician	\$87.69	12	216.00	\$18,941.47	\$18,941
Pumps serving ASHP, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
ASHP Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
ASHP Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
ASHP Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
ASHP Circ. Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
ASHP Circ. Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
ASHP Circ. Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
ASHP Circ. Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
ASHP Circ. Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000	ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077
Concrete foundation	800	SF	\$12.00	\$9,600.00	Cement Masons	\$72.62	0.12	96.00	\$6,971.24	\$16,571
Earthwork including excavation, backfill, & disposal	92	CY	\$100.00	\$9,200.00	Laborer Foreman	\$61.79	1	92.00	\$5,684.91	\$14,885
Trench 12" Direct Buried HDPE Pipe	300	ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24	each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2	each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
				\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - AIR SOURCE HEAT PUMP (ASHP)										\$3,564,800
GEOTHERMAL WELLFIELD										
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 667 bore holes, 499' depth	667	each	\$13,473.00	\$8,986,491.00	Plumbers	\$85.78	51.325	34,233.78	\$2,936,674.21	\$11,923,165
Direct digital control of wellfield (est 100 pts each)	100	points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913

SCENARIO D1 - AMBIENT LOOP W/HEAT PUMP PEAKING UNITS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Wellfield Circulating Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000	ft-Trench	\$308.40	\$616,800.00	Plumbers	\$85.78	4.69	9,383.31	\$804,927.69	\$1,421,728
TOTAL - GEOTHERMAL WELLFIELD										\$13,686,089
ELECTRIC										
13.8kV - cable (500 kcmil)	2000	ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100	ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kv - Ground rods	3	each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6	each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12	each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kv - Switch	1	each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	0	each	\$703,528.00	\$0.00	Electrician	\$87.69	240	0.00	\$0.00	\$0
160A-4,160 Feed to ASHP (inside plant)	200	ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500	ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	0	ft	\$100.00	\$0.00	Electrician	\$87.69	0.8	0.00	\$0.00	\$0
120A-4,160V Feed to WSHP-2 (inside plant)	0	ft	\$100.00	\$0.00	Electrician	\$87.69	0.80	0.00	\$0.00	\$0
13.8kv/480V Transformer	1	each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100	ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1	each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1	each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600	ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1	each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200	ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC										\$1,112,280
SUBTOTAL										\$90,460,763
GENERAL CONDITIONS										15% \$104,029,877
OVERHEAD AND PROFIT										10% \$114,432,865
DESIGN CONTINGENCY										20% \$137,319,438
BID CONTINGENCY										5% \$144,185,410
PHASING										10% \$158,603,951
GRAND TOTAL										\$158,603,951

SCENARIO D2 - AMBIENT LOOP W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DECENTRALIZE WITH HEAT PUMPS @ 60% CAPACITY AND NG BOILER BACKUP									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
200 Harrison St LLC (Chataqua IDA) (46 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
3644 Holdings LLC (Priscilla) (15 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
3644 Holdings LLC 2 (Cameo) (15 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Agnes Home (5 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
Anderson Manor LB (15 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Anderson Tower LP (21 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Best Western Hotel (20 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Board Of Education - JHS (276 gpm)	1 each	\$671,934.57	\$671,934.57	Plumbers	\$85.78	3033.26	3033.263526	\$260,202.29	\$932,137
Board Of Education - LOVE (73 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Board Of Education (Tech Cntr) (11 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
BPU - DH-carlson (25 gpm)	1 each	\$1,133,058.37	\$1,133,058.37	Plumbers	\$85.78	4134.76	4134.759339	\$354,691.85	\$1,487,750
BPU - low pres gas heat (3 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
BPU - monitor building (29 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Carlson Tower LP (18 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Chataqua Brick, Inc (23 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Chataqua Opportunities (82 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
City of Jamestown (City Hall) (48 gpm) Not Connected	0 each	\$178,102.93	\$0.00	Plumbers	\$85.78	1046.99	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
CODE Euclid Gardens (37 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Covenant Manor Apartments, LLC (55 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
DPW (14 gpm) Not Connected	0 each	\$178,102.93	\$0.00	Plumbers	\$85.78	1046.99	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 each	\$178,102.93	\$0.00	Plumbers	\$85.78	1046.99	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
Eliz W Marvin House (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
E-Z Clean Car Wash (3 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
First Covenant Church (33 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
First Lutheran Church (57 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Fourth St Housing (11 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Herbert A Duke II (17 gpm) Not Connected	0 each	\$178,102.93	\$0.00	Plumbers	\$85.78	1046.99	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Heritage Ministries 2 (Childcare) (8 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Inter'n Ordinance Tech (18 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Jamestown Boys & Girls Club (55 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Jamestown City (Ice Arena) (119 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Jamestown Newspaper Corp (22 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
JHA (5th St. High Rise) (44 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
JHA (Chadakoin Bldg) (38 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
JHA (Hotel Jamestown) (70 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
JRP (Jody Peterson) (8 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.4710103	\$53,997.88	\$134,077
JRP (South County Office Bldg) (32 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Kaleida Health (72 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Krog Corp (BWB Center) (22 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1046.990358	\$89,813.92	\$267,917
Legal Assistance of WNY (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
Lewis & Lewis P C (.001) (.1) (5 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077

SCENARIO D2 - AMBIENT LOOP W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
Little Theater Jamestown (95 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
National Comedy Center, Inc. (26 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Northwest Bank (13 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Prendergast Library (25 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
REALiFE Church Inc. (24 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Reg Lenna Center for the Arts (86 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Riverwalk Properties (JAMA) (174 gpm)	1 each	\$671,934.57	\$671,934.57	Plumbers	\$85.78	3033.26	3,033.26	\$260,202.29	\$932,137
Robert H Jackson Inc, The (12 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
St James Church (53 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
St Susan Center (45 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Time Warner Cable (13 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Triple R, LLC (5 gpm)	1 each	\$80,079.03	\$80,079.03	Plumbers	\$85.78	629.47	629.47	\$53,997.88	\$134,077
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1 each	\$671,934.57	\$671,934.57	Plumbers	\$85.78	3033.26	3,033.26	\$260,202.29	\$932,137
UPMC Chautauque at WCA (Physicians) (81 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	1 each	\$3,066,965.81	\$3,066,965.81	Plumbers	\$85.78	6442.29	6,442.29	\$552,638.41	\$3,619,604
Westerberg Tower LP (20 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Windstream Corp A/P (36 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
YMCA (main) (147 gpm)	1 each	\$671,934.57	\$671,934.57	Plumbers	\$85.78	3033.26	3,033.26	\$260,202.29	\$932,137
YWCA (12 gpm)	1 each	\$178,102.93	\$178,102.93	Plumbers	\$85.78	1046.99	1,046.99	\$89,813.92	\$267,917
Removal of existing heat exchangers	130 each	\$500.00	\$65,000.00	Plumbers	\$87.69	32.00	4,160.00	\$364,798.72	\$429,799
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$85.78	8.00	552.00	\$47,352.19	\$64,602
Control system upgrades to accommodate low temperature water	130 each	\$400.00	\$52,000.00	Electrician	\$72.62	8.00	1,040.00	\$75,521.73	\$127,522
Direct digital control of equipment (8 points each)	1,040 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages	130 each	\$1,000.00	\$130,000.00	Plumbers	\$87.69	8.00	1,040.00	\$91,199.68	\$221,200
Isolation valves, automatic	260 each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260 each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520 each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260 each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
Electrical Distribution Upgrades	1 LS	\$4,125,034.45	\$4,125,034.45	Electrician	\$87.69	14050.92	14,050.92	\$1,232,153.15	\$5,357,188
TOTAL - DECENTRALIZE WITH HEAT PUMPS @ 60% CAPACITY AND NG BOILER BACKUP									\$33,435,658
AMBIENT LOOP DISTRIBUTION PIPING									
1" Site Distribution Piping DB HDPE Pipe & Fittings	0 ft-Trench	\$84.07	\$0.00	Plumbers	\$85.78	3.19	0.00	\$0.00	\$0
2" Site Distribution Piping DB HDPE Pipe & Fittings	1274 ft-Trench	\$92.71	\$118,116.55	Plumbers	\$85.78	3.36	4,284.52	\$367,538.71	\$485,655
3" Site Distribution Piping DB HDPE Pipe & Fittings	5076 ft-Trench	\$103.68	\$526,274.82	Plumbers	\$85.78	3.54	17,966.55	\$1,541,223.53	\$2,067,498
4" Site Distribution Piping DB HDPE Pipe & Fittings	7062 ft-Trench	\$120.40	\$850,264.80	Plumbers	\$85.78	3.99	28,157.16	\$2,415,404.50	\$3,265,669
6" Site Distribution Piping DB HDPE Pipe & Fittings	6699 ft-Trench	\$145.80	\$976,714.20	Plumbers	\$85.78	4.22	28,288.54	\$2,426,674.81	\$3,403,389
8" Site Distribution Piping DB HDPE Pipe & Fittings	4919 ft-Trench	\$190.80	\$938,545.20	Plumbers	\$85.78	4.39	21,571.09	\$1,850,431.62	\$2,788,977
10" Site Distribution Piping DB HDPE Pipe & Fittings	95 ft-Trench	\$250.60	\$23,807.00	Plumbers	\$85.78	4.58	434.94	\$37,310.80	\$61,118
12" Site Distribution Piping DB HDPE Pipe & Fittings	1944 ft-Trench	\$308.40	\$599,529.60	Plumbers	\$85.78	4.69	9,120.57	\$782,389.72	\$1,381,919
14" Site Distribution Piping DB HDPE Pipe & Fittings	730 ft-Trench	\$375.80	\$274,334.00	Plumbers	\$85.78	4.94	3,609.27	\$309,614.16	\$583,948
16" Site Distribution Piping DB HDPE Pipe & Fittings	1789 ft-Trench	\$457.95	\$819,264.26	Plumbers	\$85.78	5.10	9,120.83	\$782,411.56	\$1,601,676
18" Site Distribution Piping DB HDPE Pipe & Fittings	7021 ft-Trench	\$547.35	\$3,842,909.83	Plumbers	\$85.78	5.27	37,004.34	\$3,174,341.14	\$7,017,251
20" Site Distribution Piping DB HDPE Pipe & Fittings	92 ft-Trench	\$646.05	\$59,436.67	Plumbers	\$85.78	5.44	500.34	\$42,920.91	\$102,358
24" Site Distribution Piping DB HDPE Pipe & Fittings	0 ft-Trench	\$871.38	\$0.00	Plumbers	\$85.78	5.76	0.00	\$0.00	\$0
Rental boilers, 100 hp (Pipe replacement phasing)	18 MO	\$75,000.00	\$1,350,000.00	Plumbers	\$85.78	30.00	540.00	\$46,322.79	\$1,396,323
Rental boilers, 50 hp	12 MO	\$50,000.00	\$600,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$630,882

SCENARIO D2 - AMBIENT LOOP W/NG PEAKING BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Rental boilers, 20 hp	12	MO	\$35,000.00	\$420,000.00	Plumbers	\$85.78	30.00	360.00	\$30,881.86	\$450,882
Rental boilers, 100 hp, install and breakdown	2	LS	\$20,000.00	\$40,000.00	Plumbers	\$85.78	526	1,052.00	\$90,243.66	\$130,244
Rental boilers, 50 hp, install and breakdown	2	LS	\$15,000.00	\$30,000.00	Plumbers	\$85.78	439	878.00	\$75,317.43	\$105,317
Rental boilers, 20 hp, install and breakdown	2	LS	\$10,000.00	\$20,000.00	Plumbers	\$85.78	351	702.00	\$60,219.63	\$80,220
TOTAL - AMBIENT LOOP DISTRIBUTION PIPING										\$25,553,326
AMBIENT LOOP SITE DISTRIBUTION PUMPS										
Site Distribution Pumps, 2,000 gpm @ 145ft	4	each	\$34,100.00	\$136,400.00	Plumbers	\$85.78	60	240.00	\$20,587.91	\$156,988
Site Distribution Pump - VFD	4	each	\$22,600.00	\$90,400.00	Electrician	\$87.69	57.143	228.57	\$20,043.94	\$110,444
Site Distribution Pump - Isolation Valves	8	each	\$4,400.00	\$35,200.00	Plumbers	\$85.78	9.6	76.80	\$6,588.13	\$41,788
Site Distribution Pump - Nearby Piping	80	ft	\$112.50	\$9,000.00	Plumbers	\$85.78	1.02	81.60	\$6,999.89	\$16,000
Site Distribution Pump - Temperature transmitters	8	each	\$150.00	\$1,200.00	Plumbers	\$85.78	4.00	32.00	\$2,745.05	\$3,945
Site Distribution Pump - Pressure transmitters	8	each	\$200.00	\$1,600.00	Plumbers	\$85.78	4.00	32.00	\$2,745.05	\$4,345
Site Distribution Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
Site Distribution Pump - Suction Diffuser	4	each	\$2,325.00	\$9,300.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$12,594
Site Distribution Pump - Check Vlv	4	each	\$4,000.00	\$16,000.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$19,294
Direct digital control of pumps	8	points	\$0.00	\$0.00	Electrician	\$87.69	12	96.00	\$8,418.43	\$8,418
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
TOTAL - AMBIENT LOOP SITE DISTRIBUTION PUMPS										\$442,991
AIR SOURCE HEAT PUMP (ASHP)										
Air Source Heat Pumps ACXA230	7	each	\$247,058.82	\$1,729,411.76	Plumbers	\$85.78	50.794	355.56	\$30,500.81	\$1,759,913
Direct digital control of ASHP	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Pumps serving ASHP, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
ASHP Circ. Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
ASHP Circ. Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
ASHP Circ. Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
ASHP Circ. Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$1,973
ASHP Circ. Pump - Pressure transmitters	4	each	\$200.00	\$800.00	Plumbers	\$85.78	4.00	16.00	\$1,372.53	\$2,173
ASHP Circ. Pump - Test and balance	1	LS	\$0.00	\$0.00	Plumbers	\$85.78	80.00	80.00	\$6,862.64	\$6,863
ASHP Circ. Pump - Suction Diffuser	2	each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
ASHP Circ. Pump - Check Vlv	2	each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Direct digital control of pumps	10	points	\$0.00	\$0.00	Electrician	\$87.69	12	120.00	\$10,523.04	\$10,523
Electric Service	1000	ft	\$50.00	\$50,000.00	Electrician	\$87.69	0.4	400.00	\$35,076.80	\$85,077
Concrete foundation	800	SF	\$12.00	\$9,600.00	Cement Masons	\$72.62	0.12	96.00	\$6,971.24	\$16,571
Earthwork including excavation, backfill, & disposal	92	CY	\$100.00	\$9,200.00	Laborer Foreman	\$61.79	1	92.00	\$5,684.91	\$14,885
Trench 12" Direct Buried HDPE Pipe	300	ft-Trench	\$308.40	\$92,520.00	Plumbers	\$85.78	4.69	1,407.50	\$120,739.15	\$213,259
200' Supply and return piping in plant to header	200	ft	\$184.60	\$36,920.00	Plumbers	\$85.78	1.48	296.00	\$25,391.75	\$62,312
6" Isolation Valves	24	each	\$4,675.00	\$112,200.00	Plumbers	\$85.78	8	192.00	\$16,470.33	\$128,670
12" isolation valves	2	each	\$12,632.00	\$25,264.00	Plumbers	\$85.78	14.118	28.24	\$2,422.17	\$27,686
				\$0.00	Plumbers	\$85.78		0.00	\$0.00	\$0
TOTAL - AIR SOURCE HEAT PUMP (ASHP)										\$2,550,717
GEOHERMAL WELLFIELD										
Wellfield piping, includes vertical piping within the wellfield and distribution connecting each well, 667 bore holes, 499' depth	667	each	\$13,473.00	\$8,986,491.00	Plumbers	\$85.78	51.325	34,233.78	\$2,936,674.21	\$11,923,165
Direct digital control of wellfield (est 100 pts each)	100	points	\$700.00	\$70,000.00	Electrician	\$87.69	6	600.00	\$52,615.20	\$122,615
Pumps serving borefield, 2,000 gpm @ 45ft	2	each	\$48,950.00	\$97,900.00	Plumbers	\$85.78	73.14	146.28	\$12,548.33	\$110,448
Wellfield Circulating Pump - VFD	2	each	\$22,600.00	\$45,200.00	Plumbers	\$85.78	57.143	114.29	\$9,803.79	\$55,004
Wellfield Circulating Pump - Isolation Valves	4	each	\$4,400.00	\$17,600.00	Plumbers	\$85.78	9.6	38.40	\$3,294.07	\$20,894
Wellfield Circulating Pump - Nearby Piping	40	ft	\$112.50	\$4,500.00	Plumbers	\$85.78	1.02	40.80	\$3,499.94	\$8,000
Wellfield Circulating Pump - Temperature transmitters	4	each	\$150.00	\$600.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$913

SCENARIO D2 - AMBIENT LOOP W/NG PEAKING BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Wellfield Circulating Pump - Pressure transmitters	4 each	\$200.00	\$800.00	Plumbers	\$85.78	0.91	3.65	\$312.84	\$1,113
Wellfield Circulating Pump - Test and balance	1 LS	\$0.00	\$0.00	Plumbers	\$85.78	73.04	73.04	\$6,265.20	\$6,265
Wellfield Circulating Pump - Suction Diffuser	2 each	\$2,325.00	\$4,650.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$6,297
Wellfield Circulating Pump - Check Vlv	2 each	\$4,000.00	\$8,000.00	Plumbers	\$85.78	9.6	19.20	\$1,647.03	\$9,647
Wellfield piping from borefield to central plant HDPE Piping System	2000 ft-Trench	\$308.40	\$616,800.00	Plumbers	\$85.78	4.69	9,383.31	\$804,927.69	\$1,421,728
TOTAL - GEOTHERMAL WELLFIELD									\$13,686,089
ELECTRIC									
13.8kV - cable (500 kcmil)	2000 ft	\$10.25	\$20,500.00	Electrician	\$87.69	0.06667	133.34	\$11,692.85	\$32,193
13.8kV - Grounding Conductor (4/0)	100 ft	\$6.35	\$635.00	Electrician	\$87.69	0.05	5.00	\$438.46	\$1,073
13.8kV - Ground rods	3 each	\$98.50	\$295.50	Electrician	\$87.69	2	6.00	\$526.15	\$822
13.8kV - Exothermic welds	6 each	\$4.45	\$26.70	Electrician	\$87.69	1.143	6.86	\$601.39	\$628
13.8kV - Terminations	12 each	\$395.00	\$4,740.00	Electrician	\$87.69	1.739	20.87	\$1,829.96	\$6,570
13.8kV - Switch	1 each	\$5,150.00	\$5,150.00	Electrician	\$87.69	33.939	33.94	\$2,976.18	\$8,126
4,000A 480V double ended switchgear w/xfmr	0 each	\$703,528.00	\$0.00	Electrician	\$87.69	240	0.00	\$0.00	\$0
160A-4,160 Feed to ASHP (inside plant)	200 ft	\$125.00	\$25,000.00	Electrician	\$87.69	1.2	240.00	\$21,046.08	\$46,046
160A-4,160 Feed to ASHP (outside buried)	500 ft	\$125.00	\$62,500.00	Electrician	\$87.69	1.20	600.00	\$52,615.20	\$115,115
120A-4,160V Feed to WSHP-1 (inside plant)	0 ft	\$100.00	\$0.00	Electrician	\$87.69	0.8	0.00	\$0.00	\$0
120A-4,160V Feed to WSHP-2 (inside plant)	0 ft	\$100.00	\$0.00	Electrician	\$87.69	0.80	0.00	\$0.00	\$0
13.8kV/480V Transformer	1 each	\$100,000.00	\$100,000.00	Electrician	\$87.69	120	120.00	\$10,523.04	\$110,523
2000a-480V Feed from XFMR to Switchgear	100 ft	\$125.00	\$12,500.00	Electrician	\$87.69	1.2	120.00	\$10,523.04	\$23,023
480V (2000A) Switchgear	1 each	\$50,000.00	\$50,000.00	Electrician	\$87.69	160	160.00	\$14,030.72	\$64,031
480V Feed to ASHP Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to ASHP Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to Borefield Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-1	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-2	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-3	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-4	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V Feed to District Htg Sys Circulating Pump-5	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
480V/120V Transformer	1 each	\$10,000.00	\$10,000.00	Electrician	\$87.69	32	32.00	\$2,806.14	\$12,806
200A-120V Feed from XFMR to 120V Panel	600 ft	\$50.00	\$30,000.00	Electrician	\$87.69	0.4	240.00	\$21,046.08	\$51,046
120V 42 Circuit Panel	1 each	\$1,500.00	\$1,500.00	Electrician	\$87.69	8	8.00	\$701.54	\$2,202
20 Amp Circuit Feeds various controls/misc. equip	4200 ft	\$25.00	\$105,000.00	Electrician	\$87.69	0.2	840.00	\$73,661.28	\$178,661
TOTAL - ELECTRIC									\$1,112,280
SUBTOTAL									\$76,781,060
GENERAL CONDITIONS								15%	\$88,298,220
OVERHEAD AND PROFIT								10%	\$97,128,041
DESIGN CONTINGENCY								20%	\$116,553,650
BID CONTINGENCY								5%	\$122,381,332
PHASING								10%	\$134,619,465
GRAND TOTAL									\$134,619,465

SCENARIO E1 - DECENTRALIZE WITH NG BOILERS

Description	Quantity		Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DECENTRALIZE WITH NG BOILERS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
200 Harrison St LLC (Chataqua IDA) (46 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
3644 Holdings LLC (Priscilla) (15 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
3644 Holdings LLC 2 (Cameo) (15 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Agnes Home (5 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Anderson Manor LB (15 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Anderson Tower LP (21 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Best Western Hotel (20 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Board Of Education - JHS (276 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Board Of Education - LOVE (73 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Board Of Education (Tech Cntr) (11 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
BPU - DH-carlson (25 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
BPU - low pres gas heat (3 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
BPU - monitor building (29 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Carlson Tower LP (18 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Chautauqua Brick, Inc (23 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Chautauqua Opportunities (82 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
City of Jamestown (City Hall) (48 gpm) Not Connected	0	lot	\$82,180.17	\$0.00	Plumbers	\$85.78	892.72	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
CODE Euclid Gardens (37 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Covenant Manor Apartments, LLC (55 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
DPW (14 gpm) Not Connected	0	lot	\$36,853.28	\$0.00	Plumbers	\$85.78	605.15	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0	lot	\$36,853.28	\$0.00	Plumbers	\$85.78	605.15	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Eliz W Marvin House (6 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
E-Z Clean Car Wash (3 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
First Covenant Church (33 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
First Lutheran Church (57 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Fourth St Housing (11 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Herbert A Duke II (17 gpm) Not Connected	0	lot	\$36,853.28	\$0.00	Plumbers	\$85.78	605.15	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Heritage Ministries 2 (Childcare) (8 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Inter'n Ordinance Tech (18 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
Jamestown Boys & Girls Club (55 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Jamestown City (Ice Arena) (119 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Jamestown Newspaper Corp (22 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
JHA (5th St. High Rise) (44 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
JHA (Chadakoin Bldg) (38 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
JHA (Hotel Jamestown) (70 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
JRP (Jody Peterson) (8 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.1522362	\$51,911.74	\$88,765
JRP (South County Office Bldg) (32 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Kaleida Health (72 gpm)	1	lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1681.756225	\$144,266.01	\$332,332
Krog Corp (BWB Center) (22 gpm)	1	lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.7248942	\$76,580.57	\$158,761
Legal Assistance of WNY (6 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Lewis & Lewis P C (.001) (.1) (5 gpm)	1	lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765

SCENARIO E1 - DECENTRALIZE WITH NG BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Little Theater Jamestown (95 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
National Comedy Center, Inc. (26 gpm)	1 lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.72	\$76,580.57	\$158,761
Northwest Bank (13 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Prendergast Library (25 gpm)	1 lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.72	\$76,580.57	\$158,761
REALiFE Church Inc. (24 gpm)	1 lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.72	\$76,580.57	\$158,761
Reg Lenna Center for the Arts (86 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
Riverwalk Properties (JAMA) (174 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
Robert H Jackson Inc, The (12 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
St James Church (53 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
St Susan Center (45 gpm)	1 lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.72	\$76,580.57	\$158,761
Time Warner Cable (13 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Triple R, LLC (5 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
UPMC Chautauque at WCA (Physicians) (81 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	1 lot	\$574,057.89	\$574,057.89	Plumbers	\$85.78	2238.95	2,238.95	\$192,063.47	\$766,121
Westerberg Tower LP (20 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Windstream Corp A/P (36 gpm)	1 lot	\$82,180.17	\$82,180.17	Plumbers	\$85.78	892.72	892.72	\$76,580.57	\$158,761
YMCA (main) (147 gpm)	1 lot	\$188,066.30	\$188,066.30	Plumbers	\$85.78	1681.76	1,681.76	\$144,266.01	\$332,332
YWCA (12 gpm)	1 lot	\$36,853.28	\$36,853.28	Plumbers	\$85.78	605.15	605.15	\$51,911.74	\$88,765
Removal of existing heat exchangers	130 each	\$500.00	\$65,000.00	Plumbers	\$87.69	32.00	4,160.00	\$364,798.72	\$429,799
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$85.78	8.00	552.00	\$47,352.19	\$64,602
Control system upgrades to accommodate low temperature water	130 each	\$400.00	\$52,000.00	Electrician	\$72.62	8.00	1,040.00	\$75,521.73	\$127,522
Direct digital control of equipment (8 points each)	1,040 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages	130 each	\$1,000.00	\$130,000.00	Plumbers	\$87.69	8.00	1,040.00	\$91,199.68	\$221,200
Isolation valves, automatic	260 each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260 each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520 each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260 each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
Decommission Distribution Pipe Network/Slurry fill	1,296 CY	\$177.00	\$229,411.78	Electrician	\$87.69	0.80	1,036.89	\$90,926.91	\$320,339
TOTAL - DECENTRALIZE WITH NG BOILERS									\$17,413,377
SUBTOTAL									\$17,413,377
GENERAL CONDITIONS									15% \$20,025,384
OVERHEAD AND PROFIT									10% \$22,027,922
DESIGN CONTINGENCY									20% \$26,433,507
BID CONTINGENCY									5% \$27,755,182
PHASING									10% \$30,530,700
GRAND TOTAL									\$30,530,700

SCENARIO F1 - DECENTRALIZE WITH HEAT PUMPS & PEAKING NG BOILERS

Description	Quantity	Material		Labor					Total	
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost		
DECENTRALIZE WITH HEAT PUMPS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
200 Harrison St LLC (Chatauqua IDA) (46 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
3644 Holdings LLC (Priscilla) (15 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
3644 Holdings LLC 2 (Cameo) (15 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Agnes Home (5 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
Anderson Manor LB (15 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Anderson Tower LP (21 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Best Western Hotel (20 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Board Of Education - JHS (276 gpm)	1 lot		\$1,212,321.41	\$1,212,321.41	Plumbers	\$85.78	4016.49	4016.486226	\$344,546.04	\$1,556,867
Board Of Education - LOVE (73 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Board Of Education (Tech Cntr) (11 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
BPU - DH-carlson (25 gpm)	1 each		\$1,133,058.37	\$1,133,058.37	Plumbers	\$85.78	4134.76	4134.759339	\$354,691.85	\$1,487,750
BPU - low pres gas heat (3 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
BPU - monitor building (29 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Carlson Tower LP (18 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Chatauqua Brick, Inc (23 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Chatauqua Opportunities (82 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
City of Jamestown (City Hall) (48 gpm) Not Connected	0 lot		\$295,743.02	\$0.00	Plumbers	\$85.78	1451.18	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
CODE Euclid Gardens (37 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Covenant Manor Apartments, LLC (55 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
DPW (14 gpm) Not Connected	0 lot		\$295,743.02	\$0.00	Plumbers	\$85.78	1451.18	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 lot		\$295,743.02	\$0.00	Plumbers	\$85.78	1451.18	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
Eliz W Marvin House (6 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
E-Z Clean Car Wash (3 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
First Covenant Church (33 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
First Lutheran Church (57 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Fourth St Housing (11 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Herbert A Duke II (17 gpm) Not Connected	0 lot		\$295,743.02	\$0.00	Plumbers	\$85.78	1451.18	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Heritage Ministries 2 (Childcare) (8 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Inter'n Ordinance Tech (18 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Jamestown Boys & Girls Club (55 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Jamestown City (Ice Arena) (119 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Jamestown Newspaper Corp (22 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
JHA (5th St. High Rise) (44 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
JHA (Chadakoin Bldg) (38 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
JHA (Hotel Jamestown) (70 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
JRP (Jody Peterson) (8 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.517049	\$58,462.54	\$164,067
JRP (South County Office Bldg) (32 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Kaleida Health (72 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Krog Corp (BWB Center) (22 gpm)	1 lot		\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1451.17631	\$124,486.18	\$420,229
Legal Assistance of WNY (6 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.52	\$58,462.54	\$164,067
Lewis & Lewis P C (.001) (.1) (5 gpm)	1 lot		\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.52	\$58,462.54	\$164,067

SCENARIO F1 - DECENTRALIZE WITH HEAT PUMPS & PEAKING NG BOILERS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	1 lot	\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.52	\$58,462.54	\$164,067
Little Theater Jamestown (95 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
National Comedy Center, Inc. (26 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Northwest Bank (13 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Prendergast Library (25 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
REALiFE Church Inc. (24 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Reg Lenna Center for the Arts (86 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Riverwalk Properties (JAMA) (174 gpm)	1 lot	\$1,212,321.41	\$1,212,321.41	Plumbers	\$85.78	4016.49	4,016.49	\$344,546.04	\$1,556,867
Robert H Jackson Inc, The (12 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
St James Church (53 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
St Susan Center (45 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Time Warner Cable (13 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Triple R, LLC (5 gpm)	1 lot	\$105,604.41	\$105,604.41	Plumbers	\$85.78	681.52	681.52	\$58,462.54	\$164,067
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1 lot	\$1,212,321.41	\$1,212,321.41	Plumbers	\$85.78	4016.49	4,016.49	\$344,546.04	\$1,556,867
UPMC Chautauque at WCA (Physicians) (81 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	1 lot	\$3,066,965.81	\$3,066,965.81	Plumbers	\$85.78	6442.29	6,442.29	\$552,638.41	\$3,619,604
Westerberg Tower LP (20 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Windstream Corp A/P (36 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
YMCA (main) (147 gpm)	1 lot	\$1,212,321.41	\$1,212,321.41	Plumbers	\$85.78	4016.49	4,016.49	\$344,546.04	\$1,556,867
YWCA (12 gpm)	1 lot	\$295,743.02	\$295,743.02	Plumbers	\$85.78	1451.18	1,451.18	\$124,486.18	\$420,229
Removal of existing heat exchangers	130 each	\$500.00	\$65,000.00	Plumbers	\$87.69	32.00	4,160.00	\$364,798.72	\$429,799
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$85.78	8.00	552.00	\$47,352.19	\$64,602
Control system upgrades to accommodate low temperature water	130 each	\$400.00	\$52,000.00	Electrician	\$72.62	8.00	1,040.00	\$75,521.73	\$127,522
Direct digital control of equipment (8 points each)	1,040 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages	130 each	\$1,000.00	\$130,000.00	Plumbers	\$87.69	8.00	1,040.00	\$91,199.68	\$221,200
Isolation valves, automatic	260 each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260 each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520 each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260 each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
Electrical Distribution Upgrades	1 LS	\$4,125,034.45	\$4,125,034.45	Electrician	\$87.69	14050.92	14,050.92	\$1,232,153.15	\$5,357,188
Decommission Distribution Pipe Network/Slurry fill	1,296 CY	\$177.00	\$229,411.78	Electrician	\$87.69	0.80	1,036.89	\$90,926.91	\$320,339
TOTAL - DECENTRALIZE WITH HEAT PUMPS									\$43,651,158
SUBTOTAL									\$43,651,158
GENERAL CONDITIONS									15% \$50,198,831
OVERHEAD AND PROFIT									10% \$55,218,714
DESIGN CONTINGENCY									20% \$66,262,457
BID CONTINGENCY									5% \$69,575,580
PHASING									10% \$76,533,138
GRAND TOTAL									\$76,533,138

SCENARIO F2 - DECENTRALIZE WITH HEAT PUMPS - PEAKING & BACKUP WITH HEAT PUMPS

Description	Quantity	Material		Labor					Total	
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost		
DECENTRALIZE WITH HEAT PUMPS										
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
200 Harrison St LLC (Chataqua IDA) (46 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
3644 Holdings LLC (Priscilla) (15 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
3644 Holdings LLC 2 (Cameo) (15 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
3644 Holdings LLC 3 Jefferson St Apts) (7 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Agnes Home (5 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
Anderson Manor LB (15 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Anderson Tower LP (21 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Best Western Hotel (20 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Board Of Education - JHS (276 gpm)	1 lot		\$3,034,137.18	\$3,034,137.18	Plumbers	\$85.78	5340.21	5340.21467	\$458,099.37	\$3,492,237
Board Of Education - LOVE (73 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Board Of Education (Tech Cntr) (11 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
BPU - DH-carlson (25 gpm)	1 each		\$1,133,058.37	\$1,133,058.37	Plumbers	\$85.78	4134.76	4134.759339	\$354,691.85	\$1,487,750
BPU - low pres gas heat (3 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
BPU - monitor building (29 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Carlson Tower LP (18 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Chautauqua Brick, Inc (23 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Chautauqua Opportunities (82 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
City of Jamestown (City Hall) (48 gpm) Not Connected	0 lot		\$411,598.11	\$0.00	Plumbers	\$85.78	1423.04	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
CODE Euclid Gardens (37 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Covenant Manor Apartments, LLC (55 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
DPW (14 gpm) Not Connected	0 lot		\$411,598.11	\$0.00	Plumbers	\$85.78	1423.04	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 lot		\$411,598.11	\$0.00	Plumbers	\$85.78	1423.04	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
Eliz W Marvin House (6 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
E-Z Clean Car Wash (3 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
First Covenant Church (33 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
First Lutheran Church (57 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Fourth St Housing (11 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Herbert A Duke II (17 gpm) Not Connected	0 lot		\$411,598.11	\$0.00	Plumbers	\$85.78	1423.04	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Heritage Ministries 2 (Childcare) (8 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Inter'n Ordinance Tech (18 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Jamestown Boys & Girls Club (55 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Jamestown City (Ice Arena) (119 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Jamestown Newspaper Corp (22 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
JHA (5th St. High Rise) (44 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
JHA (Chadakoin Bldg) (38 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
JHA (Hotel Jamestown) (70 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
JRP (Jody Peterson) (8 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.0200977	\$52,415.11	\$196,554
JRP (South County Office Bldg) (32 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Kaleida Health (72 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Krog Corp (BWB Center) (22 gpm)	1 lot		\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1423.035116	\$122,072.15	\$533,670
Legal Assistance of WNY (6 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.02	\$52,415.11	\$196,554
Lewis & Lewis P C (.001) (.1) (5 gpm)	1 lot		\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.02	\$52,415.11	\$196,554

SCENARIO F2 - DECENTRALIZE WITH HEAT PUMPS - PEAKING & BACKUP WITH HEAT PUMPS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Lewis and Lewis (6 gpm)	1 lot	\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.02	\$52,415.11	\$196,554
Little Theater Jamestown (95 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
National Comedy Center, Inc. (26 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Northwest Bank (13 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Prendergast Library (25 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
REALiFE Church Inc. (24 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Reg Lenna Center for the Arts (86 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Riverwalk Properties (JAMA) (174 gpm)	1 lot	\$3,034,137.18	\$3,034,137.18	Plumbers	\$85.78	5340.21	5,340.21	\$458,099.37	\$3,492,237
Robert H Jackson Inc, The (12 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
St James Church (53 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
St Susan Center (45 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Time Warner Cable (13 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Triple R, LLC (5 gpm)	1 lot	\$144,139.00	\$144,139.00	Plumbers	\$85.78	611.02	611.02	\$52,415.11	\$196,554
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1 lot	\$3,034,137.18	\$3,034,137.18	Plumbers	\$85.78	5340.21	5,340.21	\$458,099.37	\$3,492,237
UPMC Chautauque at WCA (Physicians) (81 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	1 lot	\$3,034,137.18	\$3,034,137.18	Plumbers	\$85.78	5340.21	5,340.21	\$458,099.37	\$3,492,237
Westerberg Tower LP (20 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Windstream Corp A/P (36 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
YMCA (main) (147 gpm)	1 lot	\$3,034,137.18	\$3,034,137.18	Plumbers	\$85.78	5340.21	5,340.21	\$458,099.37	\$3,492,237
YWCA (12 gpm)	1 lot	\$411,598.11	\$411,598.11	Plumbers	\$85.78	1423.04	1,423.04	\$122,072.15	\$533,670
Removal of existing heat exchangers	130 each	\$500.00	\$65,000.00	Plumbers	\$87.69	32.00	4,160.00	\$364,798.72	\$429,799
6" Concrete Pad	69 each	\$250.00	\$17,250.00	Cement Masons	\$85.78	8.00	552.00	\$47,352.19	\$64,602
Control system upgrades to accommodate low temperature water	130 each	\$400.00	\$52,000.00	Electrician	\$72.62	8.00	1,040.00	\$75,521.73	\$127,522
Direct digital control of equipment (8 points each)	1,040 each	\$0.00	\$0.00	Electrician	\$87.69	12.00	12,480.00	\$1,094,396.16	\$1,094,396
Valve packages	130 each	\$1,000.00	\$130,000.00	Plumbers	\$87.69	8.00	1,040.00	\$91,199.68	\$221,200
Isolation valves, automatic	260 each	\$1,500.00	\$390,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$568,429
Flow meters, ultrasonic	260 each	\$3,500.00	\$910,000.00	Plumbers	\$85.78	8.00	2,080.00	\$178,428.54	\$1,088,429
Temperature transmitters	520 each	\$1,000.00	\$520,000.00	Plumbers	\$85.78	4.00	2,080.00	\$178,428.54	\$698,429
Pressure transmitters	260 each	\$1,000.00	\$260,000.00	Plumbers	\$85.78	4.00	1,040.00	\$89,214.27	\$349,214
Differential pressure switch	130 each	\$500.00	\$65,000.00	Plumbers	\$85.78	2.00	260.00	\$22,303.57	\$87,304
Test and balance	65 buildings	\$0.00	\$0.00	Plumbers	\$85.78	80.00	5,200.00	\$446,071.34	\$446,071
Electrical Distribution Upgrades	1 LS	\$6,871,209.65	\$6,871,209.65	Electrician	\$87.69	23462.08	23,462.08	\$2,057,436.35	\$8,928,646
Decommission Distribution Pipe Network/Slurry fill	1,296 CY	\$177.00	\$229,411.78	Electrician	\$87.69	0.80	1,036.89	\$90,926.91	\$320,339
SUB TOTAL - DECENTRALIZE WITH HEAT PUMPS									\$60,477,346
GENERAL CONDITIONS									15% \$69,548,948
OVERHEAD AND PROFIT									10% \$76,503,843
DESIGN CONTINGENCY									20% \$91,804,612
BID CONTINGENCY									5% \$96,394,842
PHASING									10% \$106,034,326
TOTAL - DECENTRALIZE WITH HEAT PUMPS									\$106,034,326
ESTIMATED BUILDING MODIFICATIONS REQUIRED TO MEET PEAK LOAD USING BUILDING HOT WATER SUPPLY AT 160°F (NO ABILITY TO INCREASE TEMP DURING PEAK PERIODS)									
15 E 5th St LLC (Burgett & Robbins) (6 gpm)	1 lot	\$37,879.56	\$37,879.56	Plumbers	\$85.78	189.25	189.2462116	\$16,234.10	\$54,114
200 Harrison St LLC (Chataqua IDA) (46 gpm)	1 lot	\$288,868.81	\$288,868.81	Plumbers	\$85.78	1443.19	1443.187929	\$123,800.92	\$412,670
3644 Holdings LLC (Priscilla) (15 gpm)	1 lot	\$52,469.51	\$52,469.51	Plumbers	\$85.78	262.14	262.137548	\$22,486.93	\$74,956
3644 Holdings LLC 2 (Cameo) (15 gpm)	1 lot	\$46,480.87	\$46,480.87	Plumbers	\$85.78	232.22	232.2183274	\$19,920.37	\$66,401
3644 Holdings LLC 3 (Jefferson St Apts) (7 gpm)	1 lot	\$15,749.19	\$15,749.19	Plumbers	\$85.78	78.68	78.68289556	\$6,749.65	\$22,499
3644 Holdings LLC 4 (Parkview Apts) (13 gpm)	1 lot	\$39,770.67	\$39,770.67	Plumbers	\$85.78	198.69	198.6941807	\$17,044.57	\$56,815
Agnes Home (5 gpm)	1 lot	\$13,352.84	\$13,352.84	Plumbers	\$85.78	66.71	66.7107827	\$5,722.65	\$19,075
Anderson Manor LB (15 gpm)	1 lot	\$52,589.04	\$52,589.04	Plumbers	\$85.78	262.73	262.7347373	\$22,538.16	\$75,127

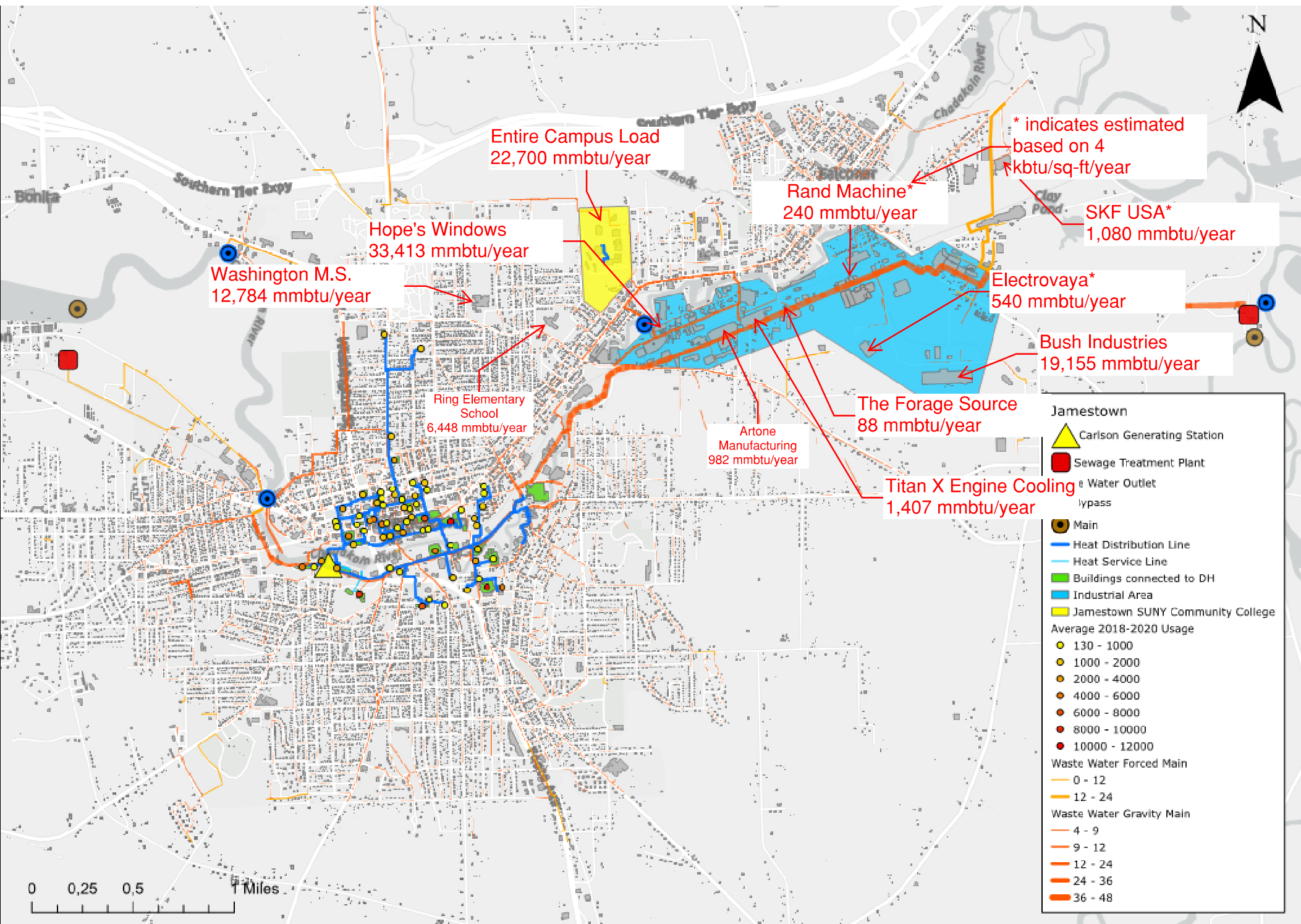
SCENARIO F2 - DECENTRALIZE WITH HEAT PUMPS - PEAKING & BACKUP WITH HEAT PUMPS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
Anderson Tower LP (21 gpm)	1 lot	\$79,892.76	\$79,892.76	Plumbers	\$85.78	399.14	399.1440522	\$34,239.75	\$114,133
Best Western Hotel (20 gpm)	1 lot	\$81,287.33	\$81,287.33	Plumbers	\$85.78	406.11	406.111324	\$34,837.43	\$116,125
Board Of Education - JHS (276 gpm)	1 lot	\$1,325,325.27	\$1,325,325.27	Plumbers	\$85.78	6621.32	6621.322121	\$567,996.54	\$1,893,322
Board Of Education - LOVE (73 gpm)	1 lot	\$314,091.48	\$314,091.48	Plumbers	\$85.78	1569.20	1569.200364	\$134,610.64	\$448,702
Board Of Education (Tech Cntr) (11 gpm)	1 lot	\$91,060.33	\$91,060.33	Plumbers	\$85.78	454.94	454.9372317	\$39,025.86	\$130,086
BPU - DH-carlson (25 gpm)	1 lot	\$267,959.48	\$267,959.48	Plumbers	\$85.78	1338.72	1338.724987	\$114,839.78	\$382,799
BPU - low pres gas heat (3 gpm)	1 lot	\$26,161.72	\$26,161.72	Plumbers	\$85.78	130.70	130.7039188	\$11,212.17	\$37,374
BPU - monitor building (29 gpm)	1 lot	\$475,667.72	\$475,667.72	Plumbers	\$85.78	2376.43	2376.434887	\$203,857.60	\$679,525
Carlson Tower LP (18 gpm)	1 lot	\$148,181.12	\$148,181.12	Plumbers	\$85.78	740.31	740.3125401	\$63,506.19	\$211,687
Chautauqua Brick, Inc (23 gpm)	1 lot	\$189,942.05	\$189,942.05	Plumbers	\$85.78	948.95	948.9500578	\$81,403.74	\$271,346
Chautauqua Opportunities (82 gpm)	1 lot	\$379,210.18	\$379,210.18	Plumbers	\$85.78	1894.53	1894.53321	\$162,518.65	\$541,729
City of Jamestown (City Hall) (48 gpm) Not Connected	0 lot	\$288,812.74	\$0.00	Plumbers	\$85.78	1442.91	0	\$0.00	\$0
City Of Jamestown 3 (Main St. Parking) (30 gpm)	1 lot	\$359,034.00	\$359,034.00	Plumbers	\$85.78	1793.73	1793.733053	\$153,871.71	\$512,906
CODE Euclid Gardens (37 gpm)	1 lot	\$155,972.19	\$155,972.19	Plumbers	\$85.78	779.24	779.2367169	\$66,845.22	\$222,817
Covenant Manor Apartments, LLC (55 gpm)	1 lot	\$263,537.72	\$263,537.72	Plumbers	\$85.78	1316.63	1316.633874	\$112,944.74	\$376,482
DPW (14 gpm) Not Connected	0 lot	\$110,989.14	\$0.00	Plumbers	\$85.78	554.50	0	\$0.00	\$0
DPW 2 (19 gpm) Not Connected	0 lot	\$221,978.27	\$0.00	Plumbers	\$85.78	1109.00	0	\$0.00	\$0
Duncan Olesnak (4 gpm)	1 lot	\$22,344.28	\$22,344.28	Plumbers	\$85.78	111.63	111.6319651	\$9,576.12	\$31,920
Eliz W Marvin House (6 gpm)	1 lot	\$16,372.89	\$16,372.89	Plumbers	\$85.78	81.80	81.79892493	\$7,016.95	\$23,390
E-Z Clean Car Wash (3 gpm)	1 lot	\$22,134.40	\$22,134.40	Plumbers	\$85.78	110.58	110.5834368	\$9,486.17	\$31,621
First Covenant Church (33 gpm)	1 lot	\$81,498.10	\$81,498.10	Plumbers	\$85.78	407.16	407.1643056	\$34,927.76	\$116,426
First Lutheran Church (57 gpm)	1 lot	\$152,199.73	\$152,199.73	Plumbers	\$85.78	760.39	760.3895064	\$65,228.46	\$217,428
Fourth St Housing (11 gpm)	1 lot	\$32,826.58	\$32,826.58	Plumbers	\$85.78	164.00	164.001546	\$14,068.54	\$46,895
Gregory J Buzzanco (Foote Ave Church) (17 gpm)	1 lot	\$37,292.41	\$37,292.41	Plumbers	\$85.78	186.31	186.3128209	\$15,982.46	\$53,275
Herbert A Duke II (17 gpm) Not Connected	0 lot	\$155,456.48	\$0.00	Plumbers	\$85.78	776.66	0	\$0.00	\$0
Heritage Ministries (Heritage Park) (30 gpm)	1 lot	\$500,093.26	\$500,093.26	Plumbers	\$85.78	2498.46	2498.464819	\$214,325.68	\$714,419
Heritage Ministries 2 (Childcare) (8 gpm)	1 lot	\$36,467.86	\$36,467.86	Plumbers	\$85.78	182.19	182.1933414	\$15,629.08	\$52,097
HH Jamestown, LLC (Cherry St. Parking) (60 gpm)	1 lot	\$772,650.86	\$772,650.86	Plumbers	\$85.78	3860.16	3860.162009	\$331,136.08	\$1,103,787
Inter'n Ordinance Tech (18 gpm)	1 lot	\$176,172.82	\$176,172.82	Plumbers	\$85.78	880.16	880.1590314	\$75,502.64	\$251,675
Jamestown Boys & Girls Club (55 gpm)	1 lot	\$82,667.41	\$82,667.41	Plumbers	\$85.78	413.01	413.0061803	\$35,428.89	\$118,096
Jamestown City (Ice Arena) (119 gpm)	1 lot	\$191,721.24	\$191,721.24	Plumbers	\$85.78	957.84	957.8389017	\$82,166.25	\$273,887
Jamestown Newspaper Corp (22 gpm)	1 lot	\$517,946.65	\$517,946.65	Plumbers	\$85.78	2587.66	2587.660342	\$221,977.14	\$739,924
JHA (5th St. High Rise) (44 gpm)	1 lot	\$173,892.60	\$173,892.60	Plumbers	\$85.78	868.77	868.7670526	\$74,525.40	\$248,418
JHA (Chadakoin Bldg) (38 gpm)	1 lot	\$133,705.36	\$133,705.36	Plumbers	\$85.78	667.99	667.9916981	\$57,302.30	\$191,008
JHA (Hotel Jamestown) (70 gpm)	1 lot	\$337,201.88	\$337,201.88	Plumbers	\$85.78	1684.66	1684.659852	\$144,515.09	\$481,717
JRP (Jody Peterson) (8 gpm)	1 lot	\$24,241.17	\$24,241.17	Plumbers	\$85.78	121.11	121.1088339	\$10,389.07	\$34,630
JRP (South County Office Bldg) (32 gpm)	1 lot	\$287,791.40	\$287,791.40	Plumbers	\$85.78	1437.81	1437.805212	\$123,339.17	\$411,131
Kaleida Health (72 gpm)	1 lot	\$260,451.86	\$260,451.86	Plumbers	\$85.78	1301.22	1301.216923	\$111,622.23	\$372,074
Krog Corp (BWB Center) (22 gpm)	1 lot	\$185,770.50	\$185,770.50	Plumbers	\$85.78	928.11	928.1089859	\$79,615.93	\$265,386
Legal Assistance of WNY (6 gpm)	1 lot	\$41,455.06	\$41,455.06	Plumbers	\$85.78	207.11	207.11	\$17,766.46	\$59,222
Lewis & Lewis P C (.001) (.1) (5 gpm)	1 lot	\$23,318.47	\$23,318.47	Plumbers	\$85.78	116.50	116.50	\$9,993.63	\$33,312
Lewis and Lewis (6 gpm)	1 lot	\$33,671.87	\$33,671.87	Plumbers	\$85.78	168.22	168.22	\$14,430.80	\$48,103
Little Theater Jamestown (95 gpm)	1 lot	\$282,630.02	\$282,630.02	Plumbers	\$85.78	1412.02	1,412.02	\$121,127.15	\$403,757
National Comedy Center, Inc. (26 gpm)	1 lot	\$110,102.35	\$110,102.35	Plumbers	\$85.78	550.07	550.07	\$47,186.72	\$157,289
Northwest Bank (13 gpm)	1 lot	\$119,183.30	\$119,183.30	Plumbers	\$85.78	595.44	595.44	\$51,078.56	\$170,262
Prendergast Library (25 gpm)	1 lot	\$173,986.89	\$173,986.89	Plumbers	\$85.78	869.24	869.24	\$74,565.81	\$248,553
REALIFE Church Inc. (24 gpm)	1 lot	\$58,836.31	\$58,836.31	Plumbers	\$85.78	293.95	293.95	\$25,215.56	\$84,052
Reg Lenna Center for the Arts (86 gpm)	1 lot	\$235,031.45	\$235,031.45	Plumbers	\$85.78	1174.22	1,174.22	\$100,727.76	\$335,759
Riverwalk Properties (JAMA) (174 gpm)	1 lot	\$655,026.16	\$655,026.16	Plumbers	\$85.78	3272.51	3,272.51	\$280,725.50	\$935,752
Robert H Jackson Inc, The (12 gpm)	1 lot	\$48,399.01	\$48,399.01	Plumbers	\$85.78	241.80	241.80	\$20,742.43	\$69,141

SCENARIO F2 - DECENTRALIZE WITH HEAT PUMPS - PEAKING & BACKUP WITH HEAT PUMPS

Description	Quantity	Material		Labor					Total
		Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
St James Church (53 gpm)	1 lot	\$147,090.78	\$147,090.78	Plumbers	\$85.78	734.87	734.87	\$63,038.90	\$210,130
St Susan Center (45 gpm)	1 lot	\$546,898.21	\$546,898.21	Plumbers	\$85.78	2732.30	2,732.30	\$234,384.95	\$781,283
Time Warner Cable (13 gpm)	1 lot	\$88,050.55	\$88,050.55	Plumbers	\$85.78	439.90	439.90	\$37,735.95	\$125,787
Triple R, LLC (5 gpm)	1 lot	\$38,703.48	\$38,703.48	Plumbers	\$85.78	193.36	193.36	\$16,587.21	\$55,291
UPMC Chautauqua at WCA (Jones Hill) (231 gpm)	1 lot	\$897,164.82	\$897,164.82	Plumbers	\$85.78	4482.23	4,482.23	\$384,499.21	\$1,281,664
UPMC Chautauque at WCA (Physicians) (81 gpm)	1 lot	\$293,328.43	\$293,328.43	Plumbers	\$85.78	1465.47	1,465.47	\$125,712.18	\$419,041
UPMC Chautauque at WCA (Hospital)1 (668 gpm)	0 lot	\$36,513,338.14	\$0.00	Plumbers	\$85.78	182420.56	0.00	\$0.00	\$0
Westerberg Tower LP (20 gpm)	1 lot	\$80,783.94	\$80,783.94	Plumbers	\$85.78	403.60	403.60	\$34,621.69	\$115,406
Windstream Corp A/P (36 gpm)	1 lot	\$367,167.48	\$367,167.48	Plumbers	\$85.78	1834.37	1,834.37	\$157,357.49	\$524,525
YMCA (main) (147 gpm)	1 lot	\$220,745.75	\$220,745.75	Plumbers	\$85.78	1102.85	1,102.85	\$94,605.32	\$315,351
YWCA (12 gpm)	1 lot	\$51,687.41	\$51,687.41	Plumbers	\$85.78	258.23	258.23	\$22,151.75	\$73,839
SUB TOTAL - ESTIMATED BUILDING MODIFICATIONS REQUIRED TO MEET PEAK LOAD USING BUILDING HOT WATER SUPPLY AT 160°F (NO ABILITY TO INCREASE TEMP DURING PEAK PERIODS)									\$18,947,413
GENERAL CONDITIONS									10% \$20,842,154
OVERHEAD AND PROFIT									10% \$22,926,369
DESIGN CONTINGENCY									15% \$26,365,325
BID CONTINGENCY									5% \$27,683,591
PHASING									0% \$27,683,591
TOTAL - ESTIMATED BUILDING MODIFICATIONS REQUIRED TO MEET PEAK LOAD USING BUILDING HOT WATER SUPPLY AT 160°F (NO ABILITY TO INCREASE TEMP DURING PEAK PERIODS)									\$27,683,591
GRAND TOTAL									\$133,717,917

Appendix B
Additional Potential Heating Load Map



Appendix C
Task 2B Lower District Heating Temperature

TASK 2B

LOWER DISTRICT HEATING TEMPERATURE

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Task 2B: Lower District Heating Temperature

1. SUMMARY

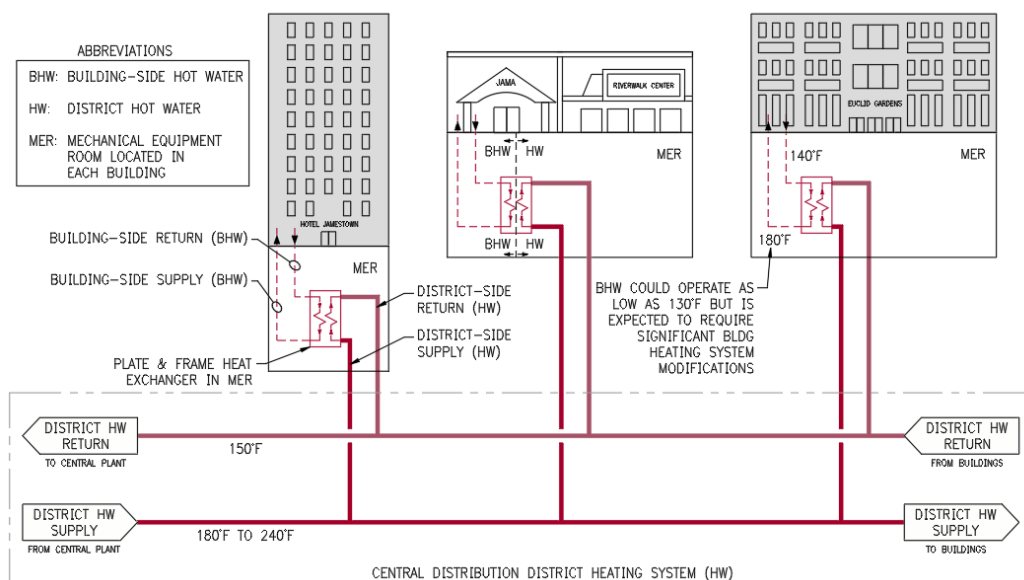
Evaluation of system temperatures is one step towards a successful transition from fossil fuels to heat pumps using renewable or low carbon energy. Lowering the central distribution (HW) supply temperature from 240°F to 160°F is recommended and will not only improve efficiency but will ensure a district heating system ready for long-term operation and not reliant on fossil fuels. The Jamestown Board of Public Utilities (BPU) located in Jamestown, New York recognizes the importance of decarbonizing their district heating system and has a long-term vision of maintaining its operation. As a result, Ramboll Americas Engineering Solutions, Inc. (Ramboll) was retained to evaluate the current hot-water supply and return temperatures of BPU's HW and building-side (BHW) systems.

There are many benefits to reducing district hot water temperatures, some of which include:

- Greater long-term economics
- Ability to employ more renewable technologies
- Reduce distribution heat losses
- Minimize overall temperature drop to furthest building.
- Permit the use of different pipe material such as PEX
- Improve heat pump performance
- Reduce reliance on fossil fuel combustion
- Increase life expectancy of steel components
- Reduce safety risks associated with higher temperatures

The current district heating system supplies 180°F to 240°F HW depending on the time of year. The system is designed to maintain a return temperature of 150°F. Apart from a few locations, district heating customers use the HW for standard space heating (SH) and domestic hot water (DHW) needs that could be met with HW temperatures below 160°F. Currently, most building-side systems are designed to meet the peak load with 180°F BHW supply and 140°F BHW return. **These systems would require modifications to operate at lower temperatures.** Figure 1 illustrates the various parts of the heating system described throughout this technical memo.

Figure 1- Jamestown District Heating System & Building-Side System Points of Demarcation



Although lowering the temperature is recommended, it would not be required for a centralized heat pump system since this option will use the existing boilers to boost HW temperatures during peak conditions. However, any decentralized option using local heat pumps at each building will either require peaking boilers be installed with the heat pumps or lower BHW temperatures since standard available heat pumps produce a maximum of 160°F.¹ Table 1 includes a list of the six scenarios that were evaluated and their associated work. Only three scenarios will require building modifications to meet peak heating loads with lower BHW temperatures. Building modifications required to reduce the BHW from 180°F to 160°F are estimated to be less than or equal to the cost of installing local boilers.

Table 1 - Scenarios & Associated Work

Scenarios	Work Type Required for Each Scenario								
	Boilers		Distribution Systems			Heat Pumps			
	A	B	C	D	E	F	G	H	I
1) Business as Usual	X		X						
2) Centralized Heat Pumps	X		X			X		X	
3) Centralized Hybrid Option	X		X ¹	X ²		X	X ²	X	X ²
4) Ambient Geothermal Loop			X	X			X	X	X
5) Decentralize w/Gas-Fired Boilers		X			X				
6) Decentralize w/Heat Pumps				X			X	X	X

Work Type Descriptions

A - Continued use of existing boilers for peaking and resiliency

B - Install local boilers

C - Replacement of HW district distribution piping

D - Upgrade electrical distribution systems

E - Upgrade natural gas distribution systems

F - Heat pumps installed in central plant

G - Heat pumps installed locally at each building

H - Install heat sources (e.g, geothermal, air source, waste, solar, etc.)

I - Building modifications necessary to lower BHW

Note 1: The hybrid option would only require HW distribution piping replaced up to 6th St.

Note 2: Upgrades and modifications only required in four bldgs north of 6th St. where local heat pumps will be installed.

This technical memo documents the 12 buildings surveyed, the current and future performance of existing BHW systems, various modifications anticipated within the buildings, and the calculated peak heating loads of each surveyed building. It reviews the potential heat-pump technology and equipment arrangement and provides a comparison of estimated costs for building modifications required to lower the temperature of the BHW against installing a local boiler.

It is possible, but not likely, that current building SH systems could meet peak loads at lower BHW temperatures without modifications. Further investigation and testing is recommended as an initial step by each customer to determine the extent of modifications required.

¹ Heat Pumps using natural refrigerants such as Ammonia (NH₃) and CO₂ operate at higher BHW supply temperatures than units using conventional chemical refrigerants. These heat pumps are being considered as part of this study and new products reviewed as they become available. However, standard CO₂ machines require low return water temperatures and are typically not good candidates for SH but could work for DHW production. Heat pumps using NH₃ are generally used for large industrial applications and require an additional external heat source in lieu of a compressor. [Absorption Heat Pumps | Department of Energy](#)

2. SCOPE

The goal of this Task was to identify the lowest BHW supply temperature the customers of the Applicant could accept at their buildings under a heating only condition. This evaluation looks beyond the historic operation of the system to consider each customer's use of the BHW. The evaluation considered each building's current operating mode, and a future mode if the building's energy system is modified. Modifications may include, but are not limited to, changes in controls, equipment, system arrangement, or technology used. Establishing the lowest BHW operating temperature will allow the Contractor to propose those technologies that best meet the Applicant's needs. The lower the operating temperature reached, the greater the variety of alternative technologies to choose from. Once the appropriate technology and equipment are identified, preliminary study work can be performed. This preliminary study work will lead to estimating equipment sizing, sizing of ancillary systems, and equipment costing.

3. APPROACH

The field investigation and engineering analysis required by Task 2B were conducted between January 24th and February 23rd, 2023. The execution of the work included the following tasks:

- 1) A review and analysis of the BPU provided operational data in excel format including 9 years of hourly incremental thermal supply energy delivered from the central plant to the distribution system.
- 2) Field investigations of 12 connected customers were performed on Tuesday January 24th and Wednesday January 25th, 2023. On the days the survey was performed, the outside air temperature averaged approximately 28°F.
- 3) Interviews with the BPU plant staff and distribution system engineers were conducted to gain an understanding of how the systems are currently being operated. Discussions of operational issues, reliability concerns, and systemic problems were documented.
- 4) Drawings were provided regarding the construction, details, and arrangement of the district heating system. Limited customer drawings were available except what was found on site during the investigation.

4. EXISTING SYSTEMS

On Tuesday January 24th and Wednesday January 25th, 2023, Ramboll surveyed the mechanical rooms and connected heating equipment in 12 buildings.

On the days the survey was performed, the outside air temperature (OAT) averaged 28°F. The BHW was recorded as shown in Figure 2.

The results indicate that the buildings currently operate at various temperatures and there is no standard set temperature. The survey also revealed that not all buildings have similar designs or equipment and require different operating BHW's to meet the buildings load on a design day. The OAT on a design day in Chautauqua County is 4.5°F in accordance with the latest published ASHRAE climate data.

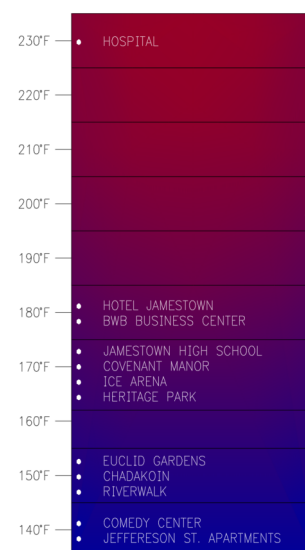


Figure 2 - Surveyed Buildings BHW's

5. EXISTING CONDITIONS – BUILDINGS OPERATING @ 230°F BHW

5.1 UPMC Chataqua Hospital



UPMC Chataqua Hospital is a 340,000 ft² multi-story building constructed in 1885 with a total annual heat load of 10,800 MMBtu, which is about 7.5% of the district system's total annual heat load.

At the time of the survey, the Hospital's heating loads were met using local boilers in the mechanical room since the district heat exchanger had failed. However, the Facilities Director met with Ramboll and BPU to provide an overview of their operation. The facility indicated that the Hospital's space heating system is designed for low-pressure steam and that 240°F supply temperatures from the district are required.

The steam is used for space heating and humidification systems. The Hospital also has two sanitizers that require 45 psig steam. However, the higher-pressure steam required for sanitizing is always provided by the local boilers since the district supply temperature is not capable of producing steam above 8 psig.

The Hospital currently has 3 gas-fired boilers that were installed in 1974. The boilers are a fire-tube type with a combined total heat output of 900 HP (30MMBtuh) as manufactured by Cleaver Brooks. The facility indicated that these boilers are beyond their useful life and are currently performing an engineering study for replacement.

BUILDING INFORMATION:
 BUILDING NAME: UPMC CHATAUQUE AT WCA
 ADDRESS: 207 FOOTE AVE.
 METER NUMBER: 471205
 GSF: 340,010
 YEAR BUILT: 1885
 BUILDING USE: HOSPITAL

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 240°F
 DISTRICT HW RETURN TEMP = 150°F

BUILDING ENERGY USE:
 EUI: 32
 ANNUAL CONSUMPTION: 10,838 MMBTU
 ESTIMATED PEAK: 13,345,000 BTUH
 ESTIMATED PEAK: (33 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = STEAM & HOT WATER
 BUILDING STEAM SUPPLY = 5 PSIG
 BUILDING RETURN = CONDENSATE
 CONNECTED END USE EQUIPMENT:

- REHEAT COILS
- PERIMETER HEAT
- AHU COILS
- HUMIDIFIERS
- STEAM TO HW HX (ADDITION)

LOCAL STEAM BOILERS

- Boiler 1 = 160 HP
- Boiler 2 = 370 HP
- Boiler 3 = 370 HP



Photo 1 - Hospital Boilers



Photo 2 - District Heat to Bldg HW Heat Exchanger

The survey revealed that the Hospital's space heating equipment consists of steam coils within variable-air-volume (VAV) boxes throughout the main building and a steam-to-hot-water heat exchanger that serves an extension that was constructed in 2011. The building extension accounts for approximately 20% of the total building area.

The building also has year-round cooling needs that will be considered for heat recovery.

6. **EXISTING CONDITIONS – BUILDINGS OPERATING @ 180°F BHW**

6.1 *Hotel Jamestown*



BUILDING INFORMATION:
 BUILDING NAME: HOTEL JAMESTOWN
 ADDRESS: 100-112 W. 3RD STREET
 METER NUMBER: 8795086
 GSF: 140,000 (ESTIMATED)
 YEAR BUILT: 1910
 BUILDING USE: RESIDENTIAL

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 234°F
 DISTRICT HW RETURN TEMP = 154°F

BUILDING ENERGY USE:
 EUI: 40
 ANNUAL CONSUMPTION: 5,700 MMBTU
 ESTIMATED PEAK: 1,381,000 BTUH
 ESTIMATED PEAK: (10 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 180°F
 BHW RETURN TEMP = 140°F
CONNECTED END USE EQUIPMENT:
 • RADIATORS
 • HOT WATER CONVECTORS

Hotel Jamestown is ~ 140,000 ft² nine story building constructed in 1910 with 113 apartments and commercial space on the 1st floor. The building has a total annual heat load of 5,700 MMBtu or about 4% of the district system's total annual heat load. The building's heating system was originally steam which was then converted to hot water. It appears most of the original steam radiators remain and were repurposed for hot water. Some of the east apartments have been fitted with finned tube units.



Photo 3 - Typical Steam Radiator - Corridor



Photo 4 - Typical Finned-Tube Unit - East Apartment

The Hotel Jamestown does not have backup heating equipment and relies solely on the district heating system.

6.2 BWB Business Center



The BWB Center is a 35,850 ft² three story business center that was constructed in 2008. The building has a total annual heat load of 640 MMBtu or about 0.4% of the district system's total annual heat load. The heat distributing units within the building were all water-source to air heat pumps that operate with a maximum supply temperature of 90°F. Although the heat pumps only require a BHW of 90°F, the domestic hot-water was heated using the building side hot-water supply and, therefore, the site facility manager indicated that it maintained a constant BHW of 180°F. The heat pumps were arranged in a primary-secondary loop to reduce the temperature of the hot-water supply to match the needs of the heat pumps.

The BWB Business Center does not have backup heating equipment and relies solely on the district heating system.

BUILDING INFORMATION:
BUILDING NAME: KROG CORP. (BWB BUSINESS CNTR)
ADDRESS: 201 W. 3RD ST.
METER NUMBER: 306505
GSF: 35,850
YEAR BUILT: 2008
BUILDING USE: 100% OFFICE
DISTRICT HEATING SYSTEM:
DISTRICT HW SUPPLY TEMP = 230°F
DISTRICT HW RETURN TEMP = 165°F
BUILDING ENERGY USE:
EUI: 18
ANNUAL CONSUMPTION: 641 MMBTU
ESTIMATED PEAK: 440,000 BTUH
ESTIMATED PEAK: (12 BTU/SQ-FT)
BUILDING HEATING SYSTEM:
HEATING SYSTEM = HOT WATER
BHW SUPPLY TEMP = 90°F
BHW RETURN TEMP = 80°F
CONNECTED END USE EQUIPMENT:
• CLIMATE MASTER WSHPS

7. **EXISTING CONDITIONS – BUILDINGS OPERATING @ 170°F BHW**

7.1 *Heritage Park*



Heritage Park is a 63,081 ft² three story in-patient rehabilitation center with a total annual heat load of 7,700 MMBtu or approximately 5% of the district system's total annual heat load.

The building has a combination of baseboard perimeter heat, air handling units, and recessed wall convectors in stairwells. In addition to the district heat plate and frame heat exchangers, the mechanical room also contained three local gas-fired boilers with a total capacity of 140HP that were used for backup purposes. The largest backup boiler was rated for 65 HP and was installed in 1975. The facility manager indicated it was still operational but unreliable and has exceeded its useful life.

District heat is also provided to a separate heat exchanger that is dedicated for a snow melt system that extends under the walkways around the perimeter of the building.

BUILDING INFORMATION:
BUILDING NAME: HERITAGE PARK
ADDRESS: 28 EUCLID AVE.
METER NUMBER: 4799-02
GSF: 63,081
YEAR BUILT: 1980
BUILDING USE: ASSISTED LIVING
DISTRICT HEATING SYSTEM:
DISTRICT HW SUPPLY TEMP = 224°F
DISTRICT HW RETURN TEMP = 161°F
BUILDING ENERGY USE:
EUI: 123
ANNUAL CONSUMPTION: 7,735 MMBTU
ESTIMATED PEAK: 594,000 BTUH
ESTIMATED PEAK: (10 BTU/SQ-FT)
BUILDING HEATING SYSTEM:
HEATING SYSTEM = HOT WATER
BHW SUPPLY TEMP = 180°F
BHW RETURN TEMP = 140°F
CONNECTED END USE EQUIPMENT:
• PERIMETER CONVECTORS • BASEBOARD • AIR HANDLING UNITS



Photo 5 - Heritage Park - District Heat Plate & Frame HX



Photo 6 - Heritage Park - Backup Boilers

7.2 Ice Arena



The Ice Arena is a 68,532 ft² building that operates two hockey rinks seasonally. The arena was constructed in 2000 and has a total annual heat load of 4,300 MMBtu or 3% of the district system's total annual heat load.

The arena has a variety of needs for the district heating system including space heating, dehumidification, ice resurfacing and an interior ice melt pit. There were no backup systems installed for the ice arena.

BUILDING INFORMATION:
 BUILDING NAME: JAMESTOWN SAVINGS
 BANK ICE ARENA
 ADDRESS: 319 W. 3RD ST.
 METER NUMBER: 245507
 GSF: 68,532
 YEAR BUILT: 2000
 BUILDING USE: ICE RINK

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 240°F
 DISTRICT HW RETURN TEMP = 170°F

BUILDING ENERGY USE:
 EUI: 63
 ANNUAL CONSUMPTION: 4,300 MMBTU
 ESTIMATED PEAK: 2,400,000 BTUH
 ESTIMATED PEAK: (35 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 200°F
 BHW RETURN TEMP = 160°F
CONNECTED END USE EQUIPMENT:

- ENERGY RECOVERY UNITS
- AIR HANDLING UNITS
- ROOFTOP UNITS
- CABINET UNIT HEATERS
- PERIMETER FINNED TUBE
- DEHUMIDIFICATION
- RINK ICE MELT
- RINK ICE RESURFACING

The building heat is provided using hot-water coils in an energy recovery unit, 4 air handling units, 2 rooftop units, 2 cabinet unit heaters, and perimeter finned tube radiation. All the units have a design operating temperature of 200°F. The mechanical spaces consist of 6 plate & frame heat exchangers that serve the space heating and dehumidification units, 3 shell & tube heat exchangers for the ice resurfacing system, 4 shell & tube heat exchangers for domestic hot water, and 1 small plate & frame that serves the interior ice melt pit. The ice arena is also equipped with a Carrier i-Vu central BMS system but did not have trend data available.



Photo 7 - Ice Rink Space Heat HX's



Photo 8 - Ice Rink - Ice Melt Pit



Photo 9 - Ice Rink BMS Screen



Photo 10 - Ice Rink Arena Conditions BMS Screen

7.3 Covenant Manor



Covenant Manor is a 109,416 ft² 7-story assisted living facility that has a total annual heat load of 5,100 MMBtu or 3.5% of the district system's total annual heat load.

The mechanical equipment room (MER) contains 2 plate & frame heat exchangers for space heating and 1 for domestic hot water. Space heating is primarily done in the rooms with panel radiators and hallway makeup air is heated with a rooftop air handling unit.

BUILDING INFORMATION:
 BUILDING NAME: COVENANT MANOR APARTMENTS, LLC
 ADDRESS: 11-23 W. 3RD ST.
 METER NUMBER: 482703
 GSF: 109,416
 YEAR BUILT: 1900
 BUILDING USE: ASSISTED LIVING

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 230°F
 DISTRICT HW RETURN TEMP = 156°F

BUILDING ENERGY USE:
 EUI: 47
 ANNUAL CONSUMPTION: 5,120 MMBTU
 ESTIMATED PEAK: 1,100,000 BTUH
 ESTIMATED PEAK: (10 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 200°F
 BHW RETURN TEMP = 160°F
 CONNECTED END USE EQUIPMENT:
 • PANEL RADIATORS
 • ROOFTOP UNITS



Photo 11 - Covenant Manor Panel Radiator



Photo 12 - Rooftop Air Handler

Covenant Manor does not have backup heating equipment and relies solely on the district heating system.

7.4 Jamestown High School



The Jamestown High School is a 252,460 ft² building constructed in 1867. The high school has the largest space heating needs of all connected buildings with a total annual heating load of 12,000 MMBtu or 8% of the district system's total annual heating load.

The building has 8 different mechanical rooms that serve hot-water coils in 9 rooftop air handlers which provide all of the buildings space heat. District heat is also used for pool heating.

The high school does not have backup heating equipment and relies solely on the district heating system.

BUILDING INFORMATION:
 BUILDING NAME: JAMESTOWN HIGH SCHOOL
 ADDRESS: 320 E. 2ND ST.
 METER NUMBER: N/A
 GSF: 252,460
 YEAR BUILT: 1867
 BUILDING USE: SCHOOL

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 220°F
 DISTRICT HW RETURN TEMP = 165°F

BUILDING ENERGY USE:
 EUI: 47
 ANNUAL CONSUMPTION: 12,000 MMBTU
 ESTIMATED PEAK: 5,500,000 BTUH
 ESTIMATED PEAK: (22 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 200°F
 BHW RETURN TEMP = 160°F
 CONNECTED END USE EQUIPMENT:

- POOL HEATING
- ROOFTOP AIR HANDLERS



Photo 13 – Jamestown HS - Pool Plate & Frame HX



Photo 14 - Jamestown HS - Swimming Pool

8. EXISTING CONDITIONS – BUILDINGS OPERATING @ 150°F BHW

8.1 Euclid Gardens



BUILDING INFORMATION:
 BUILDING NAME: CODE EUCLID GARDENS
 ADDRESS: 28 EUCLID AVE.
 METER NUMBER: 4799-02
 GSF: 29,711
 YEAR BUILT: 1910
 BUILDING USE: RESIDENCE

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 217°F
 DISTRICT HW RETURN TEMP = 154°F

BUILDING ENERGY USE:
 EUI: 66
 ANNUAL CONSUMPTION: 2,000 MMBTU
 ESTIMATED PEAK: 680,000 BTUH
 ESTIMATED PEAK: (24 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 180°F
 BHW RETURN TEMP = 140°F
 CONNECTED END USE EQUIPMENT:
 • CONVECTORS

Euclid Gardens is a 29,711 ft² 2 story building that was originally constructed as a school in 1910, then later converted to apartments. The building has a total annual heat load of 2,000 MMBtu or 1.5% of the district system's total annual heat load.

The buildings MER contains 2 plate & frame heat exchangers for space heating and 1 plate & frame heat exchanger along with two 119-gallon domestic hot-water heaters. Figure 3 below is a flow diagram illustrating the piping arrangement of the systems within the Euclid MER. The district hot-water supply temperature was 217°F at the time of the survey. Euclid Gardens is one of the most hydraulically remote buildings in the system and the district supply temperature was the lowest recorded of all buildings surveyed.

The piping arrangement shown in Figure 3, was similar in all other buildings surveyed.

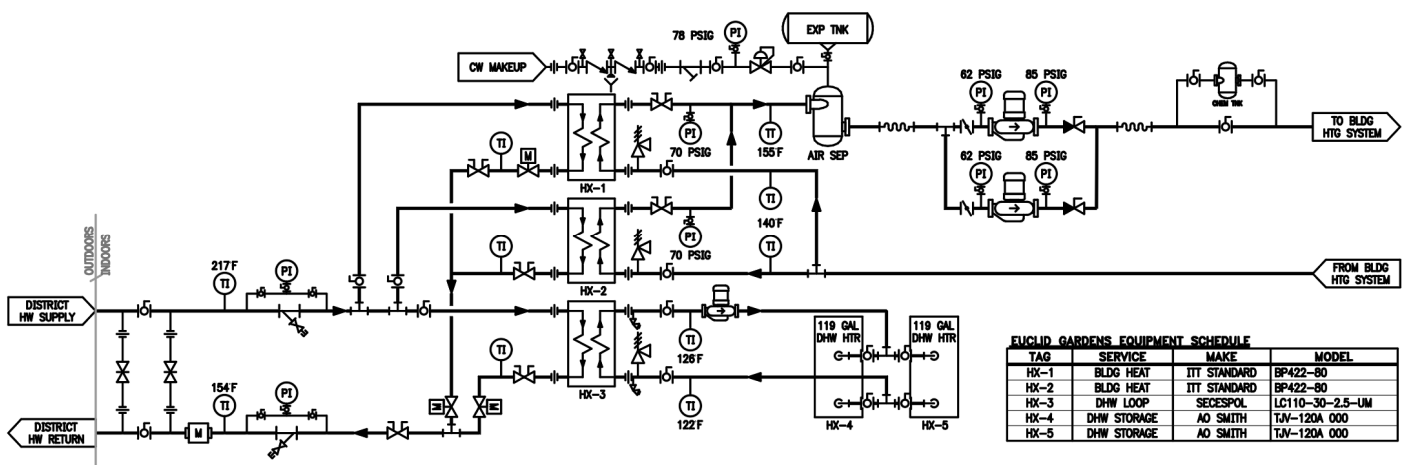


Figure 3 - Euclid Gardens Flow Diagram & HX Schedule

The building space heating is met with perimeter and interior convectors throughout the building. Temperature control in the rooms is performed through local thermostatic control valves at each convector.



Photo 15 - Euclid Gardens - MER HX's



Photo 16 - Euclid Gardens - Typical Finned Tube Convector

Euclid Gardens does not have backup heating equipment and relies solely on the district heating system.

8.2 Chadakoin Apartments



Chadakoin Apartments is a 55,512 ft² 6 story complex with 101 apartments constructed in 1920. The building has a total annual heat load of 2,560 MMBtu or almost 2% of the district system's total annual heat load.

The building was originally constructed based on a steam system and has since been converted to hot water. Each apartment is fitted with individual fan coil units and the common spaces such as hallways and stairwells have a mixture of convectors and radiators.

Chadakoin Apartments does not have backup heating equipment and relies solely on the district heating system. The Facility manager indicated that he recently received a proposal for \$1.6M to install a backup boiler system to serve both the adjacent Hotel Jamestown and the Chadakoin Apartments which are both owned and operated by the Jamestown Housing Authority.

BUILDING INFORMATION:
BUILDING NAME: CHADAKOIN BLDG
ADDRESS: 144-122 W 3RD ST.
METER NUMBER: 199304
GSF: 55,512
YEAR BUILT: 1920
BUILDING USE: RESIDENCE
DISTRICT HEATING SYSTEM:
DISTRICT HW SUPPLY TEMP = 235°F
DISTRICT HW RETURN TEMP = 154°F
BUILDING ENERGY USE:
EUI: 46
ANNUAL CONSUMPTION: 2,560 MMBTU
ESTIMATED PEAK: 755,000 BTUH
ESTIMATED PEAK: (14 BTU/SQ-FT)
BUILDING HEATING SYSTEM:
HEATING SYSTEM = HOT WATER
BHW SUPPLY TEMP = 180°F
BHW RETURN TEMP = 140°F
CONNECTED END USE EQUIPMENT:
- FAN COILS - CONVECTORS

8.3 JAMA (Jamestown Area Medical Associates) Building



BUILDING INFORMATION:
 BUILDING NAME: JAMESTOWN AREA MEDICAL ASSOC.
 ADDRESS: 15 S. MAIN ST.
 METER NUMBER: 53137625 & 419409
 GSF: 82,624
 YEAR BUILT: 1978
 BUILDING USE: MEDICAL

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 226°F
 DISTRICT HW RETURN TEMP = 148°F

BUILDING ENERGY USE:
 EUI: 62
 ANNUAL CONSUMPTION: 5,100 MMBTU
 ESTIMATED PEAK: 3,465,000 BTUH
 ESTIMATED PEAK: (42 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 180°F
 BHW RETURN TEMP = 140°F
 CONNECTED END USE EQUIPMENT:
 • ROOFTOP UNITS
 • SNOW MELT

The JAMA building is an 82,624 ft² medical center that was constructed in 1978. A majority of the building is single story but has a second floor on the east side of the building that accounts for approximately 10% of the building area. The building has a total annual heat load of 5,100 MMBtu or 3.5% of the district system's total annual heat load.

The space heating load is met by hot-water coils in 33 rooftop units that are controlled by a central BMS system. The buildings MER contains two plate & frame heat exchangers for space heating and a shell & tube heat exchanger and storage tank for domestic hot water.

The building also has two separate snow melt systems that use district heat through two plate & frame heat exchangers throughout the walkways around the perimeter of the building.

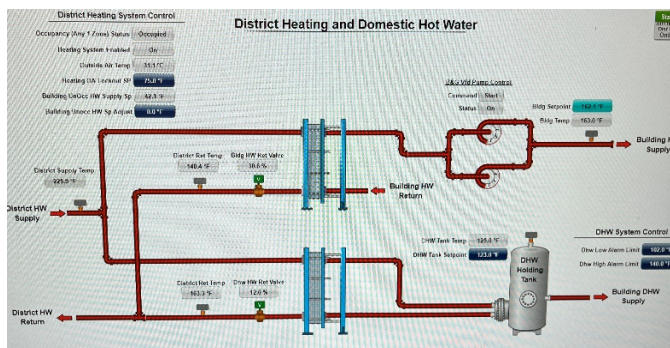


Photo 17 - JAMA Bldg - Heating System BMS Screen Capture

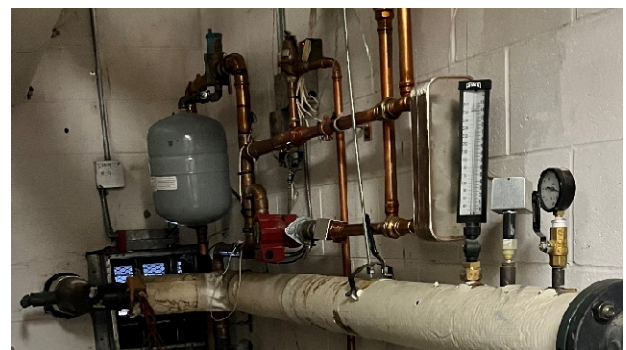


Photo 18 - JAMA Bldg - Snow Melt HX

The JAMA building does not have backup heating equipment and relies solely on the district heating system.

9. **EXISTING CONDITIONS – BUILDINGS OPERATING @ 140°F BHW**

9.1 Comedy Center



The Comedy Center merged an existing train station and substation to form a single building. The substation and connecting wing are heated by gas-fired rooftop units and an electric split unit. The remaining portion of the building is heated using district hot water. The district heating connected portion of the building is 22,456 ft² that was originally constructed in 1920 as a train station. The building has a total annual heat load of 1,400 MMBtu or 1% of the district system's total annual heat load.

BUILDING INFORMATION:
 BUILDING NAME: NATIONAL COMEDY CENTER
 ADDRESS: 211-217 W. 2ND ST.
 METER NUMBER: 364307
 GSF: 22,456
 YEAR BUILT: 1920
 BUILDING USE: RECREATIONAL

DISTRICT HEATING SYSTEM:
 DISTRICT HW SUPPLY TEMP = 224°F
 DISTRICT HW RETURN TEMP = 118°F

BUILDING ENERGY USE:
 EUI: 62
 ANNUAL CONSUMPTION: 1,400 MMBTU
 ESTIMATED PEAK: 500,000 BTUH
 ESTIMATED PEAK: (22 BTU/SQ-FT)

BUILDING HEATING SYSTEM:
 HEATING SYSTEM = HOT WATER
 BHW SUPPLY TEMP = 180°F
 BHW RETURN TEMP = 140°F
 CONNECTED END USE EQUIPMENT:
 • AIR HANDLERS
 • UNIT HEATERS

The space heating load is met by hot-water coils in 2 air handling units and a small number of unit heaters in the mechanical spaces. The AHU's are controlled by a central BMS system. The building MER contains four plate & frame heat exchangers for space heating and a shell & tube heat exchanger for domestic hot water.



Photo 19 - Comedy Center - Space Heating HX's



Photo 20 - Comedy Center - DHW HX

The Comedy Center does not have backup heating equipment and relies solely on the district heating system.

9.2 Jefferson Street Apartments



BUILDING INFORMATION:
BUILDING NAME: JEFFERSON ST. APARTMENTS
ADDRESS: 211-217 W. 2ND ST.
METER NUMBER: 53137621
GSF: 6,237
YEAR BUILT: 1930
BUILDING USE: RESIDENTIAL
DISTRICT HEATING SYSTEM:
DISTRICT HW SUPPLY TEMP = 224°F
DISTRICT HW RETURN TEMP = 118°F
BUILDING ENERGY USE:
EUI: 71
ANNUAL CONSUMPTION: 444 MMBTU
ESTIMATED PEAK: 140,000 BTUH
ESTIMATED PEAK: (22 BTU/SQ-FT)
BUILDING HEATING SYSTEM:
HEATING SYSTEM = HOT WATER
BHW SUPPLY TEMP = 180°F
BHW RETURN TEMP = 140°F
CONNECTED END USE EQUIPMENT:
• CONVECTORS (ASSUMED)

Jefferson St. Apartments is a 6,237 ft² four story building constructed in 1930. The building has a total annual heat load of 450 MMBtu or 0.3% of the district system's total annual heat load. The facility manager was unavailable at the time of the survey and only the mechanical room was accessible. Based on the size, age, and similar buildings surveyed, the individual apartments are likely heated with room convectors. There appeared to be a total of 14 apartments and the mechanical system was zoned by circulators. Control appears to be done using a programmable thermostat in each apartment to operate its associated circulator.

The mechanical room has 1 plate & frame HX for space heating and another for the domestic hot water loop.



Photo 21 - Jefferson St. Apartments - HW Circulator Zone Control



Photo 22 - Jefferson St. Apartments - District Heat Supply & Return Pipes

Jefferson St. Apartments does not have backup heating equipment and relies solely on the district heating system

10. HEATING LOADS

Nine years of hourly energy supply data was provided by BPU. This data is useful in determining the peak load of the central heating plant; however, additional analysis is required to determine the peak heating load of each individual building due to heat load diversity, domestic hot water loads, and thermal losses. In a conventional (decentralized) heating system where the heat source is installed locally in the building it serves, the equipment is sized to meet the buildings peak load. However, in a district (centralized) heating system with a large number and variation of buildings, the peak load of the central plant is lower than the sum of individual peak loads of all buildings due to heat load diversity. Heat load diversity simply means that all buildings will not demand their peak load at the same time. A significant benefit of a central system is that the total installed capacity in the plant will be less than the sum of units in a decentralized system. However, consideration must be provided for situations when a central plant trips offline during peak load. In these circumstances supply temperature and flow can be increased temporarily until the load is met.

Heat load diversity is estimated based on the number of buildings connected to the system. Figure 4 below shows the diversity factor for space heating as a function of the number of buildings according to different norms².

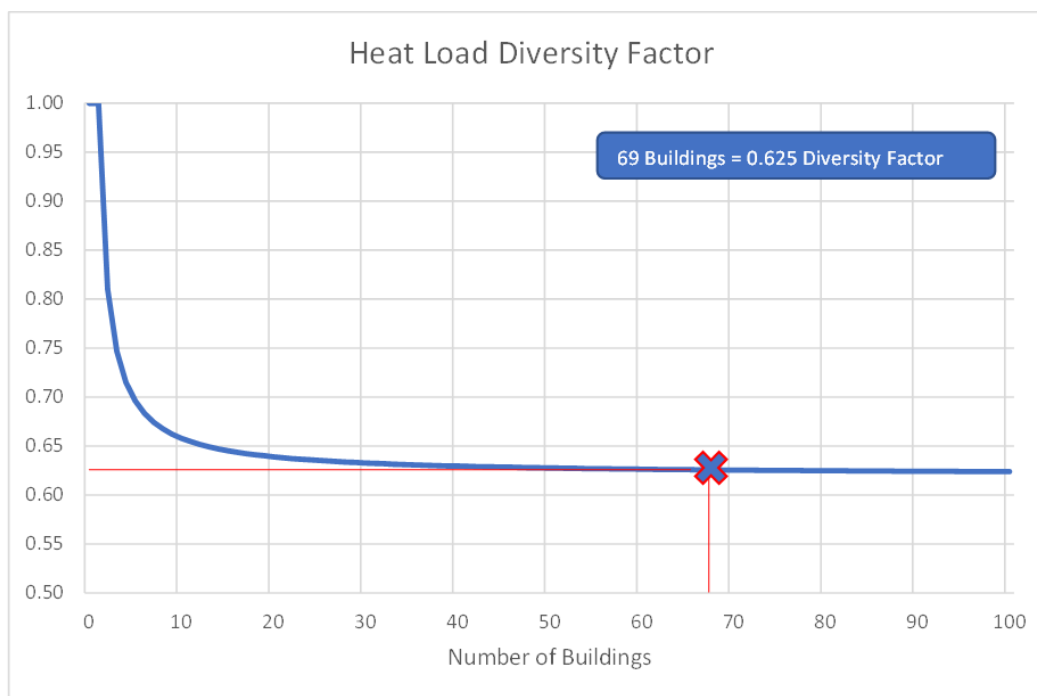


Figure 4 - Heat Load Diversity Factor

The more buildings connected to a central system, the lower the diversity factor. From Figure 4 we see that the capacity of a heating system for a single building is 100% of, or equivalent to, its peak heating load. The capacity of centralized equipment in a district heating system with 69 buildings is 62.5% of the total connected sum of the building peak heating loads.

² CIBSE CP1 2020 (Heat Network Code of Practice for UK) & Varme Stabi 7th edition, 1st print 2015, published by Praxis-Nyt Teknisk Forlag 2015

To size equipment and analyze decentralization, individual peak loads at each building must be determined. Since hourly trend data for buildings is not available, a cursory heat analysis was performed to estimate peak loads.

A heat-load analysis determines the heat that must be supplied to the building to overcome convective/conductive heat transfer from the warm inside to the cold outside through walls, windows, roofs, and floors. The analysis also considers the losses associated with infiltration of cold air into the building through small openings in the building walls, or cracks around doors and windows. Building characteristics including location, size and shape, number of floors, % fenestration, and occupancy type were determined for each building.

A summary of the peak heating building loads, along with the percentage that building represents of the thermal district system's peak load, is included in Table 2 below.

Table 2 - Peak Heating Loads

Building	Estimated Peak Load (Btuh)	Btu/ Sq-Ft	% of Total Load
15 E 5th St LLC (Burgett & Robbins)	118,280	16	0.2%
200 Harrison St LLC (Chataqua IDA)	919,619	8	1.4%
3644 Holdings LLC (Priscilla)	298,669	14	0.4%
3644 Holdings LLC 2 (Cameo)	284,310	15	0.4%
3644 Holdings LLC 3 Jefferson St Apts)	138,717	22	0.2%
3644 Holdings LLC 4 (Parkview Apts)	248,697	16	0.4%
Agnes Home	94,650	18	0.1%
Anderson Manor LB	287,912	13	0.4%
Anderson Tower LP	410,833	12	0.6%
Best Western Hotel	391,842	12	0.6%
Board Of Education - JHS	5,506,083	22	8.1%
Board Of Education - LOVE	1,452,504	24	2.1%
Board Of Education (Tech Cntr)	211,505	12	0.3%
BPU - DH-carlson	481,520	14	0.7%
BPU - low pres gas heat	59,593	18	0.1%
BPU - monitor building	562,335	9	0.8%
Carlson Tower LP	348,013	12	0.5%
Chautauqua Brick, Inc	444,098	19	0.7%
Chautauqua Opportunities	1,630,625	22	2.4%
City of Jamestown (City Hall)	952,014	16	1.4%
City Of Jamestown 3 (Main St. Parking)	583,239	13	0.9%
CODE Euclid Gardens	722,802	24	1.1%
Covenant Manor Apartments, LLC	1,089,861	10	1.6%
DPW	265,639	19	0.4%
DPW 2	376,705	13	0.6%
Duncan Olesnak	61,336	14	0.1%
Eliz W Marvin House	108,401	17	0.2%
E-Z Clean Car Wash	51,769	19	0.1%
First Covenant Church	658,075	40	1.0%
First Lutheran Church	1,135,995	37	1.7%
Fourth St Housing	207,896	16	0.3%
Gregory J Buzzanco (Foote Ave Church)	320,103	42	0.5%
Herbert A Duke II	333,071	11	0.5%
Heritage Ministries (Heritage Park)	593,642	9	0.9%
Heritage Ministries 2 (Childcare)	140,636	31	0.2%
HH Jamestown, LLC (Cherry St. Parking)	1,198,498	12	1.8%
Inter'n Ordinance Tech	346,259	10	0.5%
Jamestown Boys & Girls Club	1,081,424	37	1.6%
Jamestown City (Ice Arena)	2,372,321	35	3.5%
Jamestown Newspaper Corp	429,734	7	0.6%
JHA (5th St. High Rise)	868,188	12	1.3%
JHA (Chadakoin Bldg)	755,391	14	1.1%
JHA (Hotel Jamestown)	1,380,786	10	2.0%
JRP (Jody Peterson)	155,580	16	0.2%
JRP (South County Office Bldg)	629,498	11	0.9%
Kaleida Health	1,438,077	44	2.1%
Krog Corp (BWB Center)	437,465	12	0.6%
Legal Assistance of WNY	113,994	14	0.2%
Lewis & Lewis P C (.001) (.1)	98,876	22	0.1%
Lewis and Lewis	109,620	17	0.2%
Little Theater Jamestown	1,882,513	33	2.8%
National Comedy Center, Inc.	500,610	22	0.7%
Northwest Bank	258,119	11	0.4%
Prendergast Library	483,026	14	0.7%
REALiFE Church Inc.	467,616	39	0.7%
Reg Lenna Center for the Arts	1,715,887	36	2.5%
Riverwalk Properties (JAMA)	3,464,705	42	5.1%
Robert H Jackson Inc, The	226,823	12	0.3%
St James Church	1,051,474	35	1.6%
St Susan Center	898,362	8	1.3%
Time Warner Cable	246,071	14	0.4%
Triple R, LLC	92,505	12	0.1%
UPMC Chautauqua at WCA (Jones Hill)	4,603,592	41	6.8%
UPMC Chautauque at WCA (Physicians)	1,605,585	43	2.4%
UPMC Chautauque at WCA (Hospital)	13,344,745	39	19.7%
Westerberg Tower LP	390,091	12	0.6%
Windstream Corp A/P	701,571	10	1.0%
YMCA (main)	2,936,395	37	4.3%
YWCA	239,944	0	0.4%

Notes:

1) JHA = Jamestown Housing Authority

2) JRP = Jamestown Rental Properties

3) Only approximately 33% of 200 Harrison St. LLC is heated for office use.

Total Peak Heating Load = 68 MMBtuh

The building peak loads can also be derived from the hourly data after removing process loads from the plant, thermal losses in the distribution system, the domestic hot-water (DHW) load and accounting for heat load diversity. This method was also used to verify the accuracy of the heat-load analysis.

The central plant's peak load of 65 MMBtuh occurred on February 1, 2019 at an average daily OAT of 5°F. Since the electric generator air preheaters were operating on this day, the process load to the preheaters must be subtracted from the total load. The process load was determined using historical hourly data and is approximately 21% of the total load at 5°F OAT. Subtracting the process load results in a peak distribution load of 51 MMBtuh.

The DHW load was determined using the average hourly recorded data from June 2019 through August 2019, subtracting the average heat losses recorded during these months. The average hourly DHW load for the system is estimated to be 3 MMBtu. Subtracting the DHW load results in a peak space heating load of 48 MMBtuh.

The monthly meter readings for all connected loads were compared to the total energy supplied to the system in February 2019. The data indicates the heat losses from the distribution system account for approximately 11% of the total energy supplied by the central plant. The large percentage of distribution losses³ can be attributed to the high supply temperature of 240°F, the long lengths of over 70,000 feet of pipe, the age, degrade condition, and number of leaks in the existing system.

Reducing the peak load by the heat losses in the distribution system, results in a connected space heating building load of 43 MMBtuh. Since the resulting load is estimated to be only 62.5% of the total due to the heat diversity, the total capacity of a decentralized system would require approximately 69 MMBtuh of installed heating equipment plus domestic hot water equipment and heating equipment for power plant operations. The difference between the calculated heat loads (68MMBtuh) and the recorded heat loads (69 MMBtuh) are within 2% of each other and provide a level of confidence in the individual building peak loads presented in Table 2.

11. EVALUATION OF EXISTING TEMPERATURES (BHW)

11.1 Radiators/Convectors/Baseboards

Most of the buildings were constructed in the early 1900's and are predominantly fitted with perimeter style radiation and convective terminal units sized for temperatures of 180°F or greater. Figure 5 contains the various types of terminal units observed during the survey.

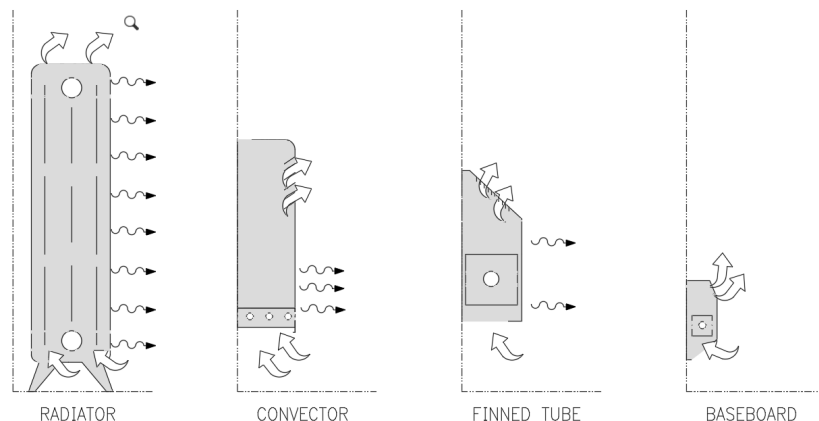


Figure 5 – Typical Building Terminal Units

³ 10%-15% industry standard rule-of-thumb heat losses from distribution systems have recently been demonstrated to overestimate actual losses. Calculated results indicate actual losses for a typical system to be between 2% and 3%. [gdhv - tuv sud - zeroth diversity design guide - 250821 - v12.pdf \(dimplex.co.uk\)](#)

A buildings heating system is intended to meet its peak load on a design day at a specific BHW. Buildings designed to operate with a BHW at 180°F, will require 180°F. However, terminal units are typically oversized and improvements to the building envelope are generally performed over time. Still, care must be taken when evaluating the reduced temperature since operating terminal units at a lower temperature reduces their capacity.

Figure 6 – Terminal Unit Correction Factors @ Nonstandard Conditions

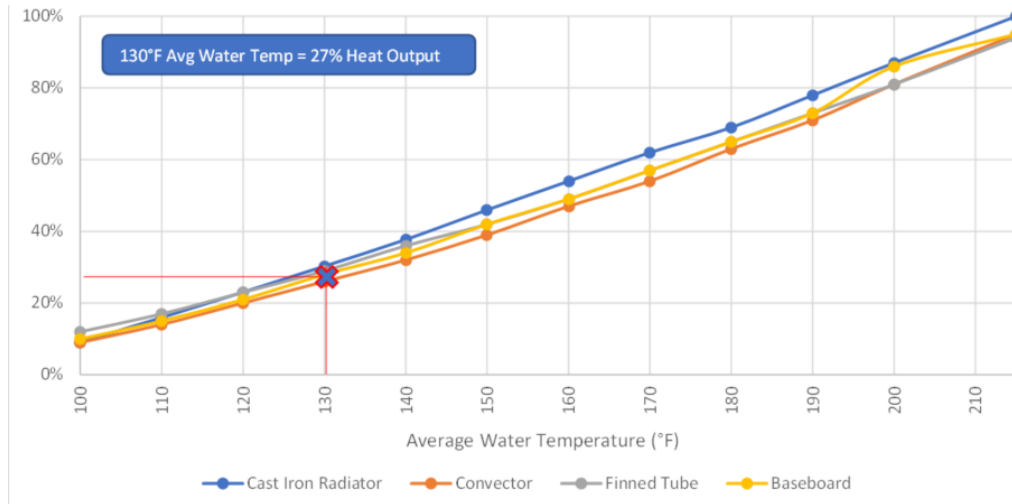
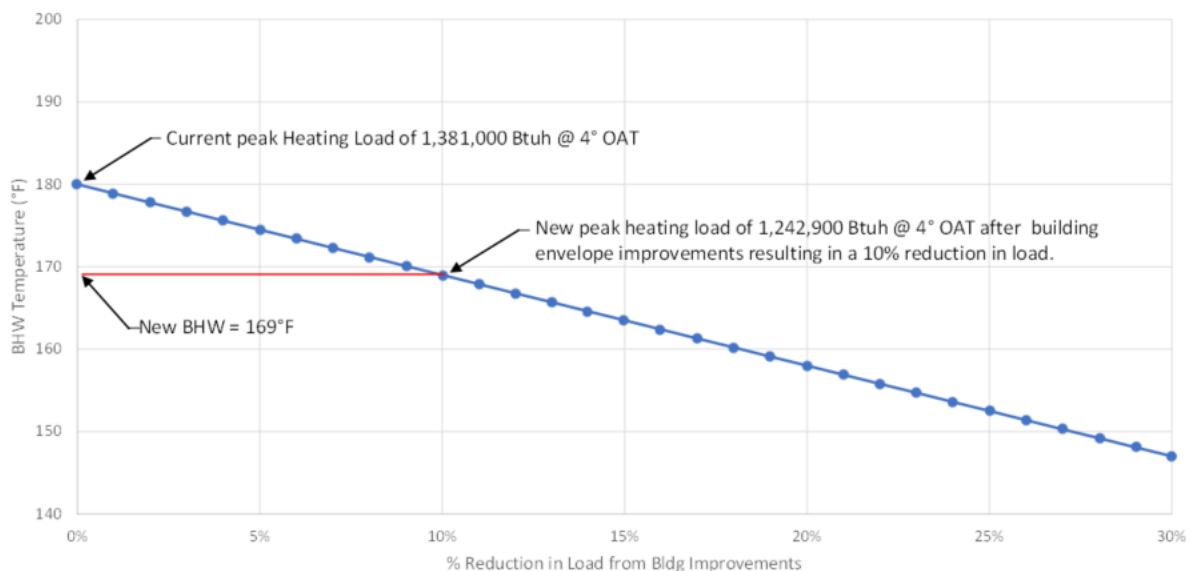


Figure 6 illustrates the effect on the buildings terminal units by reducing the BHW. The capacity of the terminal units drops to approximately 30% when the temperature is reduced from standard conditions to 130°F. Standard conditions for radiators is 215°F at 70°F room temperature. Standard conditions for convectors, baseboard, and finned tube units are 215°F at 65°F room temperature.⁴

Figure 7 below illustrates the relationship between improving building envelope and reducing the BHW. The information accounts for a reduction in terminal unit capacity. A reduction of 10% in the peak load will result in lowering the BHW from 180°F to 169°F.

Figure 7 - Relationship Between BHW and Peak Heating Load Reduction - Example Using Hotel Jamestown Loads



⁴ Nonstandard correction factors for various types of heating units are provided in the ASHRAE HVAC Systems and Equipment Handbook.

11.2 Hot Water Coils

Equipment such as air handling units and fan coils that transfer heat from a heating coil to air, can be modified by changing the coil, adding coils, or modifying nearby pipe to use an existing cooling coil as a heating coil when needed. The modifications required to transition this equipment to a system operating with lower temperatures are more straight forward and would not require extensive building pipe modifications that a traditional hydronic system with radiators, convectors or baseboards might.

Figure 8 illustrates by increasing surface area by adding coils within an air handler, fan coil, or unit heater, can reduce the BHW temperature required but maintain the same discharge air temperature.

Another alternative option typically more expensive to implement is heat recovery wheels or heat exchangers. These devices capture the heat from exhaust air and pre-heat the colder incoming supply air, reducing the overall heat load on the coil.

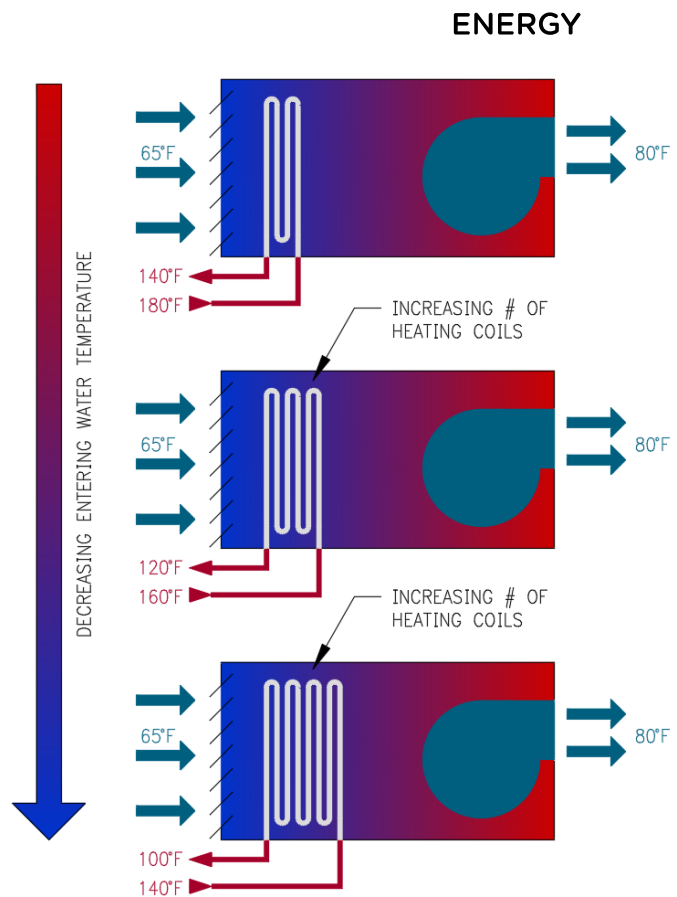


Figure 8 - Hot Water Coil Modifications

11.3 Building Envelope Improvements

Typical building envelope improvements with relatively quick payback include door and window weatherstripping, adding building insulation to accessible areas such as attic spaces, and sealing envelope penetrations such as openings from abandoned pipes, vents, and grilles. Additional building envelope improvements that could be performed are window and door replacements, but these tend to have longer paybacks and typically only done when major building renovation projects are funded.

11.4 Outdoor Temperature Reset

For all heating loads below peak, the BHW can be lowered. Outdoor temperature reset is a common type of control for building space heating and uses outside air temperature as its signal to lower the BHW. Based on the survey, it appears that outdoor reset is used by most customers on the Jamestown district. The BHW recorded in 9 of the 12 buildings surveyed, align with a typical outdoor temperature reset schedule. Below are two example curves: Figure 9 is based on a design day BHW of 180°F, and Figure 10 is based on a design day BHW of 200°F. Five of the 12 buildings surveyed were operating with BHW's similar to Figure 9 and 4 of the buildings were operating with BHW's similar to Figure 10. Three buildings do not appear to be on a reset schedule and include the Hospital, Hotel Jamestown, and the BWB Center.

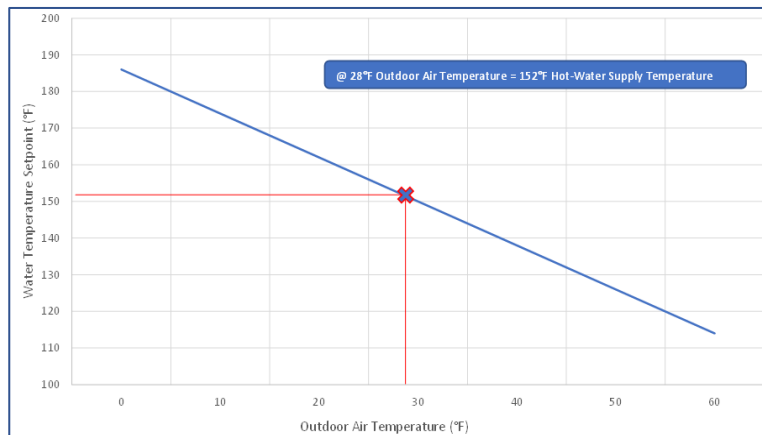


Figure 9 - (180°F) Typical Outdoor Temperature Reset Schedule

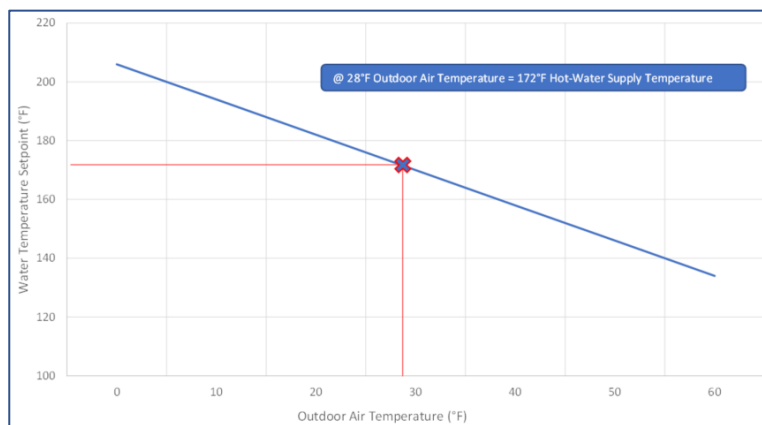


Figure 10 - (200°F) Typical Outdoor Temperature Reset Schedule

Both Figure 9 and Figure 10 illustrate a linear relationship with either 180°F or 200°F BHW when the OAT is 4°F. On the days of the survey, the OAT was approximately 28°F, which correlates to a BHW of either 152°F or 172°F. A building operating on a reset schedule would be expected to be at or near one of these two temperatures.

The Ice Arena's recorded BHW was 172°F. The equipment schedule was provided and confirmed that its terminal units are designed for 200°F. Designing a buildings heating system at a higher temperature would reduce up-front costs since it requires smaller terminal units, and equipment heating coils. Since Jamestown offers temperatures as high as 240°F during the peak heating season, it is expected that even some of the newer buildings will have a design BHW of 200°F.

11.5 Higher Temperature Requirements

The Hospital requires 240°F supply temperatures to produce low-pressure steam for space heating and humidification. The Hospital also has sanitizers that require higher-pressure steam, but these loads are met with local high pressure boilers. The only other building surveyed that requires a higher temperature for process loads was the Ice Arena. However, it is expected that modifications could be made to the existing systems including the ice resurfacing, ice melt pit, and dehumidification units to operate using the lower temperatures recommended in this report.

Of the 70 buildings connected to the system it appears that the operating temperature of 240°F is set based on the Hospital's needs. One strategy to lower the district heating system HW temperature could be to continue use of the Hospitals local high-pressure steam boilers to meet the sanitizing and humidification steam loads. The remaining SH systems could be converted to operate using 160°F HW. These systems could be converted in the future to local electric steam boilers or high temperature water source heat pumps (WSHP's) that use the district HW as its source to boost the temperature.

11.6 Building Survey Summary

In summary, from the buildings surveyed, it appears their design BHW's are as follows:

Table 3 - Summary of Surveyed Buildings Current BHW Temps.

Building	Design BHW
Hospital (Note 1)	Steam
Jamestown HS	200°F
Covenant Manor	200°F
Ice Arena	200°F
Heritage Park	200°F
Euclid Gardens	180°F
Hotel Jamestown (Note 2)	180°F
Chadakoin	180°F
Riverwalk	180°F
Comedy Center	170°F
Jefferson St. Apartments	170°F
BWB Center (Note 3)	90°F

Table Notes

1. The Hospital currently uses steam.

- The Hotel Jamestown was originally designed for steam and its original steam radiators have since been converted to hot water. By converting to hot water, they have already reduced the output of their radiators by approximately 40%. Since steam radiators were typically oversized, the reduction in capacity was likely unnoticeable and their peak load is met using 180°F BHW.
- The BWB Center is heated using a number of local water-source to air heat pumps with a maximum inlet water temperature of 90°F. The facility manager indicated that the building operates with a BHW at 180°F to satisfy the domestic hot water load. The system can be modified to operate at 90°F

12. **EVALUATION OF FUTURE TEMPERATURES (BHW)**

Although lowering the temperature is recommended, it would not be required for a centralized heat pump system since this option will use the existing boilers to boost HW temperatures during peak conditions. Based on current OAT reset schedules observed during the survey, 160°F BHW would only be required when OAT falls below 20°F which is estimated to occur less than 12% of the year. Figure 11 indicates the number of hours during the year where temperatures fell between the ranges indicated on the X-axis. The chart represents the hourly temperature data recorded during 2014, which had the 9-year low winter and annual average temperatures. Temperature data was provided by BPU.

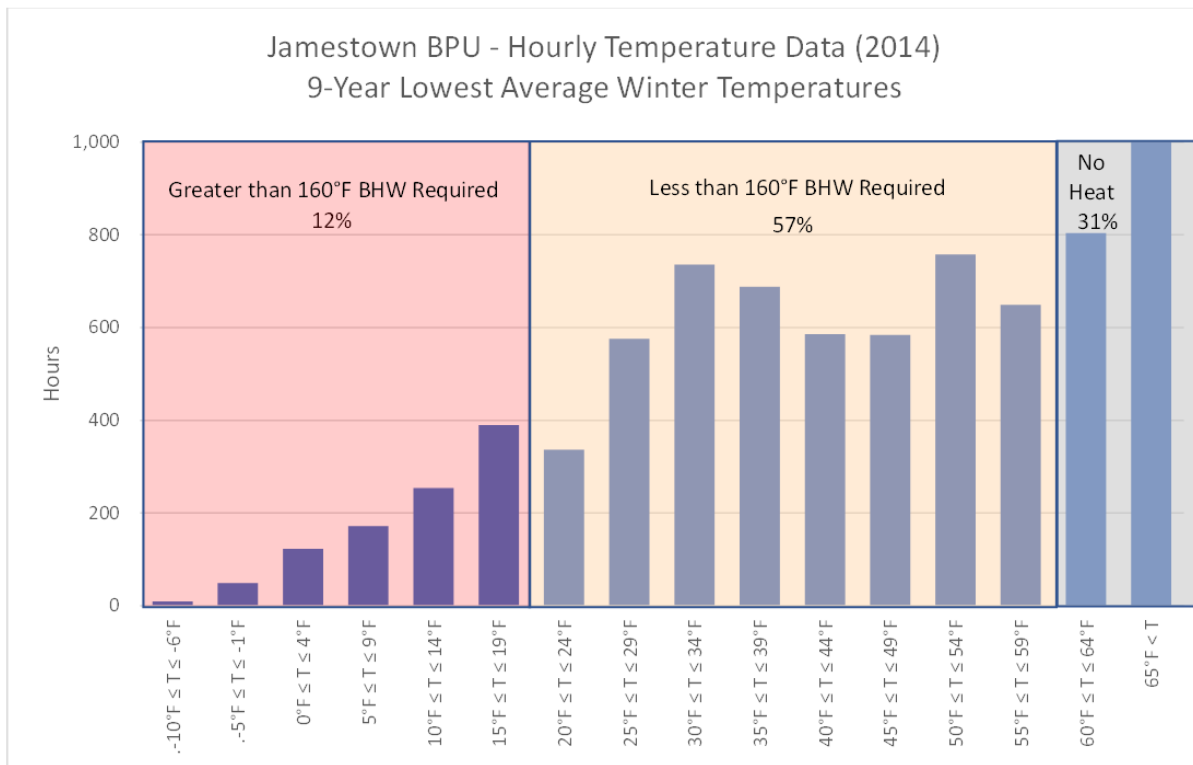


Figure 11 - 9 Year Low - Jamestown BIN Temperatures

Any decentralized option using local heat pumps at each building will either require peaking boilers be installed with the heat pumps or lower BHW temperatures since standard available heat pumps produce a maximum of 160°F.

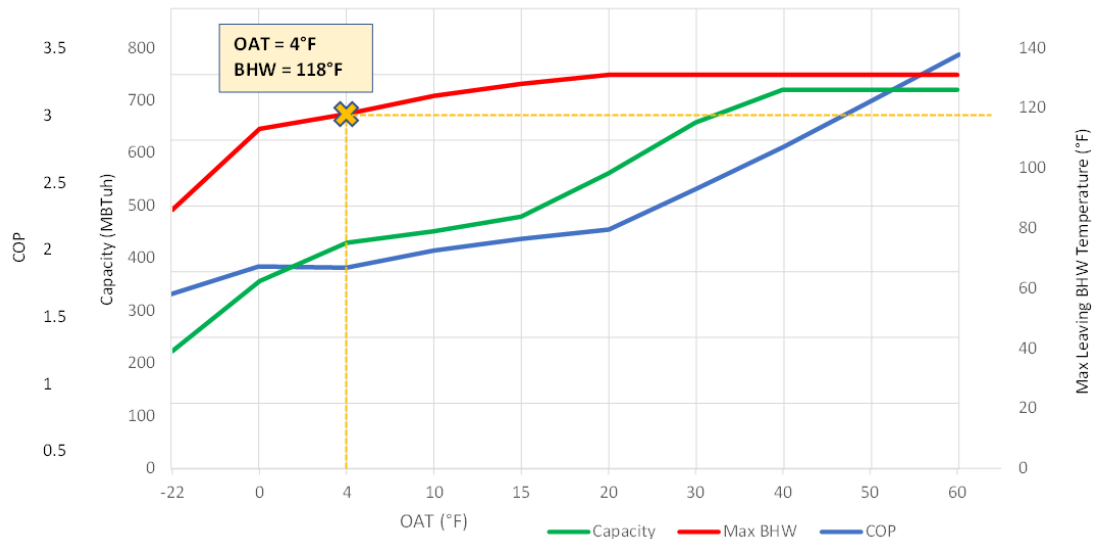
Ideally, the BHW at each building should be lowered as much as possible to achieve the greatest efficiency. To do this, it is likely that most buildings on the Jamestown district will require adding terminal units. It may also be more cost effective in some buildings to improve the building envelope to reduce the amount of heating system modifications required. Furthermore, some buildings may require changes to their piping systems.

A future system must be capable of providing temperatures high enough to meet SH needs as well as DHW production year round. Consideration must be given to safe production of DHW. All of the buildings surveyed had DHW storage tanks and it is expected that most buildings on the district system contain similar equipment. Where DHW is stored in tanks, supply temperatures must be high enough to kill the Legionella bacteria. The CDC, OSHA, and the NYS Health Department recommend storing DHW at or above 140°F.

A typical air source heat pump (ASHP) is only capable of producing up to 130°F when the outdoor air temperature is above 20°F. Once the OAT drops below 20°F, there is a reduction in its BHW, Coefficient of Performance (COP), and capacity. COP is a performance rating that measures the effectiveness of a heat pump and is the ratio of heat output to the amount of energy in.

Figure 12 below shows the relationship of these 3 performance characteristics for a typical ASHP.

Figure 12 - ASHP Performance Curves @ Max. Capacity & Max. BHW at Various OAT's



Although a typical air source heat pump is not capable of producing the temperatures required for safe DHW production, there are other options. One option could convert a building from a storage tank system to one that uses point-of-use electric heaters eliminating the need for higher storage temperature. However, in most locations this may not be cost effective. Another option could be to install a local electric boiler, however depending on the load, the electric service may need to be upgraded. A third option which may be more expensive to install but would be efficient to operate is to install local higher temperature WSHP's that are sized to handle the DHW load. In a central system, the district HW would provide the source water and the heat pump would boost the temperature for DHW production. In a decentralized system, either ground source or an ASHP in series with a WSHP could be installed.

Water source heat pumps (WSHP) are capable of producing higher temperatures and outperform ASHP's since the outdoor air temperatures do not affect their operation. However, they need a consistent source of warm water, above 50°F, to operate. **When ground source is not available**, heat pump manufacturers offer a solution that uses ASHP's to provide a consistent source of warm water. Manufacturer's currently offer WSHP's that can produce BHW temperatures as high as 160°F¹. Figure 13 illustrates the arrangement of an ASHP and WSHP in series.

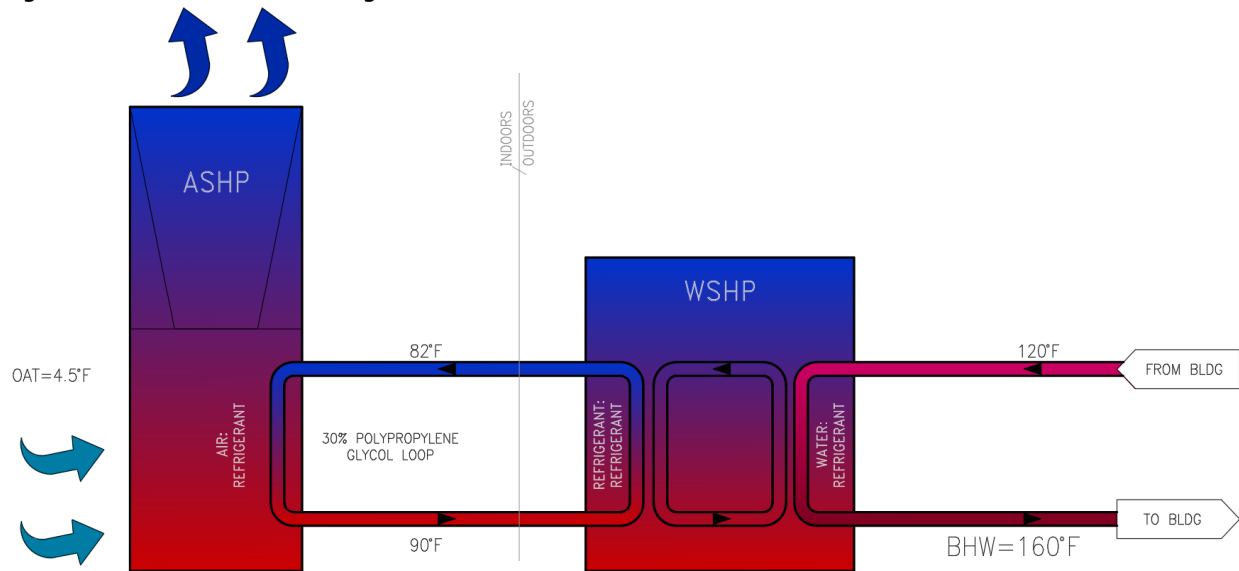


Figure 13 - ASHP & WSHP In Series Arrangement

This arrangement could also be used for space heating in a decentralized scenario. Although this BHW is higher than the 118°F that an ASHP can produce on a design day, building modifications would still be required. In the arrangement shown in Figure 13, a building must be capable of meeting its peak load with a maximum BHW of 160°F.

Achieving operational temperatures lower than 160°F will improve efficiency, however, it would not be required. Additional building improvements could be performed by customers if desired to reduce their BHW temperature and associated energy consumption and utility costs.

Although it is possible that the existing buildings have enough capacity to meet peak loads using 160°F BHW, it is not likely that all areas within a building will be oversized and modifications will be required.

Figure 14 illustrates the excess in heating capacity of existing radiators that would be required to reduce the BHW from 180°F to 160°F. An existing 2 pipe system with separate hot water supply and returns operating with a delta T of 40°F would see an average radiator temperature of 160°F. Using the correction factors from Figure 6, a reduction of 20°F would require the current system's radiators to be oversized by 15%.

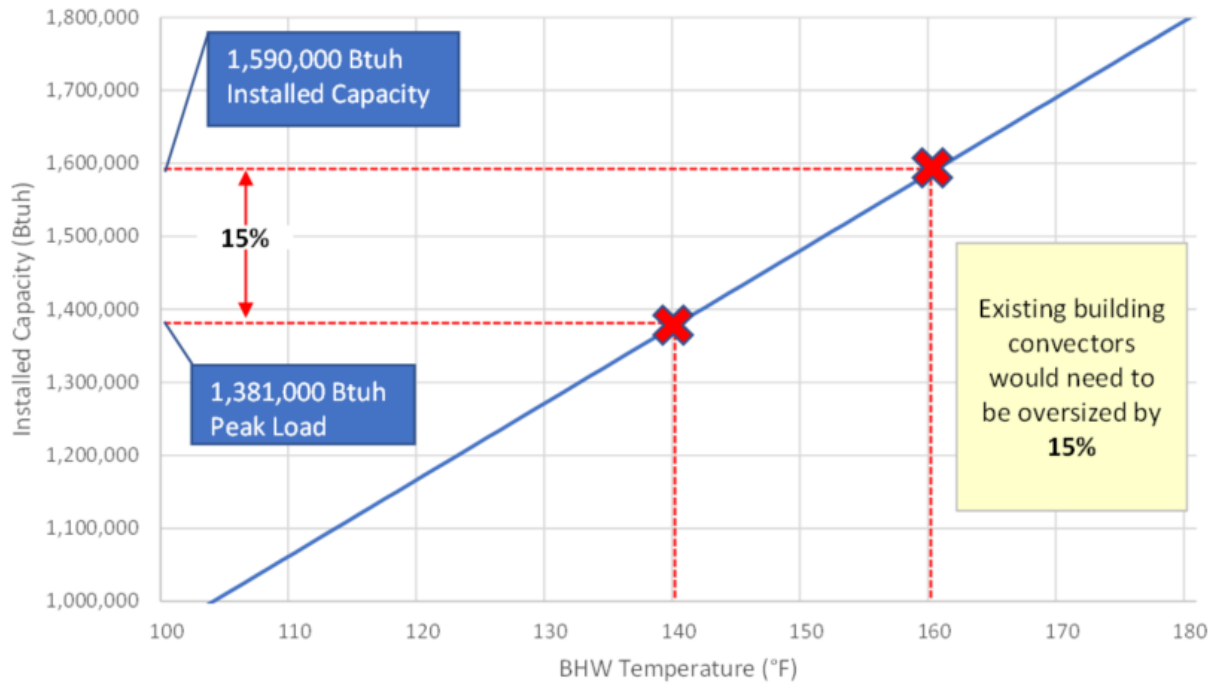


Figure 14 - Excess in Heating System Capacity Required to Reduce the BHW.

13. **EVALUATING THE COST OF BUILDING MODIFICATIONS VS. INSTALLING LOCAL BOILERS**

Up-front costs to perform building modifications must be carefully considered since the buildings are not owned by BPU and available funding is expected to be limited. However, most customers would be required to fund the installation of their own local boiler if the BPU central heating system were decommissioned. Therefore, a customer's cost to modify their buildings and make ready for heat pump technology (electrification-based) may be feasible to implement if that cost does not exceed the customer's expense to install their own boiler.

The projected costs to perform building modifications required to reduce BHW from 180°F to 160°F were developed based on two possible approaches. One approach examined modifying the Hotel Jamestown, a building solely heated by radiators and convector units and a second approach reviewed modifying the Jamestown High School, a building solely heated by air handling units with hot-water coils. Most other buildings are expected to either match one of these two approaches of heating systems modification or be a combination of the two and fall within the cost ranges estimated.

All estimates include 8% for general conditions, 20% for OH&P, 10% design contingencies, and 13% construction contingencies. The estimates do not include any costs associated with hazardous material removal and disposal.

Jamestown High School – The Jamestown H.S. is heated exclusively with hot water coils within 9 air handling units located on the roof.

Jamestown High School Assumptions

- Air handling units currently operate at 200°F entering water temperature (EWT) and 160°F leaving water temperature (LWT)
- There is enough space within each air handling unit to accommodate additional coils.
- Nearby piping will need to be removed and reinstalled to accommodate the installation of additional coils within each air handling unit.
- Flow rates for the new lower-temperature system will match existing flow rates and existing building pipe can remain without modifications.
- Boilers can be installed in the garage area where the distribution pipe enters the building.
- Natural gas piping with sufficient capacity can be provided to the building at no additional cost to the customer.

Unit pricing is based on recent pricing for similar work.

Cost to replace 9 air handling unit hot-water coils = \$340,000 (\$1.52/ft²)

The estimated cost to install a boiler system at the Jamestown High School is \$930,000. The cost of new boilers is estimated to be approximately three times more than performing the building modifications required to lower the BHW by 20°F.

Hotel Jamestown – during the site visit, the facility manager indicated that the building has a hot water express riser that supplies the building with hot water from the top down. These systems are typically installed with a single down feed pipe containing supply and return as shown in Figure 15. The supply is blended with the return from each floor and the radiators supply temperature reduces as the HW is delivered to the lower floors.

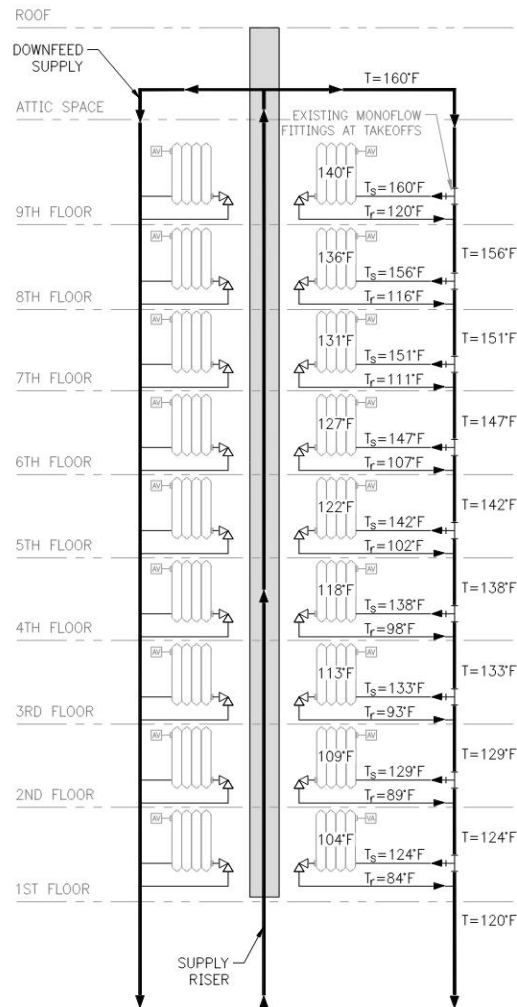


Figure 15 - Hotel Jamestown Heating System

Hotel Jamestown Assumptions

- 9 Floors (8 Apartments, 1 Commercial)
- 112 Apartments
- 14 Apartments/floor
- 70 Radiators/floor (5 radiators/apt)
- Heated area = 14,000 ft²
- Peak load = 140,000 Btuh (14,000 ft² x 10 Btu/sq-ft)
- Delta T = 40°F
- Existing temps = +20°F from those shown in Figure 15
- Existing radiators meet peak load at current temps
- Existing radiator capacity = 2,000 Btuh/each
- New temps = those shown in Figure 15
- Reduction in capacity per floor = 15%
- New radiator capacity = 1,700 Btuh/each
- A taller/wider radiator can increase capacity by 81%.
 - Minimal pipe modifications. See Figure 16
- Reduction in capacity = 21,000 Btuh/floor
- New capacity = 1,700 x 181% = 3,077 Btuh/radiator
- Assuming no additional room to install new radiators and that existing units will need to be removed and replaced with larger units.
- Increase in total capacity = 3,077 Btuh - 1,700 Btuh = +1,377 Btuh/radiator
- 21,000 Btuh/1,377 Btuh = 15 replacement radiators
- Assume 1 radiator replacement per apartment and 1 radiator replaced in hallway.
- 9 Floors x 15 radiators = 135 radiators replaced.

Unit pricing is based on RS Means CostWorks 2023.

Cost to replace 135 radiators = \$465,000 (\$3.68/ft²)

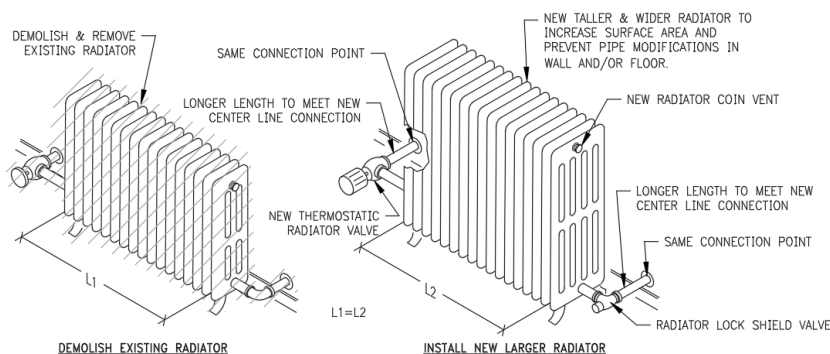


Figure 16 - Pipe modifications to install taller & wider radiator w/same length.

The estimated cost to install a boiler system at the Hotel Jamestown is \$500,000. The cost of the new boilers and building modifications are expected to be similar.

Table 4 includes the estimated range in cost to modify the buildings heating systems. These costs are based on the assumptions indicated and are provided to give a general order-of-magnitude cost for each building. A complete building assessment would be required at each location to confirm the assumptions made in this report. The table also includes an estimated price to install local boilers based on \$3.63/ft² which is the approximate cost per square foot for both the Hotel Jamestown and Jamestown High School.

Table 4 - Estimated Costs of Bldg Modifications and Local Boilers

Building	Range in Cost for Bldg Modifications	Local Boiler Cost
15 E 5th St LLC (Burgett & Robbins)	\$9,778 - \$23,673	\$23,351
200 Harrison St LLC (Chataqua IDA)	\$160,422 - \$388,391	\$383,114
3644 Holdings LLC (Priscilla)	\$27,794 - \$67,291	\$66,376
3644 Holdings LLC 2 (Cameo)	\$25,813 - \$62,495	\$61,646
3644 Holdings LLC 3 Jefferson St Apts)	\$8,343 - \$20,198	\$19,923
3644 Holdings LLC 4 (Parkview Apts)	\$21,067 - \$51,005	\$50,312
Agnes Home	\$7,073 - \$17,125	\$16,892
Anderson Manor LB	\$29,205 - \$70,707	\$69,747
Anderson Tower LP	\$44,368 - \$107,418	\$105,958
Best Western Hotel	\$45,143 - \$109,293	\$107,808
Board Of Education - JHS	\$337,690 -	\$924,130
Board Of Education - LOVE	\$80,030 - \$193,757	\$191,124
Board Of Education (Tech Cntr)	\$23,202 - \$56,173	\$55,410
BPU - DH-carlson	\$45,211 - \$109,458	\$107,971
BPU - low pres gas heat	\$4,414 - \$10,687	\$10,542
BPU - monitor building	\$80,256 - \$194,304	\$191,664
Carlson Tower LP	\$38,250 - \$92,605	\$91,347
Chautauqua Brick, Inc	\$32,048 - \$77,589	\$76,535
Chautauqua Opportunities	\$97,886 - \$236,986	\$233,766
City of Jamestown (City Hall)	\$78,791 - \$190,758	\$188,166
City Of Jamestown 3 (Main St. Parking)	\$60,577 - \$146,661	\$144,668
CODE Euclid Gardens	\$39,741 - \$96,216	\$94,909
Covenant Manor Apartments, LLC	\$146,355 - \$354,333	\$349,518
DPW		
DPW 2		
Duncan Olesnak	\$5,768 - \$13,964	\$13,774
Eliz W Marvin House	\$8,673 - \$20,998	\$20,712
E-Z Clean Car Wash	\$3,735 - \$9,042	\$8,919
First Covenant Church	\$22,234 - \$53,829	\$53,097
First Lutheran Church	\$41,522 - \$100,526	\$99,161
Fourth St Housing	\$17,389 - \$42,099	\$41,527
Gregory J Buzzanco (Foote Ave Church)	\$10,174 - \$24,631	\$24,297
Herbert A Duke II	\$40,128 - \$97,152	\$95,832
Heritage Ministries (Heritage Park)	\$84,377 - \$204,282	\$201,506

Building	Range in Cost for Bldg Modifications	Local Boiler Cost
Heritage Ministries 2 (Childcare)	\$6,153 - \$14,897	\$14,694
HH Jamestown, LLC (Cherry St. Parking)	\$130,364 - \$315,618	\$311,329
Inter'n Ordinance Tech	\$44,889 - \$108,677	\$107,201
Jamestown Boys & Girls Club	\$39,526 - \$95,695	\$94,395
Jamestown City (Ice Arena)		
Jamestown Newspaper Corp	\$87,389 - \$211,574	\$208,700
JHA (5th St. High Rise)	\$96,571 - \$233,803	\$230,626
JHA (Chadakoin Bldg)	\$74,253 - \$179,770	\$177,328
JHA (Hotel Jamestown)	- \$465,000	\$497,001
JRP (Jody Peterson)	\$12,841 - \$31,089	\$30,666
JRP (South County Office Bldg)	\$74,288 - \$179,854	\$177,411
Kaleida Health	\$43,944 - \$106,391	\$104,946
Krog Corp (BWB Center)	\$47,953 - \$116,097	\$114,519
Legal Assistance of WNY	\$25,907	\$25,555
Lewis & Lewis P.C. (.001) (.1)	\$14,573	\$14,375
Lewis and Lewis	\$8,692 - \$21,043	\$20,757
Little Theater Jamestown	\$186,674	\$184,138
National Comedy Center, Inc.	\$30,037 - \$72,722	\$71,733
Northwest Bank	\$30,765 - \$74,483	\$73,471
Prendergast Library	\$44,911 - \$108,733	\$107,255
REALIFE Church Inc.	\$16,051 - \$38,861	\$38,333
Reg Lenna Center for the Arts	\$64,119 - \$155,236	\$153,127
Riverwalk Properties (JAMA)	\$110,518 - \$267,570	\$263,934
Robert H Jackson Inc, The	\$25,638 - \$62,070	\$61,227
St James Church	\$40,128 - \$97,152	\$95,832
St Susan Center	\$149,200 - \$361,221	\$356,313
Time Warner Cable	\$22,728 - \$55,027	\$54,279
Triple R, LLC	\$9,991 - \$24,188	\$23,859
UPMC Chautauque at WCA (Jones Hill)	\$151,372 - \$366,480	\$361,501
UPMC Chautauque at WCA (Physicians)	\$49,491 - \$119,821	\$118,193
UPMC Chautauque @WCA (Hospital)		
Westerberg Tower LP	\$44,863 - \$108,616	\$107,140
Windstream Corp A/P	\$94,777 - \$229,460	\$226,342
YMCA (main)	\$105,546 - \$255,532	\$252,061
YWCA	\$24,713 - \$59,833	\$59,020

Notes:

- 1) JHA = Jamestown Housing Authority
- 2) JRP = Jamestown Rental Properties
- 3) Buildings in bold font were surveyed
- 4) Bldgs in greyscale font are no longer connected
- 5) For purposes of this report the BPU DH Carlson includes the entire plant load.

The Hospital and the Ice Arena are not included in Table 4 since these buildings have specialty equipment that would need further evaluation. However, these buildings could be provided with local equipment to meet the higher temperature requirements of the process loads. In addition, the Hospital currently has its own local high-pressure boilers that are used year-round to provide the steam required for sanitizing equipment. It is assumed that local production of high-pressure steam will continue to exist to meet the Hospital's process loads. The Hospital also has steam reheat and VAV coils throughout for SH that would need to be modified to work with a hot-water system. This is unlike the buildings estimated and therefore a cost to modify the Hospital systems is not included and requires further evaluation.

14. CONCLUSION

Lowering the peak HW supply temperature below 160°F is not possible without building modifications and local temperature boosting equipment at the Hospital. The building modifications should include a combination of correcting deficiencies, improving building envelope, increasing the surface area of terminal units and coils, and performing hydraulic balancing within the buildings.

Other than the Hospital, all other buildings require a peak HW temperature of 200°F or less. Therefore, the Hospital dictates the current supply temperature of the system. Some buildings only require 180°F and the BWB Center is fully equipped with water-source-to-air heat pumps and only needs HW temperatures high enough for safe DHW production.

As part of the evaluation, we compared costs to perform typical building modifications to installing local boilers. The customers could be expected to fund local boilers if the central system is decommissioned or be required to convert their buildings to lower temperatures if heat pumps are employed. The cost estimates revealed that modifying a building requiring only partial replacement of its terminal units is estimated to be less than or equal to the installation of a local gas-fired boiler system. The estimate is based on the installed heating system capacity matching the buildings load during peak condition. Since systems are often oversized, the comparison indicates further investigation of each building is warranted to confirm the actual modifications required and better estimate costs.

Further investigation of a buildings heating system components and capacity could reveal actual building modifications will be greater than estimated. However, it is more likely that current building systems are oversized and modifications will be less.

The investigation should also include a review of each buildings return temperature. In addition to reducing supply temperatures, it is important to maintain a high delta between the HW supply and HW return. Lower return temperatures permit efficient operation of renewable systems as well as reduce flow rates resulting in smaller distribution pipe sizes. If high return temperatures are found during the investigation, common causes can be examined. Common causes of high return temperatures are leaking or failed control valves⁵, bypasses left open between supply and return lines, lack of or bypassed pump controls resulting in high flow rates, terminal units with bypassed thermostatic controls, failed sensors, fouled heat exchangers, incorrect OAT reset settings, AHU outlet temperature settings, and an unbalanced system.

Although building modifications will be required, lowering the district HW temperatures are recommended for any future system to ensure the district buildings are ready for long-term operation and do not rely on fossil fuels. In addition, there are many benefits to reducing district hot water temperatures including:

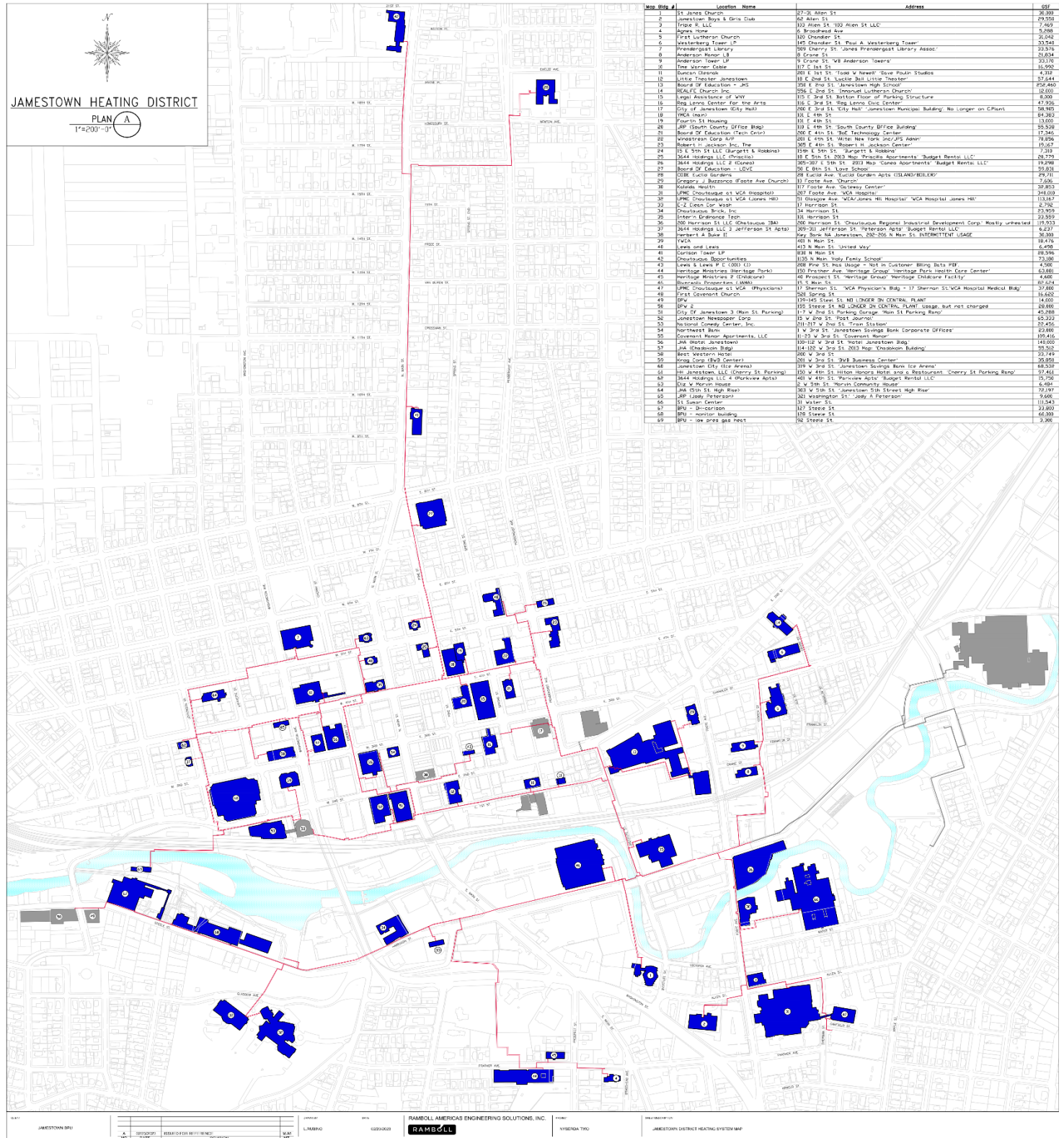
- Greater long-term economic benefits of lower temperature systems.
- Ability to employ a diversified portfolio of renewable technologies including heat pumps, geothermal, waste heat, solar thermal, and thermal storage.
- Reduction in heat distribution losses due to a lower temperature difference between the circulating fluid in the distribution pipe and its surrounding.
- Minimize the overall temperature drop from the heat source to the most hydraulically remote building.

⁵ As an example, during the survey the return temperature at the Ice Arena was 170°F, approximately 20°F higher than normal. BPU identified that the control valve for the ice melt heat exchanger had failed, its actuator removed, and the valve left open. The pit was not being used at the time so there was no load on the heat exchanger. The 240°F supply water was passing through the heat exchanger and blending directly back into the buildings' return.

- An ability to use different piping systems such as PEX or HDPE to reduce up-front capital expenses. Although this strategy may not be implemented up front due to the need to replace the existing distribution system immediately, it could be used in the future for repairs, replacement, or when adding new customers to the system.
- Increased efficiency of heat pumps by reducing the amount of temperature lift required.
- Reduced reliance on fossil fuel technology by limiting annual peaking operation to cold days.
- Longer life expectancy of steel pipes from reduced thermal stresses.
- Increased safety and lower risk of scalding injuries.

In conclusion, the building systems can be modified to meet SH loads during peak conditions with lower BHW temperatures. However, this is not required initially if fossil-fuel based peaking equipment is employed. In addition, only a 20°F reduction in BHW temperature would be required to implement local heat pump technology for the decentralized options. Over time, the customers can modify their buildings to reduce BHW temperatures and improve their overall efficiency.

APPENDIX A: JAMESTOWN BPU DISTRICT HEATING MAP



APPENDIX B: COST ESTIMATES

- Hotel Jamestown – Building Modifications
- Hotel Jamestown – Local Boiler
- Jamestown High School – Building Modifications
- Jamestown High School - Local Boiler

Estimate Detail

PROJECT: Jamestown NY
 Task 2B - Lower Temperature
 Jamestown Just Transition Program - REN2022N01416
 TWO - 1940103342-001

ESTIMATE NO. Hotel Jamestown Bldg Modifications
 SHEET NO.
 PREPARED BY: MJM DATE: 3/3/2023
 CHECKED BY: DATE:

SPEC. SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				SUB-CONTRACT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
15020	DEMOLITION & REMOVALS										
	Existing Radiators	135 ea			0.89	120	145	17,402			17,402
	Load, Haul, Dump Return Dumpster	135 ea			1.39	188	145	27,288			27,288
	Dumpster Rental	1 unit							745	745	745
											45,435
15110	VALVES										
	Thermostatic Radiator Valve	135 units	44.00	5,940	0.40	54	145	7,830			13,770
	Lockshied/Balancing Angle Valve	135 units	122.00	16,470	0.40	54	145	7,830			24,300
											38,070
15200	PIPING										
	Steel Pipe	270 ea	6.50	1,755	0.44	120	145	17,383			19,138
	Couplings	270 units	8.70	2,349	0.44	120	145	17,383			19,732
	Air Vent	135 units	9.80	1,323	0.25	34	145	4,894			6,217
											45,086
23 82 29	Radiator										
	12 Section Tall Rad. w/added columns	135 ea	864.00	116,640	2.00	271	145	39,228			155,868
	Balance & Test Building System	630 units			0.25	158	145	22,838			22,838
											178,706
	SUB TOTAL										307,296
	GENERAL CONDITIONS (8%)										24,584
	OVERHEAD & PROFIT (20%)										61,459
	DESIGN CONTINGINCIES (10%)										39,949
	CONSTRUCTION CONTINGINCIES (13%)										30,730
	GRAND TOTAL										464,018
	Jamestown Hotel NSF = 126,000									Cost per NSF	3.68

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO. Jamestown H.S. Bldg Modifications

SHEET NO.

PREPARED BY: MJM DATE: 3/3/2023

CHECKED BY: _____ DATE: _____

[illegible]

Estimate Detail

PROJECT: Jamestown NY

Task 2B - Lower Temperature

Jamestown Just Transition Program - REN2022N01416

TWO - 1940103342-001

ESTIMATE NO. Hotel Jamestown Boiler Installation

SHEET NO.

PREPARED BY: MJM

DATE: 3/3/2023

CHECKED BY:

DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
PHYSICAL EDUCATION BUILDING DECENTRALIZATION											
Div 02	Existing Conditions										
02 41 13	Mechanical Demolition										
	Drain HWS & HWR Systems	1 lot			2.00	2	145	290			290
	Pipe Removal 4" thru 6"	20 ft			0.04	1	145	116			116
	Pipe Removal 2" thru 3.5"	10 ft			0.05	1	145	77			77
	Pneumatic tubing	30 ft			0.05	2	145	218			218
	Valve Removal 4" thru 6"	4 ea			2.00	8	145	1,160			1,160
	Valve Removal 2" thru 3.5"	4 ea			1.46	6	145	844			844
	Pipe Fittings, single connection, 2" thru 4"	10 ea			1.00	10	145	1,450			1,450
	Pipe Removal up thru 1.5"	20 ft			0.04	1	145	116			116
	Pipe Hanger Support Removal	25 ea			0.10	3	145	363			363
	Heat Exchanger,Plate and Frame	4 ea			20.00	80	145	11,600			11,600
	Tank 250 thruh 500 gallons (Exp. Tank)	1 ea			4.40	4	145	638			638
	Pump Removal, 7.5 HP thru 15 HP	2 ea			8.00	16	145	2,320			2,320
02 41 13	Electrical Demolitions										
	Disconnect Motor	2 ea			1.67	3	145	483			483
	Conduit Removal, up to 1"	20 lf			0.03	1	145	96			96
	Wire Removal, #8 AWG	0.6 clf			0.20	0	145	17			17
	Wire Removal, #10 AWG	0.2 clf			0.18	0	145	5			5
											19,792
03 30 00	Cast-In-Place Concrete										
	Concrete Pads	3 ea	135.00	405	6.75	20	145	2,936			3,341
											3,341
Div 09	Finishes										
09 91 23	Interior Painting										
	Gas Piping	100 lf	0.39	39	0.05	5	145	725			764
	Hot Water Piping	100 lf	0.59	59	0.08	8	145	1,124			1,183
											1,947
Div 22	Plumbing										
22 05 53	Identification of Plumbing Piping										
	Pipe Labels, various sizes	20 ea	12.95	259	0.13	3	145	386			645
22 11 16	Piping										
	1.5" Copper Pipe & Supports	30 lf	10.45	314	0.15	5	145	670			983
	1.5" 90 Elbow	5 ea	15.35	77	0.62	3	145	446			523

Estimate Detail

PROJECT: Jamestown NY

Task 2B - Lower Temperature

Jamestown Just Transition Program - REN2022N01416

TWO - 1940103342-001

ESTIMATE NO. Hotel Jamestown Boiler Installation

SHEET NO.

PREPARED BY: MJM

DATE: 3/3/2023

CHECKED BY:

DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	1.5" Ball Valve	2 ea	76.50	153	0.73	1	145	211			364
	Valve Tags	2 ea	3.14	6	0.20	0	145	58			64
	1.5" Strainer	2 ea	176.00	352	0.62	1	145	178			530
	1.5" RPZ Assembly	1 ea	960.00	960	0.80	1	145	116			1,076
	3/4" Hose Bibb	2 ea	12.95	26	0.24	0	145	68			94
	Reducing, water pressure valve 1.5"	1 ea	1,971.00	1,971	0.62	1	145	89			2,060
	Pressure Gauges	2 units		551		10	145	1,412			1,964
	Gauge	1 ea	122.00	122	0.50	1					-
	3/4" TOL	1 ea	9.84	10	0.76	1					-
	3/4"x1/2" Red. Bushing	1 ea	6.24	6	0.50	1					-
	1/2" Gate	1 ea	78.60	79	0.33	0					-
	1/2" Nipple	1 ea	2.30	2	0.42	0					-
	1/2"x1/4" Red. Bushing	1 ea	6.00	6	0.42	0					-
	1/4" Pigtail	1 ea	14.00	14	0.08	0					-
	1/4" Tee	1 ea	28.20	28	0.80	1					-
	1/4" Plug	1 ea	3.94	4	0.21	0					-
	1/4" Nipple	2 ea	2.30	5	0.42	1					-
	Temperature Gauges	2 units		203		5	145	677			879
	Gauge	1 ea	48.00	48	0.50	1					-
	3/4" TOL	1 ea	9.84	10	0.76	1					-
	3/4"x1/2" Red. Bushing	1 ea	6.24	6	0.50	1					-
	Thermowell	1 ea	37.20	37	0.57	1					-
	Testing CW Piping	1 lot			8.00	8	145	1,160			1,160
	<u>Natural Gas Piping & Valves</u>										
	2" Steel Pipe and Supports	300 lf	12.10	3,630	0.28	84	145	12,224	1.04	312	16,166
	2" 90 Elbow	10 ea	28.50	285	2.00	20	145	2,900	7.35	74	3,259
	2" Plug Valves	3 ea	233.00	699	1.00	3	145	435			1,134
	Core drill	1 ea	1.54	2	1.41	1	145	204	10.22	10	216
	Link-seal	1 ea	130.00	130	1.67	2	145	242			372
	Valve Tags	3 ea	3.14	9	0.20	1	145	87			96
											31,584
Div 23	HVAC Equipment										
23 05 19	Gauges and Specialties										
	Expansion Tank EXP-01	1 ea	4,750.00	4,750	2.67	2.7	145	387			5,137
	Air Separator	1 ea	5,575.00	5,575	3.40	3.4	145	493			6,068

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO.	Hotel Jamestown Boiler Installation
SHEET NO.	
PREPARED BY:	MJM
DATE:	3/3/2023
CHECKED BY:	
DATE:	

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	Automatic Air Vent	1 ea	380.00	380	0.80	0.8	145	116			496
	Chemical Shot Feeder	1 ea	365.00	365	12.90	12.9	145	1,871			2,236
23 05 23	General Duty Valves										
	2" Check Valve	2 ea	635.00	1,270	1.00	2.0	145	290			1,560
	2" Ball Valve	4 ea	315.00	1,260	0.73	2.9	145	422			1,682
	1.5" Ball Valve	1 ea	241.00	241	0.62	0.6	145	89			330
	0.75" Ball Valve	15 ea	102.00	1,530	0.40	6.0	145	870			2,400
	2" Globe Valve, OS&Y, class 800	1 ea	330.00	330	1.88	1.9	145	273	6.90	7	610
	2" Two-Way Control Valve (FCV-204)	1 ea	1,150.00	1,150	4.00	4.0	145	580			1,730
23 05 93	Testing, Adjusting and Balancing										
	Testing Adjusting and Balancing	2 days			32.00	64.0	145	9,280			9,280
23 07 19	Piping Insulation										
	2" Pipe, 2" Fiberglass	200 lf	3.73	746	0.09	17.8	145	2,581			3,327
	1.5" Pipe, 1.5" Fiberglass	100 lf	2.55	255	0.08	8.0	145	1,160			1,415
	0.75" Pipe, 1.5" Fiberglass	200 lf	1.89	378	0.07	14.6	145	2,117			2,495
23 09 13	Instrumentation & Controls										
	Emergency Shutdown & Transmitters	1 lot							7,500	7,500	7,500
23 21 23	Hydronic Pumps										
	Pump, 20 HP, to 1,000 GPM, 5" Size	2 ea	18,300.00	36,600	15.00	30.0	145	4,350			40,950
23 22 13	Piping										
	2" Steel Pipe and Supports, Sch. 80, thrd	200 lf	16.75	3,350	0.26	52	145	7,598			10,948
	1.5" Steel Pipe and Supports, Sch. 80, thrd	100 lf	16.35	1,635	0.21	21	145	3,016			4,651
	0.75" Steel Pipe and Supports, Sch. 80, thrd	200 lf	8.45	1,690	0.14	28	145	4,060			5,750
	2" 90 Ell., XH, threaded	7 ea	24.50	172	0.76	5.3	145	773			945
	1.5" 90 Ell., XH, threaded	5 ea	16.05	80	0.67	3.3	145	484			564
	0.75" 90 Ell., XH, threaded	10 ea	7.85	79	0.44	4.4	145	644			722
	2" Union	4 ea	56.00	224	0.94	3.8	145	546			770
	Steel Piping and Supports	40 lf	19.50	780	0.41	16.4	145	2,378	1.51	60	3,218
23 52 16	Condensing Boilers										
	gas-fired hot-water condensing boilers	2 ea	50,000.00	100,000	80.00	160	145	23,200			123,200
	8" Vent & Combustion Air, AL-294C	40 lf	212.00	8,480	0.62	25	145	3,567			12,047
	90 Ell., AL-294C	8 ea	480.00	3,840	0.62	5	145	713			4,553
	45 Ell., AL-294C	8 ea	239.00	1,912	0.62	5	145	713			2,625
	Vent Penetrations	2 ea	3.59	7	1.92	4	145	558	13.91	28	593
	Combustion Air Penetrations	2 ea	345.00	690	2.22	4	145	644			1,334

Estimate Detail

PROJECT: Jamestown NY

Task 2B - Lower Temperature

Jamestown Just Transition Program - REN2022N01416

TWO - 1940103342-001

ESTIMATE NO. Hotel Jamestown Boiler Installation

SHEET NO.

PREPARED BY: MJM

DATE: 3/3/2023

CHECKED BY:

DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
											259,136
Div 26	Electrical										
26 05 00	Basic Electrical										
	1" RGS Conduit & Supports install	400 lf	6.90	2,760	0.12	49	145	0			2,760
	1" Elbows	20 ea	7.05	141	0.33	7	145	967			1,108
	#12 AWG Wire	4.0 clf	9.55	38	0.73	3	145	422			460
26 28 16	Switches and Circuit Breakers										
	30A Toggle Disconnect Switch	2 ea	70.00	140	1.50	3.0	145	435			575
26 51 00	Interior Lighting										
	LED, Linear, suspended-mounted, 4' long, 74W	11 ea	325.00	3,575	1.54	17	145	2,463			6,038
											10,941
Div 28	Electronic Safety and Security										
28 31 33	Fire Alarm										
	Addressable Dual Heat / Carbon Monoxide	1 ea	RedHawk Allowance		1.33	1	145	193			193
	Dual-action Pull Station	1 ea	RedHawk Allowance		0.67	1	145	97			97
	0.75" RGS Conduit & Supports install	100 lf	4.63	463	0.09	9	145	1,291			1,754
	0.75" Conduit Field Bends	4 ea			0.20	1	145	116			116
	Fire Alarm Cable: #22, 2 pair	1 clf	93.50	94	1.00	1	145	145			239
											2,398
SUB-TOTAL											329,140

GENERAL CONDITIONS (8%)										26,331
OVERHEAD & PROFIT (20%)										65,828
DESIGN CONTINGINCIES (10%)										42,788
CONSTRUCTION CONTINGINCIES (13%)										32,914

Grand Total Estimate

\$497,001

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO.	Jamestown H.S. Boiler Installation
	SHEET NO.
PREPARED BY:	MJM
	DATE: 3/3/2023
CHECKED BY:	
	DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
PHYSICAL EDUCATION BUILDING DECENTRALIZATION											
Div 02	Existing Conditions										
02 41 13	Mechanical Demolition										
	Plumbing Demolitions										
	Pipe Removal, metal, 4" thru 6"	20 lf			0.16	3	145	464			464
	Valve Removal, metal, 2" thru 3.5"	2 ea			1.46	3	145	422			422
							145				
Div 03	Concrete						145				
	Concrete Pads	3 ea	135.00	405	6.75	20	145	2,936			3,341
							145				
Div 03	Thermal						145				
	0.75" Conduit Firestopping	8 ea	12.50	100	0.50	4	145	580			680
	Boiler Vent Roofing Work	1 ea	2,500.00	2,500	48.00	48	145	6,960			9,460
							145				
Div 09	Finishes						145				
	Pipe painting, 2 coats, brushwork, 9"-12"	459 lf	1.11	509	0.06	28	145	4,126			4,636
	Pipe painting, 2 coats, brushwork, 5"-8" O.D	51 lf	0.75	38	0.04	2	145	311			349
	Pipe painting, 2 coats, brushwork, <4" O.D.	460 lf	0.37	170	0.02	10	145	1,401			1,571
							145				
Div 022	Plumbing						145				
	Gas Piping						145				
	4" Sch. 40, steel, header	30 lf	53.82	1,615	0.43	13	145	1,879			3,494
	4" Pipe Cap, steel, butt weld	1 ea	43.65	44	1.33	1	145	193			237
	4" tee	3 ea	120.50		5.33		145				
	4" weld to existing	1 ea			1.60	2	145	232			232
	Boilers Main Fuel Gas Connections	3 loc			61.52	185	145	26,760			26,760
	4" Sch. 40, steel pipe	3 lf	53.82	161	0.43	1	145	188			349
	4x2.5 Reducing Tee	1 ea	116.00	116	5.33	5	145	773			889
	4" Pipe Cap, steel, butt weld	1 ea	43.65		1.33		145				
	2.5" Sch. 40, steel pipe	20 lf	33.94	679	0.34	7	145	986			1,665
	2.5" 90 ell, steel, butt weld	2 ea	31.90	64	2.00	4	145	580			644
	2.5" tee, steel, butt weld	1 ea	62.50	63	3.20	3	145	464			527
	2.5" Pipe Cap, steel, butt weld	1 ea	34.25	34	0.89	1	145	129			163
	2.5" plug valve	2 ea	675.00	1,350	3.20	6	145	928			2,278
	2.5" Y-strainer, flanged, iron body	1 ea	228.00	228	3.20	3	145	464			692
	2.5" pressure regulator	1 ea	2,125.00	2,125	1.07	1	145	155			2,280
	2.5" weld Neck Flange, 150lb	4 ea	35.72	143	1.00	4	145	580			723
	Gas Train Piping Installations	1 ea			24.00	24	145	3,480			3,480
	Pilot Gas Train Installations	3 loc			8.00	24	145	3,480			3,480
	Natural Gas Train Vent Piping	3 loc			12.00	36	145	5,220			5,220

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO.	Jamestown H.S. Boiler Installation
SHEET NO.	
PREPARED BY:	MJM
DATE:	3/3/2023
CHECKED BY:	
DATE:	

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	Valve Tags	10 ea	4.99	50	0.20	2	145	290			340
	Pressure Gauges	9 units			4.87	44	145	6,355			6,355
	Gauge, steel case, 0-300 psi, 4.5" dial	1 ea	122.00	122	0.50	1	145	73			195
	3/4" TOL	1 ea	9.84	10	0.76	1	145	110			120
	3/4"x1/2" Red. Bushing	1 ea	6.24	6	0.50	1	145	73			79
	1/2" Gate	1 ea	78.60	79	0.33	0	145	48			127
	1/2" Nipple	1 ea	2.30	2	0.42	0	145	61			63
	1/2"x1/4" Red. Bushing	1 ea	6.00	6	0.42	0	145	61			67
	1/4" Pigtail	1 ea	14.00	14	0.08	0	145	12			26
	1/4" Tee	1 ea	28.20	28	0.80	1	145	116			144
	1/4" Plug	1 ea	3.94	4	0.21	0	145	31			35
	1/4" Nipple	1 ea	2.30	2	0.42	0	145	61			63
	1/4" Nipple	1 ea	2.30	2	0.42	0	145	61			63
	Testing, Adjustment & Balancing						145				
	Natural gas piping inert gas test	1 lot			8.00	8	145	1,160			1,160
							145				
Div 23	HVAC						145				
	Equipment:						145				
	Hot Water Pumps, in-line, 5HP to 350 GPM	3 ea	14,300.00	42,900			145				42,900
	In-line centrifugal fan, including disconnect	3 ea	1,100.00	3,300	10.67	32	145	4,640			7,940
	Cast-iron boiler, gas 3/96 MBH, includes burner	3 ea	62,000.00	186,000	10.00	30	145	4,350			190,350
	Unit heater, hot water, horizontal, 120 MBH	2 ea	2,125.00	4,250	186.00	372	145	53,940			58,190
	Miscellaneous Activities:				4.00		145				
	Drain Hot Water System (drawing note 1, DM-101)	2 men					145				
	Fill Hot Water System (drawing note 6, M-101)	2 men			4.00	8	145	1,160			1,160
	Clean Areaaway (key note 1, DM-101)	2 men			4.00	8	145	1,160			1,160
	Controls:				8.00		145				
	Master Control Panel (Install & Programming)	1 ea	3,750.00	3,750			145				3,750
	Break Glass Stations	2 ea	65.00	130	4.00	8	145	1,160			1,290
	Hot Water Header Temperature Transmitter	1 ea	167.00	167	1.00	1	145	145			312
	Control Wiring				0.80		145				
	Breakglass Station to Each Boiler						145				
	0.75" RGS Conduit	140 lf	4.96	694			145				694
	0.75" RGS Field Bends	9 ea			0.10	1	145	131			131
	Low voltage, control wire, #18-2 conductor	1.4 clf	30.00	42	0.20	0	145	41			83
	Header Transmitter to Master Control Panel				1.00		145				
	0.75" RGS Conduit	40 lf	4.96	198			145				198
	0.75" RGS Field Bends	6 ea			0.10	1	145	87			87
	Low voltage, control wire, #18-3 conductor	0.4 clf	39.00	16	0.20	0	145	12			27
	Master Control Panel to Each Boiler				1.14		145				

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO.	Jamestown H.S. Boiler Installation
	SHEET NO.
PREPARED BY:	MJM
	DATE: 3/3/2023
CHECKED BY:	
	DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	0.75" RGS Conduit	60 lf	4.96	298			145				298
	0.75" RGS Field Bends	6 ea			0.10	1	145	87			87
	Low voltage, control wire, #18-3 conductor	0.6 clf	39.00	23	0.20	0	145	17			41
	Master Control Panel to Each Pump				1.14		145				
	0.75" RGS Conduit	60 lf	4.96	298			145				298
	0.75" RGS Field Bends	6 ea			0.10	1	145	87			87
	Low voltage, control wire, #18-2 conductor	0.6 clf	30.00	18	0.20	0	145	17			35
	Combustion Air Fans to Each Boiler				1.00		145				
	0.75" RGS Conduit	150 lf	4.96	744			145				744
	0.75" RGS Field Bends	8 ea			0.10	1	145	116			116
	Low voltage, control wire, #18-2 conductor	1.5 clf	30.00	45	0.20	0	145	44			89
	Piping Systems				1.00		145				
	Hot Water						145				
	Hot Water Supply						145				
	6" Sch. 40, steel pipe, HWS Header	25 lf	95.87	2,397			145				2,397
	5" Sch. 40, steel pipe, Boiler Outlet	45 lf	29.12	1,310	0.67	30	145	4,352			5,663
	5" Sch. 40, steel pipe, Connection to existing	5 lf	29.12	146	0.50	3	145	363			508
	5" 90 ell, carbon steel, butt weld	13 ea	163.90	2,131	0.50	7	145	943			3,073
	6" Tee, welded	1 ea	133.50	134	4.00	4	145	580			714
	6"x5" Reducing Tee, welded	5 ea	204.50	1,023	8.00	40	145	5,800			6,823
	5" Weld Neck Flange, 150lb	19 ea	91.40	1,737	8.00	152	145	22,040			23,777
	6" Pipe Cap, steel, butt weld	2 ea	82.75	166	2.00	4	145	580			746
	5" Check Valve, swing type, flanged	3 ea	1,900.00	5,700	2.40	7	145	1,044			6,744
	5" Balancing Valve	5 ea	1,700.00	8,500	5.33	27	145	3,866			12,366
	5" Butterfly Valve, lug, gear operated	3 ea	1,150.00	3,450	5.33	16	145	2,320			5,770
	Valve Tags	11 ea	4.99	55	4.80	53	145	7,656			7,711
	Pressure Gauges	6 units			0.20	1	145	174			174
	Gauge	1 ea			4.87	5	145	706			706
	3/4" TOL	1 ea			0.50	1	145	73			73
	3/4"x1/2" Red. Bushing	1 ea			0.76	1	145	110			110
	1/2" Gate	1 ea			0.50	1	145	73			73
	1/2" Nipple	1 ea			0.33	0	145	48			48
	1/2"x1/4" Red. Bushing	1 ea			0.42	0	145	61			61
	1/4" Pigtail	1 ea			0.42	0	145	61			61
	1/4" Tee	1 ea			0.08	0	145	12			12
	1/4" Plug	1 ea			0.80	1	145	116			116
	1/4" Nipple	1 ea			0.21	0	145	31			31
	1/4" Nipple	1 ea			0.42	0	145	61			61
	Temperature Gauges	3 units			0.42	1	145	183			183
	Gauge	1 ea			2.33	2	145	338			338

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO.	Jamestown H.S. Boiler Installation
	SHEET NO.
PREPARED BY:	MJM
	DATE: 3/3/2023
CHECKED BY:	
	DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	3/4" TOL	1 ea			0.50	1	145	73			73
	3/4"x1/2" Red. Bushing	1 ea			0.76	1	145	110			110
	Thermowell	1 ea			0.50	1	145	73			73
	Hot Water Return				0.57		145				
	6" Sch. 40, steel pipe, HWR Header	60 lf	95.87	5,752			145				5,752
	6" Sch. 40, steel pipe, Boiler Returns	30 lf	95.87	2,876	0.67	20	145	2,901			5,778
	3" Sch. 40, steel pipe, Connection to existing	15 lf	42.57	639	0.67	10	145	1,451			2,089
	6" 90 ell, carbon steel, butt weld	6 ea	115.50	693	0.37	2	145	324			1,017
	3" 90 ell, carbon steel, butt weld	4 ea	64.65	259	4.80	19	145	2,784			3,043
	6" 45 ell, carbon steel, butt weld	2 ea	133.50	267	2.86	6	145	829			1,096
	6" Tee, welded	4 ea	190.50	762	4.80	19	145	2,784			3,546
	3" Weld-o-let	3 ea	51.90	156	8.00	24	145	3,480			3,636
	6" Weld Neck Flange, 150lb	9 ea	69.75	628	2.00	18	145	2,610			3,238
	3" Weld Neck Flange, 150lb	5 ea	40.82	204	2.40	12	145	1,740			1,944
	6" Pipe Cap, steel, butt weld	1 ea	82.75	83	1.14	1	145	166			248
	3" Check Valve, swing, flanged	2 ea	1,175.00	2,350	2.40	5	145	696			3,046
	6" Butterfly Valve, lug, gear actuator, iron body	3 ea	1,275.00	3,825	3.56	11	145	1,547			5,372
	3" Butterfly Valve, lug, gear actuator, iron body	1 ea	705.00	705	4.80	5	145	696			1,401
	Valve Tags	6 ea	4.99	30	2.00	12	145	1,740			1,770
	Pressure Gauges	3 units			0.20	1	145	87			87
	Gauge, steel case, 0-300 psi, 4.5" dial	1 ea	122.00	122	4.87	5	145	706			828
	3/4" TOL	1 ea	9.84	10	0.50	1	145	73			82
	3/4"x1/2" Red. Bushing	1 ea	6.24	6	0.76	1	145	110			117
	1/2" Gate	1 ea	78.60	79	0.50	1	145	73			151
	1/2" Nipple	1 ea	2.30	2	0.33	0	145	48			51
	1/2"x1/4" Red. Bushing	1 ea	6.00	6	0.42	0	145	61			67
	1/4" Pigtail	1 ea	14.00	14	0.42	0	145	61			75
	1/4" Tee	1 ea	28.20	28	0.08	0	145	12			40
	1/4" Plug	1 ea	3.94	4	0.80	1	145	116			120
	1/4" Nipple	1 ea	2.30	2	0.21	0	145	31			33
	1/4" Nipple	1 ea	2.30	2	0.42	0	145	61			63
	Temperature Gauges	3 units			0.42	1	145	183			183
	Gauge, bi-metal, dial type, 3.5" dial	1 ea	56.50	57	2.33	2	145	338			395
	3/4" TOL	1 ea	9.84	10	0.50	1	145	73			82
	3/4"x1/2" Red. Bushing	1 ea	6.24	6	0.76	1	145	110			117
	Thermowell	1 ea	37.20	37	0.50	1	145	73			110
	Drains				0.57		145				
	Boiler Drains	3 location					145				
	0.75" Sch. 80, threaded	10 lf	9.60	96	3.06	31	145	4,433			4,529
	0.75" Union	1 ea	115.00	115	1.60	2	145	232			347

Estimate Detail

PROJECT: Jamestown NY

Task 2B - Lower Temperature

Jamestown Just Transition Program - REN2022N01416

TWO - 1940103342-001

ESTIMATE NO. Jamestown H.S. Boiler Installation

SHEET NO.

PREPARED BY: MJM DATE: 3/3/2023

CHECKED BY: DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	0.75" Gate Valve	1 ea	63.50	64	0.62	1	145	89			153
	Hot Water Return Zone Drains	3 location			0.84	3	145	366			366
	0.75" Sch. 80, threaded	20 lf	9.60	192	2.44	49	145	7,082			7,274
	0.75" Gate Valve	2 ea	63.50	127	1.60	3	145	464			591
	Header Drains	3 location			0.84	3	145	366			366
	0.75" Sch. 80, threaded	20 lf	9.60	192	2.44	49	145	7,082			7,274
	0.75" Gate Valve	2 ea	63.50	127	1.60	3	145	464			591
	Breeching & Vent				0.84		145				
	18" double-wall, 304/316SS, 90 ell	3 ea	1,222.00	3,666			145				3,666
	18" double-wall, 304/316SS, 45 ell	1 ea	656.50	657	0.84	1	145	122			779
	18" barometric damper	3 ea	1,050.00	3,150	0.84	3	145	366			3,516
	26"x18" straight transition	1 ea	1,053.00	1,053	0.67	1	145	97			1,150
	26"x18" Y-transition	2 ea	1,053.00	2,106	1.67	3	145	483			2,589
	26" tee with drain connection	1 ea	1,886.63	1,887	2.00	2	145	290			2,177
	18" double-wall, 304/316SS	20 lf	137.80	2,756	2.62	52	145	7,593			10,349
	26" double-wall, 304/316SS	70 lf	286.00	20,020	0.42	29	145	4,273			24,293
	26" stack cap	1 ea	1,225.00	1,225	0.80	1	145	116			1,341
	26" ventilated roof timble	1 ea	485.00	485	0.96	1	145	139			624
	Stack bottom support	1 ea	315.00	315	1.85	2	145	268			583
	Ductwork				1.85		145				
	48x24 to 22x22 Transition	3 ea	50.00	150			145				150
	Ductwork modifications	1 lot			1.00	1	145	145			145
	Testing, Adjustment & Balancing				4.00		145				
	Boiler hydrostatic testing	3 ea					145				
	Hot water piping hydrostatic testing	1 lot			6.00	6	145	870			870
	Hot water pump balancing	3 ea			6.00	18	145	2,610			2,610
	Pipe Insulation				4.00		145				
	Fiberglass w/ASJ, 6" iron pipe size, 2" wall	280 lf	9.30	2,604			145				2,604
	Fiberglass w/ASJ, 5" iron pipe size, 2" wall	179 lf	10.90	1,951	0.16	29	145	4,153			6,104
	Fiberglass w/ASJ, 3" iron pipe size, 2" wall	51 lf	8.15	416	0.13	7	145	984			1,399
					0.10		145				
							145				
	Burner 1 Branch Circuit						145				
	0.75" RGS Conduit	40 lf	4.96	198	0.10	4	145	580			778
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44
	#12, 600V, THWN-THHN, copper wire, solid	1.6 clf	21.50	34	0.73	0	145	46			81
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Burner 2 Branch Circuit						145				
	0.75" RGS Conduit	50 lf	4.96	248	0.10		145				248
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44

Estimate Detail

PROJECT:	Jamestown NY
	Task 2B - Lower Temperature
	Jamestown Just Transition Program - REN2022N01416
	TWO - 1940103342-001

ESTIMATE NO. Jamestown H.S. Boiler Installation	
SHEET NO.	
PREPARED BY: MJM	DATE: 3/3/2023
CHECKED BY:	DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	#12, 600V, THWN-THHN, copper wire, solid	2 clf	21.50	43	0.73	0	145	58			101
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Burner 3 Branch Circuit						145				
	0.75" RGS Conduit	60 lf	4.96	298	0.10		145				298
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44
	#12, 600V, THWN-THHN, copper wire, solid	2.4 clf	21.50	52	0.73	0	145	70			121
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Hot Water Pump 1 Branch Circuit						145				
	0.75" RGS Conduit	35 lf	4.96	174	0.10		145				174
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44
	#12, 600V, THWN-THHN, copper wire, solid	1.4 clf	21.50	30	0.73	0	145	41			71
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Hot Water Pump 2 Branch Circuit						145				
	0.75" RGS Conduit	45 lf	4.96	223	0.10		145				223
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44
	#12, 600V, THWN-THHN, copper wire, solid	1.8 clf	21.50	39	0.73	0	145	52			91
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Hot Water Pump 3 Branch Circuit						145				
	0.75" RGS Conduit	55 lf	4.96	273	0.10		145				273
	0.75" RGS Field Bends	3 ea			0.20	0	145	44			44
	#12, 600V, THWN-THHN, copper wire, solid	2.2 clf	21.50	47	0.73	0	145	64			111
	30A, NEMA 12, non-fused disconnect switch	1 ea	299.00	299	2.58	1	145	105			404
	Combustion Air Fan 1 Branch Circuit						145				
	0.75" RGS Conduit	100 lf	4.96	496	0.10		145				496
	0.75" RGS Field Bends	4 ea			0.20	0	145	58			58
	#12, 600V, THWN-THHN, copper wire, solid	3 clf	21.50	65	0.73	1	145	87			152
	Combustion Air Fan 2 Branch Circuit						145				
	0.75" RGS Conduit	110 lf	4.96	546	0.10		145				546
	0.75" RGS Field Bends	4 ea			0.20	0	145	58			58
	#12, 600V, THWN-THHN, copper wire, solid	3.3 clf	21.50	71	0.73	1	145	96			167
	Combustion Air Fan 3 Branch Circuit						145				
	0.75" RGS Conduit	80 lf	4.96	397	0.10		145				397
	0.75" RGS Field Bends	4 ea			0.20	0	145	58			58
	#12, 600V, THWN-THHN, copper wire, solid	2.4 clf	21.50	52	0.73	0	145	70			121
	Master Control Panel 2 Branch Circuit						145				
	0.75" RGS Conduit	80 lf	4.96	397	0.10		145				397
	0.75" RGS Field Bends	4 ea			0.20	0	145	58			58
	#12, 600V, THWN-THHN, copper wire, solid	2.4 clf	21.50	52	0.73	0.5	145	70			121
	Break Glass Station 2 Branch Circuit						145				
	0.75" RGS Conduit	80 lf	4.96	397	0.10		145				397

Estimate Detail

PROJECT: Jamestown NY

Task 2B - Lower Temperature

Jamestown Just Transition Program - REN2022N01416

TWO - 1940103342-001

ESTIMATE NO. Jamestown H.S. Boiler Installation

SHEET NO.

PREPARED BY: MJM

DATE: 3/3/2023

CHECKED BY:

DATE:

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	0.75" RGS Field Bends	4 ea			0.20	0.4	145	58			58
	#12, 600V, 1HWN=1HHN, copper wire, solid	2.4 clf	21.50	52	0.73	0	145	70			121
							145				
SUB-TOTAL											612,007

GENERAL CONDITIONS (8%)										48,961
OVERHEAD & PROFIT (20%)										122,401
DESIGN CONTINGINCIES (10%)										79,561
CONSTRUCTION CONTINGINCIES (13%)										61,201

Grand Total Estimate

\$924,130

Appendix D
Task 2C Technology Screening

JAMESTOWN TECHNOLOGY SCREENING



April 14th, 2023

Entire process – where are we

Task 2A: Baseline Evaluation of Existing Site

Task 2B: Lower the District Energy Supply Temperature

➔ Task 2C: Technology Screening

- Select Technology
- Select Scenarios

Task 2D: Converting Customer Buildings to Alternate Sources

Task 2E: Scenario Evaluation

- EnergyPRO Modeling
- Electric Capacity Assessment
- Hydraulic Modeling
- Scenario Selection

Task 2F: Economic Analysis

Task 2G: Identify Funding Opportunities

Task 2H: Permitting & Regulatory Review

Task 3: District Heating Study

Agenda

01 Project Drivers and Sustainability

02 Baseload and Peaking Technologies

03 Technology screening –
Renewable & Fossil Fuel Sources

04 Technology screening –
Electrification

05 Wastewater

06 Energy Storage

07 GIS Overview

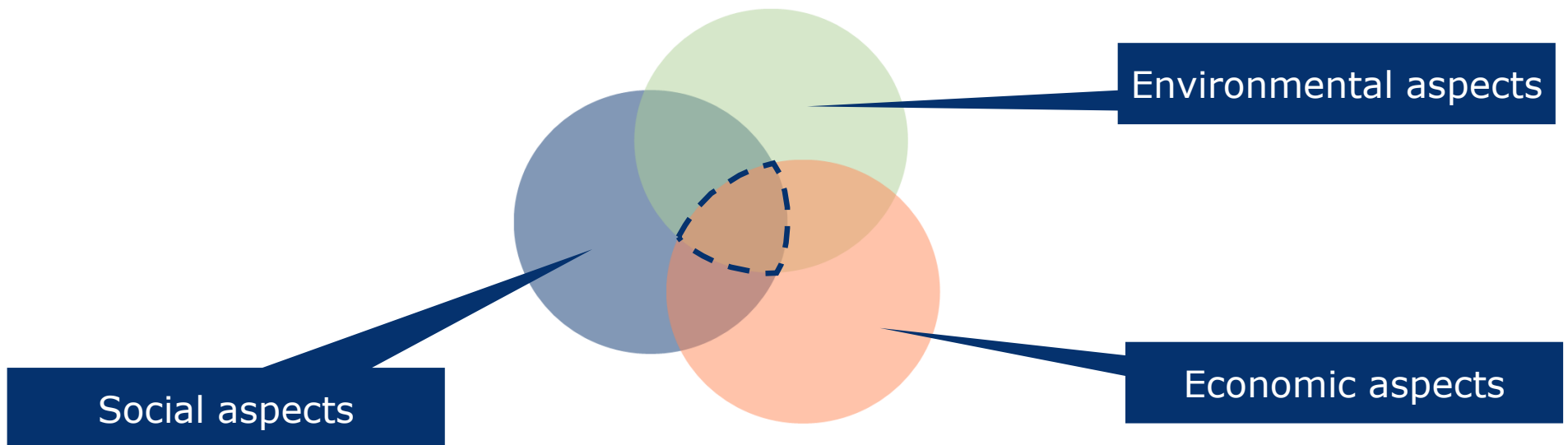
08 Scenarios

Project Drivers:

- **Viability of District Heating System**
- **Climate Leadership and Community Protection Act (CLCPA)**
 - **Utility Thermal Energy Network and Jobs Act (July 5th, 2022)**
- **NYSERDA's Program Opportunity Notice (PON) 4563 – Just Transition**
 - *Goal: Determine if there is an economic alternative to the current fossil-fuel energy source*
 - *\$150,000 funding allocated for each eligible study.*
 - *High level study*
- **PON 4614 – Community Heat Pump Systems**
 - *If Geothermal is viable, PON 4614 to help fund the detailed design & construction.*
- **DOE Funding Opportunity (\$300k - \$750k Possible Funding Available)**
 - Determine most viable geothermal solution (technically & economically)
 - Detailed Geological Surveying
 - Detailed Building Assessments

Sustainability considerations

- **Sustainable projects balances**



Sustainability considerations – Shadow price of carbon

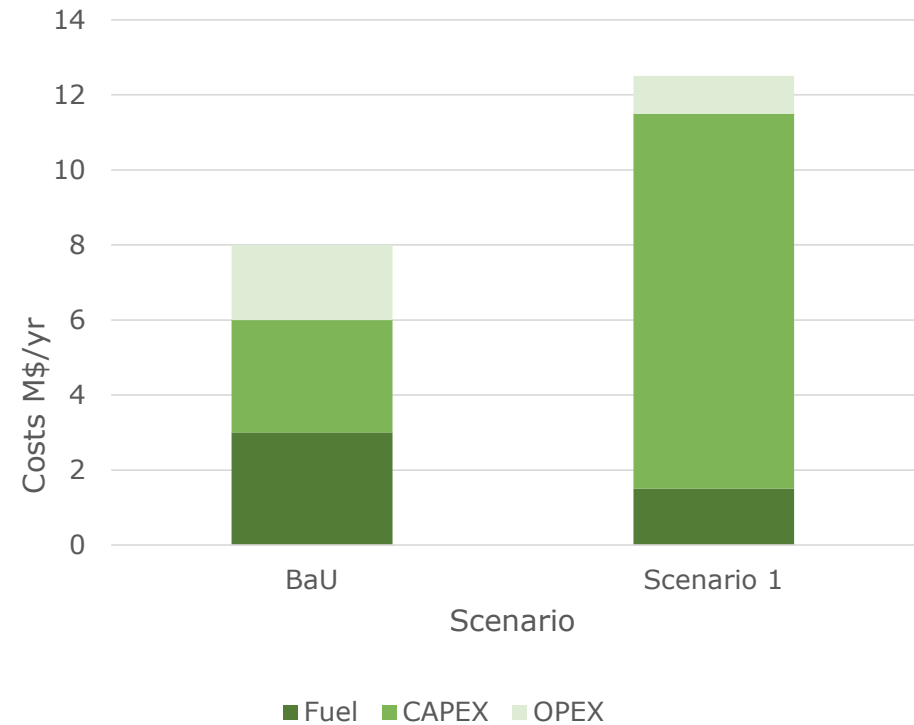
Example: Shadow price of carbon

Business as usual:

- High CO2 emissions, low costs

Scenario 1

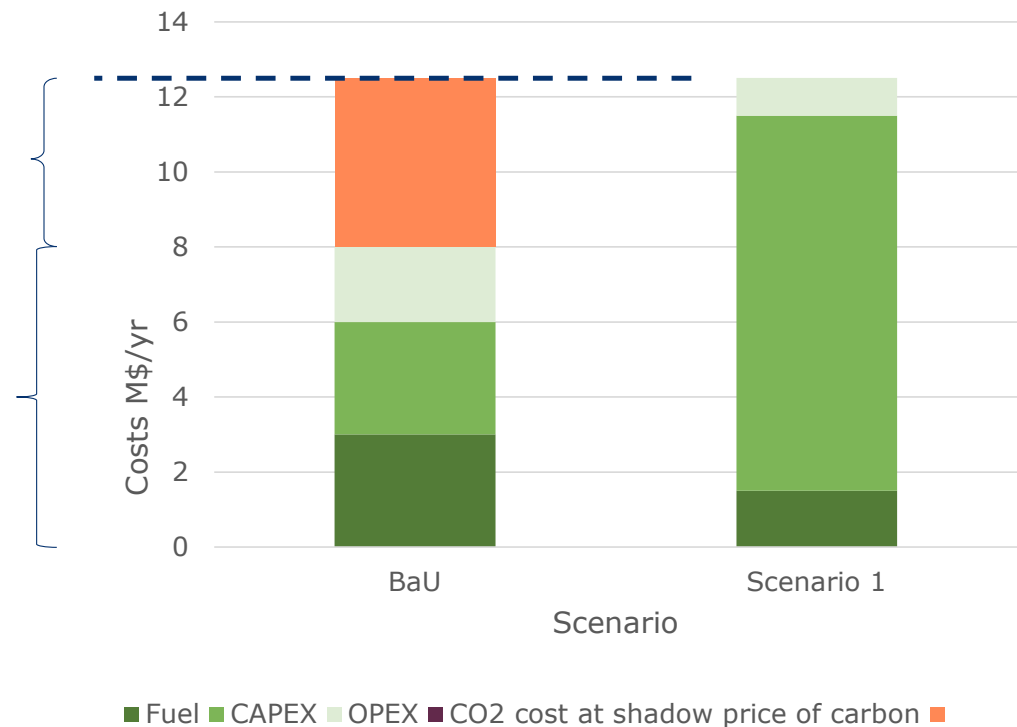
- Low CO2 emissions, high costs



Sustainability considerations – Shadow price of carbon

Shadow price of carbon equals the cost of carbon which exactly levels out the difference in cost between business as usual and scenario 1

The lower the shadow price of carbon, the higher the sustainability of the project. By focusing on projects with the lowest costs, the consequences will be economic and social improvements of the local community and reduced risk of energy poverty.



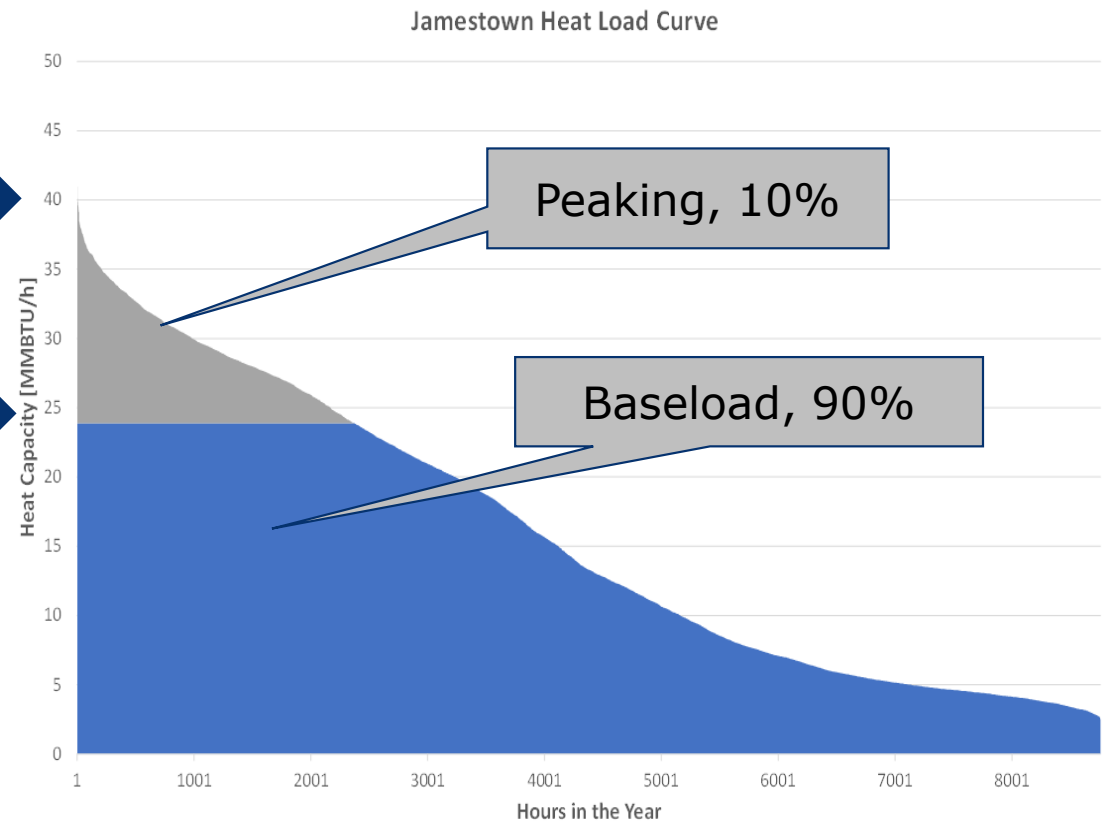
Baseload and peaking technologies

Baseload / peaking production (preliminary load curve)

- Total annual heat load is ~160,000 MMBtu/yr
- Heat Load Curve Includes:
 - Building Space Heating
 - DHW
 - Distribution Losses

100 % of peak
~41 MMBtu/h

56 % of peak
~23 MMBtu/h



Baseload / peaking characteristics

Some base load technologies characteristics

- Often high capital expense (CapEx) (should be in operation many hours per year)
- Should have low fuel costs

Some peaking / backup technologies characteristics

- Often low CapEx (e.g., boiler technology)
- High fuel costs
- Very high technology reliability (backup)
- High fuel supply reliability



Presentation of Technologies -1

Fossil technologies / fuels



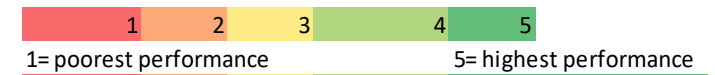
Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Gas turbine (simple cycle), Gas turbine combined cycle, rankine steam turbine, gas engines	- Electricity	Fossil fuel	- Base load technology, well proven - Not carbon neutral if NG is used - High CAPEX	1	2	4	5
Solid oxide fuel cell CHP	- Heat - Electricity	Fossil fuel	- High CAPEX - Base load technology - Not carbon neutral if NG is used - Local use of biogas seems unrealistic - Long start up times, high minimum load %	2	1	4	4
Gas boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	2	5	3	5
Oil boiler	- Heat	Fossil fuel	- Peak / backup technology, very limited operation - Not carbon neutral - Very low CAPEX	1	5	2	4
Grey Hydrogen	Fuel	Fossil fuel	- Derived from n-gas and produced from fossil fuels - CO2 is released into the air	1	1	2	3

Renewable sources / technologies



Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Bio-oil fired turbine (simple cycle)	- Heat - Electricity	Renewable fuel	- Base load technology - High CAPEX - Very high OPEX	4	2	1	3
Bio-oil engines	- Heat - Electricity	Renewable fuel	- Base load technology - Very high OPEX	4	2	1	4
Biomass ORC CHP, wood chips	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - Low OPEX	4	1	4	3
Biomass ORC, wood pellets	- Heat - Electricity	Renewable fuel	- Relatively high CAPEX - High OPEX	4	1	2	3
Biomass HOB, wood chips	- Heat	Renewable fuel	- Low CAPEX - Low OPEX	4	4	4	5
Biomass HOB, wood pellets	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	4	2	5
Bio oil boiler	- Heat	Renewable fuel	- Low CAPEX - High OPEX	4	5	2	5
Photovoltaics	- Electricity	Renewable source	- Intermittent source / need backup from grid - Limited production winter / high in summer	5	2	5	3

Renewable sources / technologies



Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Wind turbine	- Electricity	Renewable source	- Low CAPEX - Need backup from grid	5	2	5	3
Bio gas production - anaerobic digester	- Gas	Renewable fuel	-High CAPEX / OPEX	5	1	2	2
Large Solar Thermal	- Heat	Renewable source	- High CAPEX - Limited production in winter / high in summer	5	1	5	3
HOB - conversion from n-gas to bio-oil	- Heat	Renewable fuel	- Very low CAPEX - High OPEX if used in baseload	4	5	2	5
Boiler, hydrogen	- Heat	Renewable fuel	- High CAPEX / OPEX	4	1	1	1
Cogeneration, hydrogen	- Heat - Electricity	Renewable fuel	- High CAPEX / OPEX	3	1	1	1
Blue Hydrogen	Fuel	Renewable source	- Derived from n-gas and produced from fossil fuels - CO2 is captures in a CCS process and stored	4	1	1	2
Green Hydrogen	Fuel	Renewable source	- Produced from electrolyzes - Electricity is based on renewable electricity	5	2	1	2

Presentation of technologies - 2

Electrification technologies

1 2 3 4 5
1= poorest performance 5= highest performance

Technology	Output	Type	Notes	CO2 neutralit	CAPEX	OPEX	System integration
Electric boiler	- Heat	Electrification	- Base load or peak load - Very low CAPEX for boiler - High requirement for electric load. Potentially need for larger upgrade of electric feeders - High OPEX	4	5	1	5
HP (air-to-water) - large scale	- Heat - Cooling	Electrification	- Air as secondary heat source - Low efficiency in winter period - Reduction in load in winter season	5	3	3	4
HP (air-to-water) - small scale	- Heat - Cooling	Electrification	- Standardized product, low CAPEX - Low efficiency in winter period	5	2	3	3
GSHP open-loop, deep geothermal	- Heat - Cooling	Electrification	- Base load technology - High risk and high CAPEX	5	1	3	3
GSHP closed-loop, horiz, individual	- Heat - Cooling	Electrification	- Closed loop, baseload technology - Requires high available area	5	1	3	3
GSHP closed-loop, vert	- Heat - Cooling	Electrification	- Closed loop, base load technology - Requires much available space - High CAPEX - Boreholes would require balancing in summer periode	5	2	3	4
HP (sewage water-to water)	- Heat - Cooling	Electrification	- Base load technology - Often, relatively low CAPEX compared to benefits	5	3	3	4
Heat recovery chillers, electric	- Heating - Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - higher CAPEX compared to conventional chiller	4	3	4	4
Chillers, electric	- Cooling	Electrification	- low OPEX considering that heating and cooling is produced simultaneously - lower CAPEX compared to heat recovery chillers	4	3	3	5

Potential heat pump heat sources

1 – lowest, 5 - highest

HP heat source	Quality	Availability	Jamestown
Cooling of buildings	4	2	
Wastewater (effluent)	4	3	
Wastewater (influent)	3	2	
Surface water from Chadakoin river	2	4	
Heat from electrical substations	4	2	
Ground water aquifers for energy purposes	3	?	
Ground as heat source (GSHP)	2	4	
Air	1	5	
Data Center	?	?	
Nearby industrial heat sources	?	?	

Quality: Temperature, costs etc.

Availability: Accessible amount of the heat source

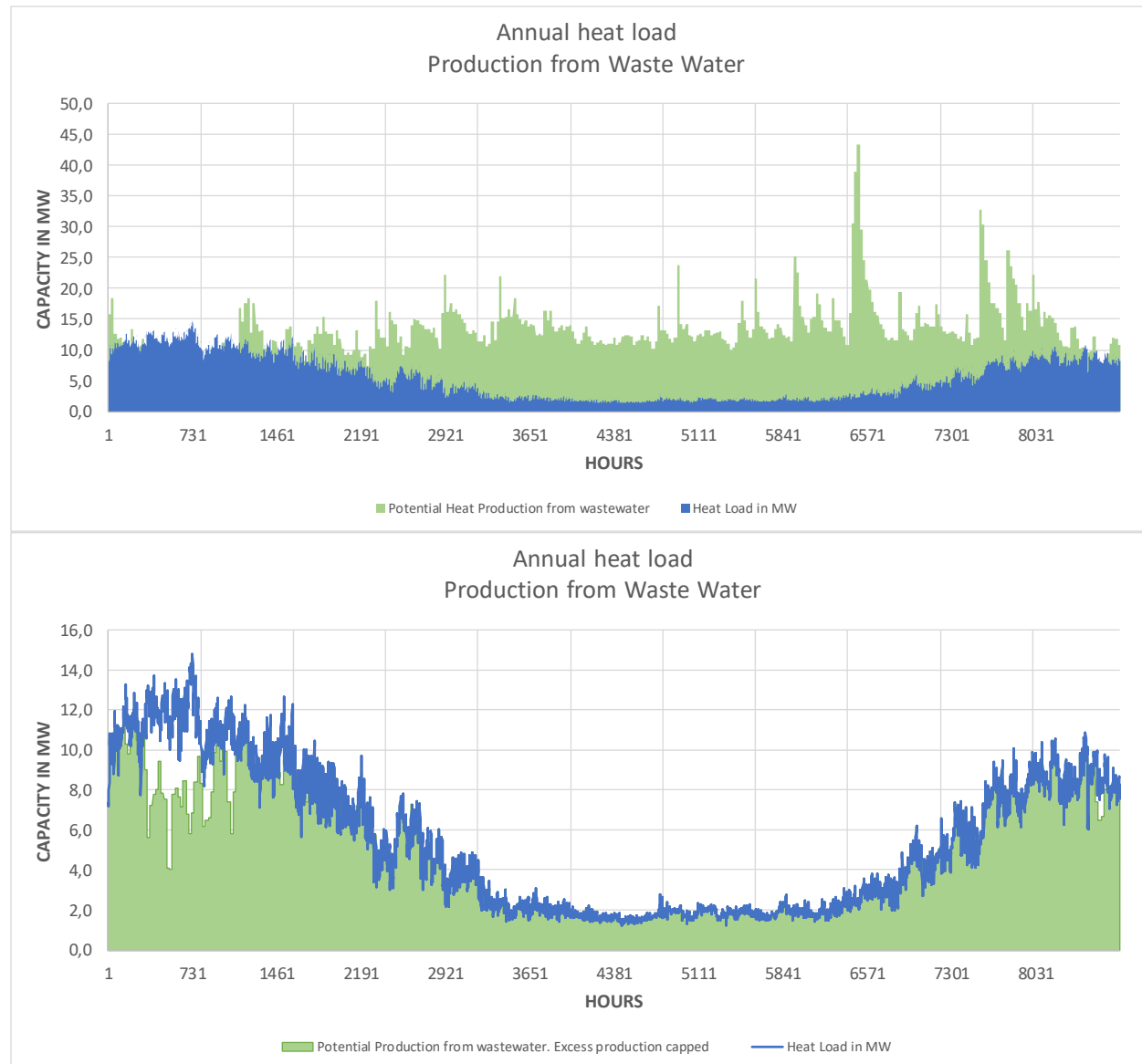
Cooling technologies

	Pros	Cons
Chillers, electrical	• Very well-known technology • Low CAPEX • High efficiency	• Normally, heat is wasted instead of being reused
Absorption chillers	• Can be cost-efficient – especially if steam (or other high temperature source) is available	• Very often, a fossil fuel is used • Low COP value
Heat recovery chillers	• Very efficient production of heating / cooling • Limited additional CAPEX compared to chiller only	• Requires connection to a heat network incl. thermal storage to enable good utilization of the heat

Wastewater effluent

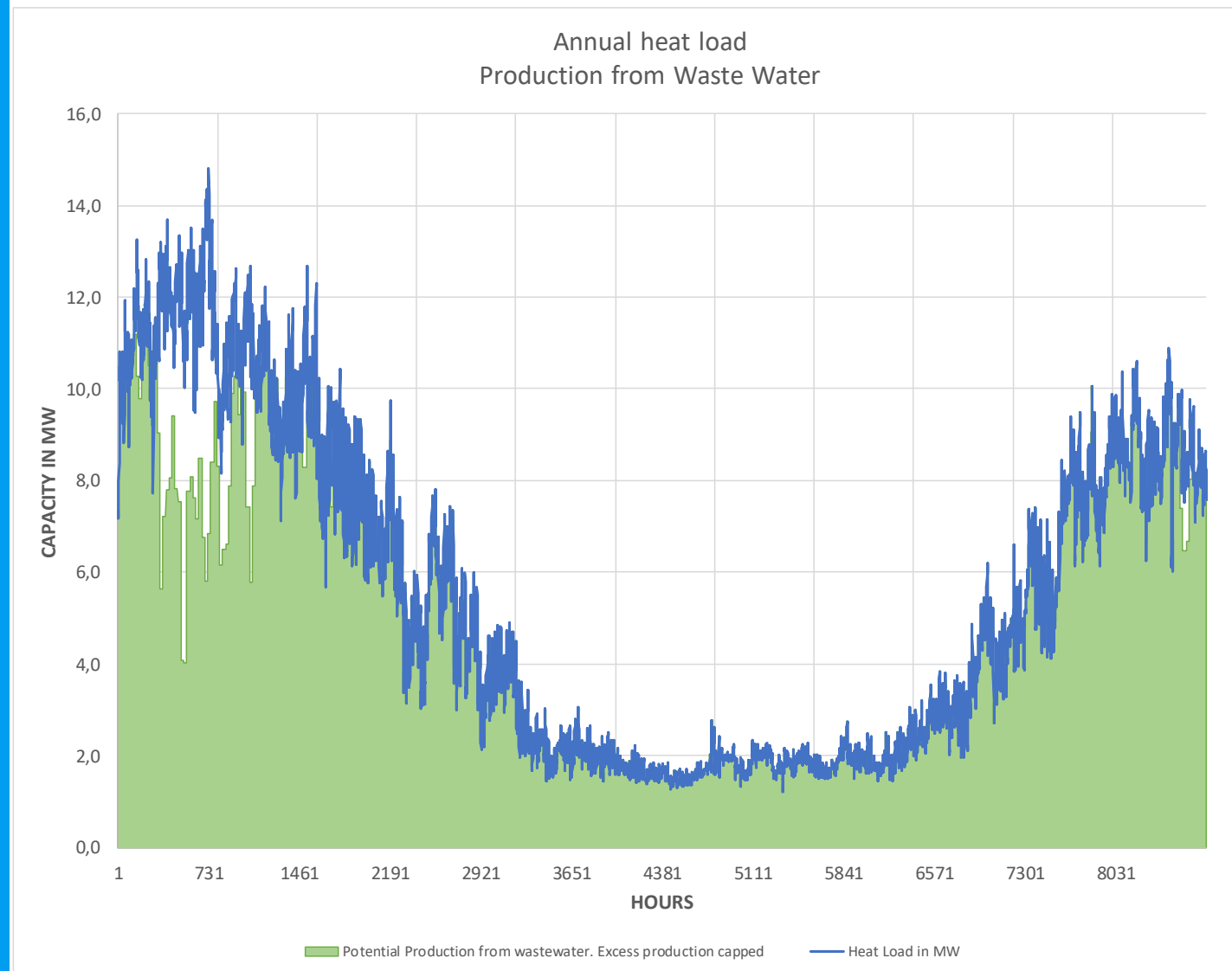
Potential heat production from wastewater

- Total potential production of heat from wastewater ~ 43,900 MWh/yr (capped)
- Total heat demand 47,400 MWh/yr
- Wastewater flow and temperatures are based on daily average from Jamestown WWTP



Potential heat production from wastewater

- Huge potential for covering the annual heat load with wastewater. Approximately 92% covered (without accounting for potential outages)
- BUT: Costly to establish a wastewater distribution pipe



Energy storage

Energy Storage - Options

	Pros	Cons
Battery storage	• Most established technology for electric storage at small scale (households) • Very suited for frequency regulation • Well-known technology	• High CAPEX, compared to energy content • Limited energy content per unit weight and unit volume • Limited technical lifetime compared to thermal storage
Tank thermal energy storage (TTES)	• Low CAPEX and OPEX • High energy content • Well-established technology in DK • Very suitable for daily storage, • Site-independent • Long technical lifetime	• Expensive at large scale, therefore, not feasible as seasonal storage • Less known in the US
Aquifer thermal energy storage (ATES)	• Very cost-effective at large scale • Very limited space requirements	• Highly site-dependent (requires specific geological conditions), • Regulation/legislation may apply • Approval process
Borehole thermal energy storage (BTES)	• much less site-dependent compared to ATES, • modular, therefore easily scalable	• High CAPEX compared to ATES • Limited capacity per borehole • Campus disruption
Pit Thermal Energy Storage (PTES)	• Low specific CAPEX (\$ per MMBtu) • Low OPEX • Can store energy for long periods	• Requires lots of space • Heat source for the storage, e.g. solar thermal also requires lots of space
Ice Storage	• Limited in size • Known technology	• Lower efficiency in chillers (due to lower temperature) • Less

Examples of storage types under development or with limited operational experience

- Different types of molten salt storage, gravity storage, sand storage, flywheels, compressed air storage

GIS overview of system

Current state

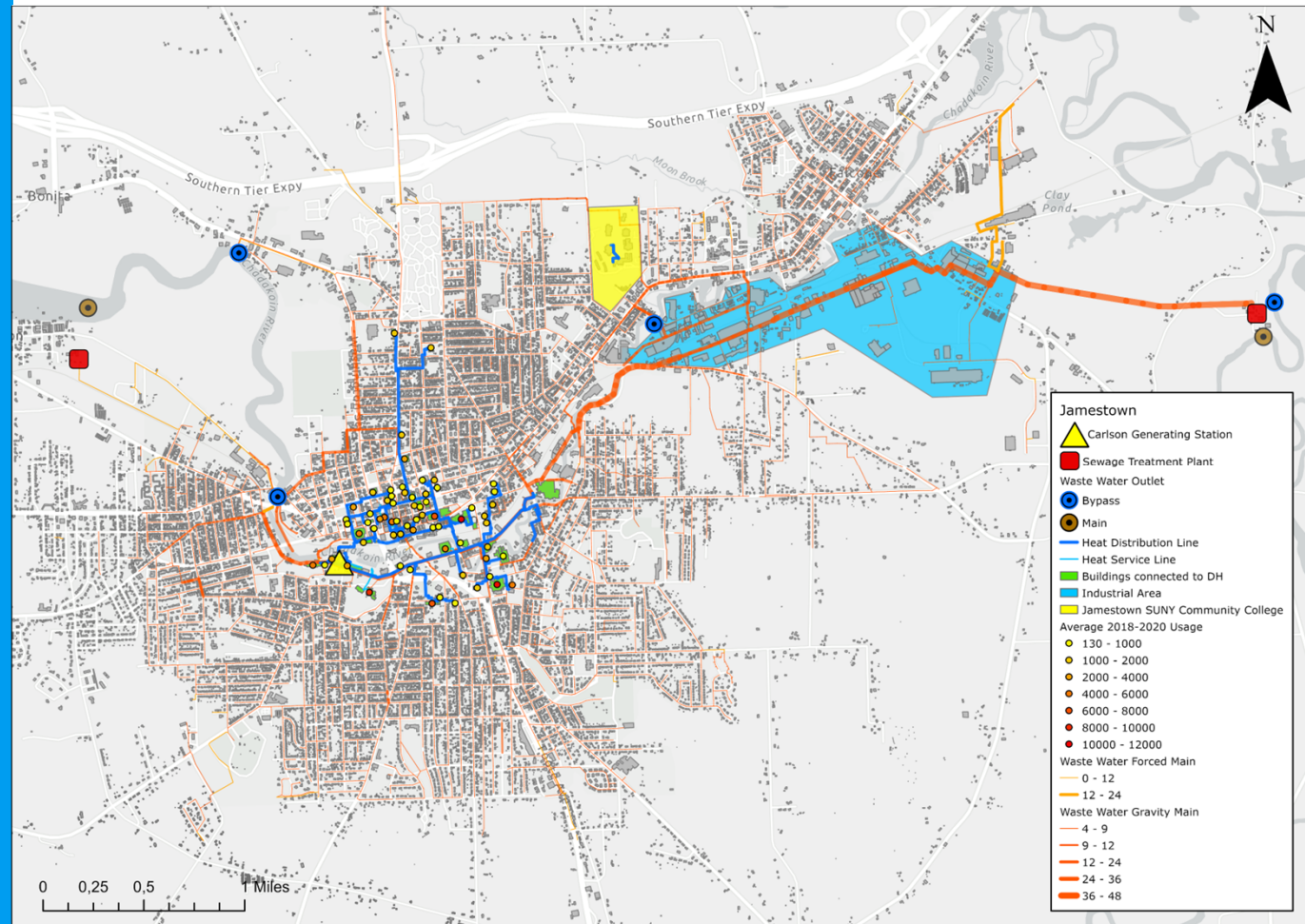
A look at the current DH system

- 67 current consumers
- 139,762 MMBtu/yr
- 15 miles of distribution pipe (supply + return)



A broader perspective

- Utilization of waste water from either waste water treatment plant
- Expansion of customer base
 - Large individual customers
 - SUNY Jamestown
 - Industrial area



Scenarios

Jamestown. Potential scenarios and variations

TWO Scenario Description ->	Business As Usual	Centralized Option & Centralized Hybrid Option						Ambient Loop		Decentralized Option 1	Decentralized Option 2
TWO Scenario ->	Scenario A	Scenario's B&C						Scenario D		Scenario E	Scenario F
Scenario Variation ->	1	1	2	3	4	5	6	1	2	1	1
Demand (Campus Load)	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current	Current
Network Configuration	Centralized HTW	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Centralized /Hybrid	Ambient Loop	Ambient Loop	Decentralized HP's	Decentralized HP's
Baseload Technology	NG	GSHP (Closed Loop), ASHP	GSHP (Closed Loop), ASHP	ASHP in cascade w/W-W HP	ASHP in cascade w/W-W HP	WSHP (Waste Water)	WSHP (Waste Water)	Individual HP's	Individual HP's	HP's	HP's
Peaking Technology	NG	NG Blrs	Electric Blrs	NG Blrs	Electric Blrs	NG Blrs	Electric Blrs	Individual HP's	NG Blrs	NG Blrs	Individual HP's
Borefield Balancing	N/A	ASHP	ASHP	N/A	N/A	N/A	N/A	ASHP	ASHP	N/A	N/A
DHW (Summer)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local
DHW (Winter)	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Local	Local	Local	Local
Space Cooling	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Local-Elec	Individual HP's	Individual HP's	Individual HP's	Individual HP's
Thermal Energy Storage	None	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Backup Heat (Emergency)	Fuel Oil	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs	NG Blrs
Network	2Pipe/2G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/4G	2Pipe/5G	2Pipe/5G	N/A	N/A

Discussion/Next Steps

Bright
ideas.
Sustainable
change.

RAMBOLL

Appendix E

Task 2D Converting Customer Buildings to Alternate Sources

TASK 2D

CONVERTING CUSTOMER BUILDINGS TO ALTERNATE SOURCES

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Task 2D: Converting Customer Buildings to Alternate Sources

1. SUMMARY

Ramboll was retained to define the work required to convert existing customers from their district heating system to stand-alone systems. The equipment considered include gas-fired condensing boilers and heat pumps. The estimated cost to install local gas-fired condensing boilers was compared to installing heat pumps locally in three different building types. Table 1 provides a summary of the results and indicates substantially higher costs to decentralize with heat pumps.

The building types were chosen based on the peak heating load of each building and the physical size of equipment available at the corresponding capacity. Since boilers require a much smaller footprint than heat pumps, building types for high-efficiency gas-fired boilers are based solely on a buildings peak heating load and standard available boilers in each category. Heat pump categories were based on the area required for installation at various capacities. Rooftop installation is expected for medium category heat pumps and building extensions for large category heat pumps.

Equipment capacities were determined based on meeting the peak load on a design day. The outdoor air temperature (OAT) on a design day in Chautauqua County is 4.5°F in accordance with the latest published ASHRAE climate data. Natural gas-fired boilers are mostly unaffected by OAT and will produce their rated capacity without a reduction in efficiency. However, heat pumps can be greatly affected by OAT, and at very low temperatures approach a COP of 1.0 (efficiency = 100%). This is important to note since the electrical consumption of a heat pump will increase at lower temperatures when the demand is highest. An analysis of the electrical distribution system in the City of Jamestown was performed and a scope of work and budget estimate developed to upgrade the existing system. It is estimated to cost approximately \$15.6M in electrical distribution upgrades to fully decentralize the current district heating customers to 100% heat pumps. The expected electrical distribution upgrade cost of each category type is included in Table 1.

Decentralizing with local heat pumps, and no backup or peaking boilers, are expected to require some level of building modifications to meet peak heating load with lower building hot water (BHW) temperatures. Standard available heat pumps for the applications indicated in this report are capable of producing up to 160°F BHW even when it is -22°F outdoors. However, most building-side heating systems on the Jamestown DH network are designed to meet the peak load with 180°F BHW or higher. The cost to perform the anticipated level of building modifications is included in Table 1.

The costs in Table 1 also include an N+1 level of redundancy for both heat pumps and boilers.

Table 1 - Comparison Summary: High Efficiency Boilers & Heat Pumps

Category	High Efficiency Gas Boilers				Heat Pumps			
	Capacity Range	Qty	Average Equip. Area (ft ²)	Average Cost	Capacity Range	Qty	Average Equip. Area (ft ²)	Average Cost
Small (Residential)	400,000 Btuh or less	31	21	\$155,000	120,000 Btuh or less	13	113	\$400,000
Medium (Light Commercial)	400,000 Btuh - 1,000,000 Btuh	20	36	\$280,000	120,001 Btuh - 2,880,000 Btuh	51	405	\$1,300,000
Large (Commercial)	1,000,000 Btuh or greater	17	100	\$580,000	2,880,001 Btuh or greater	4	2,300	\$8,000,000

Notes:

- 1) Boiler average equipment area includes main and redundant units and all service clearances.
- 2) Heat pump average equip. area includes space required for indoor WSHP (N+1), outdoor ASHP (N+1), thermal storage, and clearances.
- 3) Heat pump average cost includes electrical distribution upgrades and building modifications to operate at lower BHW temperatures
- 4) Heat pump category "Large" average cost includes a 660ft² building extension to fit (2) 300-ton water source heat pump units.
- 5) Costs include 15% for general conditions, 10% for OH&P, 20% design contingency, 5% bid contingency, and a 10% phasing contingency

Environmental abatement costs are not included in Table 1 but are expected to be similar for both options and would not affect the result of this comparison. Although it is difficult to estimate the cost of abatement without an environmental survey, based on the average building age of 85 years, it is anticipated that abatement will be required and the costs could be significant.

The comparison provided in this Task 2D report is based solely on installing either gas-fired boilers or heat pumps. The techno-economic evaluation performed in Task 2E will be based on a more standard approach of installing heat pumps for base load and natural gas-fired boilers for peaking and backup purposes. This will substantially reduce decentralization costs since heat pumps will only be sized for approximately 60% of the capacity, operated at conditions with greater efficiency reducing electrical distribution upgrades, and boilers installed to produce the higher temperatures when needed eliminating building modifications. In addition, the N+1 requirement would be met using natural gas boilers instead of expensive heat pump technology.

Table 1 does not include the Hospital since meeting 100% of the load using only heat pump technology would not be recommended for a building this size. The Hospital load and associated costs to decentralize will be included in Task 2E with a 60% heat pump base load approach. Since approximately 60% of the peak load typically accounts for 90% of the annual heating demand, employing this approach provides the maximum benefit of heat pumps, substantial reduction in capital costs, and would still greatly reduce greenhouse gas emissions.

Table 2 includes a list of all buildings, their design heating load, size, type of use and its category for both boiler and heat pump installation.

Table 2 - Building Category List

Building	Design Heating Load (Btuh)	GSF	Bldg Type	Boiler Building Category	Heat Pump Building Category
15 E 5th St LLC (Burgett & Robbins)	118,280	7,310	Office	SMALL	SMALL
200 Harrison St LLC (Chautauqua IDA)	919,619	119,933	Residence HR	MEDIUM	MEDIUM
3644 Holdings LLC (Priscilla)	298,669	20,779	Residence LR	SMALL	MEDIUM
3644 Holdings LLC 2 (Cameo)	284,310	19,298	Residence HR	SMALL	MEDIUM
3644 Holdings LLC 3 Jefferson St Apts)	138,717	6,237	Residence LR	SMALL	SMALL
3644 Holdings LLC 4 (Parkview Apts)	248,697	15,750	Residence LR	SMALL	MEDIUM
Agnes Home	94,650	5,288	Residence LR	SMALL	SMALL
Anderson Manor LB	287,912	21,834	Residence HR	SMALL	MEDIUM
Anderson Tower LP	410,833	33,170	Residence HR	MEDIUM	MEDIUM
Best Western Hotel	391,842	33,749	Residence HR	SMALL	MEDIUM
Board Of Education - JHS	5,506,083	252,460	Classroom	LARGE	LARGE
Board Of Education - LOVE	1,452,504	59,831	Classroom	LARGE	MEDIUM
Board Of Education (Tech Cntr)	211,505	17,346	Classroom	SMALL	MEDIUM
BPU - DH-carlson	481,520	33,800	Lab	MEDIUM	MEDIUM
BPU - low pres gas heat	59,593	3,300	Lab	SMALL	SMALL
BPU - monitor building	562,335	60,000	Lab	MEDIUM	MEDIUM
Carlson Tower LP	348,013	28,596	Office	SMALL	MEDIUM
Chautauqua Brick, Inc	444,098	23,959	Lab	MEDIUM	MEDIUM
Chautauqua Opportunities	1,630,625	73,180	Office	LARGE	MEDIUM
City of Jamestown (City Hall)	952,014	58,905	Student Union	MEDIUM	MEDIUM
City Of Jamestown 3 (Main St. Parking)	583,239	45,288	Lab	MEDIUM	MEDIUM
CODE Euclid Gardens	722,802	29,711	Classroom	MEDIUM	MEDIUM
Covenant Manor Apartments, LLC	1,089,861	109,416	Residence HR	LARGE	MEDIUM
DPW	265,639	14,000	Lab	SMALL	MEDIUM
DPW 2	376,705	28,000	Lab	SMALL	MEDIUM

Building	Design Heating Load (Btuh)	GSF	Bldg Type	Boiler Building Category	Heat Pump Building Category
Duncan Olesnak	61,336	4,312	Office	SMALL	SMALL
Eliz W Marvin House	108,401	6,484	Residence LR	SMALL	SMALL
E-Z Clean Car Wash	51,769	2,792	Lab	SMALL	SMALL
First Covenant Church	658,075	16,622	Student Union	MEDIUM	MEDIUM
First Lutheran Church	1,135,995	31,042	Student Union	LARGE	MEDIUM
Fourth St Housing	207,896	13,000	Residence LR	SMALL	MEDIUM
Gregory J Buzzanco (Foote Ave Church)	320,103	7,606	Student Union	SMALL	MEDIUM
Herbert A Duke II	333,071	30,000	Office	SMALL	MEDIUM
Heritage Ministries (Heritage Park)	593,642	63,081	Lab	MEDIUM	MEDIUM
Heritage Ministries 2 (Childcare)	140,636	4,600	Lab	SMALL	SMALL
HH Jamestown, LLC (Cherry St. Parking)	1,198,498	97,461	Lab	LARGE	MEDIUM
Inter'n Ordinance Tech	346,259	33,559	Classroom	SMALL	MEDIUM
Jamestown Boys & Girls Club	1,081,424	29,550	Athletic Center	LARGE	MEDIUM
Jamestown City (Ice Arena)	2,372,321	68,532	Athletic Center	LARGE	MEDIUM
Jamestown Newspaper Corp	429,734	65,333	Lab	MEDIUM	MEDIUM
JHA (5th St. High Rise)	868,188	72,197	Residence HR	MEDIUM	MEDIUM
JHA (Chadakoin Bldg)	755,391	55,512	Residence HR	MEDIUM	MEDIUM
JHA (Hotel Jamestown)	1,380,786	140,000	Residence HR	LARGE	MEDIUM
JRP (Jody Peterson)	155,580	9,600	Residence LR	SMALL	SMALL
JRP (South County Office Bldg)	629,498	55,538	Office	MEDIUM	MEDIUM
Kaleida Health	1,438,077	32,853	Lab	LARGE	MEDIUM
Krog Corp (BWB Center)	437,465	35,850	Office	MEDIUM	MEDIUM
Legal Assistance of WNY	113,994	8,000	Office	SMALL	SMALL
Lewis & Lewis P C (.001) (.1)	98,876	4,500	Office	SMALL	SMALL
Lewis and Lewis	109,620	6,498	Office	SMALL	SMALL
Little Theater Jamestown	1,882,513	57,644	Student Union	LARGE	MEDIUM
National Comedy Center, Inc.	500,610	22,456	Student Union	MEDIUM	MEDIUM
Northwest Bank	258,119	23,000	Office	SMALL	MEDIUM
Prendergast Library	483,026	33,576	Office	MEDIUM	MEDIUM
REALiFE Church Inc.	467,616	12,000	Student Union	MEDIUM	MEDIUM
Reg Lenna Center for the Arts	1,715,887	47,936	Student Union	LARGE	MEDIUM
Riverwalk Properties (JAMA)	3,464,705	82,624	Lab	LARGE	LARGE
Robert H Jackson Inc, The	226,823	19,167	Residence LR	SMALL	MEDIUM
St James Church	1,051,474	30,000	Student Union	LARGE	MEDIUM
St Susan Center	898,362	111,543	Student Union	MEDIUM	MEDIUM
Time Warner Cable	246,071	16,992	Office	SMALL	MEDIUM
Triple R, LLC	92,505	7,469	Office	SMALL	SMALL
UPMC Chautauqua at WCA (Jones Hill)	4,603,592	113,167	Lab	LARGE	LARGE
UPMC Chautauque at WCA (Physicians)	1,605,585	37,000	Lab	LARGE	MEDIUM
Westerberg Tower LP	390,091	33,540	Residence HR	SMALL	MEDIUM
Windstream Corp A/P	701,571	70,856	Office	MEDIUM	MEDIUM
YMCA (main)	2,936,395	78,907	Athletic Center	LARGE	LARGE
YWCA	239,944	18,476	Athletic Center	SMALL	MEDIUM
Notes:					
1) Lab type is used for medical centers, and miscellaneous mechanical process or manufacturing building types					
2) Student Union type is used for assembly areas such as Churches, Town Hall, and the National Comedy Center					

2. **SCOPE**

The goal of this task was to define the work required to convert existing customers from their current district energy (DE) system to stand-alone building heating systems. Two building level systems considered were local heat pumps and gas-fired condensing boilers.

A solution for each system is provided using the information gathered during the RFI phase under Task 2a, and the engineering evaluation of system temperature performed in Task 2B. Each solution includes the capacity and quantity of decentralized equipment, general arrangements, scope of work, natural gas and electric utility upgrades, listing of assumptions, and a budget estimate for each system. The work also includes an evaluation of local domestic hot-water production and the work and cost associated with each recommended approach.

Where data was not available, Ramboll developed reasonable energy use profiles based on the buildings size, shape, use, location, and by using industry standards such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Commercial Buildings Energy Consumption Survey (CBECS) methods.



Photo 1 – Samuel A. Carlson Electric Generating Station - Photo Taken from Covenant Manor Rooftop

3. **APPROACH**

The field investigation and engineering analysis required by Task 2D were conducted between January 24th and April 28th, 2023. The execution of the work included the following tasks:

- 1) **Surveyed buildings:** conducted a walk-down of 12 representative buildings. Identified spaces within each building that could be used as future mechanical equipment rooms. The majority of these spaces were located in the basement areas and in existing mechanical equipment rooms. In addition to surveying interior locations, the walk-down identified locations exterior to the building that could be used for any new free-standing structures or exterior equipment.
- 2) **Interviewed facility personnel:** collected data from the facility's personnel to understand the operation of the hot water distribution system, specifically how these systems are used at each building. Interviewed the staff responsible for system maintenance to determine operating procedures, recent improvements, and operational problems the staff are experiencing. The objective of the interviews was to document the history of the system/equipment, age of system components, any ongoing operational issues, equipment reliability issues, or any other systemic problems.
- 3) **Reviewed available records:** examined existing operating logs for the district heating system.
- 4) **Reviewed system drawings and diagrams:** reviewed the facilities existing system diagrams to determine the physical arrangement of the district heating system at a representative sample of buildings. The search focused on the point where each building is connected to the central utility system. Limited information and drawings were available from the customers and building-side systems.
- 5) **Utility distribution:** ARC GIS files of the electrical distribution system were provided by Jamestown BPU along with transformer load data as requested by Ramboll. The information included the transformer size, location, and hourly loads of affected transformers that serve buildings on the DH system. Natural gas distribution network information was not available since this utility is not provided by Jamestown BPU.
- 6) **Heating loads:** individual peak heating loads for each building were determined during Task 2B and is included in Appendix A.
- 7) **Equipment layout:** An equipment layout for a typical building was prepared for both proposed decentralized systems.
- 8) **System diagram:** a simplified flow diagram was prepared for the space heating and domestic hot water systems to indicate the new equipment and how it is tied into the existing building systems.
- 9) **Capital budget cost:** Prepared a budget for the proposed decentralization of each option. The budget contains a detailed breakdown of the costs into man hours, hourly rates, and material unit costs. The cost estimate is in the standard CSI format.

4. EXISTING SYSTEM

The space heating and domestic hot-water-production needs of 72 buildings within the City of Jamestown are met via a centralized district heating hot-water system. These buildings include schools, hospitals, commercial, residence, and public types. The district heating system was initially established as a steam system in 1948 and was ultimately abandoned in 1969 when building owners decided to install their own local boilers¹. The central system was reestablished to 4 buildings as a hot-water network in 1984. Since then, the system has grown to supply over 70 customers. However, approximately 85% (~60,000') of the networks direct-buried piping system has been in operation over 35 years and is beyond its useful life. Replacing the piping network will require extensive capital investment and likely increased utility rates. As part of this study, Ramboll is evaluating the capital cost required to abandon the district heating system and install local units at each building. The evaluation will include the cost to install heat pumps with the cost to install high-efficiency natural gas-fired boilers.

Hot water from the site is mostly used for space heating and domestic hot water (DHW). Both the ice rink and the Hospital have additional process loads including humidification, sanitizing, ice melt, and dehumidification. All of the connected buildings are currently equipped with hot water heat exchangers that use hot water from the district heating system to produce hot water for hydronic building heat and domestic-hot-water. Fully decentralizing the hot-water distribution system will require the installation of heating equipment to produce both space heating hot-water and DHW.

5. EXISTING CONDITIONS

5.1 *Building Mechanical Rooms*

The available footprint to install new heating equipment within the mechanical rooms in each building is expected to vary based on Ramboll's findings during the January 2023 field investigation. During the investigation, some buildings were found to have enough open area within their mechanical rooms to install new equipment. Other buildings would require demolition of existing backup boilers to accommodate additional space for the new equipment. While others would either require existing rooms be repurposed as mechanical equipment rooms or an exterior structure be built to house the new equipment. Table 3 indicates the buildings surveyed and the anticipated approach that would be required at each to install new local heating equipment.

Table 3 - Buildings Surveyed & Available Space for New Equip.

Available Space	Boiler Demolition Required	Repurpose Rm or Exterior Structure
Comedy Center	Hotel Jamestown	Jamestown H.S.
Covenant Manor	Heritage Park	Euclid
	Hospital	BWB
	Ice Rink (Chiller Demolition)	Chautauqua Hotel
		JAMA
		Jefferson St. Apts

See Section 8.2 for basis of estimate assumptions regarding the location and installation of new equipment within each building.

¹ Second Quarter 2005, Twenty Years Later: Revisiting the growing Jamestown system, District Energy, pages 7-9

5.2 Building Heating Systems

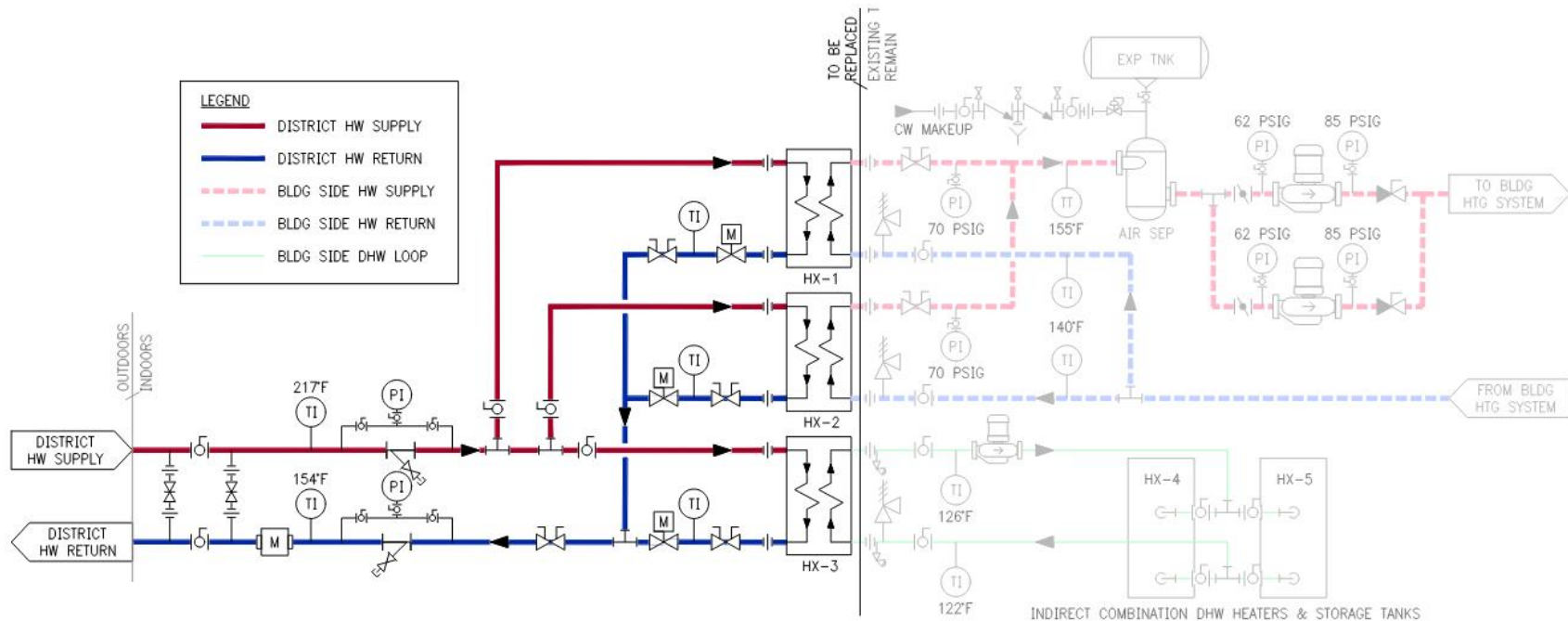


Figure 1 - Typical Building Heating System Schematic Diagram

Figure 1 is a typical schematic of the equipment located in each buildings mechanical room connected to the Jamestown District Heating system. The figure illustrates the systems that will need to be demolished, removed and replaced with local heating equipment. These systems include all pipe, valves, fittings, heat exchangers and components shown in bold on the left side of the diagram. The heat exchangers in each building are the demarcation point between the district HW system and the building-side heating system. The items in grey scale on the right side of the figure are expected to remain and include all pipe, valves, fittings, heating circulators, air separators, expansion, makeup devices, and domestic hot water storage tanks

6. DECENTRALIZING WITH HIGH EFFICIENCY CONDENSING BOILERS

6.1 Boiler Selection

The boiler design is based on high-efficiency gas-fired condensing units that are constructed of cast iron, stainless steel, or aluminum depending on the manufacturer. The design of condensing boilers provides superior efficiencies compared to other types of boilers and are typically in excess of 94%. These high efficiencies are achieved by reducing the circulated water temperature to the building at part load resulting in lower flue gas temperatures below the dew point. The lower temperatures allow condensation of the water vapor in the flue gases and the recovery of its latent heat. Corrosion resistant material must be provided for the vent since the condensed water vapor tends to be slightly acidic. The low exhaust temperatures also allow the combustion gases to be vented directly through the wall in lieu of a chimney. The use of a direct vent reduces the construction costs significantly since the existing buildings do not require the installation of a chimney.

Condensing boilers are available for hydronic applications only and will meet the needs of all connected buildings with the exception of the Hospital which requires steam for its humidification and sanitizing processes. In addition, approximately 75% of the Hospitals space heating equipment is designed to operate using steam. Since the Hospital currently has three backup steam firetube boilers sized to handle the full load, it is assumed that replace-in-kind boilers will be installed in this location in lieu of converting the buildings internal piping system and connected terminal units to hot water.

Condensing boilers are commercially available in various capacities ranging from 80 MBtuh residential units to large scale commercial sizes up to 8,000 MBtuh. As an example, a single unit with an 8,000 MBtuh capacity can meet the peak heating load of the Jamestown H.S. and the Ice Arena. The capacity of condensing boilers and typical connected sizes of nearby pipe, vent, and air intake are provided in Table 4. The table also indicates the number of buildings included within each category and the boiler model number for the basis of estimate. The Ultra-80 is manufactured by Weil McLain and the AM-500 and BMK-1500 are manufactured by AERCO. The local distributors IRR Supply and RP Fedder Corp were contacted to discuss current pricing.

Table 4 - Boiler Categories

CATEGORY	CAPACITY	HW PIPE SIZE (IN)		GAS LINE SIZE (IN)		FLUE & AIR	QTY BLDGS	BASIS OF ESTIMATE ¹
		BOILER	HEADER	INTERIOR ³	EXTERIOR ²			
Residential	400,000 Btuh or less	1"	1.25"	1.25"	0.5"	3"	31	ULTRA-80
Light Commercial	400,000 Btuh - 1,000,000 Btuh	2"	3"	2"	0.75"	4"	20	AM-500
Commercial	1,000,000 Btuh or greater	4"	6"	3"	1.25"	6"	17	BMK-1500

Notes:

- 1) The basis of estimate indicates the model boiler at the capacity that occurs with the greatest frequency.
- 2) Exterior gas line size indicates the direct buried high pressure main upstream of the gas meter.
- 3) Interior gas line size is the downstream side of the gas meter.
- 4) Manufacturers considered: Lochinvar, AERCO, Weil McLain, and Cleaver Brooks.

The Hospital is not included in Table 4 since its boilers are anticipated to be replaced in kind with three new firetube steam boilers as manufactured by Cleaver Brooks. However, further evaluation is required of the Hospital's existing air facility registration emission limits and if using local boilers as the main source of heat production will trigger annual limits required to post registration.

6.2 Domestic Hot Water

There are two options available for supplying domestic hot water at each building. The options include the installation of additional gas-fired DHW heaters or the installation of an indirect-fired storage tank. The first option would require a minimum of two gas-fired DHW heaters installed in the event of a failure to one of the heaters. The DHW heaters will operate completely independent of the boilers system and will require dedicated vents to remove the combustion products from each unit.

The second option for DHW production is the use of an indirect-fired storage tank. The system uses boiler water to heat the domestic water in the storage tank. A dedicated HW zone pump is activated by an aquastat in the DHW storage tank to circulate boiler water through the indirect-fired heater when the temperature in the storage tank drops below the setpoint. The indirect-fired units require the boilers to operate year round, but eliminates the need for additional fuel burning equipment, combustion air duct, and exhaust venting.

Residential buildings typically experience peak DHW loads for a limited period from the use of showers. A typical gas-fired DHW storage tank system must be oversized to account for peak water usage. In a similar manner, the typical boiler system will have excess capacity since the boiler selection is based on meeting the design-day full load of the building. Two boilers are typically provided for redundancy, and allows one unit to meet the building needs, but still results in 100% excess boiler capacity in the building. The use of an indirect-fired DHW system allows the excess capacity in the boilers to be used for DHW production.

Using the boiler for DHW production has an added benefit in a condensing boiler since the efficiency of the boiler improves as the return hot-water temperatures decreases. During periods of peak heating, the returning water from the domestic water system is at a lower temperature than the water returning from the heating system. As a result, the blended temperature returning to the boiler is reduced, which increases the boiler efficiency. Controls on the integrated Heating/DHW system are provided to prioritize DHW production over heating on peak days. Prioritizing the DHW production allows the system to meet the short DHW peak without noticeably affecting the building heating.

It is recommended that indirect-fired domestic water heaters be used in all buildings to meet the DHW load. In addition, since the buildings are connected to the district heating system and generally do not have their own gas-fired equipment, the indirect arrangement would currently exist in most or all buildings. In all 12 buildings surveyed by Ramboll, the buildings were equipped with their own indirect-fired heaters, storage, and circulators. The plate and frame heat exchanger separating the district heating system from the building-side system would be removed and the new boiler piping installed in its place as shown in Figure 2 on the following page

6.3 Building-Side Heating System Modifications

The boilers are capable of producing temperatures required to meet the peak heating loads without requiring any modifications to the building-side heating system including all pipe, valves, fittings, coils, terminal units, convectors, circulators, etc.

6.4 Gas Boiler Schematic Diagram with Primary/Secondary Piping

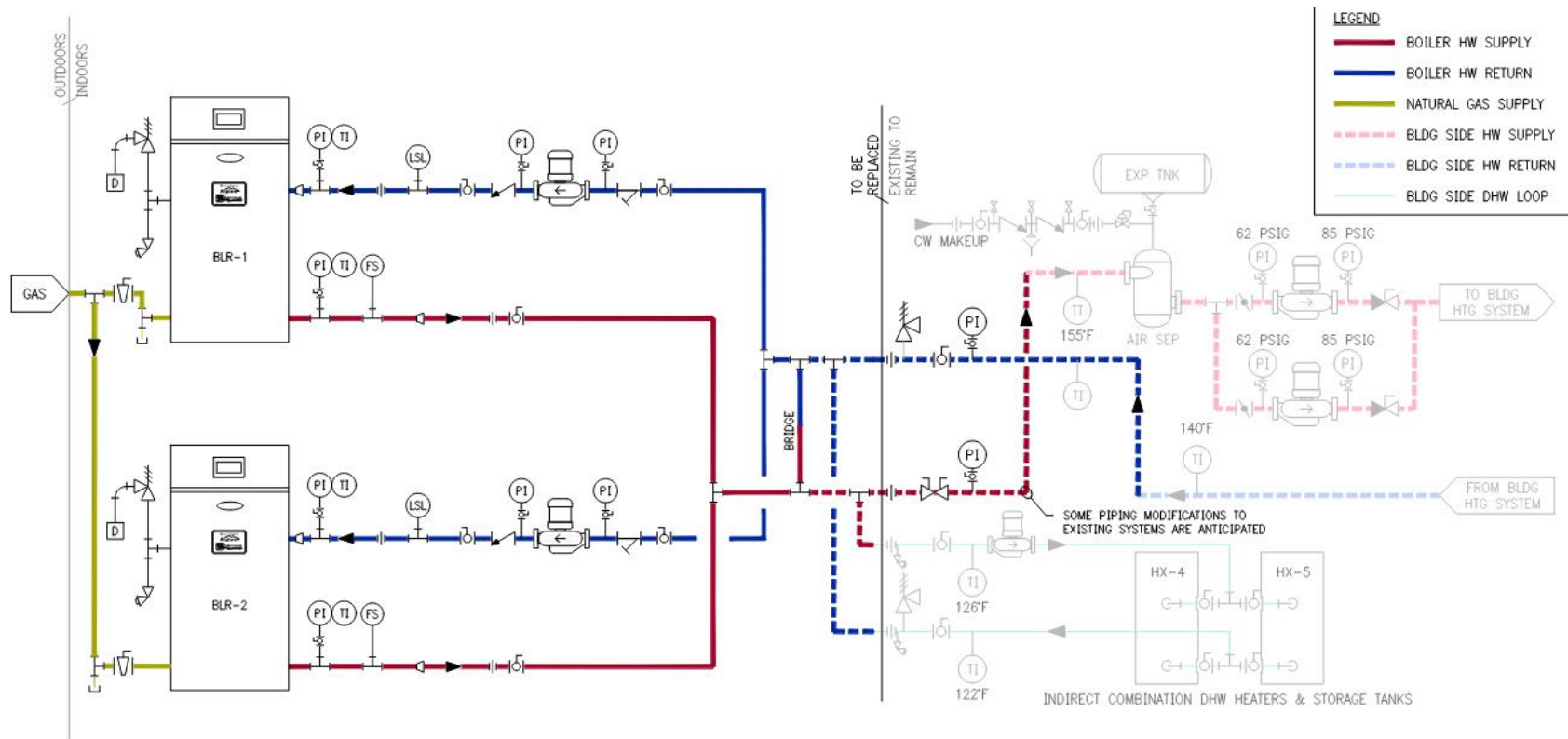


Figure 2 - Typical Decentralization Scenario with Gas-Fired Boilers

Figure 2 is a typical schematic of a boiler installation in each building. The new equipment to be provided as part of the decentralization is shown on the left side of the illustration. Manufacturers of high-efficiency natural gas-fired boilers typically require a primary/secondary piping arrangement to ensure minimum flow through the boilers. A primary/secondary system consists of two connected, but independent loops. The primary loop shown on the left side of Figure 2 is used to circulate water through the boilers and the secondary loop shown on the right is the existing system which circulates water throughout the buildings heating system and connected coils and terminal units. The loops are connected through a common bridge that allows flow in both directions. During periods when the flow in the primary loop is greater than the secondary loop, HW is recirculated back to the boilers and when flow is less, recirculated back to the building. The bridge connection should be as short as possible to ensure a low pressure drop.

6.5 Natural Gas Distribution System

Jamestown's natural gas distribution system is owned and operated by National Fuel Gas Distribution Corporation. It is assumed that the distribution system has sufficient capacity to meet the needs of the loads in the buildings and that the scope of work at each building would require 100 feet of direct-buried gas pipe be furnished and installed by the building owner. For further discussion regarding this assumption see Section 9.4.

A majority of the buildings were constructed prior to 1985 when the current district heating system was placed into service and were once heated with local gas-fired boilers. However, it is likely that all buildings will require new internal gas pipe, valves and fittings. National Fuel Gas Distribution Corporation was contacted and indicated that a new service line application must be completed for all new service requests. The utility also indicated that the cost for all surface restoration and the house line to the meter bar are required to be installed by the building owner.

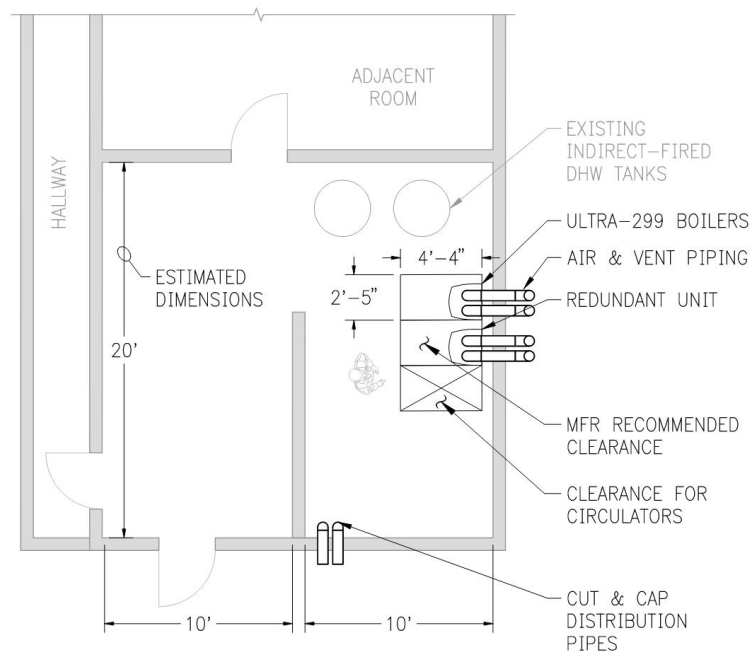
6.6 Decentralizing with Gas Boilers – General Arrangements

General arrangements of each category boiler size have been developed to provide an overall sense of the physical size of the units and the general space required for auxiliary equipment. Three example buildings, one in each category, were used to demonstrate how new boilers could fit within existing building footprints. These buildings are; Residential Category: Jefferson St. Apartments, Light Commercial Category: Euclid Gardens, Commercial Category: Hotel Jamestown.

Category: Residential

A general arrangement of the residential category boiler was developed to illustrate how the units would fit into an existing space once the existing heat exchangers and associated pipe, valves, and fittings are removed. Figure 3 illustrates the size of the average boiler model in the residential category along with the manufacturers recommended clearances. The building shown is the Jefferson St. apartment building which was surveyed in January 2023. The boilers will fit within the existing space and due to the nearby receptors of adjacent buildings within the city, venting is assumed to terminate at the roof level and be routed with insulated metal pipe along the outside of the building.

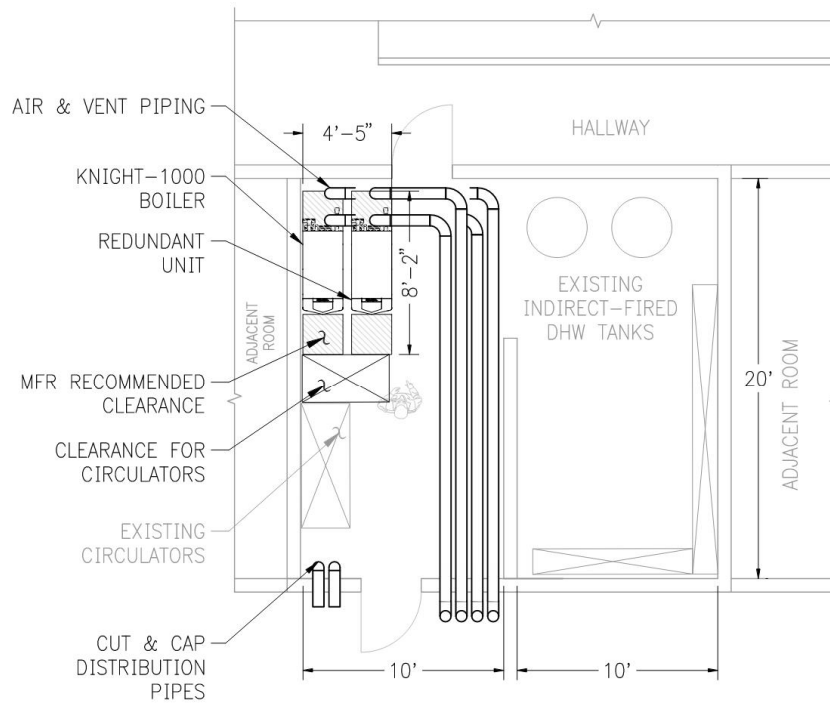
Figure 3 - New Boilers: Residential Category GA – Jefferson St. Apartments



Category: Light Commercial

A general arrangement of the light commercial category boiler was developed to illustrate how the units would fit into an existing space once the existing heat exchangers and associated pipe, valves, and fittings are removed. Figure 4 illustrates the size of the average boiler model in the light commercial category along with the manufacturers recommended clearances. The building shown is Euclid Gardens which was surveyed in January 2023. The boilers will fit within the existing space and due to the nearby receptors of adjacent buildings within the city, venting is assumed to terminate at the roof level and be routed with insulated metal pipe along the outside of the building.

Figure 4 – New Boilers: Light Commercial Category GA – Euclid Gardens

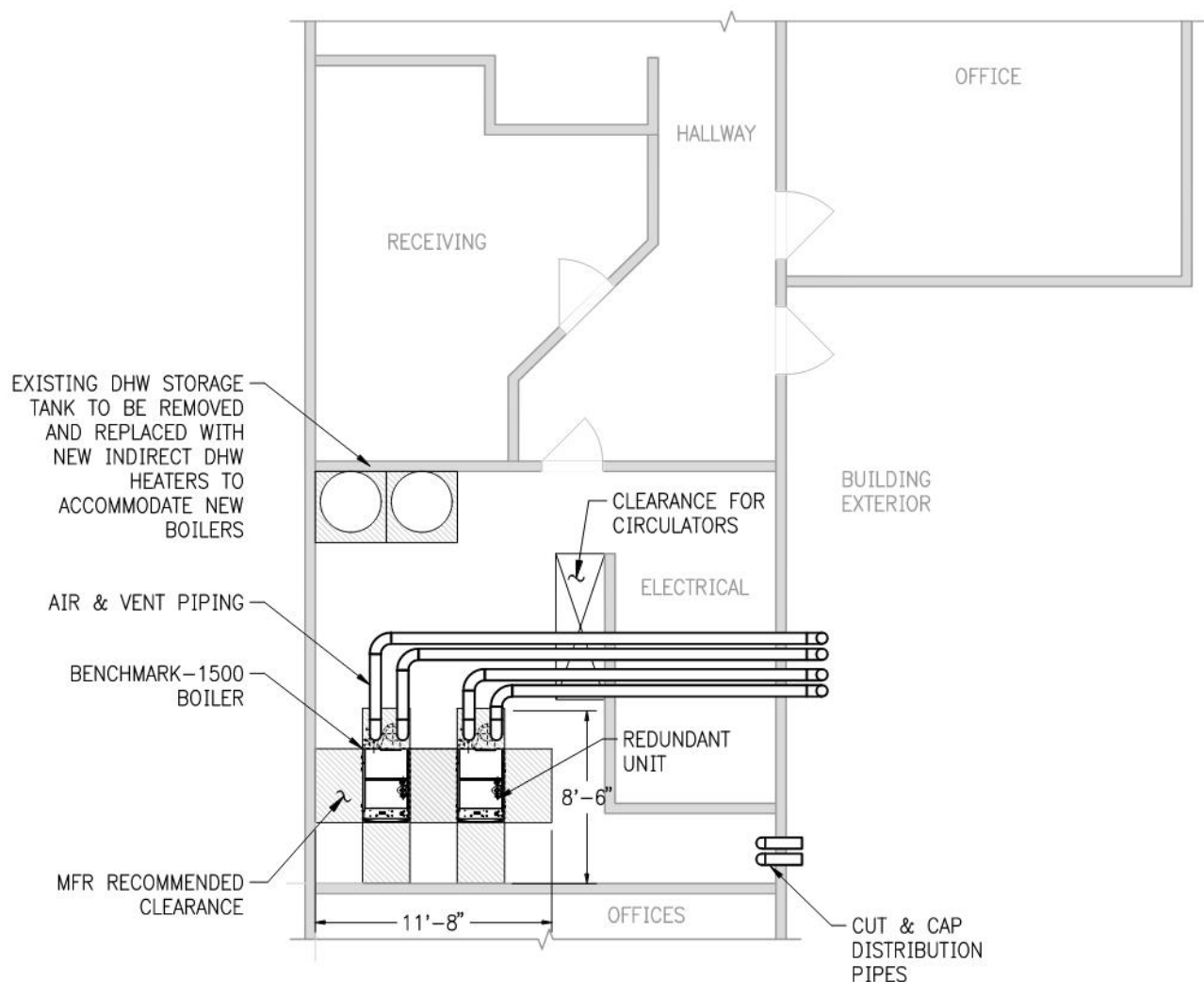


TYPICAL BOILER GENERAL ARRANGEMENT

Category: Commercial

A general arrangement of the commercial category boiler was developed to illustrate how the units would fit into an existing space once the existing heat exchangers and associated pipe, valves, and fittings are removed. Figure 5 illustrates the size of the average boiler model in the commercial category along with the manufacturers recommended clearances. The building shown is the Riverwalk Properties (JAMA) Medical Center which was surveyed in January 2023. The existing heat exchangers and domestic hot water storage tank must be removed in order to fit the new boilers. Due to the nearby receptors of adjacent buildings within the city, venting is assumed to terminate at the roof level and be routed with insulated metal pipe along the outside of the building.

Figure 5 - New Boilers: Commercial Category GA – Riverwalk Properties (JAMA)



6.7 Decentralizing with Gas Boilers - Scope of Work

The following scope of work is defined and included in the cost estimate to install local high-efficiency gas-fired boilers. The work in the mechanical room of each building will be similar and is anticipated to include the following:

- 1) Demolish and remove existing heat exchangers, pipe, valves, and fittings on the district heating system within the mechanical room.
- 2) Cut and cap the existing district heating piping systems as they enter the mechanical rooms from outside.
- 3) Furnish and install two gas-fired, condensing, hot water boilers in the mechanical room of each building.
- 4) Furnish and install new concrete pads for each boiler.
- 5) Furnish and two install primary circulators and associated valves, gauges, supports, and fittings.
- 6) Furnish and install all pipe, valves and fittings associated with the primary piping system and connect the new primary loop to the existing building side secondary system.
- 7) Furnish and install combustion air piping and flue gas piping for the boilers.
- 8) Furnish and install piping from the secondary pipe loop to the existing domestic hot water heating-side loop.
- 9) Furnish and install instrumentation and controls for the new boilers and associated circulators. Ensure equipment is provided with provisions to connect to existing BMS systems.
- 10) Furnish and install new break glass emergency shutdown circuit.
- 11) Furnish and install electrical power to the new equipment.
- 12) Modify the MER lighting as necessary.
- 13) Furnish and install necessary fire alarm devices and add to existing fire protection control system.
- 14) Furnish and install 100 feet of direct-buried gas main including all excavation, piping, and restoration.
- 15) Install interior gas main, valves, fittings, regulators, gauges, and dirt legs to each boiler.
- 16) Label, paint and insulate new interior piping and valves as required.
- 17) Perform all startup, testing, adjusting and balancing.

7. DECENTRALIZING WITH HEAT PUMPS

7.1 Heat Pump Selection

Decentralizing buildings with heat pumps offers a versatile approach to heating since these systems and equipment come in many different types and configurations. Figure 6 below is a hierarchical chart that illustrates the major categories of heat pumps and indicates their heat source and means of heat transfer from the source to the building interior. HP's in yellow font were evaluated and estimated.

Figure 6 - Typical Heat Pump Systems

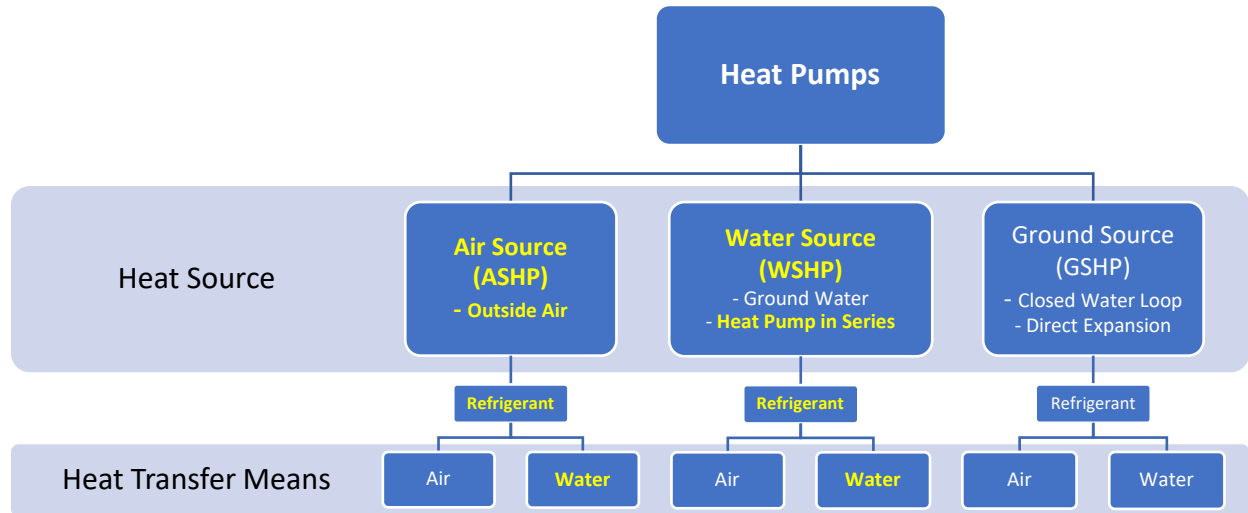


Figure 8, illustrates how each arrangement or a combination of the arrangements shown in Figure 6 can be applied at a typical building. Due to the wide variety of equipment types and building-side heat transfer arrangements, extensive and careful pre-planning are required prior to installing equipment at each location. Since this study does not include surveys at each building, assumptions are made based on the walk-down conducted in January 2023 of 12 representative buildings to classify all of the buildings, with the exception of the Hospital, into three general categories; small, medium and large. As described in the Task 2B report, high-temperature water source heat pumps are estimated for all heat pump solutions. These heat pumps will minimize building modifications, allow continued use of existing hydronic systems, and overcome the cold climate conditions experienced in Jamestown.

Table 5 below defines the three categories of heat pump installation, and the basis of design for estimating each category. Figure 7 on the following page illustrates a schematic arrangement of each category. Although the selections represent standard heat pump installations, a complete evaluation and pre-planning is required if a customer decides to move forward with the conversion from district heat to decentralizing with heat pumps.

Table 5 - Heat Pump Categories

CATEGORY	HEAT PUMP CAPACITY	PIPE SIZE/ UNIT	HEADER PIPE SIZE HEADERS	BUFFER TANK SIZE (GAL)	QTY BLDGS	BASIS OF ESTIMATE	QTY UNITS	AVERAGE CATEGORY PEAK LOAD (Btuh)
Small	120,000 Btuh or less	Refrigerant Tubing	2"	100	13	LG/HYDROKIT-ARN-U-76 & LG/MULTI-V5	4	103,381
Medium	120,001 Btuh - 2,880,000 Btuh	2"	3"	600	51	NORDIC/WH-SERIES-240 & LG/MULTI-V5	4	721,899
Large	2,880,001 Btuh or greater	6"	10"	3,400	4	TRANE/RTHD & TRANE ASCEND ACXA	2	4,127,694

Notes:

- 1) Manufacturers considered included Trane, LG, & Nordic.
- 2) The hospital is not included in this table due to the large capacity heat pump and extensive bldg. scope required.

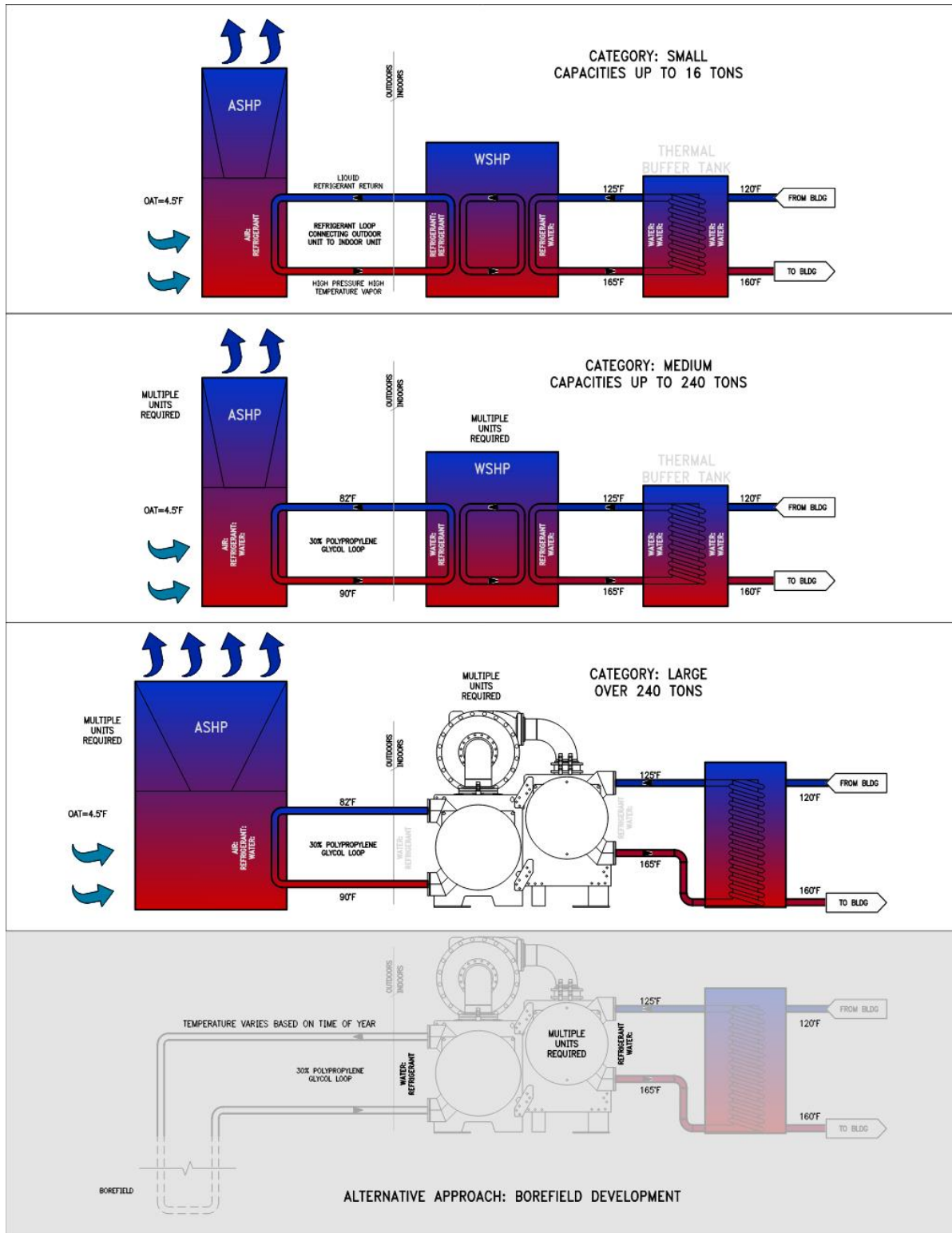


Figure 7 - Heat Pump Category Schematics

Figure 7 illustrates the configurations considered for decentralizing buildings with heat pumps. All buildings have a series ASHP to WSHP arrangement. Small category buildings will connect the indoor and outdoor units using a refrigerant loop piped with small bore tubing. Medium and large category buildings will have a connecting loop in standard piping with a glycol mixture.

The glycol mixture will be necessary to prevent large quantities of refrigerant piped within a building. The medium and large categories require larger ASHP's that need a much bigger footprint to install. It is anticipated that ASHP's will need to be installed on the roof of many medium and large category buildings. Rooftop installations will have long distances between the indoor WSHP and outdoor ASHP that would otherwise require large quantities of refrigerant if a glycol loop is not employed. Figure 8 below demonstrates the variety of building HVAC terminal units expected throughout a building and how heat pumps connect to existing building-side hydronic heating systems. The figure also shows ASHP's located on the roof and associated water/glycol loop piping that could be required to connect rooftop units with indoor WSHP's located in a basement mechanical room.

In both Figures 7 & 8, borefields are shown as an alternative approach but are not used to compare heat pumps and boilers in this report. Borefields do not produce the higher source temperatures in northern climates required for high temperature WSHP's to function during peak conditions. If a borefield is requested, it is recommended that additional evaluation be performed using heat pumps for base load and boilers for peaking. The heat pump and boiler approach, allows smaller borefields sized for part load operation which minimizes capital cost and maximizes its use.

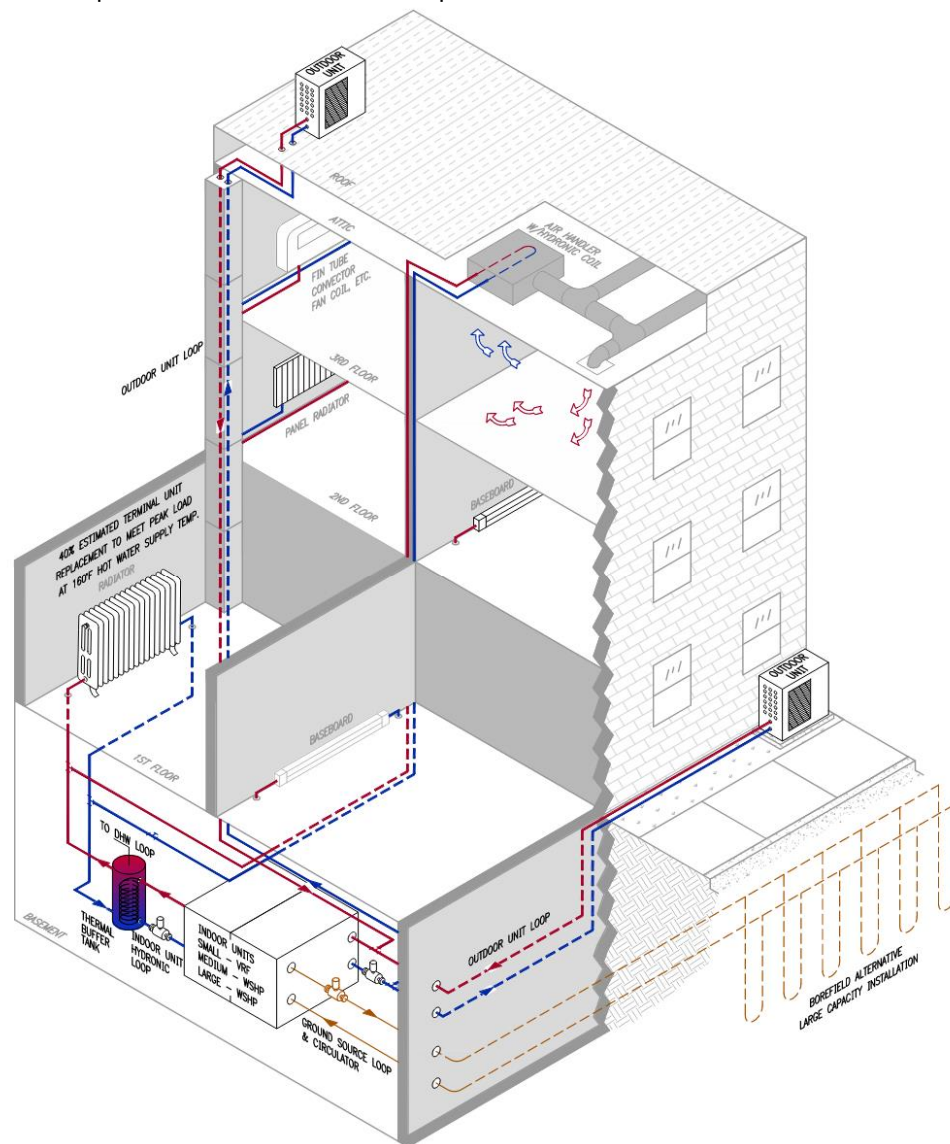


Figure 8 - Versatility of Decentralized Heat Pump Solutions

7.2 Domestic Hot Water

A building heated solely by heat pump systems must be capable of providing temperatures high enough to meet SH needs as well as DHW production year round. Consideration must be given to safe production of DHW. All of the buildings surveyed had DHW storage tanks and it is expected that most buildings on the district system contain similar equipment. Where DHW is stored in tanks, supply temperatures must be high enough to kill the Legionella bacteria. The CDC, OSHA, and the NYS Health Department recommend storing DHW at or above 140°F.

There are multiple options to meet the DHW needs such as point-of use electric heaters, additional heat pumps, or a combination of both. However, since a high temperature heat pump capable of producing 160°F is considered in this evaluation for all buildings, the evaluation is based on these same units provided with a DHW priority scheme and used to produce DHW similar to the approach described in Section 6.2 in this report.

7.3 Building-Side Heating System Modifications

Decentralizing with local heat pumps will either require peaking boilers be installed along with heat pumps or building modifications made to meet peak heating load with lower building hot water (BHW) temperatures. Standard available heat pumps for the applications indicated in this report² are capable of producing up to 160°F BHW even when it is -22°F outdoors. However, most building-side heating systems on the Jamestown DH network are designed to meet the peak load with 180°F BHW or higher.

Since terminal heating units throughout a building are often oversized, it is possible that current building space heating systems could meet peak loads at lower BHW temperatures without modifications. However, oversized units in all areas of a building are not likely and some level of modifications are anticipated in each building. In addition, alterations from original construction are expected to have occurred over time since the average building age is 85 years old. Although some types of building alterations improve building envelope and reduce heating load, other types modify internal space configuration with little to no consideration of the HVAC system. For these reasons, it is difficult to determine the extent of the modifications required without further evaluation, investigation and testing. These next steps could reveal some buildings or zones within buildings require additional modifications beyond what was estimated or that current building systems are oversized and modifications are less.

Evaluation: Building-level temperature monitoring is an important action to help inform future design and to help determine and prioritize which buildings need renovations to support the further reduction of hot water supply temperatures. If a building owner can monitor building hot water supply and return temperatures over the course of at least one heating season, then that data would be very useful in defining the design parameters of the proposed heat pump solutions and also identify locations that require retrofits and modifications. Monitored temperature data would also indicate the system temperature difference (delta T; hot water supply temperature minus return temperature) throughout the season. Knowing the delta-T will help define the design parameters and also identify buildings with a low delta T that may benefit from a retrofit. A low delta T can reduce heating capacity, increase pumping power, and/or require larger pipes in the distribution system.

Jamestown BPU has installed hot water supply and return temperatures in the buildings, but interval trend data is not collected. As part of the evaluation effort, all building hot water supply and return points should be verified for accuracy and set up for trend data collection. It is important that the BHW setpoints be set up for OAT reset functionality as well, because for a majority of the heating season,

² Heat Pumps using natural refrigerants such as Ammonia (NH₃) and CO₂ operate at higher BHW supply temperatures than units using conventional chemical refrigerants. These heat pumps are being considered as part of this study and new products reviewed as they become available. However standard CO₂ machines require low return water temperatures and are typically not good candidates for SH but could work for DHW production. Heat pumps using NH₃ are generally used for large industrial applications and require an additional external heat source in lieu of a compressor.

the BHW temperature can be lower than the design point and heat pump capacity and efficiency will improve significantly. Additional discussion regarding OAT reset is provided in the Task 2B report.

In addition to temperature, the position of BHW control valves also provides important operational information and can help to optimize OAT reset schedules for each building.

Investigation: The investigation should include identifying existing issues such as leaking or failed control valves, bypasses left open between supply and return lines, lack of or bypassed pump controls, terminal units with bypassed thermostatic controls, failed sensors, fouled heat exchangers, incorrect OAT reset settings, air handler unit temperature settings, and an unbalanced system.

Testing: After the investigation is complete, deficiencies corrected, and the hydronic system balanced, testing of the system should be performed by lowering the BHW temperature on peak days. This will help to determine if and how much the BHW temperature can be lowered while still meeting peak loads. It is important to note that lowering the BHW temperature at peak temperature will also lower the operating BHW temperature across the entire OAT reset operating range.

Since the evaluation, investigation, and testing as discussed above is not included in the scope of this report, for estimating purposes, it is assumed that approximately 40% of each building will require BHW distribution system modifications. The 40% value is based on existing heating systems exactly sized to meet peak loads at 180°F and the expected reduction in capacity of typical building heating terminal units when reducing the temperature by 20°F. A more detailed description of evaluating the affect lower temperatures have on terminal units is provided in the Task 2B report.

In June of 2023, Ramboll Engineering along with Trophy Point Construction Services performed an extensive cost estimate for buildings of different sizes, types, age and construction. The estimate was developed to determine sq-ft costs of various building modifications as well as entire gut rehabilitation of building HVAC systems required to reduce building system temperature. A summary of the costs per sq-ft for typical modifications is included in Table 6. The average cost per square-foot shown in bold font in Table 6 was used to estimate the modifications since most buildings are expected to have a variety of heating systems throughout a single building. Perimeter radiation includes a buildings radiators, baseboard, and convectors. Terminal units include variable air volume boxes, unit heaters, and fan coil units. It is anticipated that the Hospital will require a complete gut rehabilitation of its existing HVAC infrastructure throughout most of the building to convert from its current steam heating system to a hydronic heating system.

Table 6 - Building Modification Unit Pricing

	Office	Student Union	Athletic Center	Residence HR	Residence LR	Lab	Classroom	Hospital
Perimeter Radiation	\$13.47	\$13.47	\$10.10	\$13.47	\$13.47	\$6.74	\$16.84	\$26.94
Air Handler Coil Replacement	\$2.02	\$1.78	\$2.71	\$1.42	\$1.57	\$2.71	\$2.08	\$3.25
Terminal Unit Replacement	\$40.03	\$37.28	\$17.16	\$10.92	\$12.01	\$75.49	\$37.33	\$66.72
Average	\$18.51	\$17.51	\$9.99	\$8.60	\$9.02	\$28.31	\$18.75	\$32.30
Upgrade Building Controls	\$21.74	\$20.80	\$23.92	\$18.40	\$19.93	\$35.88	\$19.93	\$31.66
Building Piping Replacement	\$29.43	\$25.23	\$20.38	\$17.66	\$20.38	\$58.87	\$24.08	\$52.98
Air Handler & Duct Replacement	\$53.39	\$50.43	\$56.81	\$61.14	\$50.03	\$72.01	\$44.15	\$66.13
Full Bldg HVAC Gut Renovation	\$128.87	\$127.48	\$118.64	\$106.37	\$96.55	\$199.38	\$128.87	\$204.55

Notes:

- 1) Cost shown are \$/sq-ft
- 2) Costs include 10% general conditions, 10% OH&P, 15% design contingencies and 5% bid contingency
- 3) Costs do not include any work associated with hazardous material removal and disposal
- 4) Costs do not include escalation
- 5) Lab unit pricing used for Medical Centers
- 6) Student Union pricing used for National Comedy Center

By applying these factors to 40% of the building area, the average building modification cost for each category is shown in Table 7. The table also indicates the range in cost determined for all buildings within each category. The Hospital and Ice Arena are included separately since the modifications in these locations are not standard and require additional work.

Table 7 - Average Building Modification Cost by Category

CATEGORY	CATEGORY AVERAGE BUILDING SIZE (GSF)	AVERAGE ESTIMATED BLDG MODIFICATION COST	NOTES
Small	5,876	\$38,665	Costs range from \$20k to \$60k depending on building size and type
Medium	43,695	\$296,647	Costs range from \$50k to \$1.1M depending on building size and type
Large	131,790	\$1,106,522	Costs range from \$350k to \$2M depending on building size and type
Ice Arena	68,532	\$346,102	Includes additional estimated costs to convert ice pit & ice resurfacing
Hospital	340,010	\$69,549,216	Estimate based on HVAC gut rehab of building to convert from steam to hot water

7.4 Heat Pump System Schematic Diagrams

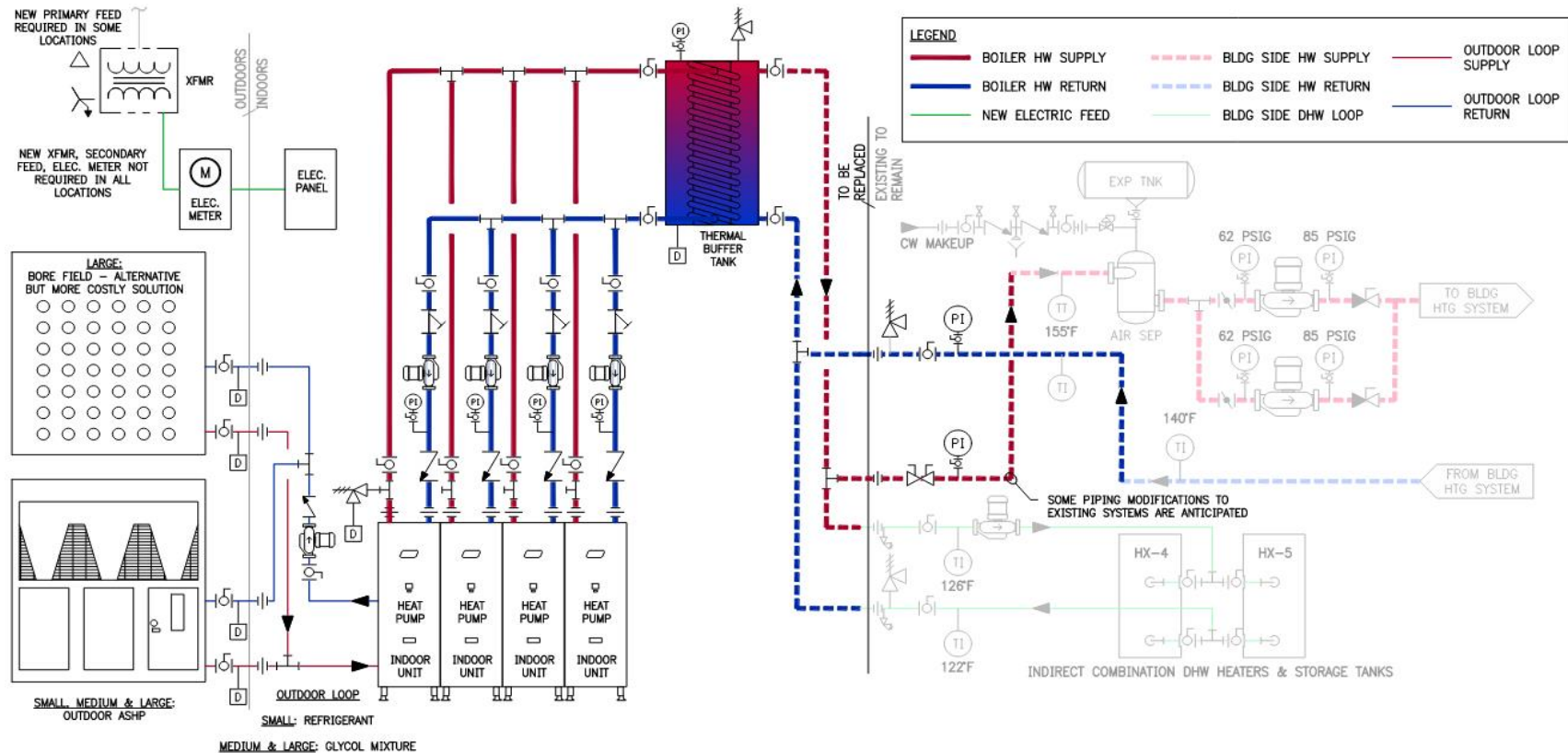


Figure 9 - Typical Decentralization Scenario with Heat Pumps

Figure 9 is a typical schematic of a heat pump installation. The new equipment to be provided as part of the decentralization includes an indoor WSHP in series with an outdoor ASHP and is shown on the left side of the illustration. The purpose of placing these heat pumps in series is to ensure that the source water temperature to the indoor WSHP is always 50°F or warmer even when it is below 0°F outside. The warmer source temperature makes the higher outlet temperatures up to 160°F possible. Similar to high efficiency condensing boilers, heat pump manufacturers also require a primary/secondary piping arrangement. However, instead of bridge piping, a thermal buffer tank is placed to prevent short cycling and minimizes partial load periods for more efficient operation. An outdoor loop consists of refrigerant tubing for small category installations and a glycol mixture with insulated water lines for medium and large installations. Borefields are shown as an alternate solution but would require full building modifications for much lower BHW temperature or peaking boilers.

7.5 Electrical Distribution System

Electrification of the Jamestown district heating system will result in increased electricity use for heating purposes, as well as an increase of approximately 20% in peak electric load. The BPU provides electric power to more than 18,000 customers across multiple service territories including the City of Jamestown, the Villages of Falconer and Celoron, and the Town of Ellicott. In 2022, the peak recorded electric load was 81.5 MW and occurred on January 27th with an OAT of 3°F. The COP of a cascading heat pump system will approach 1.0 at this temperature or below and consume the greatest amount of electricity at the current peak electric periods, only further increasing the peak load.

Figure 10 - Jamestown BPU Hourly Electric Load (2022)

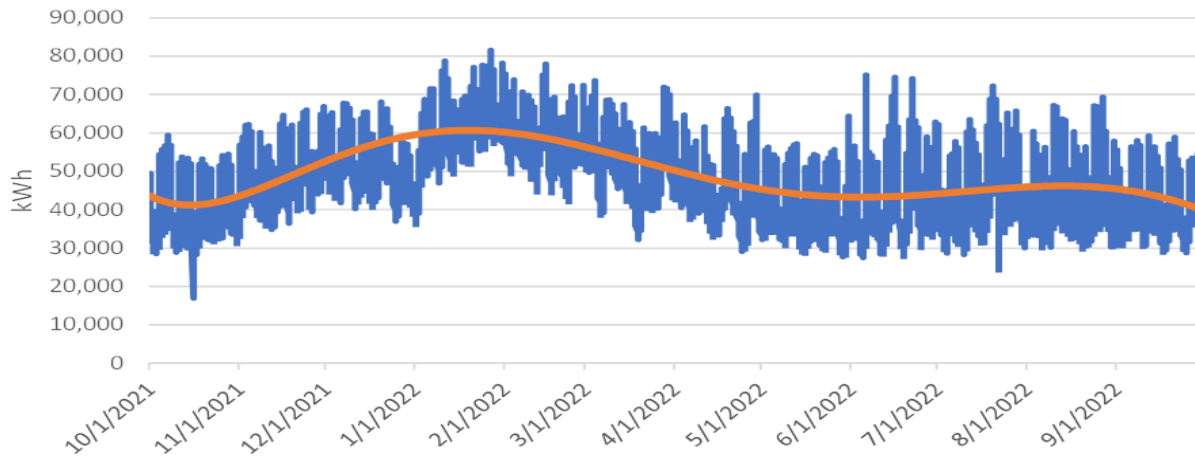


Table 8 is a list of the buildings and their estimated increase in peak electric load in descending order.

Table 8 - Estimated Increase in Peak Electric Load by Building

Building	Added (kW)	Building	Added (kW)	Building	Added (kW)
UPMC Chautauque at WCA (Hospital)	3,911	CODE Euclid Gardens	212	3644 Holdings LLC 2 (Cameo)	83
Board Of Education - JHS	1,614	Windstream Corp A/P	206	Northwest Bank	76
UPMC Chautauque at WCA (Jones Hill)	1,349	First Covenant Church	193	3644 Holdings LLC 4 (Parkview Apts)	73
Riverwalk Properties (JAMA)	1,015	JRP (South County Office Bldg)	184	Time Warner Cable	72
Jamestown City (Ice Arena)	695	Heritage Ministries (Heritage Park)	174	YWCA	70
Little Theater Jamestown	552	City Of Jamestown 3 (Main St. Parking)	171	Robert H Jackson Inc, The	66
Reg Lenna Center for the Arts	503	BPU - monitor building	165	Board Of Education (Tech Cntr)	62
Chautauque Opportunities	478	National Comedy Center, Inc.	147	YMCA (main)	61
UPMC Chautauque at WCA (Physicians)	471	Prendergast Library	142	Fourth St Housing	61
Board Of Education - LOVE	426	REALiFE Church Inc.	137	JRP (Jody Peterson)	46
Kaleida Health	421	Chautauque Brick, Inc	130	Heritage Ministries 2 (Childcare)	41
JHA (Hotel Jamestown)	405	Krog Corp (BWB Center)	128	3644 Holdings LLC 3 Jefferson St Apts)	41
HH Jamestown, LLC (Cherry St. Parking)	351	Jamestown Newspaper Corp	126	15 E 5th St LLC (Burgett & Robbins)	35
First Lutheran Church	333	Anderson Tower LP	120	Legal Assistance of WNY	33
Covenant Manor Apartments, LLC	319	Best Western Hotel	115	Lewis and Lewis	32
Jamestown Boys & Girls Club	317	Westerberg Tower LP	114	Eliz W Marvin House	32
St James Church	308	Carlson Tower LP	102	Lewis & Lewis P C (.001) (.1)	29
City of Jamestown (City Hall)	279	Inter'n Ordinance Tech	101	Agnes Home	28
200 Harrison St LLC (Chatauqua IDA)	270	Gregory J Buzzanco (Foote Ave Church)	94	Triple R, LLC	27
St Susan Center	263	3644 Holdings LLC (Priscilla)	88	Duncan Olesnak	18
JHA (5th St. High Rise)	254	Anderson Manor LB	84	E-Z Clean Car Wash	15
JHA (Chadakoin Bldg)	221				

The electric distribution system was evaluated based on a review of the existing distribution network using ARC GIS mapping, JBPU Easy Power Electrical Model, and the hourly load data of the affected transformers. All data was provided by Jamestown BPU. Based on Ramboll's review, a number of constraints were identified where the existing distribution system would not support the future loads and upgrades are necessary if the district is decentralized with heat pumps as described in this report.

A map of the of the electric distribution system and expected upgrades is provided in Appendix D. The upgrades include replacing 35 transformers and their associated secondary feeds to the buildings as well as electric metering. The upgrades also include the replacement of approximately 40,000-feet of primary cables.

The estimated cost to perform these upgrades is \$15.6M. A detailed breakdown of this estimate is included in Appendix B.

Additional costs for transmission system upgrades are also possible since the increase in load will be greater than 10MW and trigger NYISO Class Year study limits. The Class Year study is performed annually by NYISO to evaluate the cumulative impact a group of large projects will have on the NYS transmission system. The process identifies specific system upgrades required at a transmission level and allocates cost. NYISO's main concern is grid reliability and their evaluation includes dispatchable power sources. As a result, unpredictable transmission system upgrade costs may be required in addition to the expected high costs to modify the electrical distribution.

Furthermore, the increase in electrical consumption by decentralizing with local heat pumps is expected to exceed the 100MW interconnection limit between JBPU and National Grid. Although National Grid has indicated that they could likely support up to a 120MW with the existing transmission level equipment, changes to the current contract as well as relays, settings, and other modifications will be necessary. Additional costs associated with relay programming and modifications is included in the estimate.

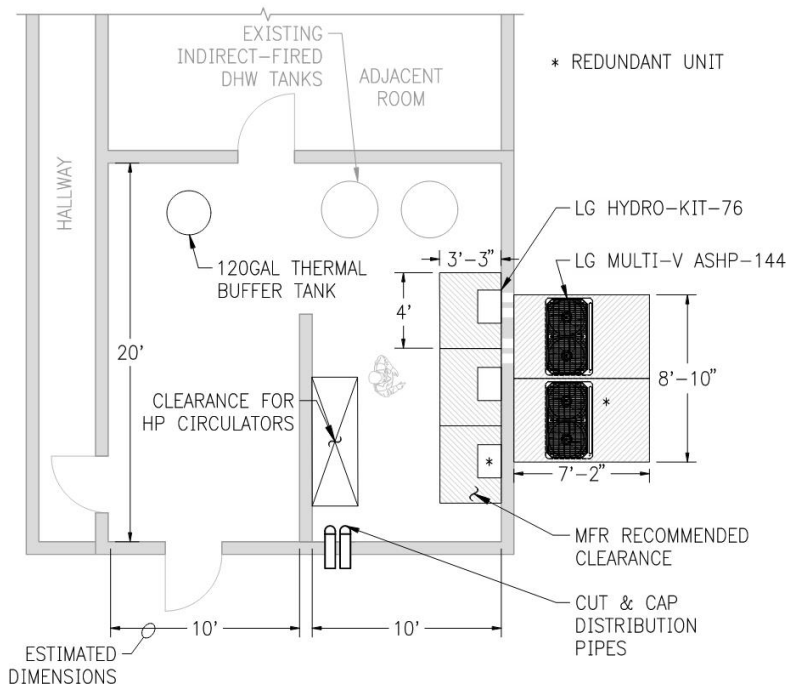
7.6 Decentralizing with Heat Pumps – General Arrangements

General arrangements of each category heat pump size have been developed to provide an overall sense of the physical footprint required for these units and the general space required for auxiliary equipment. The same three example buildings as described in Section 6.6 are used to compare the space required for boilers versus heat pumps. These buildings are; Small Category (<10tons): Jefferson St. Apartments, Medium Category (10tons – 240tons): Euclid Gardens, Large Category (>240tons): Riverwalk Properties (JAMA) Medical Center.

Category: Small (<10tons)

A general arrangement of the small category heat pumps and associated thermal buffer tank was developed to illustrate how the units would fit into an existing space once the current heat exchangers and associated pipe, valves, and fittings are removed. Figure 11 illustrates the size of the average heat pump in the small category along with the manufacturers recommended clearances. The building shown is the Jefferson St. apartment building which was surveyed in January 2023. The indoor WSHP will fit within the existing space and the outdoor ASHP for the small category are anticipated to fit outside and adjacent to the mechanical rooms. Three indoor WSHP's each with a capacity sized to meet 50% of the peak load are shown. In the event of a single failure, the equipment can still meet 100% of the peak load. The outdoor ASHP's each have a capacity sized at 100% peak load at the design outdoor air temperature of 4.5°F.

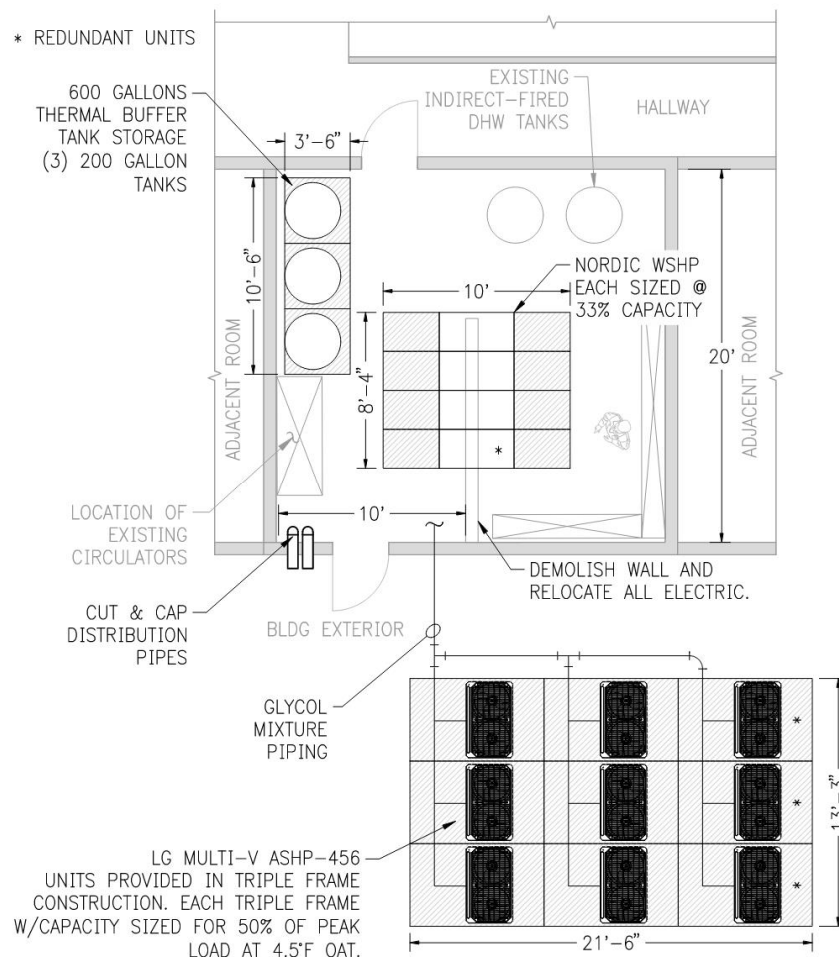
Figure 11 - New Heat Pumps: Small Category GA – Jefferson St. Apartments



Category: Medium (11tons-240tons)

A general arrangement of the medium category heat pumps and associated thermal buffer tanks was developed to illustrate how the units would fit into an existing space once the current heat exchangers and associated pipe, valves, and fittings are removed. Figure 12 illustrates the size of the average heat pumps in the medium category along with the manufacturers recommended clearances. The building shown is Euclid Gardens which was surveyed in January 2023. The indoor WSHP's will fit within the existing space and at this location there is enough available area at grade level to install the outdoor ASHP's. However, at other locations it is anticipated that the ASHP's will need to be installed at further distances or even on the rooftop of buildings to accommodate the footprint required. To eliminate the need to install large amounts of refrigerant piping, the outdoor and indoor units will be connected using a glycol mixture. Three indoor WSHP's each with a capacity sized to meet 33% of the peak load are shown. In the event of a single failure, the equipment can still meet 100% of the peak load. Each triple frame constructed outdoor ASHP's is sized at a capacity at 50% peak load at the design outdoor air temperature of 4.5°F.

Figure 12 - New Heat Pumps: Medium Category GA - Euclid Gardens

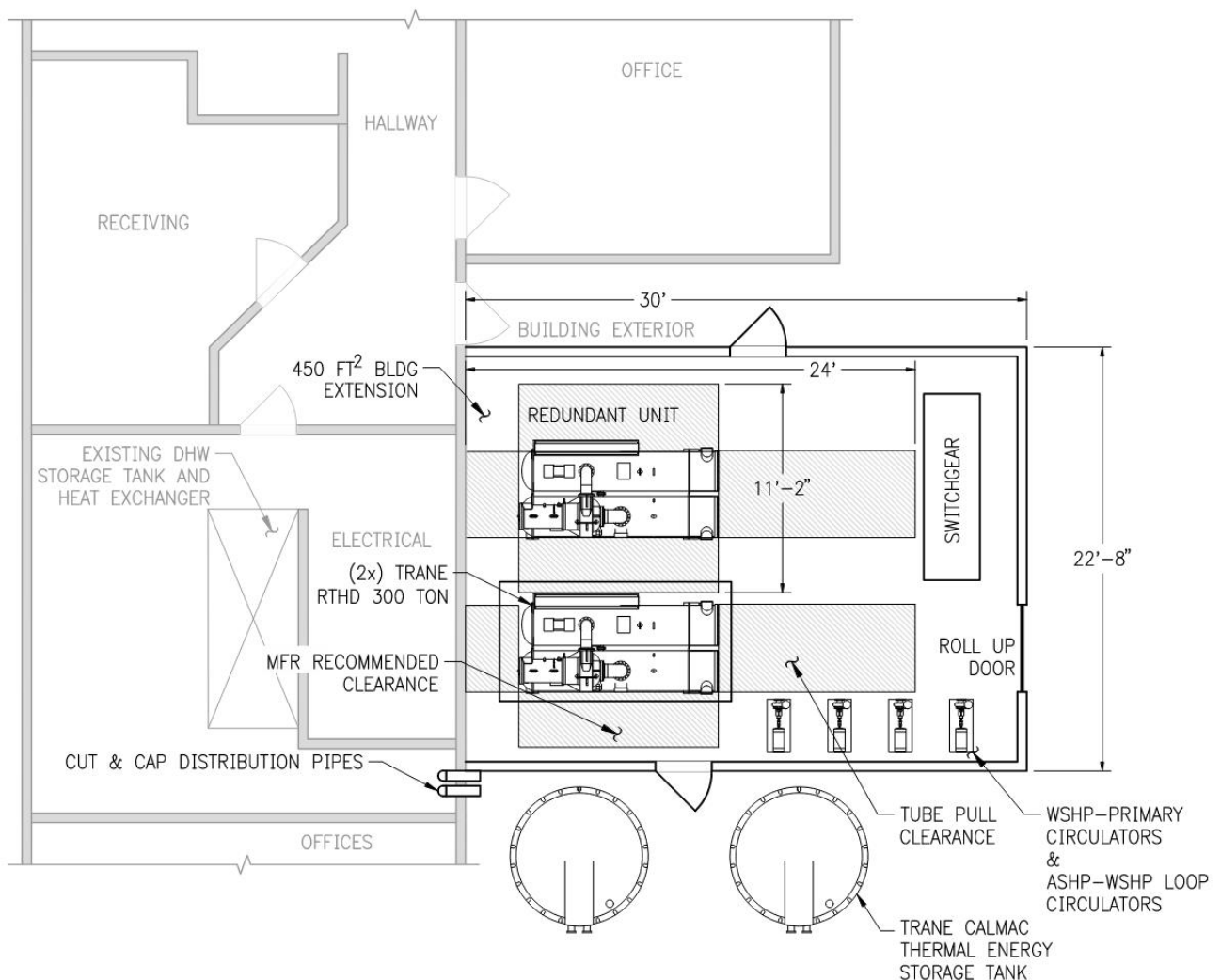


Category: Large

A general arrangement of the large category heat pumps and associated thermal buffer tanks was developed to illustrate that the large category units are anticipated to require building extensions due to the physical size of the units. Figure 13 illustrates the size of the average heat pumps in the large category along with the manufacturers recommended clearances. Two indoor WSHP's each sized at 100% capacity are displayed. The building shown is Riverwalk Properties (JAMA) Medical Center which was surveyed in January 2023.

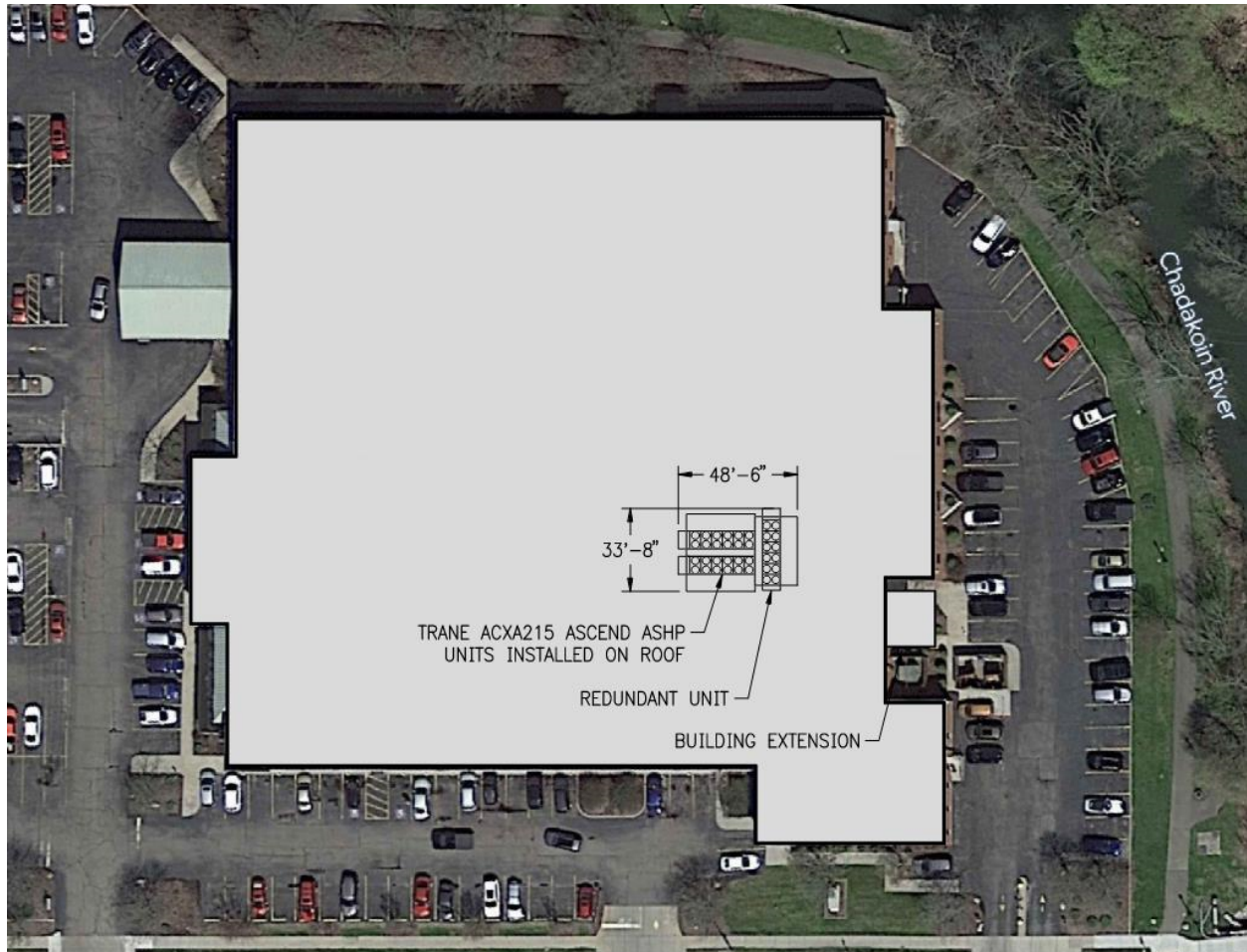
The indoor WSHP's will not fit within the existing space and a 660 ft² building extension is estimated to house the new units and provide adequate clearances for maintenance. In some locations rollup doors could be installed to accommodate clearance for tube pulls. Trane provides thermal buffer tanks rated for outdoor installation and these units are shown on the south side of the extension along the exterior side of the wall.

Figure 13 - New Heat Pumps: Large Category GA – Riverwalk Properties (JAMA)



There is no available space at grade level for the outdoor ASHP's and are therefore shown installed on the rooftop of the existing building. These units would be provided with a glycol mixture and piped from the rooftop units to the indoor WSHP's located in the building extension. There are three ASHP's shown each sized for 50% capacity to meet an N+1 level of redundancy. Figure 14 illustrates the location of the ASHP's on the rooftop and the footprint required including clearances.

Figure 14 - New Heat Pumps: Large Category ASHP GA - Riverwalk Properties (JAMA)



7.7 Decentralizing with Heat Pumps – Scope of Work

The following scope of work is defined and included in the cost estimate to install local heat pumps. The work includes installation with the existing mechanical spaces for the large and medium category buildings and constructing a building extension for large buildings and is anticipated to include the following:

- 1) Demolish and remove existing heat exchangers, pipe, valves, and fittings on the district heating system within the mechanical room.
- 2) Cut and cap the existing district heating piping systems as they enter the mechanical rooms from outside.
- 3) Large Category Only: Build block constructed building extension with basic MEP infrastructure including all earthwork, excavation, site preparation, foundation, and sitework restoration required.
- 4) Small Category Only: Install outdoor ASHP and associated refrigerant piping
- 5) Medium & Large Category Only: Furnish and install new rooftop ASHP's and associated glycol mixture piping valves and fittings. Provide structural steel support rooftop modifications as needed to adequately support the new rooftop equipment.
- 6) Furnish and install indoor WSHP's and all associated pipe, valves fittings to pipe to existing secondary BHW side piping system.
- 7) Furnish and install new concrete pads for each heat pump.
- 8) Furnish and two install primary circulators and associated valves, gauges, supports, and fittings.
- 9) Furnish and install all pipe, valves and fittings associated with the primary piping system and connect the new primary loop to the new thermal buffer tanks.
- 10) Furnish and install new thermal buffer tanks and all associated appurtenances.
- 11) Furnish and install piping from the secondary pipe loop to the existing domestic hot water heating-side loop.
- 12) Furnish and install instrumentation and controls for the new heat pumps and associated circulators. Ensure equipment is provided with provisions to connect to existing BMS systems.
- 13) Modify the MER lighting as necessary.
- 14) Provide all site electrical distribution upgrades required based on location requirements including but not limited to; primary feeder replacement, secondary feeder replacement, transformer upgrade, new electric meter and devices.
- 15) Provide new electric power panels within each MER. Reconnect existing feeds and install new feeds to the new equipment.
- 16) Label, paint and insulate new interior piping and valves as required.

Perform all startup, testing, adjusting and balancing.

8. ASSUMPTIONS COMMON TO BOTH SCENARIOS

8.1 Quantity and Capacity of Units

- N+1

The design load for decentralized buildings varies from 51 MBtuh (EX Clean Car Wash) to 13,300 MBtuh (Hospital). Table 2 **Error! Reference source not found.** includes a list of buildings and their estimated peak heating load and is included in the opening summary of this report. In each building, the recommended unit(s) (boiler or heat pump), sizing and quantity is based on providing 100% of the heating capacity with one unit out of service. For the purpose of estimating, it is assumed that two boilers will be installed at 100% capacity or three heat pumps at 50% capacity in each location. However, if local units are decided by a building owner, further evaluation is required to determine the exact number of units and their capacity to achieve the greatest benefit. Factors such as the available space, variation in load throughout the year and turndown required to attain the highest annual efficiency will all need to be considered but are outside the scope of this study.

8.2 Location of Units

- With the exception of category large heat pumps, there is enough available space for new heating equipment installed within a buildings footprint and no external structure required.

For the purpose of estimating, it is assumed that all buildings will have enough available space that can be repurposed to install local heating units and associated equipment.

8.3 Building Systems

- With the exception of the Hospital, all buildings are heated with hot water.

For the purpose of estimating it is assumed that all buildings with the exception of the Hospital are heated with hot water. All buildings surveyed by Ramboll contained water-to-water heat exchangers in their mechanical equipment rooms (MER). It is assumed that no building side system modifications will be required to convert equipment and converters from steam to hot water.

8.4 Existing District Heating Network

- No costs associated with decommissioning the existing system are included.

After the buildings have been decentralized, the central system equipment associated with district heat and the distribution piping network will no longer be required. The cost to decommission these systems is not included in this report since it would be similar for either decentralization scenario and not affect the comparison. However, it is understood that decommissioning costs will differ from central options and will be included in the comparisons made between these scenarios as part of the other Task deliverables.

8.5 Environmental Concerns

- No asbestos abatement, lead or PCB removal costs included.

Prior to any work an environmental survey should be performed. Costs associated with removal of environmental hazards and contaminants are not included in the estimate and are assumed to be similar for both scenarios.

8.6 Auxiliary Equipment

- Existing building-side auxiliary equipment to remain.

The scope of work will not include the replacement of the auxiliary equipment on the building-side of the heating system including but not limited to pumps, air separators, expansion tanks, piping, valves, circulators, and building management systems. Boiler burner controls will operate independently from existing BMS systems, but have the capability to allow the BMS to monitor the boiler operation if decided by the customer.

9. ASSUMPTIONS MADE WHEN DECENTRALIZING WITH BOILERS

9.1 NYS Building Code Requirements

- Boiler rooms require fire-rated construction modifications to meet NYS code requirements.

Section 302.1.1 of the NYS Building code classifies new boiler rooms as incidental use areas, and in accordance with Table 302.1.1, any furnace room with equipment over 400,000 Btuh requires a 1-hour fire separation or an automatic fire-extinguishing system. Although most buildings, with the exception of the few installed after 1980, had operated with their own local boilers, during the walkthrough it was found that most spaces where a boiler would be installed are not equipped with a fire-extinguishing system and would need to be rated to meet the 1-hour fire rating. Estimated costs to provide fire-rated gypsum construction with fire stopping at penetrations is included.

In addition, Section 1007 of the NYS Building Code requires two exits from any mechanical room containing fuel-burning equipment exceeding 400,000 Btuh that is larger than 500 sq.ft. Costs have been included to install a new fire rated door and frame in each category.

For mechanical rooms with refrigeration equipment in mechanical rooms Section 1005.5 of the NYS Mechanical Building Code prohibits fuel-burning equipment in the same machinery room and sealed to prevent any refrigerant leakage from entering the combustion chamber. It is assumed that all air to the new boilers will be ducted directly from the outdoors, a separate enclosed space for the boilers is not required.

9.2 Flue Gas Venting

- Available space to route vent and air pipe through boiler room walls to the building exterior.

The flue gas from each boiler can be vented through the mechanical room wall to the building exterior since the combustion gases will be at low temperatures. The flue gas is almost invisible on moderate temperature days. However, the condensing water vapor can create a steam plume that is visible on cold, damp days, and capable of causing condensation on nearby windows and discoloration of the building wall and due to the nearby receptors of adjacent buildings within the city, venting is assumed to terminate at the roof level and be routed with insulated metal pipe along the outside of the building. In addition, it is recommended the project include provisions for minimizing the effects of the plume by constructing remote chimneys, architectural screens, and venting through the roof where possible. Costs associated with constructing additional components on the exterior of buildings is not included in the cost.

9.3 Electrical Systems

- The existing electrical distribution and building-side infrastructure is sufficiently sized to power the new equipment.

The electric load associated with the operation of new boilers and auxiliary equipment will not significantly change the overall load on the existing electric systems. The auxiliary equipment proposed to be installed in each building will generally consist of two primary hot-water boiler circulating pumps, two boilers, and controls.

9.4 City Natural Gas Distribution System

- The existing natural gas mains in the City of Jamestown have sufficient capacity to meet the new loads. The installation of 600ft of new branch piping will be required from the main to each building.

Jamestown's natural gas distribution system is owned and operated by National Fuel Gas Distribution Corporation. Prior to 1985, all buildings at that time were heated locally with their own gas-fired boilers. Since only 7 buildings accounting for less than 7% of the total peak load were constructed after 1985, it is assumed that the existing natural gas infrastructure has sufficient capacity to meet the new loads. In addition, some buildings such as Heritage Ministries and the Hospital have backup gas-fired boilers that can meet the entire peak load of the building if the district heating system is out of service. The utility company indicated that they typically install the first 500 feet of pipe at no additional cost to the building owner. For the purpose of estimating, it is assumed that an additional 100 feet will be required and paid for by the building owner.

10. ASSUMPTIONS MADE WHEN DECENTRALIZING WITH HEAT PUMPS

10.1 Small Category Buildings

- A maximum of two single frame ASHP's can fit adjacent to the mechanical room and a limited amount of refrigerant tubing would be required.

Larger outdoor ASHP units above 10 tons at 4.5°F OAT would be double frame construction and likely not fit adjacent to the mechanical room. Units that cannot fit adjacent to the mechanical room are estimated to require further runs of refrigerant piping and therefore are considered medium or large size. Medium and large category units are considered in this report to contain a glycol mixture in lieu of refrigerant between the indoor WSHP and the outdoor ASHP and are connected by water distribution piping.

10.2 Medium Category Buildings

- A maximum of eight 30 ton WSHP's for a total capacity of 240 tons can be connected in parallel per the manufacturer.

Medium category heat pumps are considered for all installations between 11 tons and 240 tons. The ASHP's for these applications are estimated to be installed on rooftops due to the footprint required for the equipment and equipment clearances.

10.3 Large Category Buildings - WSHP

- Large units including an N+1 redundant unit and all tube pull and recommended maintenance clearances will require approximately 450 ft² of area for the indoor WSHP's. Since the area required is so large, it is anticipated that a building extension will be required to house the new equipment.

The area required, inclusive of all redundant units and maintenance clearances, per ton of indoor WSHP reduces as you increase from the small category size to the large category size. The approximately area required per nominal ton is as follows:

- Small Category = 2.2 ft²/ton
- Medium Category = 1.4 ft²/ton
- Large Category = 0.8 ft²/ton

10.4 Large Category Buildings - ASHP

- ASHP's will be installed on the rooftop of each large category building.

Large category heat pumps are considered for all installations between above 240 tons. The ASHP's for these applications are estimated to be installed on rooftops due to the footprint required for the equipment and equipment clearances.

APPENDIX A: COST ESTIMATES

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY RESIDENTIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
033053403550	Structural concrete, in place, equipment pad (3000 psi), 4' x 4' x 6", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	2	Ea.	\$138.00	\$276.00	Cement Masons	\$72.62	1.60	3.20	\$232.37	\$508
38213100300	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time	1	Ea.	\$0.46	\$0.46	Cement Masons	\$72.62	0.89	0.89	\$64.70	\$65
038213100350	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	6	Ea.	\$0.07	\$0.42	Cement Masons	\$72.62	0.02	0.12	\$8.63	\$9
038213100700	Concrete core drilling, core, reinforced concrete slab, 6" diameter, up to 6" thick slab, includes bit cost, layout and set up time	4	Ea.	\$0.97	\$3.88	Cement Masons	\$72.62	1.02	4.07	\$295.75	\$300
038213100750	Concrete core drilling, core, reinforced concrete slab, 6" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	24	Ea.	\$0.16	\$3.84	Cement Masons	\$72.62	0.04	0.95	\$68.76	\$73
TOTAL - DIVISION 3 CONCRETE											\$955
DIVISION 9 FINISHES											
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	200	L.F.	\$0.47	\$94.00	Painters	\$62.86	0.021	4.20	\$264.01	\$358
8050510	Existing door demolition	1	Ea.		\$0.00	Carpenter Foreman	\$66.65	1.4	1.40	\$93.31	\$93
81313150360	Fire Doors	1	Ea.	\$1,150.00	\$1,150.00	Carpenter Foreman	\$66.65	1	1.00	\$66.65	\$1,217
81213135400	Fire Door Frame	1	Ea.	\$277.00	\$277.00	Carpenter Foreman	\$66.65	1.067	1.07	\$71.11	\$348
92910302195	Construct Fire Rated Walls/Ceiling	2400	SF	\$0.63	\$1,512.00	Carpenter Foreman	\$66.65	0.021	50.40	\$3,359.11	\$4,871
78413100720	Fire stop wall joints	120	LF	\$18.60	\$2,232.00	Carpenter Foreman	\$66.65	0.107	12.84	\$855.77	\$3,088
78413100200	Fire stop penetrations	50	ea	\$22.00	\$1,100.00	Plumbers	\$85.78	0.5	25.00	\$2,144.57	\$3,245
TOTAL - DIVISION 9 FINISHES											\$13,220
DIVISION 10 SPECIALTIES											
104416130160	Fire extinguishers, CO2, portable, with hose & "H" horn, 15 lb	1	Ea.	\$420.00	\$420.00	Plumbers	\$85.78		0.00	\$0.00	\$420
TOTAL - DIVISION 10 SPECIALTIES											\$420
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.27	5.34	\$458.08	\$458
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.57	11.41	\$978.56	\$979
220505101980	Pipe hanger / support, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.10	2.00	\$171.60	\$172
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	50	L.F.		\$0.00	Plumbers	\$85.78	0.04	2.00	\$171.60	\$172
220505102050	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.05	5.34	\$458.08	\$458
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	10	Ea.		\$0.00	Plumbers	\$85.78	0.29	2.85	\$244.64	\$245

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY RESIDENTIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
220505109110	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	1.46	20.37	\$1,747.40	\$1,747
220553101120	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	20	Ea.	\$3.86	\$77.20	Plumbers	\$85.78	0.13	2.66	\$228.33	\$306
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	10	Ea.	\$3.64	\$36.40	Plumbers	\$85.78	0.20	2.00	\$171.60	\$208
220719107624	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1" iron pipe size	50	L.F.	\$12.25	\$612.50	Plumbers	\$85.78	0.07	3.61	\$309.88	\$922
220719107626	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1-1/4" iron pipe size	40	L.F.	\$14.45	\$578.00	Plumbers	\$85.78	0.07	2.98	\$255.28	\$833
221113440580	Pipe, steel, black, threaded, 1" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	50	L.F.	\$8.90	\$445.00	Plumbers	\$85.78	0.15	7.65	\$655.92	\$1,101
221113440590	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	20	L.F.	\$11.75	\$235.00	Plumbers	\$85.78	0.16	3.27	\$280.81	\$516
221113440590	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	20	L.F.	\$11.75	\$235.00	Plumbers	\$85.78	0.16	3.27	\$280.81	\$516
221113450661	Tee, steel, cast iron, black, reducing on the run and outlet, threaded, standard weight, 1/2"	2	Ea.	\$40.00	\$80.00	Plumbers	\$85.78	0.90	1.80	\$154.58	\$235
221113454040	Coupling, steel, cast iron, black, straight, merchants, threaded, standard weight, 3/8"	2	Ea.	\$2.55	\$5.10	Plumbers	\$85.78	0.43	0.86	\$73.75	\$79
221113454374	Plug, steel, cast iron, galvanized, square head, threaded, standard weight, 1/2"	2	Ea.	\$11.95	\$23.90	Plumbers	\$85.78	0.21	0.42	\$36.45	\$60
221113454810	Nipple, steel, galvanized, threaded, standard weight, 1/2" x 4" long	2	Ea.	\$6.60	\$13.20	Plumbers	\$85.78	0.43	0.86	\$73.75	\$87
221113455110	Elbow, 90 Deg., steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	5	Ea.	\$18.35	\$91.75	Plumbers	\$85.78	0.66	3.31	\$283.64	\$375
221113455520	Tee, steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	1	Ea.	\$28.50	\$28.50	Plumbers	\$85.78	1.04	1.04	\$89.35	\$118
221113455995	Cap, steel, malleable iron, black, threaded, 150 lb., 1-1/4"	1	Ea.	\$11.65	\$11.65	Plumbers	\$85.78	0.28	0.28	\$23.97	\$36
221113459764	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1"	20	Ea.	\$42.00	\$840.00	Plumbers	\$85.78	0.62	12.40	\$1,063.66	\$1,904
221113459765	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1-1/4"	10	Ea.	\$81.00	\$810.00	Plumbers	\$85.78	0.73	7.27	\$623.64	\$1,434
221113459804	Tee, steel, forged steel, black, threaded, 3000 lb., 1"	4	Ea.	\$58.00	\$232.00	Plumbers	\$85.78	1.01	4.03	\$346.04	\$578
221113459805	Tee, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	4	Ea.	\$112.00	\$448.00	Plumbers	\$85.78	1.04	4.17	\$357.39	\$805
221113459844	Cap, steel, forged steel, black, threaded, 3000 lb., 1"	4	Ea.	\$23.50	\$94.00	Plumbers	\$85.78	0.27	1.08	\$92.47	\$186

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY RESIDENTIAL

Cost Works Line Number	Description	Quantity	Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
221113459845	Cap, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	4 Ea.	\$37.00	\$148.00	Plumbers	\$85.78	0.31	1.23	\$105.68	\$254
221113475601	Reducer, steel, forged steel, black, socket weld, 3000 lb., schedule 40, 3/8" pipe size, includes 1 weld per joint and weld machine	2 Ea.	\$62.50	\$125.00	Plumbers	\$85.78	0.63	1.26	\$107.78	\$233
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size, includes 1 weld per joint and weld machine	2 Ea.	\$12.05	\$24.10	Plumbers	\$85.78	0.63	1.26	\$107.78	\$132
221113479805	Pipe fittings, steel, flanged, butt welded or mechanical joint, minimum labor/equipment charge	2 Ea.	\$152.00	\$304.00	Plumbers	\$85.78	0.16	0.32	\$27.80	\$332
221119340150	Sleeve, pipe, steel with water stop, 12" long, 3" diam. for 1-1/4" carrier pipe, includes link seal	1 Ea.	\$144.00	\$144.00	Plumbers	\$85.78	1.12	1.12	\$96.44	\$240

TOTAL - DIVISION 22 PLUMBING \$15,719
DIVISION 23 HVAC

230505100297	Boiler blowdown, selective demolition	2 Ea.		\$0.00	Master Mechanic	\$93.84	1.82	3.64	\$341.32	\$341
230505102770	Heat exchanger, plate type, selective demolition	3 Ea.		\$0.00	Master Mechanic	\$93.84	13.33	40.00	\$3,753.68	\$3,754
230523701060	Valves, semi-steel, lubricated plug valve, threaded, 200 psi, 1-1/4"	2 Ea.	\$156.00	\$312.00	Master Mechanic	\$93.84	0.67	1.34	\$125.67	\$438
230523805340	Valves, steel, forged, ball, threaded, 1,500 psi, 1/4"	2 Ea.	\$72.00	\$144.00	Master Mechanic	\$93.84	0.33	0.66	\$62.06	\$206
230523805380	Valves, steel, forged, ball, threaded, 1,500 psi, 1"	4 Ea.	\$179.00	\$716.00	Master Mechanic	\$93.84	0.42	1.69	\$158.25	\$874
230523805390	Valves, steel, forged, ball, threaded, 1,500 psi, 1-1/4"	2 Ea.	\$196.00	\$392.00	Master Mechanic	\$93.84	0.54	1.07	\$100.84	\$493
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2 Ea.		\$0.00	Master Mechanic	\$93.84	10.00	20.00	\$1,876.84	\$1,877
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2 Ea.		\$0.00	Master Mechanic	\$93.84	6.00	12.00	\$1,126.11	\$1,126
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1 Ea.		\$0.00	Master Mechanic	\$93.84	4.00	4.00	\$375.37	\$375
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	2 Ea.	\$34.50	\$69.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$116
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	2 Ea.	\$209.00	\$418.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$465
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	2 Ea.	\$25.50	\$51.00	Master Mechanic	\$93.84	0.24	0.48	\$44.84	\$96
232120760140	Strainer, Y type, bronze body, screwed, 125 lb., 1" pipe size	2 Ea.	\$106.00	\$212.00	Master Mechanic	\$93.84	0.48	0.96	\$89.98	\$302
232123131060	1/8HP Boiler Primary Circulator	2 Ea.	\$1,425.00	\$2,850.00	Master Mechanic	\$93.84	2.67	5.33	\$500.55	\$3,351
235123100080	3" insulated metal vent pipe	400 L.F.	\$10.65	\$4,260.00	Master Mechanic	\$93.84	0.22	88.80	\$8,333.18	\$12,593
235123100950	3" insulated metal vent pipe fittings	16 Ea.	\$31.50	\$504.00	Master Mechanic	\$93.84	0.44	7.10	\$666.65	\$1,171
1200, 1460, 1750	Tee, tee cap, top, and supports	4 lots	\$127.28	\$509.12	Master Mechanic	\$93.84	1.80	7.19	\$674.54	\$1,184

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY RESIDENTIAL											
Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
235123101020	Vent chimney, prefabricated metal, gas, double wall, galvanized steel fitting, wall thimble, 4 to 7" adjustable, 3" diameter, UL listed	4	Ea.	\$18.35	\$73.40	Master Mechanic	\$93.84	0.39	1.55	\$145.84	\$219
235223203040	Boiler, gas fired, natural or propane, cast iron, hot water, gross output, 122 MBH, includes standard controls and insulated jacket, packaged	2	Ea.	\$3,621.00	\$7,242.00	Master Mechanic	\$93.84	29.09	58.18	\$5,459.73	\$12,702
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1	Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064
TOTAL - DIVISION 23 HVAC											\$43,747
DIVISION 26 ELECTRICAL											
260505100100	Conduit, rigid galvanized steel, 1/2" to 1" diameter, electrical demolition, remove conduit to 10' high, including fittings & hangers	100	L.F.		\$0.00	Electrician	\$87.69	0.03	3.30	\$289.68	\$290
260505101830	Wire, THW-THWN-THHN, #14, electrical demolition, removed from in place conduit, to 10' high	100	C.L.F.		\$0.00	Electrician	\$87.69	0.12	12.30	\$1,078.61	\$1,079
260519900940	Wire, copper, solid, 600 volt, #12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	15	C.L.F.	\$20.50	\$307.50	Electrician	\$87.69	0.73	10.94	\$959.19	\$1,267
260533131230	Aluminum conduit elbows, 1" diameter, to 10' H	20	Ea.	\$20.50	\$410.00	Electrician	\$87.69	0.29	5.71	\$500.78	\$911
260533131470	Aluminum conduit couplings, 1" diameter, to 10' H	10	Ea.	\$6.45	\$64.50	Electrician	\$87.69	0.05	0.50	\$43.91	\$108
260533131800	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	150	L.F.	\$7.10	\$1,065.00	Electrician	\$87.69	0.12	18.45	\$1,617.92	\$2,683
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20	Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10	Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386
262416200100	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15-50 amp	2	Ea.	\$24.00	\$48.00	Electrician	\$87.69	0.80	1.60	\$140.22	\$188
262726103800	Low voltage switching, flush switch, standard	2	Ea.	\$18.05	\$36.10	Electrician	\$87.69	0.20	0.40	\$34.98	\$71
262726104200	Low voltage switching, transformer, low voltage switching, 115 V to 25 V	2	Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	1	C.L.F.	\$400.00	\$400.00	Electrician	\$87.69	3.22	3.22	\$281.98	\$682
262726200500	Toggle switch, quiet type, single pole, 20 amp	5	Ea.	\$4.08	\$20.40	Electrician	\$87.69	0.30	1.48	\$129.82	\$150
265113502700	Fluorescent fixture, interior, strip, surface mounted, S.L., 2-75 W, 8' long, incl lamps, mounting hardware and connections	6	Ea.	\$117.00	\$702.00	Electrician	\$87.69	1.29	7.75	\$679.53	\$1,382
TOTAL - DIVISION 26 ELECTRICAL											\$9,858
DIVISION 28											
284611218710	Carbon monoxide detector, hardwired, wall mounted	1	Ea.	\$80.00	\$80.00	Electrician	\$87.69	1.12	1.12	\$98.62	\$179
284611505010	Detection system, fire alarm, detector, heat (addressable type), excl. wires & conduit	1	Ea.	\$125.00	\$125.00	Electrician	\$87.69	1.24	1.24	\$108.63	\$234

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY RESIDENTIAL											
Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
284620507010	Detection system, break glass station, addressable, excluding wires & conduits	2	Ea.	\$166.00	\$332.00	Electrician	\$87.69	1.24	2.48	\$217.26	\$549
TOTAL - DIVISION 28											\$962
DIVISION 33											
National Fuel	Natural Gas Upgrades	1	lot	\$1,942.86	\$1,942.86	Plumbers	\$85.78	22.648523	22.65	\$1,942.86	\$3,886
TOTAL - DIVISION 33											\$3,886
SUBTOTAL											\$88,765
GENERAL CONDITIONS										15%	\$13,315
OH&P										10%	\$10,208
DESIGN CONTINGENCY										20%	\$22,458
BID CONTINGENCY										5%	\$6,737
PHASING										10%	\$14,148
TOTAL											\$155,631

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY LIGHT COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
033053403550+1	Structural concrete, in place, equipment pad (3000 psi), 5' x 5' x 8", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	2	Ea.	\$249.00	\$498.00	Cement Masons	\$72.62	2.67	5.35	\$388.17	\$886
38213100300+1	Concrete core drilling, core, reinforced concrete slab, 4" diameter, up to 6" thick slab, includes bit cost, layout and set up time	1	Ea.	\$0.61	\$0.61	Cement Masons	\$72.62	1.07	1.07	\$77.48	\$78
038213100350+1	Concrete core drilling, core, reinforced concrete slab, 4" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	6	Ea.	\$0.11	\$0.66	Cement Masons	\$72.62	0.03	0.18	\$12.91	\$14
038213100700+1	Concrete core drilling, core, reinforced concrete slab, 6" diameter, up to 6" thick slab, includes bit cost, layout and set up time	4	Ea.	\$1.41	\$5.64	Cement Masons	\$72.62	1.10	4.40	\$319.52	\$325
038213100750+1	Concrete core drilling, core, reinforced concrete slab, 8" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	24	Ea.	\$0.24	\$5.76	Cement Masons	\$72.62	0.05	1.18	\$85.87	\$92
TOTAL - DIVISION 3 CONCRETE											\$1,395
DIVISION 9 FINISHES											
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	200	L.F.	\$0.47	\$94.00	Painters	\$62.86	0.021	4.20	\$264.01	\$358
8050510	Existing door demolition	2	Ea.		\$0.00	Carpenter Foreman	\$66.65	1.4	2.80	\$186.62	\$187
81313150360	Fire Doors	2	Ea.	\$1,150.00	\$2,300.00	Carpenter Foreman	\$66.65	1	2.00	\$133.30	\$2,433
81213135400	Fire Door Frame	2	Ea.	\$277.00	\$554.00	Carpenter Foreman	\$66.65	1.067	2.13	\$142.23	\$696
92910302195	Construct Fire Rated Walls/Ceiling	3200	SF	\$0.63	\$2,016.00	Carpenter Foreman	\$66.65	0.021	67.20	\$4,478.81	\$6,495
78413100720	Fire stop wall joints	200	LF	\$18.60	\$3,720.00	Carpenter Foreman	\$66.65	0.107	21.40	\$1,426.29	\$5,146
78413100210	Fire stop penetrations	100	ea	\$32.00	\$3,200.00	Plumbers	\$85.78	0.571	57.10	\$4,898.21	\$8,098
TOTAL - DIVISION 9 FINISHES											\$23,413
DIVISION 10 SPECIALTIES											
104416130160	Fire extinguishers, CO2, portable, with hose & "H" horn, 15 lb	1	Ea.	\$420.00	\$420.00	Plumbers	\$85.78		0.00	\$0.00	\$420
TOTAL - DIVISION 10 SPECIALTIES											\$420
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.27	5.34	\$458.08	\$458
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.71	14.28	\$1,224.55	\$1,225
220505101980	Pipe hanger / support, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.10	2.00	\$171.60	\$172
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	50	L.F.		\$0.00	Plumbers	\$85.78	0.04	2.00	\$171.60	\$172
220505102050+1	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.16	16.00	\$1,372.53	\$1,373
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	10	Ea.		\$0.00	Plumbers	\$85.78	0.29	2.85	\$244.64	\$245
220505109110+1	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	2.00	28.00	\$2,401.92	\$2,402

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY LIGHT COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
220553101120	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	20	Ea.	\$3.86	\$77.20	Plumbers	\$85.78	0.13	2.66	\$228.33	\$306
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	10	Ea.	\$3.64	\$36.40	Plumbers	\$85.78	0.20	2.00	\$171.60	\$208
220719107624	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1" iron pipe size	50	L.F.	\$12.25	\$612.50	Plumbers	\$85.78	0.07	3.61	\$309.88	\$922
220719107626+2	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1-1/4" iron pipe size	40	L.F.	\$14.45	\$578.00	Plumbers	\$85.78	0.10	4.00	\$343.13	\$921
221113440580	Pipe, steel, black, threaded, 1" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	50	L.F.	\$8.90	\$445.00	Plumbers	\$85.78	0.15	7.65	\$655.92	\$1,101
221113440590+2	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	20	L.F.	\$18.80	\$376.00	Plumbers	\$85.78	0.18	3.60	\$308.82	\$685
221113440590+2	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	20	L.F.	\$18.80	\$376.00	Plumbers	\$85.78	0.18	3.60	\$308.82	\$685
221113450661	Tee, steel, cast iron, black, reducing on the run and outlet, threaded, standard weight, 1/2"	2	Ea.	\$40.00	\$80.00	Plumbers	\$85.78	0.90	1.80	\$154.58	\$235
221113454040	Coupling, steel, cast iron, black, straight, merchants, threaded, standard weight, 3/8"	2	Ea.	\$2.55	\$5.10	Plumbers	\$85.78	0.43	0.86	\$73.75	\$79
221113454374+1	Plug, steel, cast iron, galvanized, square head, threaded, standard weight, 1/2"	2	Ea.	\$11.95	\$23.90	Plumbers	\$85.78	0.25	0.50	\$42.89	\$67
221113454810+1	Nipple, steel, galvanized, threaded, standard weight, 1/2" x 4" long	2	Ea.	\$8.20	\$16.40	Plumbers	\$85.78	0.44	0.89	\$76.18	\$93
221113455110+1	Elbow, 90 Deg., steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	5	Ea.	\$24.50	\$122.50	Plumbers	\$85.78	0.80	4.00	\$343.13	\$466
221113455520+1	Tee, steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	1	Ea.	\$35.50	\$35.50	Plumbers	\$85.78	1.23	1.23	\$105.60	\$141
221113455995+1	Cap, steel, malleable iron, black, threaded, 150 lb., 1-1/4"	1	Ea.	\$16.00	\$16.00	Plumbers	\$85.78	0.33	0.33	\$28.57	\$45
221113459764+1	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1"	20	Ea.	\$81.00	\$1,620.00	Plumbers	\$85.78	0.73	14.54	\$1,247.28	\$2,867
221113459765 +1	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1-1/4"	10	Ea.	\$104.00	\$1,040.00	Plumbers	\$85.78	0.80	8.00	\$686.26	\$1,726
221113459804	Tee, steel, forged steel, black, threaded, 3000 lb., 1"	4	Ea.	\$58.00	\$232.00	Plumbers	\$85.78	1.01	4.03	\$346.04	\$578
221113459805	Tee, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	4	Ea.	\$112.00	\$448.00	Plumbers	\$85.78	1.04	4.17	\$357.39	\$805
221113459844	Cap, steel, forged steel, black, threaded, 3000 lb., 1"	4	Ea.	\$23.50	\$94.00	Plumbers	\$85.78	0.27	1.08	\$92.47	\$186
221113459845+1	Cap, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	4	Ea.	\$44.50	\$178.00	Plumbers	\$85.78	0.33	1.33	\$114.26	\$292
221113475601	Reducer, steel, forged steel, black, socket weld, 3000 lb., schedule 40, 3/8" pipe size, includes 1 weld per joint and weld machine	2	Ea.	\$62.50	\$125.00	Plumbers	\$85.78	0.63	1.26	\$107.78	\$233

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY LIGHT COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size, includes 1 weld per joint and weld machine	2	Ea.	\$12.05	\$24.10	Plumbers	\$85.78	0.63	1.26	\$107.78	\$132
221113479805	Pipe fittings, steel, flanged, butt welded or mechanical joint, minimum labor/equipment charge	2	Ea.	\$152.00	\$304.00	Plumbers	\$85.78	0.16	0.32	\$27.80	\$332
221119340150	Sleeve, pipe, steel with water stop, 12" long, 4" diam. for 1-1/4" carrier pipe, includes link seal	1	Ea.	\$162.00	\$162.00	Plumbers	\$85.78	1.33	1.33	\$114.35	\$276
TOTAL - DIVISION 22 PLUMBING											\$19,425
DIVISION 23 HVAC											
230505100297	Boiler blowdown, selective demolition	5	Ea.		\$0.00	Master Mechanic	\$93.84	1.82	9.09	\$853.29	\$853
230505102770	Heat exchanger, plate type, selective demolition	5	Ea.		\$0.00	Master Mechanic	\$93.84	13.33	66.67	\$6,256.14	\$6,256
230523701060+1	Valves, semi-steel, lubricated plug valve, threaded, 200 psi, 1-1/4"	2	Ea.	\$186.00	\$372.00	Master Mechanic	\$93.84	0.73	1.45	\$136.45	\$508
230523805340	Valves, steel, forged, ball, threaded, 1,500 psi, 1/4"	2	Ea.	\$72.00	\$144.00	Master Mechanic	\$93.84	0.33	0.66	\$62.06	\$206
230523805380+1	Valves, steel, forged, ball, threaded, 1,500 psi, 1"	4	Ea.	\$196.00	\$784.00	Master Mechanic	\$93.84	0.53	2.13	\$200.07	\$984
230523805390+1	Valves, steel, forged, ball, threaded, 1,500 psi, 1-1/4"	2	Ea.	\$196.00	\$392.00	Master Mechanic	\$93.84	0.54	1.07	\$100.84	\$493
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	20.00	40.00	\$3,753.68	\$3,754
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	12.00	24.00	\$2,252.21	\$2,252
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1	Ea.		\$0.00	Master Mechanic	\$93.84	8.00	8.00	\$750.74	\$751
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	2	Ea.	\$34.50	\$69.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$116
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	2	Ea.	\$209.00	\$418.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$465
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	2	Ea.	\$25.50	\$51.00	Master Mechanic	\$93.84	0.24	0.48	\$44.84	\$96
232120760140+1	Strainer, Y type, bronze body, screwed, 125 lb., 1" pipe size	2	Ea.	\$167.00	\$334.00	Master Mechanic	\$93.84	0.53	1.07	\$100.04	\$434
232123131060	2"-1/6HP Boiler Primary Circulator	2	Ea.	\$2,075.00	\$4,150.00	Master Mechanic	\$93.84	3.20	6.40	\$600.59	\$4,751
235123100080	4" insulated metal vent pipe	400	L.F.	\$13.20	\$5,280.00	Master Mechanic	\$93.84	0.24	94.00	\$8,821.16	\$14,101
235123100950	4" insulated metal vent pipe fittings	16	Ea.	\$37.50	\$600.00	Master Mechanic	\$93.84	0.47	7.54	\$707.19	\$1,307
1200, 1460, 1750	Tee, tee cap, top, and supports	4	lots	\$137.52	\$550.08	Master Mechanic	\$93.84	1.91	7.64	\$716.95	\$1,267
235123101020+1	Vent chimney, prefabricated metal, gas, double wall, galvanized steel fitting, wall thimble, 4 to 7" adjustable, 3" diameter, UL listed	4	Ea.	\$20.50	\$82.00	Master Mechanic	\$93.84	0.47	1.88	\$176.80	\$259
235223203220	Boiler, gas fired, natural or propane, cast iron, hot water, gross output, 544 MBH, includes standard controls and insulated jacket, packaged	2	Ea.	\$20,000.00	\$40,000.00	Master Mechanic	\$93.84	62.99	125.98	\$11,822.60	\$51,823
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1	Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY LIGHT COMMERCIAL											
Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
TOTAL - DIVISION 23 HVAC											\$92,740
DIVISION 26 ELECTRICAL											
260505100100	Conduit, rigid galvanized steel, 1/2" to 1" diameter, electrical demolition, remove conduit to 10' high, including fittings & hangers	150	L.F.		\$0.00	Electrician	\$87.69	0.03	4.96	\$434.53	\$435
260505101830	Wire, THW-THWN-THHN, #14, electrical demolition, removed from in place conduit, to 10' high	150	C.L.F.		\$0.00	Electrician	\$87.69	0.12	18.45	\$1,617.92	\$1,618
260519900940	Wire, copper, solid, 600 volt, #12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	22.5	C.L.F.	\$20.50	\$461.25	Electrician	\$87.69	0.73	16.41	\$1,438.79	\$1,900
260533131230	Aluminum conduit elbows, 1" diameter, to 10' H	20	Ea.	\$20.50	\$410.00	Electrician	\$87.69	0.29	5.71	\$500.78	\$911
260533131470	Aluminum conduit couplings, 1" diameter, to 10' H	10	Ea.	\$6.45	\$64.50	Electrician	\$87.69	0.05	0.50	\$43.91	\$108
260533131800	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	225	L.F.	\$7.10	\$1,597.50	Electrician	\$87.69	0.12	27.68	\$2,426.88	\$4,024
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20	Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10	Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386
262416200100	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15-50 amp	2	Ea.	\$24.00	\$48.00	Electrician	\$87.69	0.80	1.60	\$140.22	\$188
262726103800	Low voltage switching, flush switch, standard	2	Ea.	\$18.05	\$36.10	Electrician	\$87.69	0.20	0.40	\$34.98	\$71
262726104200	Low voltage switching, transformer, low voltage switching, 115 V to 25 V	2	Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	1.5	C.L.F.	\$400.00	\$600.00	Electrician	\$87.69	3.22	4.82	\$422.97	\$1,023
262726200500	Toggle switch, quiet type, single pole, 20 amp	5	Ea.	\$4.08	\$20.40	Electrician	\$87.69	0.30	1.48	\$129.82	\$150
265113502700	Fluorescent fixture, interior, strip, surface mounted, S.L., 2-75 W, 8' long, incl lamps, mounting hardware and connections	9	Ea.	\$117.00	\$1,053.00	Electrician	\$87.69	1.29	11.62	\$1,019.29	\$2,072
TOTAL - DIVISION 26 ELECTRICAL											\$13,548
DIVISION 28											
284611218710	Carbon monoxide detector, hardwired, wall mounted	1	Ea.	\$80.00	\$80.00	Electrician	\$87.69	1.12	1.12	\$98.62	\$179
284611505010	Detection system, fire alarm, detector, heat (addressable type), excl. wires & conduit	1	Ea.	\$125.00	\$125.00	Electrician	\$87.69	1.24	1.24	\$108.63	\$234
284620507010	Detection system, break glass station, addressable, excluding wires & conduits	2	Ea.	\$166.00	\$332.00	Electrician	\$87.69	1.24	2.48	\$217.26	\$549
TOTAL - DIVISION 28											\$962
DIVISION 33											
National Fuel	Natural Gas Upgrades	1	lots	\$3,428.57	\$3,428.57	Plumbers	\$85.78	39.967982	39.97	\$3,428.57	\$6,857
TOTAL - DIVISION 33											\$6,857
SUBTOTAL										\$158,761	
GENERAL CONDITIONS									15%	\$23,814	
OH&P									10%	\$18,257	
DESIGN CONTINGENCY									20%	\$40,166	
BID CONTINGENCY									5%	\$12,050	
PHASING									10%	\$25,305	
TOTAL										\$278,354	

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
033053403550+2	Structural concrete, in place, equipment pad (3000 psi), 5' x 5' x 8", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	2	Ea.	\$325.00	\$650.00	Cement Masons	\$72.62	3.43	6.86	\$498.01	\$1,148
38213100300+2	Concrete core drilling, core, reinforced concrete slab, 4" diameter, up to 6" thick slab, includes bit cost, layout and set up time	1	Ea.	\$0.97	\$0.97	Cement Masons	\$72.62	1.07	1.07	\$77.48	\$78
038213100350+2	Concrete core drilling, core, reinforced concrete slab, 4" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	6	Ea.	\$0.16	\$0.96	Cement Masons	\$72.62	0.04	0.26	\$19.17	\$20
038213100700+2	Concrete core drilling, core, reinforced concrete slab, 6" diameter, up to 6" thick slab, includes bit cost, layout and set up time	4	Ea.	\$1.74	\$6.96	Cement Masons	\$72.62	1.33	5.32	\$386.32	\$393
038213100750+2	Concrete core drilling, core, reinforced concrete slab, 8" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	24	Ea.	\$0.29	\$6.96	Cement Masons	\$72.62	0.07	1.61	\$116.77	\$124
TOTAL - DIVISION 3 CONCRETE											\$1,764
DIVISION 9 FINISHES											
090505300100	Demolish interior block wall	160	SF		\$0.00	Painters	\$62.86	0.182	29.12	\$1,830.47	\$1,830
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	200	L.F.	\$0.93	\$186.00	Painters	\$62.86	0.042	8.40	\$528.02	\$714
099123740840	Paint interior wall surfaces from anticipated demolition of interior walls.	320	SF	\$0.12	\$38.40	Painters	\$62.86	0.01	3.20	\$201.15	\$240
092910301195	Fire rated gypsum wall - level 5 finish	320	SF	\$0.54	\$172.80	Painters	\$62.86	0.026	8.32	\$522.99	\$696
8050510	Existing door demolition	4	Ea.		\$0.00	Carpenter Foreman	\$66.65	1.4	5.60	\$373.23	\$373
81313150360	Fire Doors	4	Ea.	\$1,150.00	\$4,600.00	Carpenter Foreman	\$66.65	1	4.00	\$266.60	\$4,867
81213135400	Fire Door Frame	4	Ea.	\$277.00	\$1,108.00	Carpenter Foreman	\$66.65	1.067	4.27	\$284.46	\$1,392
92910302195	Construct Fire Rated Walls/Ceiling	9600	SF	\$0.63	\$6,048.00	Carpenter Foreman	\$66.65	0.021	201.60	\$13,436.44	\$19,484
78413100720	Fire stop wall joints	680	LF	\$18.60	\$12,648.00	Carpenter Foreman	\$66.65	0.107	72.76	\$4,849.38	\$17,497
78413100210	Fire stop penetrations	200	ea	\$32.00	\$6,400.00	Plumbers	\$85.78	0.571	114.20	\$9,796.41	\$16,196
TOTAL - DIVISION 9 FINISHES											\$63,290
DIVISION 10 SPECIALTIES											
104416130160	Fire extinguishers, CO2, portable, with hose & "H" horn, 15 lb	1	Ea.	\$420.00	\$420.00	Plumbers	\$85.78		0.00	\$0.00	\$420
TOTAL - DIVISION 10 SPECIALTIES											\$420
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	30	Ea.		\$0.00	Plumbers	\$85.78	0.27	8.01	\$687.12	\$687
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.86	17.13	\$1,469.46	\$1,469
220505101980	Pipe hanger / support, selective demolition	30	Ea.		\$0.00	Plumbers	\$85.78	0.10	3.00	\$257.40	\$257

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	75	L.F.		\$0.00	Plumbers	\$85.78	0.04	3.00	\$257.40	\$257
220505102050+2	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.27	26.70	\$2,290.40	\$2,290
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	15	Ea.		\$0.00	Plumbers	\$85.78	0.29	4.28	\$366.96	\$367
220505109110+2	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	3.00	42.00	\$3,602.88	\$3,603
220553101120+2	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	20	Ea.	\$5.90	\$118.00	Plumbers	\$85.78	0.14	2.86	\$245.34	\$363
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	10	Ea.	\$3.64	\$36.40	Plumbers	\$85.78	0.20	2.00	\$171.60	\$208
220719107624	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1" iron pipe size	75	L.F.	\$12.25	\$918.75	Plumbers	\$85.78	0.07	5.42	\$464.82	\$1,384
220719107626+8	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1-1/4" iron pipe size	60	L.F.	\$16.15	\$969.00	Plumbers	\$85.78	0.20	12.00	\$1,029.40	\$1,998
221113440580	Pipe, steel, black, threaded, 1" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	75	L.F.	\$8.90	\$667.50	Plumbers	\$85.78	0.15	11.47	\$983.88	\$1,651
221113440590+6	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	30	L.F.	\$59.00	\$1,770.00	Plumbers	\$85.78	0.44	13.32	\$1,142.63	\$2,913
221113440590+6	Pipe, steel, black, threaded, 1-1/4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	30	L.F.	\$59.00	\$1,770.00	Plumbers	\$85.78	0.44	13.32	\$1,142.63	\$2,913
221113450661	Tee, steel, cast iron, black, reducing on the run and outlet, threaded, standard weight, 1/2"	2	Ea.	\$40.00	\$80.00	Plumbers	\$85.78	0.90	1.80	\$154.58	\$235
221113454040	Coupling, steel, cast iron, black, straight, merchants, threaded, standard weight, 3/8"	2	Ea.	\$2.55	\$5.10	Plumbers	\$85.78	0.43	0.86	\$73.75	\$79
221113454374+4	Plug, steel, cast iron, galvanized, square head, threaded, standard weight, 1/2"	2	Ea.	\$24.00	\$48.00	Plumbers	\$85.78	0.33	0.67	\$57.13	\$105
221113454810+4	Nipple, steel, galvanized, threaded, standard weight, 1/2" x 4" long	2	Ea.	\$21.50	\$43.00	Plumbers	\$85.78	0.76	1.52	\$130.73	\$174
221113455110+4	Elbow, 90 Deg., steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	5	Ea.	\$137.00	\$685.00	Plumbers	\$85.78	1.60	8.00	\$686.26	\$1,371
221113455520+4	Tee, steel, malleable iron, black, straight, threaded, 150 lb., 1-1/4"	1	Ea.	\$192.00	\$192.00	Plumbers	\$85.78	2.67	2.67	\$228.78	\$421
221113455995+2	Cap, steel, malleable iron, black, threaded, 150 lb., 1-1/4"	1	Ea.	\$23.50	\$23.50	Plumbers	\$85.78	0.38	0.38	\$32.68	\$56
221113459764+2	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1"	20	Ea.	\$104.00	\$2,080.00	Plumbers	\$85.78	0.80	16.00	\$1,372.53	\$3,453

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
221113459765+2	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1-1/4"	10	Ea.	\$126.00	\$1,260.00	Plumbers	\$85.78	0.89	8.89	\$762.61	\$2,023
221113459804	Tee, steel, forged steel, black, threaded, 3000 lb., 1"	6	Ea.	\$58.00	\$348.00	Plumbers	\$85.78	1.01	6.05	\$519.06	\$867
221113459805	Tee, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	6	Ea.	\$112.00	\$672.00	Plumbers	\$85.78	1.04	6.25	\$536.08	\$1,208
221113459844	Cap, steel, forged steel, black, threaded, 3000 lb., 1"	4	Ea.	\$23.50	\$94.00	Plumbers	\$85.78	0.27	1.08	\$92.47	\$186
221113459845+3	Cap, steel, forged steel, black, threaded, 3000 lb., 1-1/4"	4	Ea.	\$64.50	\$258.00	Plumbers	\$85.78	0.38	1.52	\$130.73	\$389
221113475601	Reducer, steel, forged steel, black, socket weld, 3000 lb., schedule 40, 3/8" pipe size, includes 1 weld per joint and weld machine	2	Ea.	\$62.50	\$125.00	Plumbers	\$85.78	0.63	1.26	\$107.78	\$233
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size, includes 1 weld per joint and weld machine	2	Ea.	\$12.05	\$24.10	Plumbers	\$85.78	0.63	1.26	\$107.78	\$132
221113479805	Pipe fittings, steel, flanged, butt welded or mechanical joint, minimum labor/equipment charge	2	Ea.	\$152.00	\$304.00	Plumbers	\$85.78	0.16	0.32	\$27.80	\$332
221113742540	Pipe, plastic, PVC, 6" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	240	L.F.	\$48.50	\$11,640.00	Plumbers	\$85.78	0.42	101.04	\$8,667.51	\$20,308
221113762190	Elbow, 90 Deg., plastic, PVC, socket joint, 6", schedule 80	24	Ea.	\$177.00	\$4,248.00	Plumbers	\$85.78	1.58	38.02	\$3,261.12	\$7,509
221119340150	Sleeve, pipe, steel with water stop, 12" long, 4" diam. for 1-1/4" carrier pipe, includes link seal	1	Ea.	\$162.00	\$162.00	Plumbers	\$85.78	1.33	1.33	\$114.35	\$276
TOTAL - DIVISION 22 PLUMBING											\$59,717

DIVISION 23 HVAC

230505100297	Boiler blowdown, selective demolition	10	Ea.		\$0.00	Master Mechanic	\$93.84	1.82	18.19	\$1,706.59	\$1,707
230505102770	Heat exchanger, plate type, selective demolition	10	Ea.		\$0.00	Master Mechanic	\$93.84	13.33	133.33	\$12,512.28	\$12,512
230523701060+4	Valves, semi-steel, lubricated plug valve, threaded, 200 psi, 1-1/4"	2	Ea.	\$292.00	\$584.00	Master Mechanic	\$93.84	3.56	7.11	\$667.41	\$1,251
230523805340	Valves, steel, forged, ball, threaded, 1,500 psi, 1/4"	2	Ea.	\$72.00	\$144.00	Master Mechanic	\$93.84	0.33	0.66	\$62.06	\$206
230523805380+4	Valves, steel, forged, ball, threaded, 1,500 psi, 1"	4	Ea.	\$345.00	\$1,380.00	Master Mechanic	\$93.84	0.62	2.46	\$230.85	\$1,611
230523805390+3	Valves, steel, forged, ball, threaded, 1,500 psi, 1-1/4"	2	Ea.	\$370.00	\$740.00	Master Mechanic	\$93.84	0.73	1.45	\$136.45	\$876
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	40.00	80.00	\$7,507.37	\$7,507
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	24.00	48.00	\$4,504.42	\$4,504
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1	Ea.		\$0.00	Master Mechanic	\$93.84	16.00	16.00	\$1,501.47	\$1,501
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	2	Ea.	\$34.50	\$69.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$116

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	2	Ea.	\$209.00	\$418.00	Master Mechanic	\$93.84	0.25	0.50	\$47.32	\$465
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	2	Ea.	\$25.50	\$51.00	Master Mechanic	\$93.84	0.24	0.48	\$44.84	\$96
232120760140+3	Strainer, Y type, bronze body, screwed, 125 lb., 1" pipe size	2	Ea.	\$294.00	\$588.00	Master Mechanic	\$93.84	0.62	1.23	\$115.43	\$703
232123131060	3"-1HP Boiler Primary Circulator	2	Ea.	\$4,200.00	\$8,400.00	Master Mechanic	\$93.84	4.00	8.00	\$750.74	\$9,151
235123100140	6" insulated metal vent pipe	400	L.F.	\$17.80	\$7,120.00	Master Mechanic	\$93.84	0.27	106.80	\$10,022.34	\$17,142
235123100950	6" insulated metal vent pipe fittings	16	Ea.	\$54.00	\$864.00	Master Mechanic	\$93.84	0.53	8.53	\$800.29	\$1,664
1200, 1460, 1750	Tee, tee cap, top, and supports	4	lots	\$162.60	\$650.40	Master Mechanic	\$93.84	2.10	8.40	\$787.90	\$1,438
235123101020+3	Vent chimney, prefabricated metal, gas, double wall, galvanized steel fitting, wall thimble, 4 to 7" adjustable, 3" diameter, UL listed	4	Ea.	\$26.00	\$104.00	Master Mechanic	\$93.84	0.53	2.13	\$200.07	\$304
235223203300	Boiler, gas fired, natural or propane, cast iron, hot water, gross output, 1,530 MBH, includes standard controls and insulated jacket, packaged	2	Ea.	\$47,000.00	\$94,000.00	Master Mechanic	\$93.84	105.00	210.00	\$19,706.84	\$113,707
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1	Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064
TOTAL - DIVISION 23 HVAC											\$178,528

DIVISION 26 ELECTRICAL

260505100100	Conduit, rigid galvanized steel, 1/2" to 1" diameter, electrical demolition, remove conduit to 10' high, including fittings & hangers	200	L.F.		\$0.00	Electrician	\$87.69	0.03	6.61	\$579.37	\$579
260505101830	Wire, THW-THWN-THHN, #14, electrical demolition, removed from in place conduit, to 10' high	200	C.L.F.		\$0.00	Electrician	\$87.69	0.12	24.60	\$2,157.22	\$2,157
260519900940	Wire, copper, solid, 600 volt, #12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	30	C.L.F.	\$20.50	\$615.00	Electrician	\$87.69	0.73	21.88	\$1,918.39	\$2,533
260533131230	Aluminum conduit elbows, 1" diameter, to 10' H	20	Ea.	\$20.50	\$410.00	Electrician	\$87.69	0.29	5.71	\$500.78	\$911
260533131470	Aluminum conduit couplings, 1" diameter, to 10' H	10	Ea.	\$6.45	\$64.50	Electrician	\$87.69	0.05	0.50	\$43.91	\$108
260533131800	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	300	L.F.	\$7.10	\$2,130.00	Electrician	\$87.69	0.12	36.90	\$3,235.83	\$5,366
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20	Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10	Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386
262416200100	Circuit breakers, bolt-on, 10 k A I.C., 1 pole, 120 volt, 15-50 amp	2	Ea.	\$24.00	\$48.00	Electrician	\$87.69	0.80	1.60	\$140.22	\$188
262726103800	Low voltage switching, flush switch, standard	2	Ea.	\$18.05	\$36.10	Electrician	\$87.69	0.20	0.40	\$34.98	\$71
262726104200	Low voltage switching, transformer, low voltage switching, 115 V to 25 V	2	Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	2	C.L.F.	\$400.00	\$800.00	Electrician	\$87.69	3.22	6.43	\$563.96	\$1,364

TASK 2D - DECENTRALIZE W/NG BOILERS: CATEGORY COMMERCIAL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
262726200500	Toggle switch, quiet type, single pole, 20 amp	5	Ea.	\$4.08	\$20.40	Electrician	\$87.69	0.30	1.48	\$129.82	\$150
265113502700	Fluorescent fixture, interior, strip, surface mounted, S.L., 2-75 W, 8' long, incl lamps, mounting hardware and connections	12	Ea.	\$117.00	\$1,404.00	Electrician	\$87.69	1.29	15.50	\$1,359.05	\$2,763
TOTAL - DIVISION 26 ELECTRICAL											\$17,239
DIVISION 28											
284611218710	Carbon monoxide detector, hardwired, wall mounted	2	Ea.	\$80.00	\$160.00	Electrician	\$87.69	1.12	2.25	\$197.23	\$357
284611505010	Detection system, fire alarm, detector, heat (addressable type), excl. wires & conduit	2	Ea.	\$125.00	\$250.00	Electrician	\$87.69	1.24	2.48	\$217.26	\$467
284620507010	Detection system, break glass station, addressable, excluding wires & conduits	2	Ea.	\$166.00	\$332.00	Electrician	\$87.69	1.24	2.48	\$217.26	\$549
TOTAL - DIVISION 28											\$1,374
DIVISION 33											
National Fuel	Natural Gas Upgrades	1	lot	\$5,000.00	\$5,000.00	Plumbers	\$85.78	58.286641	58.29	\$5,000.00	\$10,000
TOTAL - DIVISION 33											\$10,000
SUBTOTAL											\$332,332
GENERAL CONDITIONS										15%	\$49,850
OH&P										10%	\$38,218
DESIGN CONTINGENCY										20%	\$84,080
BID CONTINGENCY										5%	\$25,224
PHASING										10%	\$52,970
TOTAL											\$582,675

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY SMALL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
033053403550	Structural concrete, in place, equipment pad (3000 psi), 4' x 4' x 6", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	6	Ea.	\$138.00	\$828.00	Cement Masons	\$72.62	1.60	9.60	\$697.12	\$1,525
38213100300	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time	1	Ea.	\$0.46	\$0.46	Cement Masons	\$72.62	0.89	0.89	\$64.70	\$65
038213100350	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	6	Ea.	\$0.07	\$0.42	Cement Masons	\$72.62	0.02	0.12	\$8.63	\$9
TOTAL - DIVISION 3 CONCRETE											\$1,599
DIVISION 9 FINISHES											
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	50	L.F.	\$0.47	\$23.50	Painters	\$62.86	0.021	1.05	\$66.00	\$90
TOTAL - DIVISION 9 FINISHES											\$90
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.27	5.34	\$458.08	\$458
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.57	11.41	\$978.56	\$979
220505101980	Pipe hanger / support, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.10	2.00	\$171.60	\$172
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	50	L.F.		\$0.00	Plumbers	\$85.78	0.04	2.00	\$171.60	\$172
220505102050	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.05	5.34	\$458.08	\$458
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	10	Ea.		\$0.00	Plumbers	\$85.78	0.29	2.85	\$244.64	\$245
220505109110	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	1.46	20.37	\$1,747.40	\$1,747
220553101120	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	40	Ea.	\$3.86	\$154.40	Plumbers	\$85.78	0.13	5.32	\$456.66	\$611
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	20	Ea.	\$3.64	\$72.80	Plumbers	\$85.78	0.20	4.00	\$343.21	\$416
220719107624	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1" iron pipe size	40	L.F.	\$12.25	\$490.00	Plumbers	\$85.78	0.07	2.89	\$247.90	\$738
220719107628	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 1-1/2" iron pipe size	110	L.F.	\$14.45	\$1,589.50	Plumbers	\$85.78	0.09	10.34	\$887.00	\$2,476
221113440580	Pipe, steel, black, threaded, 1" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	40	L.F.	\$8.90	\$356.00	Plumbers	\$85.78	0.15	6.12	\$524.74	\$881

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY SMALL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
221113440600	Pipe, steel, black, threaded, 1-1/2" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	110	L.F.	\$14.00	\$1,540.00	Plumbers	\$85.78	0.20	22.00	\$1,887.22	\$3,427
221113457050	1" Union at Heat Pumps	8	Ea.	\$37.00	\$296.00	Plumbers	\$85.78	0.67	5.34	\$457.74	\$754
221113457070	1.5" Union at Buffer Tank	2	Ea.	\$67.00	\$134.00	Plumbers	\$85.78	0.84	1.68	\$144.46	\$278
220523205650	1" safety relief valve	4	Ea.	\$420.00	\$1,680.00	Plumbers	\$85.78	0.33	1.33	\$114.26	\$1,794
220523205670	1.5" safety relief valve	1	Ea.	\$1,350.00	\$1,350.00	Plumbers	\$85.78	0.44	0.44	\$38.09	\$1,388
220523201870	1" check valve	4	Ea.	\$228.00	\$912.00	Plumbers	\$85.78	0.42	1.68	\$144.46	\$1,056
220523201890	1-1/2" check valve	1	Ea.	\$330.00	\$330.00	Plumbers	\$85.78	0.62	0.62	\$52.76	\$383
220719104286	Foam cell refrigerant tubing insulation	50	ft	\$8.15	\$407.50	Plumbers	\$85.78	0.13	6.65	\$570.46	\$978
221113455120	Elbow, 90 Deg., steel, malleable iron, black, straight, threaded, 150 lb., 1-1/2"	20	Ea.	\$24.50	\$490.00	Plumbers	\$85.78	0.80	16.00	\$1,372.53	\$1,863
221113455530	Tee, steel, malleable iron, black, straight, threaded, 150 lb., 1-1/2"	8	Ea.	\$35.50	\$284.00	Plumbers	\$85.78	1.23	9.85	\$844.79	\$1,129
221113459764	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 1"	8	Ea.	\$42.00	\$336.00	Plumbers	\$85.78	0.62	4.96	\$425.46	\$761
221113475601	Reducer, steel, forged steel, black, socket weld, 3000 lb., schedule 40, 3/8" pipe size, includes 1 weld per joint and weld machine	10	Ea.	\$62.50	\$625.00	Plumbers	\$85.78	0.63	6.28	\$538.92	\$1,164
221223133080	200 gallon thermal storage tank	1	Ea.	\$7,175.00	\$7,175.00	Plumbers	\$85.78	2.00	2.00	\$171.57	\$7,347
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size,	10	Ea.	\$12.05	\$120.50	Plumbers	\$85.78	0.63	6.28	\$538.92	\$659
221113479805	Pipe fittings, steel, flanged, butt welded or mechanical joint, minimum labor/equipment charge	10	Ea.	\$152.00	\$1,520.00	Plumbers	\$85.78	0.16	1.62	\$138.98	\$1,659
221119340120	Sleeve, pipe, steel with water stop, 12" long, 3"	1	Ea.	\$106.00	\$106.00	Plumbers	\$85.78	0.95	0.95	\$81.67	\$188
TOTAL - DIVISION 22 PLUMBING											\$34,180
DIVISION 23 HVAC											
230505100297	Boiler blowdown, selective demolition	2	Ea.		\$0.00	Master Mechanic	\$93.84	1.82	3.64	\$341.32	\$341
230505102770	Heat exchanger, plate type, selective demolition	3	Ea.		\$0.00	Master Mechanic	\$93.84	13.33	40.00	\$3,753.68	\$3,754
232120760140	1" y-type strainer	4	Ea.	\$106.00	\$424.00	Master Mechanic	\$93.84	0.47	1.88	\$176.80	\$601
232120760160	1-1/2" y-type strainer	1	Ea.	\$226.00	\$226.00	Master Mechanic	\$93.84	0.57	0.57	\$53.58	\$280
230523805340	Valves, steel, forged, ball, threaded, 1,500 psi, 1/4"	4	Ea.	\$72.00	\$288.00	Master Mechanic	\$93.84	0.33	1.32	\$124.12	\$412
230523805380	Valves, steel, forged, ball, threaded, 1,500 psi, 1"	20	Ea.	\$179.00	\$3,580.00	Master Mechanic	\$93.84	0.42	8.43	\$791.24	\$4,371
230523805400	Valves, steel, forged, ball, threaded, 1,500 psi, 1-1/2"	10	Ea.	\$345.00	\$3,450.00	Master Mechanic	\$93.84	0.62	6.15	\$577.13	\$4,027

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY SMALL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	10.00	20.00	\$1,876.84	\$1,877
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	6.00	12.00	\$1,126.11	\$1,126
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1	Ea.		\$0.00	Master Mechanic	\$93.84	4.00	4.00	\$375.37	\$375
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	4	Ea.	\$34.50	\$138.00	Master Mechanic	\$93.84	0.25	1.01	\$94.64	\$233
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	10	Ea.	\$209.00	\$2,090.00	Master Mechanic	\$93.84	0.25	2.52	\$236.60	\$2,327
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	4	Ea.	\$25.50	\$102.00	Master Mechanic	\$93.84	0.24	0.96	\$89.67	\$192
232120462000	Steel liquid expansion ASME painted 15 gallon capacity	1	Ea.	\$860.00	\$860.00	Master Mechanic	\$93.84	0.94	0.94	\$88.31	\$948
232120140120	1-1/2" air scoop connection to expansion tank	1	Ea.	\$74.00	\$74.00	Master Mechanic	\$93.84	0.62	0.62	\$57.71	\$132
232120760140	Strainer, Y type, bronze body, screwed, 125 lb., 1" pipe size	3	Ea.	\$106.00	\$318.00	Master Mechanic	\$93.84	0.48	1.44	\$134.98	\$453
232123131060	1/8HP Heat Pump Primary Circulator	4	Ea.	\$1,425.00	\$5,700.00	Master Mechanic	\$93.84	2.67	10.67	\$1,001.11	\$6,701
232123131100	1/3HP Heat Pump Primary Circulator	1	Ea.	\$1,600.00	\$1,600.00	Master Mechanic	\$93.84	2.67	2.67	\$250.28	\$1,850
238126107036	Tubing Refrigerant kit 25'	2	Ea.	\$55.50	\$111.00	Master Mechanic	\$93.84	0.57	1.14	\$107.17	\$218
238146102240	ARNH76 - LG Hydrokit WSHP (Indoor Unit)	4	Ea.	\$12,250.00	\$49,000.00	Master Mechanic	\$93.84	26.67	106.67	\$10,009.95	\$59,010
238143106170	ARUM168 - LG Multi V5 ASHP (Outdoor Unit)	2	Ea.	\$24,500.00	\$49,000.00	Master Mechanic	\$93.84	32.65	65.30	\$6,127.89	\$55,128
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1	Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064
TOTAL - DIVISION 23 HVAC											\$146,419

DIVISION 26 ELECTRICAL

260505100100	Conduit, rigid galvanized steel, 1/2" to 1" diameter, electrical demolition, remove conduit to 10' high, including fittings & hangers	100	L.F.		\$0.00	Electrician	\$87.69	0.03	3.30	\$289.68	\$290
260505101830	Wire, THW-THWN-THHN, #14, electrical demolition, removed from in place conduit, to 10' high	100	C.L.F.		\$0.00	Electrician	\$87.69	0.12	12.30	\$1,078.61	\$1,079
260519900940	Wire, copper, solid, 600 volt, #12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	15	C.L.F.	\$20.50	\$307.50	Electrician	\$87.69	0.73	10.94	\$959.19	\$1,267
260533131230	Aluminum conduit elbows, 1" diameter, to 10' H	20	Ea.	\$20.50	\$410.00	Electrician	\$87.69	0.29	5.71	\$500.78	\$911
260533131470	Aluminum conduit couplings, 1" diameter, to 10' H	10	Ea.	\$6.45	\$64.50	Electrician	\$87.69	0.05	0.50	\$43.91	\$108
260533131800	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	150	L.F.	\$7.10	\$1,065.00	Electrician	\$87.69	0.12	18.45	\$1,617.92	\$2,683
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20	Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10	Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY SMALL

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
2.62416E+11	42 circuit 225A 3-wire 120/240V panel including 20A breakers and labor to install and reconnect existing circuits	1	Ea.	\$2,500.00	\$2,500.00	Electrician	\$87.69	24.24	24.24	\$2,125.83	\$4,626
262726103800	Low voltage switching, flush switch, standard	2	Ea.	\$18.05	\$36.10	Electrician	\$87.69	0.20	0.40	\$34.98	\$71
262726104200	Low voltage switching, transformer, low voltage switching, 115 V to 25 V	2	Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	1	C.L.F.	\$400.00	\$400.00	Electrician	\$87.69	3.22	3.22	\$281.98	\$682
262726200500	Toggle switch, quiet type, single pole, 20 amp	4	Ea.	\$4.08	\$16.32	Electrician	\$87.69	0.30	1.18	\$103.85	\$120
265113502700	Fluorescent fixture, interior, strip, surface mounted, S.L., 2-75 W, 8' long, incl lamps, mounting hardware and connections	6	Ea.	\$117.00	\$702.00	Electrician	\$87.69	1.29	7.75	\$679.53	\$1,382
TOTAL - DIVISION 26 ELECTRICAL											\$14,265
HEAT PUMP INSTALLATION SUBTOTAL											\$196,554
GENERAL CONDITIONS 15%											\$29,483
OH&P 10%											\$22,604
DESIGN CONTINGENCY 20%											\$49,728
BID CONTINGENCY 5%											\$14,918
PHASING 10%											\$31,329
ENTIRE PROJECT TO DECENTRALIZE SMALL BUILDINGS SUBTOTAL											\$344,616
REQUIRED BUILDING MODIFICATIONS TO OPERATE AT 160°F (JEFFERSON ST. APT. = RESIDENTIAL LR @ \$9.97/SQ-FT RAW COST x 6,237 GSFx 40% OF BLDG AREA) =											\$24,873
PORTION OF ELECTRICAL DISTRIBUTION COSTS FOR SMALL CATEGORY BUILDINGS											\$28,631
TOTAL											\$398,121

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY MEDIUM

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
033053403550+	Structural concrete, in place, equipment pad (3000 psi), 5' x 5' x 8", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	11	Ea.	\$249.00	\$2,739.00	Cement Masons	\$72.62	2.67	29.40	\$2,134.94	\$4,874
38213100300	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time	2	Ea.	\$0.46	\$0.92	Cement Masons	\$72.62	0.89	1.78	\$129.39	\$130
038213100350	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	12	Ea.	\$0.07	\$0.84	Cement Masons	\$72.62	0.02	0.24	\$17.27	\$18
TOTAL - DIVISION 3 CONCRETE											\$5,022
DIVISION 9 FINISHES											
090505300100	Demolish interior block wall	160	SF		\$0.00	Painters	\$62.86	0.182	29.12	\$1,830.47	\$1,830
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	200	L.F.	\$0.93	\$186.00	Painters	\$62.86	0.042	8.40	\$528.02	\$714
099123740840	Paint interior wall surfaces from anticipated demolition of interior walls.	320	SF	\$0.12	\$38.40	Painters	\$62.86	0.01	3.20	\$201.15	\$240
092910301195	Fire rated gypsum wall - level 5 finish	320	SF	\$0.54	\$172.80	Painters	\$62.86	0.026	8.32	\$522.99	\$696
099123525420	Paints & coatings, miscellaneous interior, pipe, paint 3 coats, oil base, brushwork, 1-4" dia	50	L.F.	\$0.47	\$23.50	Painters	\$62.86	0.021	1.05	\$66.00	\$90
TOTAL - DIVISION 9 FINISHES											\$3,569
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.27	5.34	\$458.08	\$458
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.57	11.41	\$978.56	\$979
220505101980	Pipe hanger / support, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.10	2.00	\$171.60	\$172
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	50	L.F.		\$0.00	Plumbers	\$85.78	0.04	2.00	\$171.60	\$172
220505102050+1	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.16	16.00	\$1,372.53	\$1,373
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	10	Ea.		\$0.00	Plumbers	\$85.78	0.29	2.85	\$244.64	\$245
220505109110+1	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	2.00	28.00	\$2,401.92	\$2,402
220553101120	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	40	Ea.	\$3.86	\$154.40	Plumbers	\$85.78	0.13	5.32	\$456.66	\$611
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	20	Ea.	\$3.64	\$72.80	Plumbers	\$85.78	0.20	4.00	\$343.21	\$416

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY MEDIUM

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
220719107630	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 2" iron pipe size	40	L.F.	\$13.35	\$534.00	Plumbers	\$85.78	0.10	4.00	\$343.13	\$877
220719107420	fiberglass with all service jacket, 2" wall, 4" iron pipe size	400	ft	\$8.85	\$3,540.00	Plumbers	\$85.78	0.12	49.20	\$4,220.52	\$7,761
220719107634	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 3" iron pipe size	110	L.F.	\$14.45	\$1,589.50	Plumbers	\$85.78	0.11	12.54	\$1,075.72	\$2,665
221113440610	Pipe, steel, black, threaded, 2" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	40	L.F.	\$18.80	\$752.00	Plumbers	\$85.78	0.25	10.00	\$857.83	\$1,610
221113440630	Pipe, steel, black, threaded, 3" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger assembly sized for covering, 10' OC	110	L.F.	\$40.50	\$4,455.00	Plumbers	\$85.78	0.37	40.92	\$3,510.24	\$7,965
221113457080	2" Union at Heat Pumps	8	Ea.	\$77.50	\$620.00	Plumbers	\$85.78	0.94	7.53	\$645.77	\$1,266
221113457100	3" Union at Buffer Tank	12	Ea.	\$280.00	\$3,360.00	Plumbers	\$85.78	1.78	21.34	\$1,830.27	\$5,190
220523205680	2" safety relief valve	4	Ea.	\$1,725.00	\$6,900.00	Plumbers	\$85.78	0.50	2.00	\$171.57	\$7,072
220523205680	2" safety relief valve	3	Ea.	\$1,725.00	\$5,175.00	Plumbers	\$85.78	0.50	1.50	\$128.67	\$5,304
220523201900	2" check valve	4	Ea.	\$555.00	\$2,220.00	Plumbers	\$85.78	0.73	2.91	\$249.46	\$2,469
220523201920	3" check valve	1	Ea.	\$1,625.00	\$1,625.00	Plumbers	\$85.78	1.23	1.23	\$105.60	\$1,731
221113440650	Pipe, steel, black, threaded, 4" diameter, schedule 40, Spec. A-53, includes coupling and clevis hanger	400	ft	\$59.00	\$23,600.00	Plumbers	\$85.78	0.44	177.60	\$15,235.05	\$38,835
221113455170	Elbow, 90 Deg., steel, malleable iron, black,	20	ft	\$260.00	\$5,200.00	Plumbers	\$85.78	2.67	53.34	\$4,575.66	\$9,776
221113455150	Elbow, 90 Deg., steel, malleable iron, black, straight, threaded, 150 lb., 3"	20	Ea.	\$137.00	\$2,740.00	Plumbers	\$85.78	1.60	32.00	\$2,745.05	\$5,485
221113455560	Tee, steel, malleable iron, black, straight, threaded, 150 lb., 3"	10	Ea.	\$192.00	\$1,920.00	Plumbers	\$85.78	2.67	26.67	\$2,287.83	\$4,208
221113459767	Elbow, 90 Deg., steel, forged steel, black, threaded, 3000 lb., 2"	8	Ea.	\$126.00	\$1,008.00	Plumbers	\$85.78	0.89	7.11	\$610.09	\$1,618
221113475601	Reducer, steel, forged steel, black, socket weld, 3000 lb., schedule 40, 3/8" pipe size, includes 1	14	Ea.	\$62.50	\$875.00	Plumbers	\$85.78	0.63	8.80	\$754.49	\$1,629
221223133080	200 gallon thermal storage tank	3	Ea.	\$7,175.00	\$21,525.00	Plumbers	\$85.78	2.00	6.00	\$514.70	\$22,040
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size, includes 1 weld per joint and weld machine	14	Ea.	\$12.05	\$168.70	Plumbers	\$85.78	0.63	8.80	\$754.49	\$923
221113479805	Pipe fittings, steel, flanged, butt welded or	14	Ea.	\$152.00	\$2,128.00	Plumbers	\$85.78	0.16	2.27	\$194.58	\$2,323
221119340150	Sleeve, pipe, steel with water stop, 12" long, 4" diam. for 4" carrier pipe, includes link seal	1	Ea.	\$162.00	\$162.00	Plumbers	\$85.78	1.33	1.33	\$114.09	\$276
TOTAL - DIVISION 22 PLUMBING											\$137,848

DIVISION 23 HVAC

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY MEDIUM

Cost Works Line Number	Description	Quantity		Material		Labor Type	Rate	Labor			Total
				Unit Price	Total			Labor Unit	Total Labor Hours	Total Labor Cost	
230505100297	Boiler blowdown, selective demolition	5	Ea.		\$0.00	Master Mechanic	\$93.84	1.82	9.09	\$853.29	\$853
230505102770	Heat exchanger, plate type, selective demolition	5	Ea.		\$0.00	Master Mechanic	\$93.84	13.33	66.67	\$6,256.14	\$6,256
232120780180	2" y-type strainer	4	Ea.	\$106.00	\$424.00	Master Mechanic	\$93.84	1.00	4.00	\$375.37	\$799
232120780182	3" y-type strainer	1	Ea.	\$470.00	\$470.00	Master Mechanic	\$93.84	1.46	1.46	\$136.54	\$607
230523805340	Valves, steel, forged, ball, threaded, 1,500 psi, 1/4"	10	Ea.	\$72.00	\$720.00	Master Mechanic	\$93.84	0.33	3.31	\$310.29	\$1,030
230523805410	Valves, steel, forged, ball, threaded, 1,500 psi, 2"	20	Ea.	\$370.00	\$7,400.00	Master Mechanic	\$93.84	0.73	14.54	\$1,364.46	\$8,764
230523805410	Valves, steel, forged, ball, threaded, 1,500 psi, 3"	18	Ea.	\$370.00	\$6,660.00	Master Mechanic	\$93.84	0.73	13.09	\$1,228.02	\$7,888
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	20.00	40.00	\$3,753.68	\$3,754
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2	Ea.		\$0.00	Master Mechanic	\$93.84	12.00	24.00	\$2,252.21	\$2,252
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1	Ea.		\$0.00	Master Mechanic	\$93.84	8.00	8.00	\$750.74	\$751
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	10	Ea.	\$34.50	\$345.00	Master Mechanic	\$93.84	0.25	2.52	\$236.60	\$582
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	14	Ea.	\$209.00	\$2,926.00	Master Mechanic	\$93.84	0.25	3.53	\$331.23	\$3,257
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	4	Ea.	\$25.50	\$102.00	Master Mechanic	\$93.84	0.24	0.96	\$89.67	\$192
232120462000	Steel liquid expansion ASME painted 15 gallon capacity	1	Ea.	\$860.00	\$860.00	Master Mechanic	\$93.84	0.94	0.94	\$88.31	\$948
232120140150	3" air scoop connection to expansion tank	1	Ea.	\$231.00	\$231.00	Master Mechanic	\$93.84	1.23	1.23	\$115.52	\$347
232120760180	Strainer, Y type, bronze body, screwed, 125 lb., 2" pipe size	4	Ea.	\$294.00	\$1,176.00	Master Mechanic	\$93.84	0.62	2.46	\$230.85	\$1,407
232123131060	1/8HP Heat Pump Primary Circulator	4	Ea.	\$1,425.00	\$5,700.00	Master Mechanic	\$93.84	2.67	10.67	\$1,001.11	\$6,701
232123131100	1/3HP Heat Pump Primary Circulator	1	Ea.	\$1,600.00	\$1,600.00	Master Mechanic	\$93.84	2.67	2.67	\$250.28	\$1,850
238146102300	Nordic WH-240	4	Ea.	\$35,000.00	\$140,000.00	Master Mechanic	\$93.84	58.54	234.15	\$21,972.94	\$161,973
238146102280	ARUM241- LG Multi V5 ASHP (Outdoor Unit)	4	Ea.	\$35,000.00	\$140,000.00	Master Mechanic	\$93.84	38.28	153.10	\$14,367.67	\$154,368
15419500100	Rigging ASHP Units to roof of bldg	1	day	\$1,900.00	\$1,900.00	Operator (Crane)	\$87.69	8.00	8.00	\$701.54	\$2,602
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1	Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064
TOTAL - DIVISION 23 HVAC											\$369,244
DIVISION 26 ELECTRICAL											
260505100100	Conduit, rigid galvanized steel, 1/2" to 1" diameter, electrical demolition, remove conduit to 10' high, including fittings & hangers	150	L.F.		\$0.00	Electrician	\$87.69	0.03	4.96	\$434.53	\$435
260505101830	Wire, THW-THWN-THHN, #14, electrical demolition, removed from in place conduit, to 10' high	150	C.L.F.		\$0.00	Electrician	\$87.69	0.12	18.45	\$1,617.92	\$1,618
260519900940	Wire, copper, solid, 600 volt, #12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	22.5	C.L.F.	\$20.50	\$461.25	Electrician	\$87.69	0.73	16.41	\$1,438.79	\$1,900

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY MEDIUM

Cost Works Line Number	Description	Quantity	Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
260533131230	Aluminum conduit elbows, 1" diameter, to 10' H	20 Ea.	\$20.50	\$410.00	Electrician	\$87.69	0.29	5.71	\$500.78	\$911
260533131470	Aluminum conduit couplings, 1" diameter, to 10' H	10 Ea.	\$6.45	\$64.50	Electrician	\$87.69	0.05	0.50	\$43.91	\$108
260533131800	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	225 L.F.	\$7.10	\$1,597.50	Electrician	\$87.69	0.12	27.68	\$2,426.88	\$4,024
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20 Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10 Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386
262416300550	42 circuit 225A 3-wire 120/240V panel including 20A breakers and labor to install and reconnect existing circuits	1 Ea.	\$2,500.00	\$2,500.00	Electrician	\$87.69	24.24	24.24	\$2,125.83	\$4,626
262726103800	Low voltage switching, flush switch, standard	2 Ea.	\$18.05	\$36.10	Electrician	\$87.69	0.20	0.40	\$34.98	\$71
262726104200	Low voltage switching, transformer, low voltage	2 Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	1.5 C.L.F.	\$400.00	\$600.00	Electrician	\$87.69	3.22	4.82	\$422.97	\$1,023
262726200500	Toggle switch, quiet type, single pole, 20 amp	5 Ea.	\$4.08	\$20.40	Electrician	\$87.69	0.30	1.48	\$129.82	\$150
265113502700	Fluorescent fixture, interior, strip, surface mounted, S.L., 2-75 W, 8' long, incl lamps, mounting hardware and connections	9 Ea.	\$117.00	\$1,053.00	Electrician	\$87.69	1.29	11.62	\$1,019.29	\$2,072
TOTAL - DIVISION 26 ELECTRICAL										\$17,986
HEAT PUMP INSTALLATION SUBTOTAL										\$533,670
GENERAL CONDITIONS 15%										\$80,051
OH&P 10%										\$61,372
DESIGN CONTINGENCY 20%										\$135,019
BID CONTINGENCY 5%										\$40,506
PHASING 10%										\$85,062
ENTIRE PROJECT TO DECENTRALIZE SMALL BUILDINGS SUBTOTAL										\$935,679
REQUIRED BUILDING MODIFICATIONS TO OPERATE AT 160°F (EUCLID GARDENS = CLASSROOM @ \$20.72/SQ-FT RAW COST x 29,711 GSFx 40% OF BLDG AREA) =										\$246,245
PORTION OF ELECTRICAL DISTRIBUTION COSTS FOR MEDIUM CATEGORY BUILDINGS										\$137,372
TOTAL										\$1,319,296

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY LARGE

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
DIVISION 3 CONCRETE											
33053403590	Structural concrete, in place, equipment pad (3000 psi),10' x 10' x 12" , includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	3	Ea.	\$1,125.00	\$3,375.00	Cement Masons	\$72.62	9.60	28.80	\$2,091.37	\$5,466
33053403580	Structural concrete, in place, equipment pad (3000 psi),8' x 8' x 10", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	2	Ea.	\$680.00	\$1,360.00	Cement Masons	\$72.62	6.00	12.00	\$871.40	\$2,231
33053403540	Structural concrete, in place, equipment pad (3000 psi),3' x 3' x 6", includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing	4	Ea.	\$95.50	\$382.00	Cement Masons	\$72.62	1.07	4.27	\$309.93	\$692
038213100700	Concrete core drilling, core, reinforced concrete slab, 6" diameter, up to 6" thick slab, includes bit cost, layout and set up time	6	Ea.	\$0.97	\$5.82	Cement Masons	\$72.62	1.14	6.86	\$498.01	\$504
038213100350	Concrete core drilling, core, reinforced concrete slab, 3" diameter, up to 6" thick slab, includes bit cost, layout and set up time, for each additional inch of slab thickness in same hole, add	36	Ea.	\$0.16	\$5.76	Cement Masons	\$72.62	0.04	1.58	\$115.03	\$121
TOTAL - DIVISION 3 CONCRETE											\$9,014
DIVISION 5 STEEL											
51223790050	Structrual steel beam W6c9, A992 steel shop fabricated bolted connections. Rooftop support steel for ASHP	200	LF	\$15.95	\$3,190.00	Cement Masons	\$72.62	0.08	15.60	\$1,132.83	\$4,323
220719107638	4" Steel Post Supports for dunnage	36	L.F.	\$13.35	\$480.60	Plumbers	\$85.78	0.15	5.22	\$447.79	\$928
77116200100	Pitch Pocket	12	Ea.	\$45.50	\$546.00	Cement Masons	\$72.62	0.17	2.00	\$145.52	\$692
TOTAL - DIVISION 5 STEEL											\$5,943
DIVISION 22 PLUMBING											
220505101900	Pipe fittings with a single connection, up thru 1-1/2" diameter, selective demolition	30	Ea.		\$0.00	Plumbers	\$85.78	0.27	8.01	\$687.12	\$687
220505101910	Pipe fittings with a single connection, 2" thru 4" diameter, selective demolition	20	Ea.		\$0.00	Plumbers	\$85.78	0.86	17.20	\$1,475.47	\$1,475
220505101980	Pipe hanger / support, selective demolition	30	Ea.		\$0.00	Plumbers	\$85.78	0.10	3.00	\$257.40	\$257
220505102000	Pipe, metal pipe, to 1-1/2" diam., selective demolition	75	L.F.		\$0.00	Plumbers	\$85.78	0.04	3.00	\$257.40	\$257
220505102050+2	Pipe, metal pipe, 2" to 3-1/2" diam., selective demolition	100	L.F.		\$0.00	Plumbers	\$85.78	0.27	27.00	\$2,316.14	\$2,316
220505109100	Valves or strainers and similar, metal, up thru 1-1/2" diameter, selective demolition	15	Ea.		\$0.00	Plumbers	\$85.78	0.29	4.28	\$366.96	\$367
220505109110+2	Valves, strainers and similar, metal, 2" thru 3" diameter, selective demolition	14	Ea.		\$0.00	Plumbers	\$85.78	3.00	42.00	\$3,602.88	\$3,603
220553101120	Piping system identification labels, pipe markers, indicate contents and flow direction, self adhesive, 4" pipe	60	Ea.	\$3.86	\$231.60	Plumbers	\$85.78	0.13	7.99	\$684.99	\$917
220553102200	Piping system identification labels, valve tags, numbered plus identifying legend, plastic, 1-1/2" diam.	20	Ea.	\$3.64	\$72.80	Plumbers	\$85.78	0.20	4.00	\$343.21	\$416

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY LARGE

Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
220719107638	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 4" iron pipe size	440	L.F.	\$13.35	\$5,874.00	Plumbers	\$85.78	0.15	63.80	\$5,472.95	\$11,347
220719107642	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 3" wall, 6" iron pipe size	190	L.F.	\$16.15	\$3,068.50	Plumbers	\$85.78	0.20	38.00	\$3,259.75	\$6,328
221113476520	6" Steel Flange	16	Ea.	\$58.00	\$928.00	Plumbers	\$85.78	2.40	38.40	\$3,294.07	\$4,222
221113457100	4" Steel Flange	14	Ea.	\$40.00	\$560.00	Plumbers	\$85.78	1.60	22.40	\$1,921.54	\$2,482
220523205680	2" safety relief valve	7	Ea.	\$1,725.00	\$12,075.00	Plumbers	\$85.78	0.50	3.50	\$300.24	\$12,375
221119143490	4" Flexible Pipe Connectors	10	Ea.	\$415.00	\$4,150.00	Plumbers	\$85.78	1.67	16.67	\$1,430.00	\$5,580
221113442130	Pipe steel black welded 6" schedule 40, Spec. A-53, includes yoike & roll hanger assembly, sized for covering 10'OC	190	ft	\$86.50	\$16,435.00	Plumbers	\$85.78	0.67	126.73	\$10,871.27	\$27,306
221113442110	Pipe steel black welded 4" schedule 40, Spec. A-53, includes yoike & roll hanger assembly, sized for covering 10'OC	480	ft	\$47.50	\$22,800.00	Plumbers	\$85.78	0.43	207.36	\$17,787.95	\$40,588
221113473140	Elbow, 90 Deg., steel, carbon steel, black, long radius butt weld standard weight 6" pipe. Includes 1 weld per joint and weld machine	34	Ea.	\$93.50	\$3,179.00	Plumbers	\$85.78	4.80	163.20	\$13,999.78	\$17,179
221113473130	Elbow, 90 Deg., steel, carbon steel, black, long radius butt weld standard weight 4" pipe. Includes 1	26	Ea.	\$44.50	\$1,157.00	Plumbers	\$85.78	3.20	83.20	\$7,137.14	\$8,294
221113473450	Tee, steel, carbon steel butt weld standard weight,.6"	7	Ea.	\$192.00	\$1,344.00	Plumbers	\$85.78	2.67	18.67	\$1,601.48	\$2,945
221113473440	Tee, steel, carbon steel butt weld standard weight,.4"	8	Ea.	\$90.00	\$720.00	Plumbers	\$85.78	5.33	42.64	\$3,657.78	\$4,378
221119143510	6" Flexible Pipe Connectors	8	Ea.	\$640.00	\$5,120.00	Plumbers	\$85.78	2.11	16.84	\$1,444.58	\$6,565
221223133200	1500 gallon thermal storage tank	2	Ea.	\$28,900.00	\$57,800.00	Plumbers	\$85.78	8.00	16.00	\$1,372.53	\$59,173
221113475631	Nozzle, steel, T-O-L, weld-on, 3/8" pipe size, includes 1 weld per joint and weld machine	14	Ea.	\$12.05	\$168.70	Plumbers	\$85.78	0.63	8.80	\$754.49	\$923
221113479805	Pipe fittings, steel, flanged, butt welded or mechanical joint, minimum labor/equipment charge	14	Ea.	\$152.00	\$2,128.00	Plumbers	\$85.78	0.16	2.27	\$194.58	\$2,323
221119340150	Sleeve, pipe, steel with water stop, 12" long, 4" diam. for 4" carrier pipe, includes link seal	4	Ea.	\$162.00	\$648.00	Plumbers	\$85.78	1.33	5.32	\$456.37	\$1,104
TOTAL - DIVISION 22 PLUMBING											\$223,408
DIVISION 23 HVAC											
230505100297	Boiler blowdown, selective demolition	10	Ea.		\$0.00	Master Mechanic	\$93.84	1.82	18.19	\$1,706.59	\$1,707
230505102770	Heat exchanger, plate type, selective demolition	10	Ea.		\$0.00	Master Mechanic	\$93.84	13.33	133.33	\$12,512.28	\$12,512
232120781060	4" y-type strainer	5	Ea.	\$505.00	\$2,525.00	Master Mechanic	\$93.84	5.33	26.65	\$2,500.89	\$5,026
232120781100	6" y-type strainer	4	Ea.	\$1,000.00	\$4,000.00	Master Mechanic	\$93.84	8.00	32.00	\$3,002.95	\$7,003
230523802060	150lb 4" Gate Valve flanged	14	Ea.	\$1,800.00	\$25,200.00	Master Mechanic	\$93.84	5.33	74.62	\$7,002.50	\$32,202
230523802070	150lb 6" Gate Valve flanged	8	Ea.	\$2,800.00	\$22,400.00	Master Mechanic	\$93.84	8.00	64.00	\$6,005.89	\$28,406
230523805410	Valves, steel, forged, ball, threaded, 1,500 psi, 3"	2	Ea.	\$370.00	\$740.00	Master Mechanic	\$93.84	0.73	1.45	\$136.45	\$876

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY LARGE

Cost Works Line Number	Description	Quantity	Material		Labor					Total
			Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
230593200080	Balancing, water, boiler, (Subcontractor's quote including material & labor)	2 Ea.		\$0.00	Master Mechanic	\$93.84	40.00	80.00	\$7,507.37	\$7,507
230593201000	Balancing, water, pumps, (Subcontractor's quote including material & labor)	2 Ea.		\$0.00	Master Mechanic	\$93.84	34.00	68.00	\$6,381.26	\$6,381
230593500140	Pipe testing, nondestructive hydraulic pressure test, isolate, 1 hour hold, 1" to 4" pipe, 0-250 LF	1 Ea.		\$0.00	Master Mechanic	\$93.84	16.00	16.00	\$1,501.47	\$1,501
230953102400	Control component, gauges, pressure or vacuum, 4-1/2" diameter dial	36 Ea.	\$34.50	\$1,242.00	Master Mechanic	\$93.84	0.25	9.08	\$851.74	\$2,094
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	14 Ea.	\$209.00	\$2,926.00	Master Mechanic	\$93.84	0.25	3.53	\$331.23	\$3,257
232120301040	Cocks, drains and specialties, boiler drain, bronze, pipe thread to hose, 3/4" size	7 Ea.	\$25.50	\$178.50	Master Mechanic	\$93.84	0.24	1.67	\$156.93	\$335
232120462080	Steel liquid expansion ASME painted 60 gallon capacity	1 Ea.	\$1,425.00	\$1,425.00	Master Mechanic	\$93.84	2.00	2.00	\$187.68	\$1,613
232120140160	4" air scoop connection to expansion tank	1 Ea.	\$530.00	\$530.00	Master Mechanic	\$93.84	5.33	5.33	\$500.18	\$1,030
232120180800	Air Vents	5 Ea.	\$1,675.00	\$8,375.00	Master Mechanic	\$93.84	1.33	6.67	\$625.46	\$9,000
232120260140	Circuit Setter Balancing Valves	5 Ea.	\$1,550.00	\$7,750.00	Master Mechanic	\$93.84	5.33	26.65	\$2,500.89	\$10,251
232123135410	5HP Circulators	4 Ea.	\$13,100.00	\$52,400.00	Master Mechanic	\$93.84	10.67	42.67	\$4,004.05	\$56,404
232123131100	1/3HP Heat Pump Primary Circulator	1 Ea.	\$1,600.00	\$1,600.00	Master Mechanic	\$93.84	2.67	2.67	\$250.28	\$1,850
236416100279	Trane RTHD 300 Ton	2 Ea.	\$1,200,000.00	\$2,400,000.00	Master Mechanic	\$93.84	234.00	468.00	\$43,918.10	\$2,443,918
237433107420	ACXA-215 Arrangement	3 Ea.	Included in RTHD Above		Master Mechanic	\$93.84	327.00	981.00	\$92,059.10	\$92,059
15419500100	Rigging ACXA Units to roof of bldg extension	2 day	\$1,900.00	\$3,800.00	Operator (Crane)	\$87.68	8.00	16.00	\$1,402.91	\$5,203
235324100230	Shot chemical feeder, by pass, in line mount, 300 PSIG, 12 gallon	1 Ea.	\$435.00	\$435.00	Master Mechanic	\$93.84	17.36	17.36	\$1,629.02	\$2,064
TOTAL - DIVISION 23 HVAC										\$2,732,202

DIVISION 26 ELECTRICAL

260000	Electrical associated with new building lighting, power, FA, etc. included in new building extension cost			\$0.00	Electrician	\$87.69		0.00	\$0.00	\$0
260519902600	350kcmil type THHN normal installation coinditions conduit, Wire Copper	18 C.F.F	\$990.00	\$17,820.00	Electrician	\$87.69	4.44	79.99	\$7,014.66	\$24,835
260519901650	Wire, copper, solid, 600 volt, 2/0, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	1.2 C.L.F.	\$390.00	\$468.00	Electrician	\$87.69	2.76	3.31	\$290.33	\$758
262419407870	5HP Combination Motor Starter/Disconnect	4 Ea.	\$805.00	\$3,220.00	Electrician	\$87.69	5.71	22.86	\$2,004.29	\$5,224
262816202500	600A Disconnects	5 Ea.	\$3,775.00	\$18,875.00	Electrician	\$87.69	17.02	85.11	\$7,463.03	\$26,338
260519901200	Wire, copper, solid, 600 volt,#12, type THWN-THHN, normal installation conditions in wireway, conduit, cable tray	6.4 C.L.F.	\$52.50	\$336.00	Electrician	\$87.69	0.73	4.65	\$408.01	\$744
260533131930	Rigid galvanized steel conduit, 1" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	160 LF	\$7.10	\$1,136.00	Electrician	\$87.69	0.12	19.68	\$1,725.78	\$2,862
260533131930	Rigid galvanized steel conduit, 3" diameter, to 10' H, incl 2 terminations, 2 elbows, 11 beam clamps, and 11 couplings per 100 LF	120 L.F.	\$33.00	\$3,960.00	Electrician	\$87.69	0.32	38.40	\$3,367.37	\$7,327
260533136540	EMT boxes connectors, set screw, steel, 1" diameter, to 15' H	20 Ea.	\$3.75	\$75.00	Electrician	\$87.69	0.09	1.77	\$155.63	\$231
260533160150	Outlet boxes, pressed steel, 4" square	10 Ea.	\$3.15	\$31.50	Electrician	\$87.69	0.40	4.04	\$354.40	\$386

TASK 2D - DECENTRALIZE W/HEAT PUMPS: CATEGORY LARGE											
Cost Works Line Number	Description	Quantity		Material		Labor					Total
				Unit Price	Total	Labor Type	Rate	Labor Unit	Total Labor Hours	Total Labor Cost	
262416303190	480V Panelboards	6	Ea.	\$3,825.00	\$22,950.00	Electrician	\$87.69	10.00	60.00	\$5,261.52	\$28,212
262726104200	Low voltage switching, transformer, low voltage switching, 115 V to 25 V	2	Ea.	\$157.00	\$314.00	Electrician	\$87.69	0.67	1.34	\$117.11	\$431
262726107600	Low voltage switching, control wire, 19 conductor	1.5	C.L.F.	\$400.00	\$600.00	Electrician	\$87.69	3.22	4.82	\$422.97	\$1,023
262726200500	Toggle switch, quiet type, single pole, 20 amp	5	Ea.	\$4.08	\$20.40	Electrician	\$87.69	0.30	1.48	\$129.82	\$150
	Digital Control Points wiring and terminations	50	Ea.	\$1,000.00	\$50,000.00	Electrician	\$87.69	4.00	200.00	\$17,538.40	\$67,538
TOTAL - DIVISION 26 ELECTRICAL											\$166,059
NEW BUILDING EXTENSION											
	Building extension for WSHP's block construction, including basic MEP infrastructure needed for personnel operations, this does not include any mechanical or electrical equipment for equipment	660	SF	\$350.00	\$231,000.00	Cement Masons	\$72.62	2.60	1,716.00	\$124,610.86	\$355,611
TOTAL - NEW BUILDING EXTENSION											\$355,611
HEAT PUMP INSTALLATION SUBTOTAL											\$3,492,237
GENERAL CONDITIONS										15%	\$523,835
OH&P										10%	\$401,607
DESIGN CONTINGENCY										20%	\$883,536
BID CONTINGENCY										5%	\$265,061
PHASING										10%	\$556,628
ENTIRE PROJECT TO DECENTRALIZE LARGE BUILDINGS W/HEAT PUMPS SUBTOTAL											\$6,122,903
REQUIRED BUILDING MODIFICATIONS TO OPERATE AT 160°F (RIVERWALK JAMA = LAB @ \$31.30/SQ-FT RAW COST x 82,624 GSFx 40% OF BLDG AREA) =											\$1,034,452
PORTION OF ELECTRICAL DISTRIBUTION COSTS FOR LARGE CATEGORY BUILDINGS											\$783,716
TOTAL											\$7,941,072

Estimate Detail

PROJECT: Jamestown TWO

Task 2D Decentralize

Project # 1940103342-001

ESTIMATE NO. Task 2D-01

TRADE: Elec.

PREPARED BY: MJM

CHECKED BY: -

SHEET NO. 1 of 6

DATE: 07/07/23

DATE: -

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
Jamestown BPU – Electrical Distribution System Upgrades Required to Decentralize with Heat Pumps											
Div 26	Electrical Distribution Upgrades										
	208V Secondary										
26 22 13	15kV or 5kV/208V Sec Transformer Replacement										
	50 kVA Transformer & Secondary Service Feed	0 ea	–	6,767	–	21	88	1,882	–	104	0
2940	50 kVA Transformer	1 ea	5,925.00	5,925	12.97	13	88	1,138	83.00	83	
6240	2/0 (208V)	200 ft	4.15	830	0.02	4	88	394	0.11	21	
0200	Cable Terminations	8 ea	1.54	12	0.50	4	88	351		0	
	75 kVA Transformer & Secondary Service Feed	4 ea	–	9,773	–	35	88	3,036	–	147	51,826
2950	75 kVA Transformer	1 ea	7,775.00	7,775	16.00	16	88	1,403	102.00	102	
6280	300 KCMIL (208V)	200 ft	9.85	1,970	0.05	9	88	831	0.23	45	
0400	Cable Terminations	8 ea	3.48	28	1.14	9	88	802		0	
	125 kVA Transformer & Secondary Service Feed	1 ea	–	31,799	–	114	88	9,997	–	605	42,401
5410	125kVA Transformer	1 ea	11,200.00	11,200	30.77	31	88	2,698	264.00	264	
1.4546	700 KCMIL (208V)	800 ft	25.63	20,504	0.09	71	88	6,220	0.43	341	
0550	Cable Terminations	8 ea	11.85	95	1.54	12	88	1,079		0	
26 22 13	5 kV/208V Sec Transformer Replacement										
	150 kVA Transformer & Secondary Service Feed	5 ea	–	23,374	–	105	88	9,228	–	552	165,769
5410	150kVA Transformer	1 ea	11,200.00	11,200	30.77	31	88	2,698	264.00	264	
6270	(2) Sets 250 KCMIL (208V)	1600 ft	7.58	12,120	0.04	60	88	5,282	0.18	288	
0350	Cable Terminations	16 ea	3.38	54	0.89	14	88	1,247		0	
	250 kVA Transformer & Secondary Service Feed	3 ea	–	53,698	–	203	88	17,787	–	992	217,428
5420	250kVA Transformer	1 ea	12,500.00	12,500	36.36	36	88	3,189	310.00	310	
1.4546	(2) Sets 700 KCMIL (208V)	1600 ft	25.63	41,008	0.09	142	88	12,440	0.43	682	
0550	Cable Terminations	16 ea	11.85	190	1.54	25	88	2,158		0	

Estimate Detail

PROJECT:	Jamestown TWO
	Task 2D Decentralize
	Project # 1940103342-001

ESTIMATE NO.	Task 2D-01	SHEET NO.	2 of 6
TRADE:	Elec.	DATE:	07/07/23
PREPARED BY:	MJM	DATE:	-
CHECKED BY:	-		

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
	300 kVA Transformer & Secondary Service Feed	0 ea	-	41,502	-	243	88	21,334	-	1,083	0
5430	300kVA Transformer	1 ea	16,100.00	16,100	44.44	44	88	3,897	380.00	380	
6290	(3) Sets 500 KCMIL (208V)	2400 ft	10.50	25,200	0.07	167	88	14,631	0.29	703	
0450	Cable Terminations	24 ea	8.40	202	1.33	32	88	2,805		0	
	500 kVA Transformer & Secondary Service Feed	3 ea	-	107,045	-	419	88	36,732	-	1,873	436,949
5440	500kVA Transformer	1 ea	21,500.00	21,500	57.14	57	88	5,011	490.00	490	
1.4546	(4) Sets 700 KCMIL (208V)	3200 ft	25.63	82,016	0.09	284	88	24,879	0.43	1,364	
0450	Cable Terminations	32 ea	11.85	379	1.54	49	88	4,316		0	
033053403590	Concrete Pad	3 ea	1,050.00	3,150	9.60	29	88	2,526	6.25	19	
	1000 kVA Transformer & Secondary Service Feed	2 ea	-	181,674	-	642	88	56,284	-	2,631	481,178
5460	1000 kVA Transformer	1 ea	43,100.00	43,100	66.67	67	88	5,846	535.00	535	
1.7778	(5) Sets 1000 KCMIL (208V)	4000 ft	34.00	136,000	0.12	494	88	43,352	0.52	2,084	
0550	Cable Terminations	40 ea	11.85	474	1.54	62	88	5,402		0	
033053403590	Concrete Pad	2 ea	1,050.00	2,100	9.60	19	88	1,684	6.25	13	
	1500 kVA Transformer & Secondary Service Feed	4 ea	-	332,648	-	1,224	88	107,371	-	4,827	1,779,386
5470	1500kVA Transformer	1 ea	55,500.00	55,500	74.07	74	88	6,496	635.00	635	
1.7778	(10) Sets 1000 KCMIL (208V)	8000 ft	34.00	272,000	0.12	989	88	86,705	0.52	4,167	
0550	Cable Terminations	80 ea	11.85	948	1.54	123	88	10,804		0	
033053403590	Concrete Pad	4 ea	1,050.00	4,200	9.60	38	88	3,367	6.25	25	
26 22 13	15 kV/208V Sec Transformer Replacement										
	150 kVA Transformer & Secondary Service Feed	0 ea	-	37,774	-	105	88	9,228	-	552	0
5610	150kVA Transformer	1 ea	25,600.00	25,600	30.77	31	88	2,698	264.00	264	
6270	(2) Sets 250 KCMIL (208V)	1600 ft	7.58	12,120	0.04	60	88	5,282	0.18	288	
0350	Cable Terminations	16 ea	3.38	54	0.89	14	88	1,247		0	
	250 kVA Transformer & Secondary Service Feed	1 ea	-	71,398	-	203	88	17,787	-	992	90,176
5620	250kVA Transformer	1 ea	30,200.00	30,200	36.36	36	88	3,189	310.00	310	
1.4546	(2) Sets 700 KCMIL (208V)	1600 ft	25.63	41,008	0.09	142	88	12,440	0.43	682	
0550	Cable Terminations	16 ea	11.85	190	1.54	25	88	2,158		0	
	300 kVA Transformer & Secondary Service Feed	0 ea	-	58,602	-	243	88	21,334	-	1,083	0
5630	300kVA Transformer	1 ea	33,200.00	33,200	44.44	44	88	3,897	380.00	380	
6290	(3) Sets 500 KCMIL (208V)	2400 ft	10.50	25,200	0.07	167	88	14,631	0.29	703	
0450	Cable Terminations	24 ea	8.40	202	1.33	32	88	2,805		0	
	500 kVA Transformer & Secondary Service Feed	0 ea	-	118,695	-	390	88	34,206	-	1,854	0
5660	500kVA Transformer	1 ea	36,300.00	36,300	57.14	57	88	5,011	490.00	490	

Estimate Detail

PROJECT:	Jamestown TWO
	Task 2D Decentralize
	Project # 1940103342-001

ESTIMATE NO.	Task 2D-01	SHEET NO.	3 of 6
TRADE:	Elec.	DATE:	07/07/23
PREPARED BY:	MJM	DATE:	-
CHECKED BY:	-		

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1.4546	(4) Sets 700 KCMIL (208V)	3200 ft	25.63	82,016	0.09	284	88	24,879	0.43	1,364	
0450	Cable Terminations	32 ea	11.85	379	1.54	49	88	4,316		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	
	1000 kVA Transformer & Secondary Service Feed	1 ea	-	186,124	-	632	88	55,442	-	2,625	244,191
5660	1000 kVA Transformer	1 ea	48,600.00	48,600	66.67	67	88	5,846	535.00	535	
1.7778	(5) Sets 1000 KCMIL (208V)	4000 ft	34.00	136,000	0.12	494	88	43,352	0.52	2,084	
0550	Cable Terminations	40 ea	11.85	474	1.54	62	88	5,402		0	
033053403590	Concrete Pad	1 ea	1,050.00	1,050	9.60	10	88	842	6.25	6	
	1500 kVA Transformer & Secondary Service Feed	2 ea	-	329,548	-	1,205	88	105,688	-	4,815	880,101
5670	1500kVA Transformer	1 ea	54,500.00	54,500	74.07	74	88	6,496	635.00	635	
1.7778	(10) Sets 1000 KCMIL (208V)	8000 ft	34.00	272,000	0.12	989	88	86,705	0.52	4,167	
0550	Cable Terminations	80 ea	11.85	948	1.54	123	88	10,804		0	
033053403590	Concrete Pad	2 ea	1,050.00	2,100	9.60	19	88	1,684	6.25	13	
	480V Secondary										
26 22 13	15kV or 5kV/480V Sec Transformer Replacement										
	50 kVA Transformer & Secondary Service Feed	0 ea	-	6,417	-	19	88	1,670	-	98	0
2940	50 kVA Transformer	1 ea	5,925.00	5,925	12.97	13	88	1,138	83.00	83	
6220	3AWG (480V)	200 ft	2.43	485	0.02	3	88	277	0.08	15	
0150	Cable Terminations	8 ea	0.83	7	0.36	3	88	255		0	
	75 kVA Transformer & Secondary Service Feed	0 ea	-	8,552	-	23	88	1,993	-	120	0
2950	75 kVA Transformer	1 ea	7,775.00	7,775	16.00	16	88	1,403	102.00	102	
6230	1AWG (480V)	200 ft	3.85	770	0.02	4	88	335	0.09	18	
0150	Cable Terminations	8 ea	0.83	7	0.36	3	88	255		0	
	125 kVA Transformer & Secondary Service Feed	0 ea	-	15,653	-	57	88	4,962	-	362	0
5410	125kVA Transformer	1 ea	11,200.00	11,200	30.77	31	88	2,698	264.00	264	
6250	3/0 (480V)	800 ft	5.48	4,380	0.03	20	88	1,796	0.12	98	
0250	Cable Terminations	8 ea	9.10	73	0.67	5	88	468		0	
26 22 13	5 kV/480V Sec Transformer Replacement										
	150 kVA Transformer & Secondary Service Feed	0 ea	-	16,624	-	60	88	5,296	-	378	0
5410	150kVA Transformer	1 ea	11,200.00	11,200	30.77	31	88	2,698	264.00	264	
6260	4/0 (480V)	800 ft	6.38	5,100	0.03	24	88	2,088	0.14	114	
0300	Cable Terminations	8 ea	40.50	324	0.73	6	88	510		0	
	250 kVA Transformer & Secondary Service Feed	0 ea	-	20,967	-	96	88	8,400	-	544	0
5420	250kVA Transformer	1 ea	12,500.00	12,500	36.36	36	88	3,189	310.00	310	

Estimate Detail

PROJECT: Jamestown TWO

Task 2D Decentralize

Project # 1940103342-001

ESTIMATE NO. Task 2D-01

TRADE: Elec.

PREPARED BY: MJM

CHECKED BY: -

SHEET NO. 4 of 6

DATE: 07/07/23

DATE: -

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
6290	500 KCMIL (480V)	800 ft	10.50	8,400	0.06	49	88	4,276	0.29	234	
0450	Cable Terminations	8 ea	8.40	67	1.33	11	88	935		0	
	300 kVA Transformer & Secondary Service Feed	0 ea	-	36,699	-	128	88	11,196	-	721	0
5430	300kVA Transformer	1 ea	16,100.00	16,100	44.44	44	88	3,897	380.00	380	
1.4546	700 KCMIL (480V)	800 ft	25.63	20,504	0.09	71	88	6,220	0.43	341	
0550	Cable Terminations	8 ea	11.85	95	1.54	12	88	1,079		0	
	500 kVA Transformer & Secondary Service Feed	0 ea	-	38,434	-	176	88	15,433	-	959	0
5440	500kVA Transformer	1 ea	21,500.00	21,500	57.14	57	88	5,011	490.00	490	
6290	(2) Sets 500 KCMIL (480V)	1600 ft	10.50	16,800	0.06	98	88	8,552	0.29	469	
0450	Cable Terminations	16 ea	8.40	134	1.33	21	88	1,870		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	
	1000 kVA Transformer & Secondary Service Feed	1 ea	-	69,552	-	255	88	22,321	-	1,244	93,118
5460	1000 kVA Transformer	1 ea	43,100.00	43,100	66.67	67	88	5,846	535.00	535	
6290	(3) Sets 500 KCMIL (480V)	2400 ft	10.50	25,200	0.06	146	88	12,828	0.29	703	
0450	Cable Terminations	24 ea	8.40	202	1.33	32	88	2,805		0	
033053403590	Concrete Pad	1 ea	1,050.00	1,050	9.60	10	88	842	6.25	6	
	1500 kVA Transformer & Secondary Service Feed	0 ea	-	158,494	-	490	88	42,990	-	2,340	0
5470	1500kVA Transformer	1 ea	55,500.00	55,500	74.07	74	88	6,496	635.00	635	
1.4546	(5) Sets 750 KCMIL (480V)	4000 ft	25.63	102,520	0.09	355	88	31,099	0.43	1,705	
0550	Cable Terminations	40 ea	11.85	474	1.54	62	88	5,395		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	
	2000 kVA Transformer & Secondary Service Feed	0 ea	-	276,769	-	674	88	59,109	-	3,185	0
5480	2000kVA Transformer	1 ea	113,000.00	113,000	80.00	80	88	7,015	685.00	685	
1.7778	(6) Sets 1000 KCMIL (480V)	4800 ft	34.00	163,200	0.11	520	88	45,611	0.52	2,500	
0550	Cable Terminations	48 ea	11.85	569	1.54	74	88	6,482		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	
	3000 kVA Transformer & Secondary Service Feed	0 ea	-	412,153	-	1,002	88	87,874	-	4,705	0
5500	3000kVA Transformer	1 ea	166,500.00	166,500	111.00	111	88	9,734	955.00	955	
1.7778	(9) Sets 1000 KCMIL (480V)	7200 ft	34.00	244,800	0.11	780	88	68,417	0.52	3,750	
0550	Cable Terminations	72 ea	11.85	853	1.54	111	88	9,723		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	

Estimate Detail

PROJECT:	Jamestown TWO
	Task 2D Decentralize
	Project # 1940103342-001

ESTIMATE NO.	Task 2D-01	SHEET NO.	3 of 6
TRADE:	Elec.	DATE:	07/07/23
PREPARED BY:	MJM	DATE:	-
CHECKED BY:	-		

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
26 22 13	15 kV/480V Sec Transformer Replacement										
	150 kVA Transformer & Secondary Service Feed	0 ea	-	31,024	-	60	88	5,296	-	378	0
5610	150kVA Transformer	1 ea	25,600.00	25,600	30.77	31	88	2,698	264.00	264	
6260	4/0 (480V)	800 ft	6.38	5,100	0.03	24	88	2,088	0.14	114	
0300	Cable Terminations	8 ea	40.50	324	0.73	6	88	510		0	
	250 kVA Transformer & Secondary Service Feed	0 ea	-	38,667	-	96	88	8,400	-	544	0
5620	250kVA Transformer	1 ea	30,200.00	30,200	36.36	36	88	3,189	310.00	310	
6290	500 KCMIL (480V)	800 ft	10.50	8,400	0.06	49	88	4,276	0.29	234	
0450	Cable Terminations	8 ea	8.40	67	1.33	11	88	935		0	
	300 kVA Transformer & Secondary Service Feed	0 ea	-	53,799	-	128	88	11,196	-	721	0
5630	300kVA Transformer	1 ea	33,200.00	33,200	44.44	44	88	3,897	380.00	380	
1.4546	700 KCMIL (480V)	800 ft	25.63	20,504	0.09	71	88	6,220	0.43	341	
0550	Cable Terminations	8 ea	11.85	95	1.54	12	88	1,079		0	
	500 kVA Transformer & Secondary Service Feed	1 ea	-	54,284	-	186	88	16,275	-	965	71,525
5640	500kVA Transformer	1 ea	36,300.00	36,300	57.14	57	88	5,011	490.00	490	
6290	(2) Sets 500 KCMIL (480V)	1600 ft	10.50	16,800	0.06	98	88	8,552	0.29	469	
0450	Cable Terminations	16 ea	8.40	134	1.33	21	88	1,870		0	
033053403590	Concrete Pad	1 ea	1,050.00	1,050	9.60	10	88	842	6.25	6	
	750 kVA Transformer & Secondary Service Feed	0 ea	-	64,302	-	241	88	21,114	-	1,238	0
5650	750kVA Transformer	1 ea	38,900.00	38,900	62.50	63	88	5,481	535.00	535	
6290	(3) Sets 500 KCMIL (480V)	2400 ft	10.50	25,200	0.06	146	88	12,828	0.29	703	
0450	Cable Terminations	24 ea	8.40	202	1.33	32	88	2,805		0	
033053403590	Concrete Pad	0 ea	1,050.00	0	9.60	0	88	0	6.25	0	
	1500 kVA Transformer & Secondary Service Feed	1 ea	-	158,544	-	500	88	43,832	-	2,346	204,722
5670	1500kVA Transformer	1 ea	54,500.00	54,500	74.07	74	88	6,496	635.00	635	
1.4546	(5) Sets 750 KCMIL (480V)	4000 ft	25.63	102,520	0.09	355	88	31,099	0.43	1,705	
0550	Cable Terminations	40 ea	11.85	474	1.54	62	88	5,395		0	
033053403590	Concrete Pad	1 ea	1,050.00	1,050	9.60	10	88	842	6.25	6	
	2000 kVA Transformer & Secondary Service Feed	3 ea	-	229,419	-	703	88	61,634	-	3,204	882,772
5680	2000kVA Transformer	1 ea	62,500.00	62,500	80.00	80	88	7,015	685.00	685	
1.7778	(6) Sets 1000 KCMIL (480V)	4800 ft	34.00	163,200	0.11	520	88	45,611	0.52	2,500	
0550	Cable Terminations	48 ea	11.85	569	1.54	74	88	6,482		0	
033053403590	Concrete Pad	3 ea	1,050.00	3,150	9.60	29	88	2,526	6.25	19	
	3000 kVA Transformer & Secondary Service Feed	3 ea	-	317,653	-	1,002	88	87,874	-	4,705	1,230,698
5700	3000kVA Transformer	1 ea	72,000.00	72,000	111.00	111	88	9,734	955.00	955	

Estimate Detail

PROJECT: Jamestown TWO

Task 2D Decentralize

Project # 1940103342-001

ESTIMATE NO. Task 2D-01

TRADE: Elec.

SHEET NO. 8 of 6

PREPARED BY: MJM

DATE: 07/07/23

CHECKED BY: —

DATE: —

SECTION	DESCRIPTION	QUANTITY	MATERIALS		LABOR				EQUIPMENT		TOTAL
			UNIT PRICE	AMOUNT	UNIT M.H.	TOTAL M.H.	RATE	AMOUNT	UNIT PRICE	AMOUNT	
1.7778	(9) Sets 1000 KCMIL (480V)	7200 ft	34.00	244,800	0.11	780	88	68,417	0.52	3,750	
0550	Cable Terminations	72 ea	11.85	853	1.54	111	88	9,723		0	
	Convert St. James Church, First Lutheran Church, Prendergast Library, & Chautauqua Opportunities from Overhead to Direct Buried Feed										
-	Direct Buried Feed										
	Duried Buried Feed	800 ft	450.00	360,000	1.71	1,368	88	119,963	0.43	341	480,304
	Primary Feeder Upgrades										
26 05 13	15kV Primary Feeder Replacement										
	Primary Feeder S-704 Replacement	30 MLF	26,904.00	807,120	68.74	2,062	88	180,839	0.43	13	987,972
26 05 13	15kV Primary Feeder Replacement										
1.4546	750 KCMIL	3300 ft	25.63	84,579	0.09	293	88	25,657	0.43	1,406	111,642
6270	250 KCMIL	300 ft	7.58	2,273	0.04	11	88	990	0.18	54	3,317
6260	4/0	3000 ft	6.38	19,125	0.03	89	88	7,831	0.14	429	27,385
6250	3/0	3000 ft	5.48	16,425	0.03	77	88	6,735	0.12	369	23,529
0550	Cable Terminations	60 ea	11.85	711	1.54	92	88	8,103		0	8,814
	Transformer Fuse Cutouts										
33 71 26	Cutout Fuse Assemblies										
1300	Current Transformers	35 ea	228.00	7,980	8.00	280	88	24,554	45.50	1,593	34,126
	Electric Metering										
26 05 13	15kV Primary Feeder Replacement										
0400	AC Recording ammeter	35 ea	5,525.00	193,375	2.00	70	88	6,138		0	199,513
6270	3 Current Transformers up to 800 Amp	14 ea	2,275.00	31,850	4.00	56	88	4,911		0	36,761
6270	3 Current Transformers up to 1,500 Amp	4 ea	3,250.00	13,000	6.15	25	88	2,159		0	15,159
6270	3 Current Transformers up to 4,000 Amp	17 ea	3,850.00	65,450	8.00	136	88	11,926		0	77,376
	Relay work for exceeding 100MW connection limit										
	Relay Reprogramming										
	Substation reprogramming	9 ea	0.00	0	32.00	288	88	25,255		0	25,255
	Field Work	9 ea	0.00	0	16.00	144	88	12,628		0	12,628
	Design Work	9 ea	0.00	0	16.00	144	88	12,628		0	12,628

SUB-TOTAL

8,928,646

General Conditions

15%

1,339,297

Overhead and Profit

10%

1,026,794

Design Contingency

20%

2,258,947

Bid Contingency

5%

677,684

Phasing

10%

1,423,137

Grand Total Estimate

\$15,654,506

RAMBOLL

Ice Arena Pit Storage & Ice Resurfacing Removal Installation											
Project:	Jamestown, NY Task Work Order							Estimate No.	Task 2D: Ice Arena Additional Bldg Mods		
	Task 2D - Decentralize Buildings							Prepared by:	M.Martino		
	1940103342-001							Date:	7/7/2023		
Line Number	Description	Quantity	Unit	Unit Material	Ext. Material	Unit Labor	Ext. Labor	Unit Equipment	Ext. Equipment	Unit Total	Ext. Total
Division 22											
220523201312	Valves, bronze, ball, 150 lb., 3/8", soldered	4.000	Ea.	\$22.50	\$90	23.00	\$92			\$45.50	\$182
220523201332	Valves, bronze, ball, 150 lb., 1-1/2", soldered	12.000	Ea.	\$100.00	\$1,200	44.00	\$528			\$144.00	\$1,728
221113747540	Pipe, plastic, PEX, flexible, non-barrier type, white, hot/cold tubing rolls, 1-1/2" diameter x 100', excludes couplings and hangers	400.000	L.F.	\$3.94	\$1,576		\$0			\$3.94	\$1,576
221113747790	Pipe, plastic, PEX, non-barrier type, white, hot/cold tubing, straight lengths, 2" diameter x 20', excludes couplings and hangers (Pit Storage)	40.000	L.F.	\$13.55	\$542		\$0			\$13.55	\$542
Division 23											
230953102100	Control component, gauges, pressure or vacuum, 2" diameter dial	4.000	Ea.	\$11.50	\$46	15.25	\$61			\$26.75	\$107
230953104100	Control component, thermometers, dial type, vapor type, union connection, 3-1/2" diameter	4.000	Ea.	\$209.00	\$836	15.25	\$61			\$224.25	\$897
235719161040	Heat exchanger, shell & tube type, cast iron heads, cast iron tube sheet, steel shell, 2 or 4 pass, hot water 40Deg.F to 140Deg.F, by water at 200 Deg.F, 16 GPM, 3/4" copper tubes	2.000	Ea.	\$17,900.00	\$35,800	177.00	\$354			\$18,077.00	\$36,154
238316107330	Radiant floor heating, PEX tubing fittings, insert type, PEX coupling, 1" x 1"	100.000	Ea.	\$2.99	\$299	17.55	\$1,755			\$20.54	\$2,054
				Estimate Subtotal	\$40,389		\$2,851		\$0		\$43,240
								General Conditions		15%	\$6,486
								Overhead & Profit		10%	\$4,973
								Design Contingency		20%	\$10,940
								Bid Contingency		5%	\$3,282
								Phasing		10%	\$6,892
								Total Estimate			\$75,812

APPENDIX B: ELECTRICAL DISTRIBUTION SYSTEM MAP

Appendix F

PON 4614 Site-Specific Scoping Study Attachment A.1

Community Heat Pump Systems

Program Opportunity Notice (PON) 4614

SITE-SPECIFIC SCOPING STUDY INSTRUCTIONS

ATTACHMENT A.1

A site-specific scoping study shall culminate in a final report that shall address the following areas at a minimum and shall be organized as follows:

Characterization of the Proposed Community:

- Describe the fraction of the effort that focused on studying the immediate opportunity and the fraction that focused on developing a long-range master plan, discuss any consideration for buildout in phases (i.e., initial installation, and subsequent expansion)
11 different scenarios employing heat pumps to meet heating loads have been evaluated. Consideration of the benefits to adding loads in the future was discussed and community outreach provided. 1 of the 11 scenarios includes additional loads resulting from the outreach to indicate the overall economic improvement by adding customers. Although a majority of the time was spent on the current load and immediate opportunity, consideration to long-range and future planning is included in the study's results.
- Identify and describe the specific cluster of buildings assessed.
Appendix E: Task 2B – Lower District Heating Temperature, provides a description of the buildings surveyed and assessed.
- Enumerate and tally a year's representation of 8,760 hourly loads to be served.
Task 2E Report Tables 2 and 3 in Section 4.
- Quantify the investment hurdle threshold of each prospective member of the community so as to understand what features of a deal would be needed in order to get them to join (e.g., how much cost savings would they require relative to their traditional expense)
TBD
- Identify site constraints and opportunities, including a discussion of accessible geography.
There is sufficient JBPU property that can be used to site heat pumps, bore fields, and auxiliary equipment.

A major opportunity is the large quantity of waste heat available at the JBPU's wastewater treatment facility. There is enough waste heat to cover the annual heating load of the current customer base. Installing a new central energy plant at this location is challenging due to the long distances from the current customers and the large CAPEX required to establish the piping network.

Another challenge is locating decentralized heat pump equipment. Task 2D Section 7.6 describes the challenges regarding physical footprint within existing buildings to install heat pumps in each building.

Discussion of the Technology(ies) Assessed:

- Describe the type(s) of thermal source/sink
A wide range of technologies were reviewed with NYSERDA and Jamestown BPU and are listed in Appendix D – Technology Screening. The technologies that were approved and recommended for further evaluation were water source heat pumps using geothermal ground source, wastewater, and a cascading air source heat pump arrangement.
- Discuss adjunct thermal systems if any, such as thermal storage, solar thermal, low-carbon supplemental thermal systems, supplemental thermal systems versus redundant thermal systems
Thermal energy storage is included in the analysis of all scenarios and is discussed in Sections 5.8, & 7.

Section 5.1 provides a description of recommended redundant, backup and peaking operations.
- Discuss the importance/approach to thermal resiliency and reliability.
Thermal resiliency and reliability are discussed in Section 5.1
- Discuss adjunct clean distributed energy systems if any, such as on-site solar photovoltaics (PV), battery electric storage
Clean distributed energy systems are discussed in Sections 5.10 & 6.3.

Discussion of the Analytical Methods:

- Discuss whether an exploratory ground borehole was installed, and if so, its suitability for later repurposing.
Conservative values were used to estimate heat extraction rate, depth, and placement of boreholes and are included in Section 6.5. Exploratory ground boreholes are being requested as part of PON 4614 submission to confirm the assumptions made in the scoping study.
- Describe the modeling method (e.g., software system) used and sources of data.
Both Termis and Energy Pro were used to develop hydraulic modeling as well as techno-economic models of the various scenarios. A discussion of these software systems are included in Sections 8 and 9.5
- Describe the extent to which friction caused by pumping creates additional heat load that must be rejected during cooling season and/or helps to achieve heating during heating season, and include in the analysis of peak load requirement and method of satisfaction.
The Termis model considers friction and losses when performing hydraulic modeling. The heat generated from this friction is within the accuracy of the assumptions made in the report.
- Describe the engineering design basis and business planning approach.
The engineering design basis is discussed in Section 5.1. A discussion on Tariff's and rates are provided in Section 9.1.
- Discuss the key assumptions, sensitivity analysis methodology and confidence bands.
Hourly interval data for heating loads were provided by Jamestown BPU. Monthly meter readings were provided for each customer. Peak loads were determined using ASHRAE estimating methods. Fuel price estimating was performed using EPro and natural gas and electricity prices forecasted over a 20-year period.

Results – System Design:

- Quantify, compare, and contrast the infrastructure necessary to serve such buildings either serving each building via an individual building heat pump solution (thermal island) or serving the cluster of buildings via a community configuration solution (including lateral piping runs that will bridge the various buildings into a thermal network, the seasonal implications of thermal effects of friction caused by flow of fluid within such pipes resulting in heat production, and heat loss/leakage from pipes)

Appendix E – Task 2D Converting Customer Buildings to Alternate Sources Section 7 describes the selection and layout of individual heat pumps as well as building modifications and electrical distribution system upgrades required.

Section 8 of the Task 2E report defines the various Hydraulic models and illustrates the pipe layouts for each of the centralized scenarios.

- Discuss challenges and strategies to minimize disruption/costs during cut-over from old system to new system, and to minimize system disruptions caused by air pockets forming in the thermal network pipelines

A major challenge to replacing the direct-buried piping network within the City of Jamestown is space. It is anticipated that existing pipe will need to be removed and new pipe installed in its place and there would be no room to install parallel piping systems. Temporary boilers would be required to feed sections of the piping network to phase in the new systems.

Phasing a 4G network can take advantage of reusing existing piping systems that will be similarly sized and replaced and phased over time.

Phasing a 5G network will require local peaking boilers be installed prior to removing the existing network. Due to the larger pipe sizes required for this system, reusing the existing network is not possible as part of the phasing plan.

Phasing the work within individual buildings will be similar for 5G networks and decentralized scenarios.

Air separators, high point vents, and automatic air vents within the plant will be installed to minimize air pockets within the distribution systems.

- Discuss the preliminary assessment of the feasibility of the technical design and system configuration (resource options, appraisal and selection)

The technical design and configuration is feasible and is a standard European approach to district heating which has been successfully employed for many years. A suit of scenarios was developed collaboratively with Jamestown BPU and NYSERDA to assess centralized and decentralized solutions. A clear strategy was provided for each scenario establishing dedicated heating technologies that support baseload, peaking, and backup operations. All scenarios are based on proven technologies that can be implemented with equipment currently available.

Results – Business Model:

- Describe the preliminary commercial terms/contractual relationships between project participants (project organization and operational control), and strategy for negotiating binding agreements including importance of timing relative to the sequence of project development.
This is an existing district heating system with contracts already in place. Tariff discussions are included in section 9.1 of this report.
- Explain how the preferred ownership model unlocks value, such as desirable depreciation schedules of equipment, tax implications, etc
This is an existing DH system with a strategy already in place. A more effective strategy and pricing can be further developed along with the preferred scenario.
- Explain how the project offers a value proposition to the different various stakeholders.
A centralized system offers customers a reliable and renewable heat source that reduces their maintenance and up-front capital expenses. Figure 1 in this report indicates the various levels of emissions, O&M, Fuel, and Capex costs associated with each scenario. These scenarios include centralized 4G and 5G systems as well as decentralized systems.
- Discuss regulatory/legal/environmental suitability, including permitting and franchising.
Environmental items will include the ability to drill beyond the 500' limit potentially improving heat extraction rates and reduce overall cost of borefields, air source permitting, environmental abatement, and the Jamestown air permit.
- Discuss the financial viability/net project benefits (and the impact of incentives), budget, potential sources of funds and proposed uses of funds, and implication of schedule.
Section 9 of this report indicates the financial results of the analysis.

Results – Impact:

- For the technology(ies) in question, discuss how the studied community configuration (one large system) in comparison to the next-best-alternative of that same technology(ies) but deployed as several individual smaller systems:
 - To what extent would aggregating the individual buildings into a community configuration create a composited load profile that achieves a meaningful amount of “load smoothing” and thereby reduces the overall peak size of equipment needing to be deployed.
Appendix C – Task 2B Lower District Heat Temperature Section 10 discusses the benefits and estimates the amount of heat load diversity by employing a district heating system.
 - Compare and contrast total project costs versus out-of-pocket costs (as a result of incentives, tax credits, etc) for the community configuration and the individual smaller systems configuration, and highlight any awkward economic signals (for example, an awkward economic signal would be if the community configuration has lowest total costs, but due to the incentive/tax effects of cost-shifts associated with less equipment and more piping/labor, has highest out-of-pocket costs)
TBD – Additional funding sources will be required to support a project of this size.
 - Discuss first costs, operating costs, and lifecycle costs
All costs are displayed and compared in Figure 1 of the report. These costs are further discussed in Section 9.
 - Discuss energy consumption during system operation
Energy consumption is discussed in Section 9.6 of this report and Section 10 of Appendix C – Task 2B Lower District Heat Temperature

- If the system will include ground thermal loops (ground source heat pumps), to what extent would the thermal extraction/rejection/dissipation achieve balance over an annual cycle such that the ground loop temperature profile will stay within tolerances throughout the presumed 25-year life of the project.

Section 5.8 of the report discusses balancing bore fields with air source heat pumps whose primary use is to meet baseload heating.

- Provide quantification of the energy and environmental benefits
Energy and environmental results are discussed in Sections 9.6 through 9.9

Lessons Learned:

- Discuss observations of opportunities to improve the project value proposition to stakeholders
Lowering maintenance costs and responsibilities
Providing reliable and renewable clean heat
- Discuss improvements to methods to recruit and select additional teammates to conduct subsequent work (e.g., an RFP to expand the team for conducting the next stage, if applicable)
Section 11 discusses next steps. Recommended teammates include Brightcore and Underground Energy, LLC
- If the scoping study concludes that the single-building-configuration (the non-community-scale approach, also referred to as the so-called unitary solution) is best, please explain the salient aspects
The study concluded that a community scale approach is best.

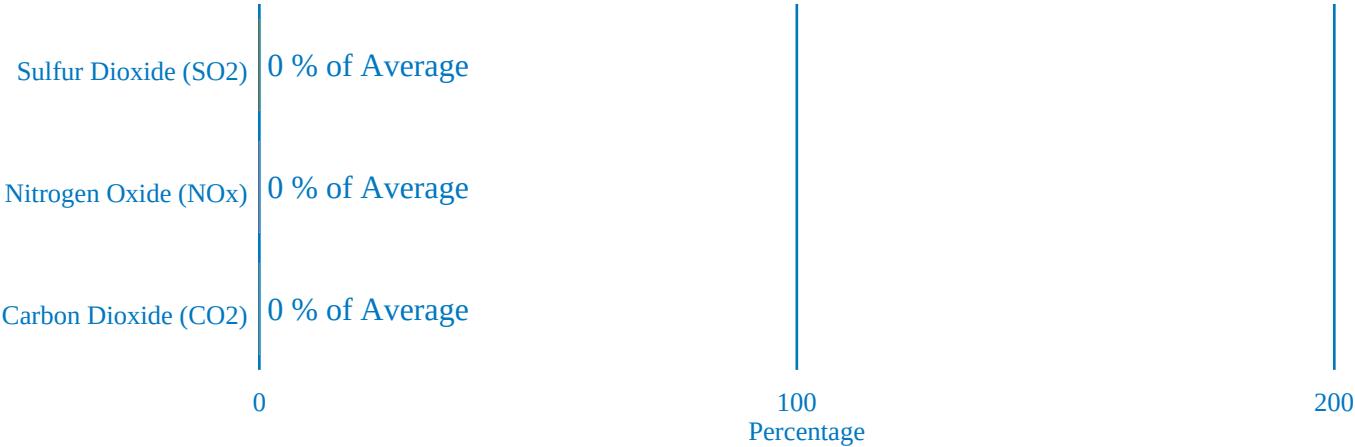
Appendix G
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Fuel Sources

Hydroelectric	98 %
Wind	2 %
Total	100 %
(Total may vary slightly from 100% due to rounding)	

Air Emissions Relative to the New York State Average



Note: Sulfur dioxide and nitrogen oxides are key pollutants that contribute to acid rain and smog, and carbon dioxide, contributes to global climate change. Depending on fuel source, size, and location, the generation of electricity may also result in other public health, environmental and socio-economic impacts not disclosed above.

This label displays information on the electricity provided to all customers of this entity. If necessary, product specific labels can be generated by the entity.