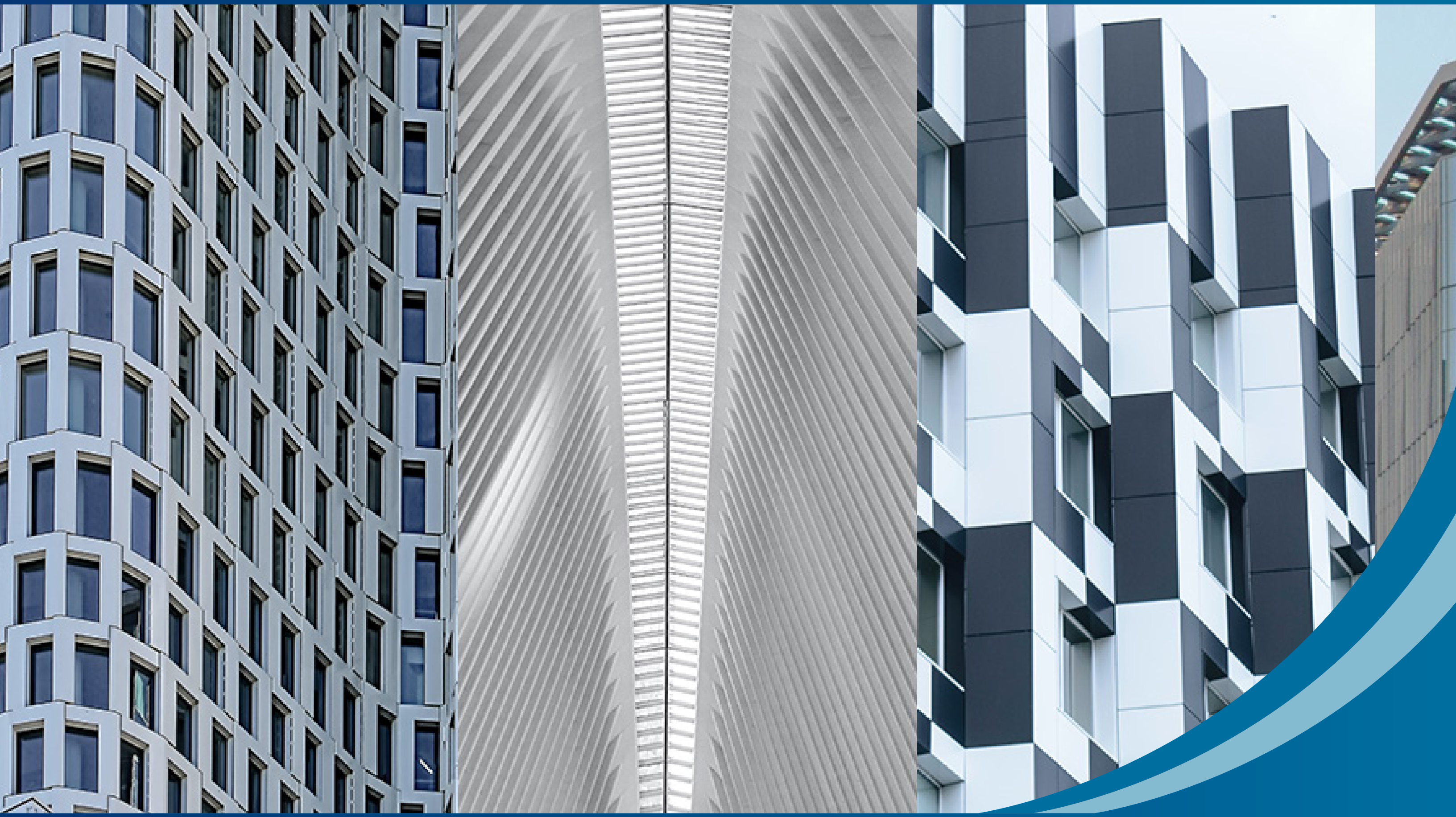
Silo City:
Geothermal Feasibility Report



Final Report | Report Number 22-20 | May 2022

NEW YORK STATE | NYSERDA

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Advance clean energy innovation and investments to combat climate change, improving the health, resiliency, and prosperity of New Yorkers and delivering benefits equitably to all.

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Silo City:
Geothermal Feasibility Report

Final Report

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NYSERDA Report 22-20 NYSERDA Contract 169161 May 2022

Notice

Abstract

District thermal systems can offer greater efficiency and lower emissions than conventional heating, ventilation, and air conditioning (HVAC) systems. Initial challenges for installing district geothermal systems are often significant barriers to overcome. These include capital costs for design and installation, and uncertain regulatory pathways. Endurant explored the feasibility of a thermal district system at Silo City (Buffalo, NY) to determine technical, regulatory, and lifecycle cost viability as compared to a business-as-usual approach. Our results indicate that a geothermal district system offers significant savings around operational cost and emissions. The installed cost of the geothermal district system, net of available incentives, is nearly double the business-as-usual option.

Keywords

Building electrification, district thermal, district geothermal, geothermal heating and cooling, ground-source heat pump, life-cycle cost analysis, Silo City

Acknowledgments

This report was prepared with the support of Generation Development and NYSERDA. The analysis and conclusions in this report rely on the technical analysis provided by Salas O'Brien and the regulatory expertise provided by the Pace Energy and Climate Center.

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Summary

The Generation Development Group is developing Silo City, a large adaptive reuse project located on the Buffalo River in Buffalo, NY. The eight historic structures that form Silo City have been vacant for over 50 years; their initial decommission was completed in 1963. Only six of the eight historical buildings are within the scope of this study, which will include approximately 400 apartments and over 40,000 square feet (sq. ft.) of mixed-use space and will be constructed over four phases. Non-residential spaces anticipate diverse uses, from a sound stage to a hydroponic farm. These varied load profiles lend themselves to district thermal systems.

Our conclusion is that it is entirely feasible technologically, and there are operational savings to be made by installing a district thermal system. Further, there are environmental benefits and no insurmountable regulatory difficulties. The geothermal solution achieves a 15% lifecycle cost reduction to the project; however, the capital costs substantially exceed the business-as-usual costs in year one due to relatively low incentives in National Grid territory.

Figure S-1. Historic Image of Silo City from the Buffalo River

This study examines the opportunity for integrating ground source heat pump (GSHP) technology into phases 2, 3, and 4 (see Figure S-2). GSHPs would provide a low-carbon solution to deliver heating, cooling, and domestic hot water to the development. Additional technologies were explored to contribute to the heating load and reduce reliance on gas-fired equipment.

Figure S-2. Silo City Phasing Plan

Our team evaluated multiple system configurations and optimized the performance of the system within the bounds of regulatory and technology parameters. We compared the benefits of developing three independent GSHP systems (one per phase) versus developing a single, district-scale solution. The district solution yielded a 14% reduction in capital costs to the project at full buildout.

Our analysis concludes that the district-scale system would improve efficiency and system performance. The study contains a robust regulatory analysis that articulates all parties engaged in the permitting process, as well as the non-governmental stakeholders that may be interested in engaging a project of this scope. The two tables below summarize annual utility costs for the BAU and the GSHP scenarios.

Table S-1. Business-as-Usual Utility Use and Cost by Phase

Building / Phase	Electricity (kWh)	Elec Utility Cost	Natural Gas (therms)	Gas Utility Cost
Phase 2	558,045	$82,615	74,464	$89,100
Phase 3	585,258	$112,467	187,165	$204,297
Phase 4	284,201	$52,686	69,829	$82,372
Total Phase 2, 3 and 4	**1,427,504**	**$247,768**	**331,458**	**$375,769**

Table S-2. GSHP Utility Cost by Phase

Building / Phase	Electricity (kWh)	Elec Utility Cost	Natural Gas (therms)	Gas Utility Cost
Phase 2	332,547	$42,705	63,519	$33,784
Phase 3	576,549	$76,609	148,634	$71,461
Phase 4	222,102	$29,899	57,258	$30,868
Total Phase 2, 3 and 4	**1,131,198**	**$149,213**	**269,411**	**$136,113**

The assessment determined technical feasibility, and that there are substantial environmental and community benefits to developing a GSHP solution at Silo City. Our preferred solution consists of a GSHP system coupled with solar thermal and a gas fired boiler. GSHP will be the priority dispatch asset with solar thermal pre-heating the source loop, while reserving a gas fired boiler for peaking. This dispatch strategy will reduce carbon emissions by leveraging the efficiencies of the GSHP and solar thermal assets.

Table ES-3. Capital Cost Comparison

	Phase 2	Phase 3	Phase 4	All Phases
Total BAU HVAC Installation Cost	$2,920,500	$5,344,515	$2,073,555	$10,338,570
Total GSHP Installation Cost	$6,949,334	$11,688,139	$4,499,093	$23,136,566
Incremental Cost	**$4,028,834**	**$6,343,624**	**$2,425,538**	**$12,797,996**
Total Incentive Value	$729,711	$1,117,529	$435,541	$2,282,782
Incremental Cost Net Incentives	**$3,299,123**	**$5,226,095**	**$1,989,996**	**$10,515,215**

The utility and maintenance costs savings expected from the GSHP scenario result in a 12-year simple payback. The GSHP solution does generate operational savings and environmental benefits; however, the benefits are realized over the lifecycle of the project and will require additional capital costs.

This project would substantially benefit from an increased incentive rate via New York State Clean Heat Incentive program. Currently National Grid’s incentives are 60% lower than Con Edison’s for this project; however, installation costs do not decline 60% in National Grid territory. The Public Service Commission should consider a more levelized statewide incentive approach that equally incentivizes projects across the State.

1 Characterization of the Proposed Community

Silo City is a large adaptive reuse project located on the Buffalo River in Buffalo, NY. The eight historic structures that form Silo City have been vacant for over 50 years; their initial decommission was completed in 1963. Only six of the eight historical buildings are within the scope of this study, which will include approximately 400 apartments and over 40,000 square feet (sq. ft.) of mixed-use space and will be constructed over four phases. Non-residential spaces anticipate diverse uses, from a sound stage to a hydroponic farm.

Phase 1, as illustrated in Figure S-2, is currently under construction and includes renovations to the three structures defined as the American Elevator and American Warehouse. Phase 1 is not considered as part of the district geothermal assessment. Phase 2 includes the Perot Warehouse and Perot Malthouse. The area and planned use for Phase 2 is well defined and was used as a basis for determining thermal loads for Phase 3 (Lake and Rail Warehouse and Lake and Rail Elevator) and Phase 4 (Marine A Elevator).

Phase 2 construction is slated to conclude between 2022 and 2023. Phases 3 and 4 are expected to conclude after 2023. This study examines the opportunity for incorporating a ground source heat pump (GSHP) system in phases 2, 3, and 4 to achieve emission reductions, overall energy efficiency, and operational savings.

This study explores the opportunity to adopt a fully electric system for delivering space heating, cooling, and domestic hot water (DHW). All-electric systems that rely on GSHPs, air source heat pumps (ASHPs), or a combination of both eliminate emissions associated with conventional fossil fuel-based systems while achieving higher coefficients of performance (COPs). This study also considers applications for additional efficient and renewable technologies including heat recovery from wastewater, solar thermal, solar photovoltaic (PV), and battery energy storage.

Figure 1. Rendering of Silo City Development

Image courtesy of Generation Development Group

1.1 Site Constraints and Opportunities

The site presents adequate open space for significant bore field capacity. The proximity to the Buffalo River may provide challenging drilling conditions due to high prevalence of groundwater. Historic use and contamination may also pose challenges. We envision locating boreholes in open areas between Phase 2, Phase 3, and Phase 4, and identifying mitigation strategies to address groundwater and contamination. Overall, the site presents adequate area for distributed energy resources (DER) siting and geothermal bore fields, presenting an opportunity to pair a historic site with a state-of-the-art renewable energy system.

2 Discussion of the Technologies Assessed

The team assessed a variety of technologies that could achieve greater efficiencies and improve the overall life-cycle value of the project as compared to conventional HVAC systems. The team explored GSHPs, ASHPs, and wastewater heat recovery to supply the thermal demands of the project, and assessed the potential to integrate solar thermal, solar PV, and battery energy storage. This section will provide a brief description of each technology and the intended benefits.

2.1 Ground Source Heat Pump

GSHPs are one of the most efficient heating and cooling technologies available. GSHP systems use water sourced heat pumps (WSHPs) containing a refrigeration loop that drives thermal exchange between the ground and the working fluid. Ground temperatures remain more stable than air temperatures making them warmer than air temperatures in the winter and cooler in the summer. This dynamic allows the GSHP to efficiently use the ground as a heat source in the winter and a heat sink in the summer. While there are a variety of ground loop heat exchange (GLHE) types, Endurant focused on a closed loop borehole solution for this project. Closed loop systems require less maintenance and less regulatory approvals in New York State when compared to open loop systems. However, the State drilling regulations will limit the vertically drilled closed loop boreholes to 500 feet in depth.

The system's uptime can be improved via an N+1 design that will allow for one heat pump to be serviced without reducing the systems' maximum capacity. The ground loop manifold design allows for the isolation of individual ground loops, which prevents a single point of failure for the system.

2.1.1 Simultaneous Load

The GSHP solution allows for simultaneous heating and cooling of the building. Water-to-water heat pumps can reject the waste heat from the cooling process to supply heating at the same time. Simultaneous heating and cooling demands may occur in the cooling season when DHW loads remain consistent. There may also be times during the year when interior spaces require heating while others require cooling.

Table 1. GSHP Key Considerations

Pros	Cons
• Most efficient heating and cooling technology (full-load COP of 5-6). • Lowest operating cost compared to other technologies assessed in this report. • Lower maintenance costs than conventional equipment. • Ability to supply heating and cooling simultaneously. • Low-to-zero-carbon solution. • Quieter operations than rooftop condensers.	• Higher capital costs.

2.1.2 Air Source Heat Pump

ASHPs operate similarly to GSHPs but rely on the atmosphere for thermal exchange rather than the GLHE. A refrigeration loop allows for thermal exchange between the ambient air and working fluid. This solution performs best at moderate ambient conditions (i.e., fall and spring), while efficiency falls during extreme temperatures of the summer and winter. ASHPs and GSHPs may be configured in a single system. This hybrid heat pump solution exploits the benefits of both GSHPs and ASHPs, especially on sites where the GLHE capacity is space limited. Our team will explore using ASHPs to supplement GSHP capacity in a hybrid design.

Table 2. ASHP Key Considerations

Pros	Cons
• Electrically powered. • Good performance at moderate temperature (COP of 3-3.5 at 50°F). • Low- to zero-carbon solution.	• Requires roof space. • Reduced efficiency at extreme temperatures (<10°F). (COP of < 2.3 at 10°F).

2.2 Wastewater Heat Recovery

The average temperature of wastewater is 70°F which presents opportunity for waste heat recovery if adequate flow rates are available. Wastewater that is normally discarded into sewer lines can be diverted, separated (into liquids and solids), and passed through a heat exchanger to extract heat. This solution is electrically powered and can be coupled to the GLHE, while not being affected by outside ambient temperatures. Due to variation in flow rates, wastewater heat recovery cannot reliably supply peak heating capacity. This analysis explores the feasibility of using wastewater heat recovery to supply building heat demands.

Table 3. Wastewater Heat Recovery Key Considerations

Pros	Cons
• Electrically powered. • Couples to the GLHE. • Low- to zero-carbon solution. • Installation costs are low.	• Very challenging to permit in New York State. • May not be suitable depending on surface water temperatures and (or) or freezing events. • Potential to negatively impact aquatic habitat.
• Electrically powered. • Couples to the GLHE. • Very efficient. • Performance not directly dictated by ambient conditions. • Low- to zero-carbon solution.	• Dependent on location and volume of flow through mains. • Variable rates of heat production. • Available thermal energy may not cover load. • Production may not always be able to be used. • Local municipality considerations if connecting into publicly owned sewer infrastructure.

2.2.1 Surface Water Heat Exchange

The Buffalo River presents an additional opportunity for thermal exchange with Silo City. A heat exchanger would serve as a means of extracting or rejecting heat between the river and the development depending on the season. The solution would remain hydraulically separated from the Buffalo River and thermal energy would be transferred through a plate and frame heat exchanger to the working fluid in the GLHE. Any abstracted water is then returned to the river a few degrees cooler or warmer than it was before. The major benefit of a water heat exchange system is the thermal capacity provided at a lower cost than a dedicated bore field.

2.3 Solar Thermal

Solar thermal technology captures solar energy as thermal energy for use in adjacent buildings. In the case of residential and commercial uses, solar thermal can be used to supplement conventional systems for supplying DHW and space heating. Solar thermal collectors would likely be located on the roof and could provide year-round thermal energy. Excess solar thermal energy could be rejected to recharge the GLHE for use in the winter months. This solution requires very little energy input and can couple to GLHE. However, thermal production is not reliable as it is dependent on the time of day and weather—additionally, it would not supply the building's entire heating load.

Table 4. Solar Thermal Key Considerations

Pros	Cons
• Able to deploy on otherwise unusable space (Rooftops, parking canopies, etc.). • Offsets fossil fuel requirements. • Low maintenance. • Competitive pricing.	• Peak production occurs when heating demand is lowest. • Large space requirements. • Intermittent production. • Thermal storage tank requirement?

2.4 Solar Photovoltaic (PV)

Solar PV technology captures solar energy and converts it to electricity. The modularity, reliability, and relatively low cost of solar PV panels has resulted in widespread adoption in all building types. In addition, utility programs allow for communities to access the value of solar PV via programs administered through the utility bill. Solar PV is limited in that it only generates electricity as solar energy is available. The system will not generate energy during nighttime hours and is limited when clouds obstruct sunlight. It also requires significant area to locate panels, typically on rooftops, parking structures, or unused land. Space constraints, especially in urban areas, can limit the solar PV system size. These constraints often prevent solar PV from generating 100% of a site's electricity use. But appropriately configured solar PV can deliver a significant source of renewable generation on site.

Table 5. Solar Photovoltaic Key Considerations

Pros	Cons
• Low capital cost. • Able to deploy on otherwise unusable space (rooftops, parking canopies, etc.). • Low maintenance.	• Intermittent productions. • Large space requirements.

2.5 Battery Energy Storage Systems

Battery energy storage systems (BESS) are used to store electricity for later use. The versatility of a BESS can deliver value for the customer facility from managing electric demands, optimizing the use of solar PV, or serving as a temporary source of power. BESS can also be interconnected to the utility distribution system and provide energy services to utilities or participate in wholesale markets.

Table 6. Battery Energy Storage System Key Considerations

Pros	Cons
• Demand Response capabilities. • Ability to shift production to more valuable hours in the day. • Value stacking revenue streams.	• Cost is high and often requires incentives to make projects viable.

2.6 Electric Vehicle (EV) Charging

As EVs become more widely adopted, charging infrastructure will become a critical component to support electric transportation. EV charging can be developed under a variety of commercial models. The ownership of the EV charger may sit with the real estate developer, utility, or third-party provider. The expected use case (i.e., residential versus commercial) and adoption rate of EVs are often considered when planning for EV charging infrastructure design and selecting the desired commercial option.

Table 7. Electric Vehicle Charging Key Considerations

Pros	Cons
• Enables EV vehicle growth. • Reduce on-site emissions from cars. • Multiple business models for development.	• EV adoption varies across regions. • Can be challenging to manage demand charges.

3 Discussion of the Analytical Methods

3.1 Overall Approach

The analysis and outcomes of this study will inform the Generation Development Group about options and benefits of including a geothermal-based system to deliver heating and cooling at the site. The approach begins by developing an energy model to understand heating, cooling, and DHW loads. The team then considers the capital and operating costs of supplying those thermal loads with conventional HVAC equipment and a geothermal-based system. By comparing the lifecycle costs and overall environmental benefits, a determination on whether and how a geothermal system will deliver advantages can be made.

At this stage of feasibility, the team maintains ± 20% confidence interval in the data presented, and rely on the most detailed and up-to-date information available to develop energy models, conceptual designs, and estimate costs. Our team gathered the following information to perform the analysis:

- Site plans
- Constructions Drawings from Phase 1 to inform assumptions around the business-as-usual (BAU) systems
- Design Drawings for Phase 2
- Geotechnical report
- CAD models

Following the data-gathering phase, our analytical approach was conducted in the following phases:

1. Generate Energy Models for each building in the development.
2. Establish BAU operational costs.
3. Design optimal GSHP solution.
4. Establish GSHP operational costs.
5. Conduct extensive regulatory research on GSHP project requirements.

3.1.1 Thermal Profile and Energy Model

Endurant developed a BAU scenario to serve as a benchmark for the GSHP alternatives. To do this, the team began by generating an energy model for each building/phase.

The Phase 2 energy model includes the Perot Elevator, Perot Warehouse, and Perot Malthouse buildings. These buildings were modelled using IES VE 2019 energy modelling software based on the information provided by the project architect including existing conditions and proposed floor plans. Phase 1's baseline equipment for residential apartments consists of gas-fired furnaces for space heating, direct expansion (DX) split systems for cooling, and gas-fired DHW heaters. Common areas and commercial spaces use variable refrigerant flow (VRF) systems to provide space heating and cooling with outdoor air provided by a dedicated outdoor air system with an energy recovery wheel. (Detailed model assumptions are presented in Appendix A.) The output of the energy model is an hourly profile of heating loads, cooling loads, and DHW loads associated with the residential and commercial spaces. The team used these outputs combined with equipment efficiency assumptions to simulate the input energy (electricity and/or natural gas) that would be needed to power the HVAC mechanical equipment. These input energy profiles simulate the energy flows that would be measured by the utility meter.

Phases 3 and 4 do not currently have adequate information to produce a schematic building energy model. Phase 1 and 2 information informed assumptions that were made for Phase 3 and 4 models regarding use type and area. Building geometry calculations were supported by a combination of site imagery and 3D Google Earth views. Phase 3 and 4 hourly profiles were scaled from Phase 2 loads using Microsoft Excel.

3.1.2 Establishing BAU Operating Costs

Annual utility costs were calculated using the modelled input energy profiles discussed in section 3.1.1 Thermal Profile and Energy Model.

The team input the data from the energy profiles created for this report into the proprietary tariff engines to simulate monthly supply and delivery bills for both gas and electric. The appropriate rate/tariff was selected from the National Grid’s tariff based on the electric consumption profile, particularly the maximum demand registered on the meter.

Establishing the BAU utility cost is influenced by the tariff/rate assumption and the metering configuration for the building spaces. For example, residential units may be direct-metered by the utility, or the building or entire campus may be master-metered.

- Each unit may be individually metered: in this scenario, we would simulate a bill at the unit level. Residences would be on National Grid’s residential rate while commercial units would be on any one of National Grid’s commercial rates, depending on the energy consumption profile.
- Each building may be master-metered: in this scenario, the entire building would appear as a commercial account to National Grid.
- The entire development may be master-metered: in this scenario, the entire development’s energy profile would be aggregated and appear as one large commercial account to National Grid.

Endurant consulted with the developer to determine that each unit would be individually metered for gas, and master metered for electricity at a building level. Table 1 below summarizes the metering configuration and utility tariffs assumed for the BAU scenario. The specific rate selection is dependent on the peak demand (kilowatts (kW)) and annual energy (kilowatt hours (kWh)) consumption, as well as annual usage of gas (therms).

Table 8. BAU Metering and Tariff Assumptions

	Elec Metering Configuration	Elec Utility Tariff	Gas Metering Configuration	Gas Utility Tariff
Residential	Tenant direct metered	Nat Grid SC-1	Tenant direct metered	Nat Grid SC-1
Commercial	Tenant direct metered	Nat Grid SC-2 Demand	Tenant direct metered	Nat Grid SC-1

Endurant worked with contractors to develop pricing for operations and maintenance (O andM) services and included them along with utility costs to determine total operating costs.

3.1.3 GSHP Solution Design

Once BAU conditions were established, the team turned attention to designing the GSHP solution. When designing the conceptual solution, existing geotechnical reports were reviewed and the proposed building's uses and layouts were assessed. The team then considered the relative size of heating and cooling demands. Available space for a GLHE and other available thermal resources were examined, and finally, the team assessed the overall costs.

The primary challenge at Silo City is an unbalanced heating load. Over the course of a year, the development demands significantly more heating than it does cooling. The thermal demands informed the GLHE design and the overall heat pump configuration, which was designed to limit the potential thermal imbalance of the GLHE.

The design team used Gaia GLD (Ground Loop Design), an industry leading GLHE design software, to run various scenarios that tested different bore-field designs and technology mixes.

The team did not drill a test bore at this stage and preferred to drill test bores at the detailed design project stage. Existing geotechnical reports to assess ground conductivity were relied on.

3.1.4 Establishing GSHP Operating Costs

Similar to the approach for estimating BAU operating costs, the team used the thermal profiles, GSHP mechanical efficiency, utility tariffs, and OandM costs to estimate annual operating costs for the GSHP system. Metering and tariff assumptions for the GSHP scenario are summarized in Table 9

Table 9. GSHP Metering and Tariff Assumptions

	Elec Metering Configuration	Elec Utility Tariff	Gas Metering Configuration	Gas Utility Tariff
Residential	Master Metered at Building	Nat Grid SC-2 Demand	Master Metered at Building	Nat Grid SC-3
Commercial	Master Metered at Building	Nat Grid SC-2 Demand	Master Metered at Building	Nat Grid SC-3

The team developed the metering configuration to reflect the BAU metering configuration and assumed that each building would be individually metered as well as that the GSHP system would be master metered under one National Grid account.

Endurant worked with mechanical contractors to develop pricing for operations and maintenance (O andM) services and included them along with utility costs to determine total operating costs for the GSHP system.

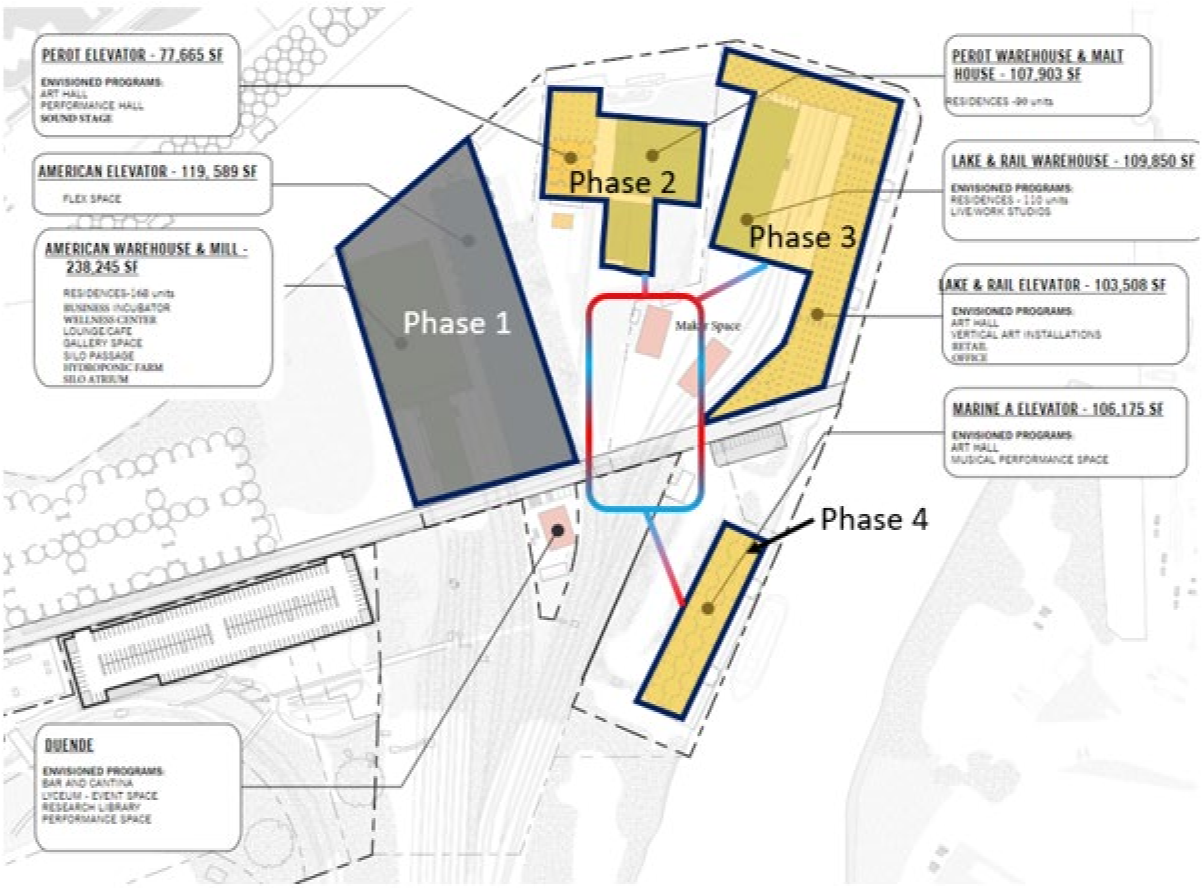
3.1.5 Regulatory Research

The team conducted a detailed regulatory review of permitting, tax laws (particularly the exposure of such projects to real property taxes), and available incentives. This phase of the feasibility analysis focused on ascertaining any potential regulatory hurdles and associated costs that could delay or obstruct project development. One major challenge for district thermal systems is the extent to which a district system triggers consumer protection requirements and/or oversight by the utility commission. Endurant worked with internal regulatory experts and external consultants to study the state of regulations around GSHP projects at the federal, State, and local level. A detailed regulatory report is located in Appendix B.

4 Results: System Design

The team mostly focused on Phase 2 of the development as it has detailed floor plans and accurate unit count estimates. Phases 3 and 4 are at an earlier stage in the development process and may go through additional concept iterations. However, we did project future space uses for Phases 3 and 4 based on discussions with the developer and the masterplan. The Phase 3 and 4 analyses included in this report should be considered indicative as future development plans may change.

Figure 2. Silo City Phases and Proposed District



4.1 Energy Model Results

Energy use within buildings is shaped by the type of occupancy, occupancy rate, and intended use of the space. Residential and commercial energy profiles have unique weekly and seasonal patterns. The team modelled thermal demands for the various project phases to inform the GSHP system design. The thermal profile of each building is a critical design element to consider when designing the GLHE and heat pump configuration to ensure the GLHE remains balanced over time.

The thermal profile for Phases 2, 3, and 4 is strongly heating dominant. This can largely be attributed to historic preservation requirements imposed by New York State Historic Preservation Office (SHPO) that prohibit changing the building's existing façade. These requirements limit or prohibit energy efficiency measures such as adding external façade or interior insulation. The result is a very inefficient building envelope, which will demand significantly more heating than cooling on an annual basis. The heating dominance will receive a slight boost from the added heat of compression,[1] but most of the thermal load remains unbalanced. A graphic representation of each phase's thermal profile can be seen below, along with a combined profile for all three phases.

Figure 3. Silo City Thermal Profile (Phases 2, 3, and 4)

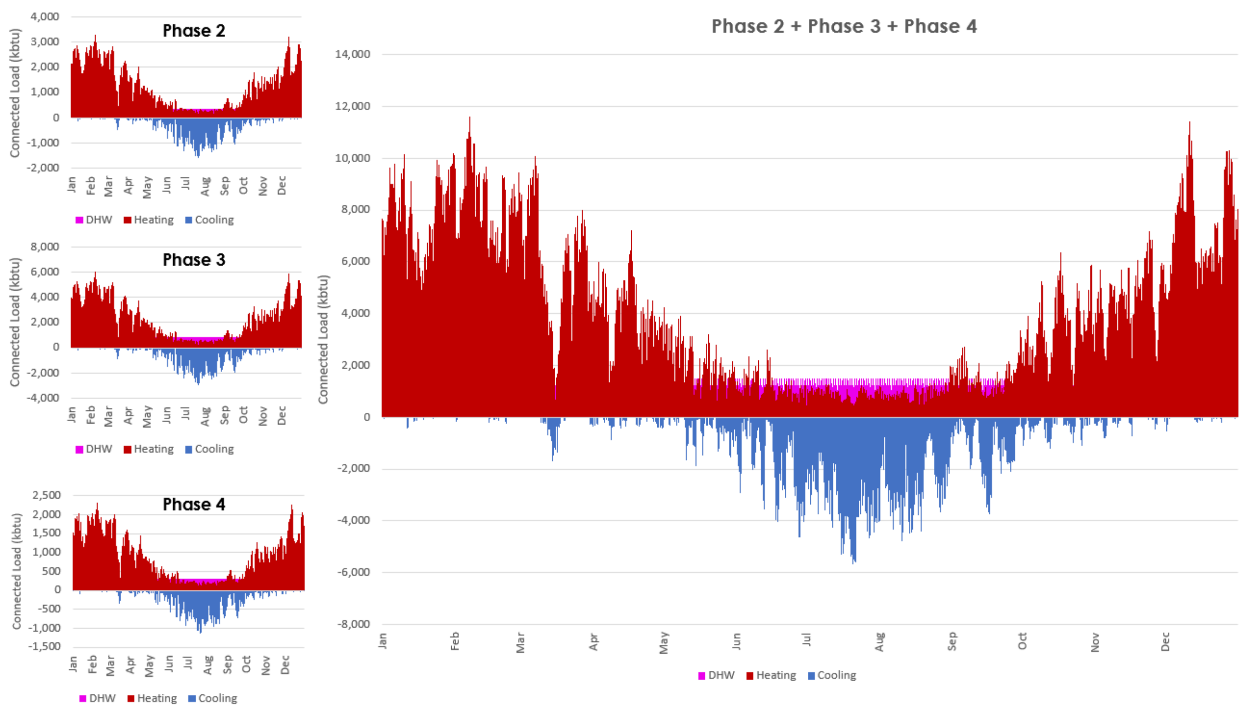


Table 10 summarizes the area and annual thermal loads for each phase. Figure 3 and Table 10 illustrate the relative size of the heating and cooling load and the overall dominance of heating demands for each phase. The heating, cooling, and domestic hot water (DHW) demand profiles were used as the basis for comparing the baseline HVAC scenario to the GSHP option.

Table 10. Thermal Demands by Phase

Building	Phase 2	Phase 3	Phase 4
Modelled Square Footage	158,766	291,296	112,215
Peak Heating (kBtu/hr)	3,283	6,024	2,321
Peak Cooling (kBtu/hr)	1,605	2,945	1,135
Peak Domestic Hot Water (kBtu/hr)	355	833	310
Annual Heating Load (kBtu)	8,800,613	16,146,935	6,220,217
Annual Cooling Load (kBtu)	1,595,611	2,927,549	1,127,768
Annual DHW Load (kBtu)	1,689,371	3,872,828	1,445,794

4.2 Business-as-Usual Operating Costs

After developing the thermal profile, the team translated thermal demands to input energy (electricity and natural gas) using equipment manufacturer efficiencies based on ambient air conditions. The electricity and/or natural gas use was then run through a tariff engine to simulate monthly utility costs for each building or customer account. Table 11 describes the HVAC equipment and efficiencies assumed for the baseline scenario.

Table 11. Equipment Efficiencies Used for BAU Scenario

Space Use-Type	Heating	Cooling	Domestic Hot Water
Residential Units	Natural Gas Furnace [92% eff.].	Split system direct expansion (DX) [EER 10.2].	Gas fired boiler (GFB) [COP 0.9 @ 100% load].
Residential Ventilation	Natural Gas Furnace for heating [92% eff.], ERV 50% sensible, 50% latent effectiveness.	Dedicated outside air system (DOAS) DX for cooling [EER 9.8].	-
Commercial/Common Space	Variable Refrigerant Flow (VRF) [COP 3.2 @ 100% Load].	VRF [COP 3.5 @ 100% Load].	GFB [COP .9 @ 100% load).
Commercial/Common Ventilation	DOAS Unit DX-cooling [EER 10.8], Electrical Resistance – heating [100% Eff.], ERV 50% sensible, 50% latent effectiveness.		-

Annual utility costs for electricity and gas are summarized in Table 12.

Table 12. Annual Baseline Utility Costs

Building / Phase	Electricity (kWh)	Elec Utility Cost	Natural Gas (therms)	Gas Utility Cost
Perot Elevator	147,771	$21,784	15,978	$20,603
Perot Warehouse and Malthouse	410,274	$60,831	58,486	$68,498
Phase 2	**558,045**	**$82,615**	**74,464**	**$89,100**
Lake and Rail Warehouse	117,330	$35,013	101,573	$100,563
Lake and Rail Elevator	467,928	$77,454	85,592	$103,734
Phase 3	**585,258**	**$112,467**	**187,165**	**$204,297**
Duende	42,683	$4,942	828	$783
Marine A Elevator	241,518	$47,744	69,001	$81,589
Phase 4	**284,201**	**$52,686**	**69,829**	**$82,372**
Total Phase 2, 3 and 4	**1,427,504**	**$247,768**	**331,458**	**$375,769**

4.3 Heat Pump and Ground Loop Conceptual Design

After establishing baseline conditions, the team turned to the GSHP design options. The basis for conceptual design relied on geotechnical reports and an assessment of the built environment. The initial assessment revealed a variety of areas to locate the borehole GLHE. The most desirable locations are located nearest to mechanical equipment to reduce the length of horizontal pipework between the GLHE and mechanical space. For this reason, the team prefers to locate the bore fields between the phases rather than on the perimeter of the site.

The design team used GLD design software to test scenarios with different bore field designs, heat pump configurations, and bore hole depths. The team identified multiple options that met the energy needs for the site, which were then run through a budgeting exercise to determine the most economically effective GSHP option for Silo City.

During the optimization exercise, we attempted to reduce the size of the GLHE while still delivering significant heating and cooling capacity. Typically, we do not design the GLHE for peak load conditions, as the marginal cost of additional boreholes is not justified by the diminishing incremental thermal capacity that the GLHE delivers for peak loads. For example, to meet 100% of the peak heating load the GLHE would require 639 bore holes. Table 4 illustrates the load contributions from three GLHE simulations and the marginal reduction in thermal capacity gains as the GLHE increases. The 850-ton configuration (simulation 1) delivers all heating and cooling loads. However, simulation 3 delivers

47.9% of the peak heating load but requires roughly 75% fewer boreholes than simulation 1. Even when the capacity of simulation 3 is increased by 33% to simulation 2, the GLHE does not deliver more heating energy, but only increases the ability to meet peak heating load. Since our goal is to reduce the bore field as much as possible while maximizing the annual load served, simulation 3 is selected as the optimal solution.

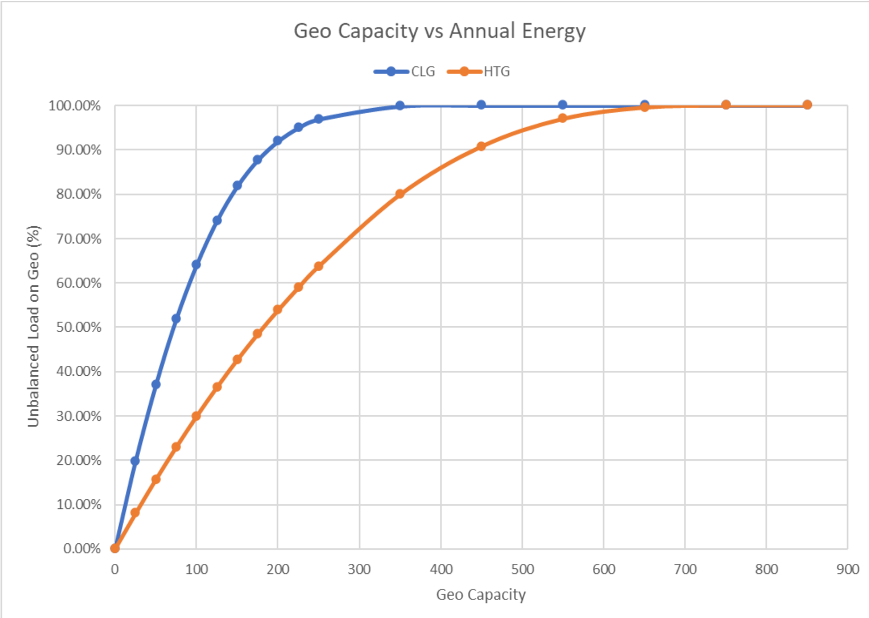
Table 13. Ground Loop Design Simulations for Various GLHE Sizes

	Simulation 1	Simulation 2	Simulation 3
Capacity (tons)	850	600	400
Peak Heating Load	100%	71.8%	47.9%
Annual Heating Load*	100%	21.7%	21.7%
Peak Cooling Load	100%	100%	100%
Annual Cooling Load*	100%	100%	100%
Number of Bores	639	268	160
Space Requirements (sq. ft.)	255,600	107,200	64,000
* The annual load estimates are a total of simultaneous and unbalanced loads.			

The principle of diminishing returns is further illustrated in the Figure 4, which graphs the optimization curve for the unbalanced load. The balanced load is the annual heating and cooling load that balances out annually. The unbalanced load is what remains. Figure 4 demonstrates that the annual cooling load (tons) can be satisfied by installing far less GLHE capacity than is required to satisfy the annual heating load.

Despite the unbalanced load there is still an opportunity to exploit simultaneous load throughout the year. WSHPs enable thermal exchange between individual spaces or buildings without the need for a storage medium such as a GLHE. We refer to this as simultaneous load. For example, when a building requires cooling, a WSHP can transfer waste heat from the cooling process into the DHW circuit. The heat rejected from cooling does not interface with the GLHE, it is simply directed to a different thermal demand in the building. Figure 2 illustrates this scenario, as DHW (pink) sits above the x-axis at the same time cooling requirements (blue) sit below the x-axis.

Figure 4. Unbalanced Load and Capacity Optimization Table for Phases 2, 3, and 4



Since this project has very high heating demands, heat pumps will be extracting significant heat from the GLHE, which in turn further reduces the temperature of the ground during the heating season. One approach to support the GLHE to operate at lower temperatures is by the addition of polypropylene glycol. The glycol allows the source loop to continue functioning at temperatures below 32ºF. Using glycol within the GLHE has a variety of effects. Firstly, it reduces the required size of the GLHE to serve a given heating load, which can result in a significant reduction in bore hole costs. In some cases, the addition of glycol can reduce the GLHE size by up to and in some cases more than 50% based on thermal profile and site geological conditions. Conversely however, the addition of glycol requires more flow (i.e., pumping power) to achieve the same amount of heat transfer, thus decreasing operational efficiency of the system. We selected an 18% glycol content for our analysis to reduce the bore field size and optimize costs, but we recommend further analysis during the detailed design stage to optimize glycol content.

Bore field area requirements resulting from the GLD simulation for each phase are summarized below. Note the reduction in boreholes when developing a district system versus an individual system. This reduction in linear feet of bore field is a result of simultaneous load across the district. These efficiencies can only be found by exploiting simultaneous loads across a multi-building, mixed use district.

Table 14. GLHE Space Requirements for Each Phase

	Phase 2	Phase 3	Phase 4	Total
Space Requirement (sq. ft.)	18,000	42,000	14,400	**74,400**
Independent Bore Fields	45	105	36	**186**
District Bore Field		160		**160**

Figure 5. Available Space for Bore Fields

Efficiencies may be gained when designing a single district system to supply thermal energy to all phases when compared to dedicated GLHEs for each phase. In the case of Silo City, a district GSHP system would only require a total of 160 bores across 64,000 sq. ft.

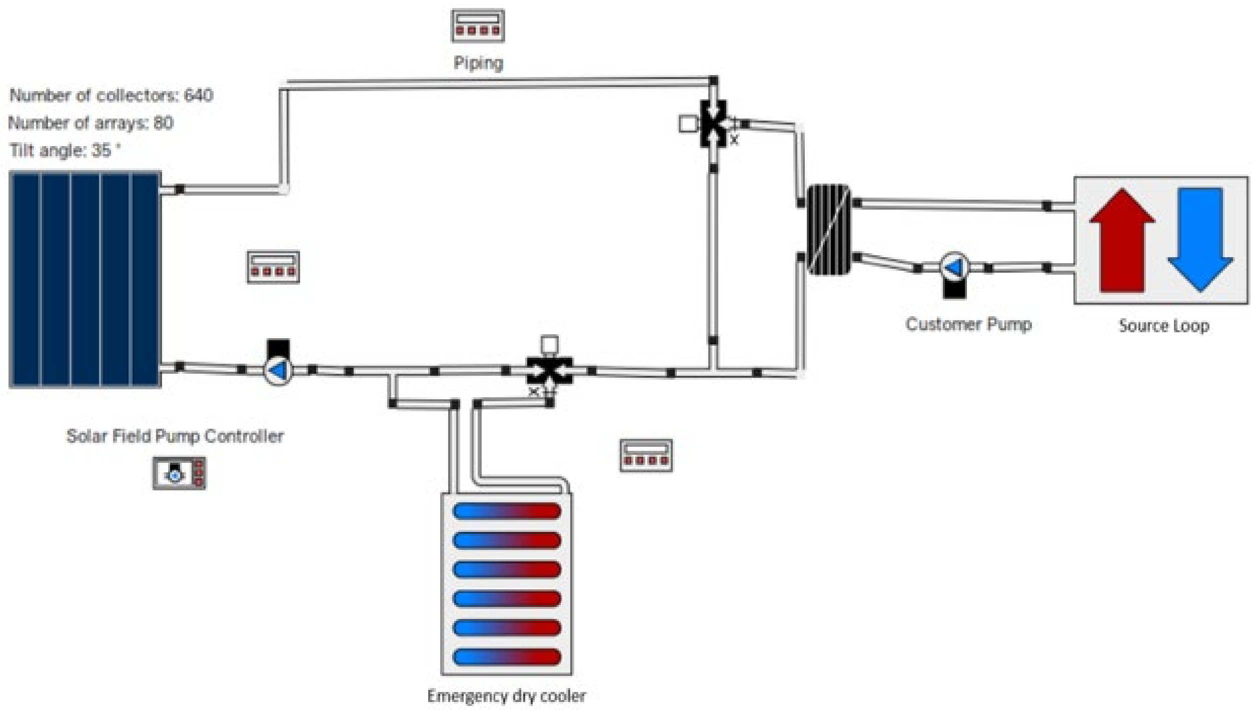
The image, Figure 5, above, shows the available space for bore field siting at the development. It demonstrates ample area for the bore requirements of each phase. Each bore field will be sited nearest its corresponding phase. Based on the high-heating demand of the project the team ruled out surface water and wastewater heat exchange and ASHP as feasible solutions. The rationale for eliminating these technologies is discussed in Section 5.8. After ruling out those systems we developed a solution that includes solar thermal, GSHP, and gas fired boilers (GFBs) to meet peak and annual heating, cooling, and DHW demands.

4.4 Solar Thermal

Estimates of solar thermal production were produced based on Phase 2, which contained an estimated 25,000 sq. ft. of roof area to host solar thermal panels. Despite making a meaningful impact on the annual heating load, this asset cannot be relied on for peak load contributions as it requires solar energy, which is by its very nature intermittent, to generate hot water.

However, hot water production from solar thermal assets would support the overall system efficiency. During summer months, excess hot water production can be used to preheat the GLHE temperature in preparation for winter extraction. During winter months, the solar thermal can be used to preheat return water to the GFB reducing carbon emissions. The solar thermal system would interact with the source loop via a heat exchanger and be hydraulically separated from the GLHE as illustrated in Figure 5. Overall, solar thermal increases operational efficiency, and reduces the emissions associated with the system.

Figure 6. Solar Thermal Conceptual Design



4.5 Gas Fired Boiler

A GFB is required to meet the high-heating demand and increase peak capabilities at a relatively low cost. The plant dispatch strategy will prioritize GSHP and solar thermal dispatch, but when loads exceed capacity, the system will rely on a GFB. The GFB selected will be a condensing boiler with efficiency of over 90%.

4.6 Equipment Capacities

Each piece of equipment was sized based on slightly different considerations. The GSHP was sized based on delivering 100% of the cooling load, the solar thermal was sized based on roof space, and the GFB is sized to pick up the remaining heating load (~78% of the annual heating load). This approach balances the tensions between cost, carbon reduction, and operational efficiency.

4.7 Plant Locations and Strategy

Our team identified a distributed plant concept as the cost optimized solution for the project. Each residential and commercial unit would have an in-unit water-to-air heat pump placed in a mechanical closet. The heat pump would hook up to a district condenser loop tied to the borefield as a thermal source and sink. As a hybrid system, the solar thermal and GFB assets will supplement the condenser loop temperatures to maintain an annually balanced geothermal system. DHW would be produced at a central location within each building in a dedicated mechanical space.

Endurant investigated the impact of installing a district condenser loop between the three phases, the analysis showed a 26-borehole reduction due to load diversity across the three phases. A more detailed description of district versus unitary geothermal systems is in Section 3.5.

Figure 7. Possible Plant Configuration

4.8 Additional Technology Assessments

4.8.1 Wastewater Heat Recovery

Our approach was not limited to GSHP but considered the viability of wastewater heat recovery as a supplemental heat source. Wastewater that is normally discarded into sewer lines can be diverted, separated (liquids and solids), and passed through a heat exchanger to extract thermal energy. The average temperature of wastewater is 70ºF, which provides excellent opportunity for thermal extraction if adequate flow rates are available. This solution, electrically powered, couples to the GLHE, is very efficient, and its performance is not affected by ambient conditions. However, at this location wastewater heat recovery cannot be relied upon for peak heating capacity, given its production depends on flow rates, which may vary.

Wastewater heat recovery can be deployed under two models. It can intercept a county or city sewer line, or it can be placed within the development to capture exiting waste heat. City and county sewer lines will be able to generate significantly higher thermal capacities due to greater volumes and flow rates. Based upon our site assessment there are no major sewer lines available for connection adjacent to the Silo City site.

Without major sewer lines heat contributions from wastewater would rely exclusively on the outflow from the development's Phase 2, 3, and 4 buildings. In general, residential use requires more domestic hot water and produces more thermally intensive waste streams. Due to the mixed-use development planned for Silo City, we do not anticipate sufficient heat from wastewater to meaningfully reduce the size of the GLHE. As a reference point for heat recovery from wastewater, our team has seen projects where 500 residential units are unable to eliminate a single borehole from the GLHE. Given this knowledge we have decided to rule wastewater heat recovery out as a viable technology.

4.8.2 Air Source Heat Pump

With 78.3% heating load remaining after deploying a GSHP solution. Our team advises against using ASHP to meet the remaining load due to relatively high up-front equipment costs. Furthermore, ASHPs efficiencies drop significantly in winter months. Buffalo's average temperature in January is a high of 31ºF and a low of 17ºF. Installing ASHP to deliver space heating in these conditions would be both capital intensive and expensive to operate. While ASHP are typically a good option for all-electric solutions, the challenge on this project is the existing inefficient building envelope that cannot be improved due to planning restrictions.

4.8.3 Surface Water Heat Exchange

We also considered using the adjacent Buffalo River as thermal energy source/sink. Proxy temperatures for the Buffalo River was sourced from Lake Erie in Buffalo, NY from a National Weather Service Station.[2] We used this data to estimate average monthly water temperatures for the Buffalo River as seen in Table 15.

Table 15. Average Monthly Water Temperatures in Degrees Fahrenheit taken in Buffalo, NY

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
35	33	32	33	40	55	68	73	72	64	54	43

Based on a combination of estimated average water temperatures and regulatory timelines, surface water was ruled out as a viable solution for this project. During the peak of the heating season, water temperatures average almost 32ºF. While it is technically feasible to extract heat from water at low temperatures using WSHPs, equipment efficiency would be marginal. The process to secure regulatory approval to access surface water in New York State is time consuming and costs can be difficult to quantify, adding risk to project execution for marginal gains. A full account of the regulatory hurdles associated with surface water heat exchange can be found in Appendix B.

4.8.4 Solar Photovoltaic (PV)

We studied the availability of rooftop area and parking lots across Silo City for solar PV array location. To achieve economies of scale, the conceptual design maximizes solar PV across all available rooftops in the development and the large parking area. Suggested Solar PV layout can be seen in Figure 10.

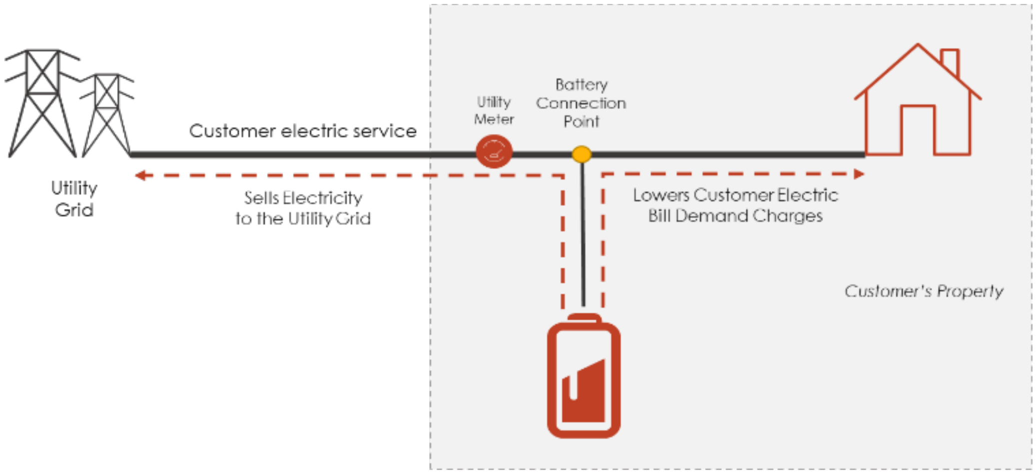
Figure 8. Solar PV Array Siting

Rooftop designs remain uncertain at this stage, and rooftop areas could be required for a variety of purposes: solar PV, solar thermal, or to locate heat pumps. If we assumed that all available rooftop space was used for solar PV, the maximum capacity is estimated to be 1.35 MW DC. If solar thermal is determined to be more advantageous, solar PV could be located in car parking spaces as a carport solution would be viable while solar thermal may be located on the building roofs.

4.8.5 Battery Energy Storage

The team conducted a comprehensive analysis of Silo City's existing and planned infrastructure to determine the potential of the site to host a battery energy storage system (BESS). Battery storage is a versatile technology that can provide a variety of technical and commercial values. Batteries provide flexibility to utility grid operators, making them a critical and valuable asset. They can supply additional energy at times of peak demand, when the grid needs it most, and deliver services that help balance and stabilize the network.

Figure 9. Illustration of Energy Storage Configuration



There are two main use cases for batteries in New York State. The first is a "front-of-the-meter" application where the battery would not connect to Silo City's facilities but would connect to the National Grid's distribution network and sell energy services to the grid. In this instance, the Generation Development Group would receive a simple lease payment as compensation for letting the battery use the land. In the second use case, the "behind-the-meter" model, the battery connects to the facility. During the facility's peak demand hours, it would draw power off the battery instead of the grid, minimizing its demand for that hour (possibly even making it "zero" from the grid's perspective) and therefore minimizing the site's electric bill demand charges. In some behind-the-meter applications, the battery can also back-feed into the grid to supply electricity and services to grid operators (seen on the right in Figure 8).

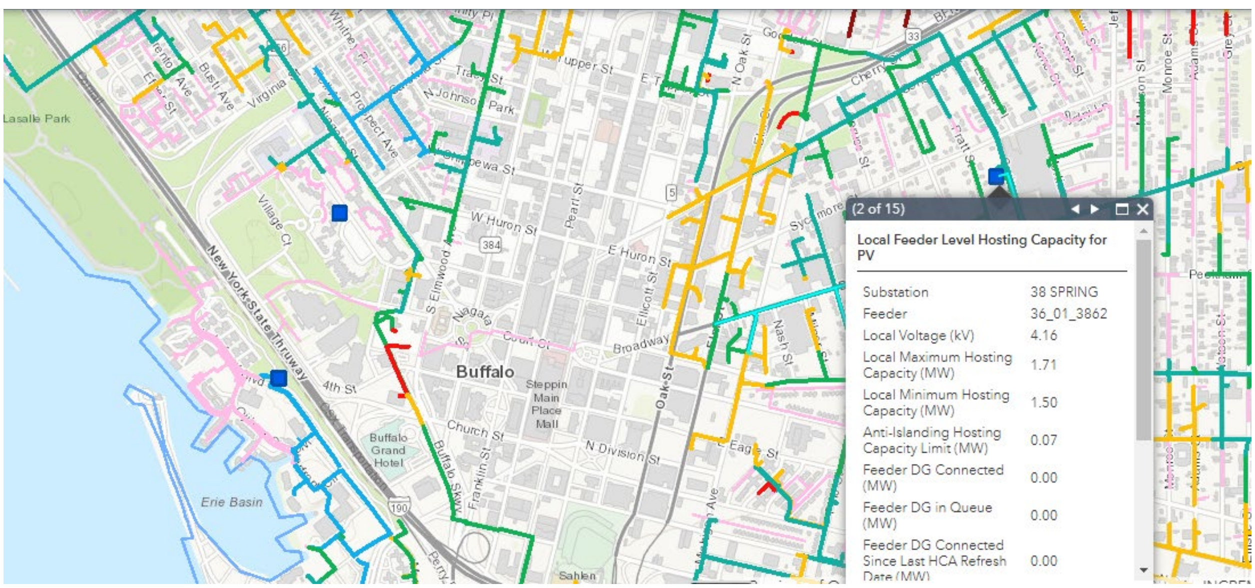
4.8.5.1 Technical

From a technical perspective, Silo City's legacy infrastructure and planned development made a strong case for battery storage. The complementary nature of the planned commercial loads, 400 residential units, and other potential industrial infrastructure, such as a community GSHP system, hydroponic farming equipment, ancillary HVAC loads, EV charging, and freight elevators are all loads that could "stack" neatly so that the battery could generate value at different times of the day. Further, many of these loads could be easily curtailed to generate energy savings or participate in demand response programs.

The timeframe differential between each asset's likely peaks and uses would make the battery valuable across different markets at different periods throughout the day and different seasons (winter and summer peaks versus shoulder seasons). For example, it could be used to drive or curtail heat pumps during the winter and other HVAC loads during the summer. Lastly, the battery could be used to provide several (~4) hours of resilient backup power during grid outages.

Endurant reviewed the existing National Grid distribution infrastructure to determine the grid's ability to accommodate new energy storage on the network. Silo City is predominantly fed by the 38 Spring Substation with a local (low) voltage of 4.16 kV. The feeder only has 370 kW of anti-islanding hosting capacity available, limiting the amount of distributed generation (or energy storage) that would be able to connect to the system without a significant and costly substation upgrade.

Figure 10. National Grid Infrastructure at Silo City



With a hosting capacity limitation this low, a behind-the-meter use case that manages Silo City's peak demand charges and time-of-use energy charges would be the most appropriate application. Due to the low-hosting capacity availability, exporting to the grid would be limited, minimizing its potential to generate revenue through energy arbitrage and selling regulation services to the utility (outside of the Demand Side Ancillary Services Program markets, which are still nascent although expected to change in the coming year).

4.8.5.2 Economic

From an economic perspective, energy storage is not an ideal solution in Buffalo, NY for several reasons. First, the State's most lucrative markets for energy storage and solar + storage systems are the new "Value of Distributed Energy Resources" (VDER) markets. These markets pay batteries for the locational marginal value of flexibility and infrastructure relief that they provide to each specific node of the grid. The "Locational System Relief Value" (LSRV) market, for example, pays batteries (and solar + storage) for the demand relief it provides for that specific node on the grid. Nodes that are more congested receive "LSRV Zone" status, making them eligible for payments in that special program. Endurant Energy analyzed the local market prices and VDER rates which can be shown below:

Table 16. VDER Value Stack Available Rates

Silo City VDER Value Stack Available Rates	
Market	Rate Price
Capacity (Alternative 3)	$2.08 ($/kW)
Environmental Component	$0.03103 ($/kWh)
Demand Reduction Value (DRV)	$0.2108 ($/kWh)
LSRV	Does not Qualify

Notably, electricity prices are relatively low in Buffalo compared to other areas of the State (specifically downstate), meaning that the economics are poor for these types of systems. Buffalo's VDER and market rates are not lucrative enough to make energy storage projects viable in the city without additional incentives.

Endurant also evaluated the value of energy storage assets if they were paired with solar PV. While pairing the BESS with solar energy does improve project economics by allowing the batteries to be eligible for the federal Investment Tax Credit (ITC), the economics are still not lucrative enough to justify the investment. It is notable that the "Reconciliation" legislation under consideration in congress is expected to include making the ITC applicable for stand-alone energy storage systems, but if and how that materializes is to be determined. Even with a new ITC, the new incentives are not likely to be sufficient to make batteries economically viable in Buffalo.

4.8.5.3 Conclusion

Silo City is not a strong candidate for battery storage projects at this time. Because the technology and its use cases are so new—but still vital to the modernizing grid's reliability—declining production costs, technology improvements, State-based policies, and local incentives could change in the future to make it a viable option in the years to come.

4.8.6 EV Charging

The site contains a large parking structure, which presents ample space for EV charging. The selection of charging technology largely relies on the intended end user. There are currently three levels of EV chargers available on the market: Level 1, Level 2, and Direct Current Fast Charge (DCFC). Each offers different features for unique applications and different commercial offerings. All three-offer charging at different rates, the table below illustrates the differences across the chargers.[3]

Table 17. EV Charging Infrastructure Summary

	Level-1	Level-2	DCFC
Voltage (V)	120	240	400+
Power (kW)	2.4	19	350
Charge Time (Miles/hr)	5	28	250-300
Application	Residential	Residential, Public, Workplace	Public

There are currently two widely accepted approaches to EV charging development:

1. Commercial Model: EV charging installed by the developer as an amenity to the residents. This would be installed and owned by the developer and the developer would be responsible for setting rates and any cost recovery.
2. Merchant Option: An EV charging developer would design, build, own, operate, and maintain the charger. This option would allow the developer to avoid the initial capital expenses while still offering charging as an amenity. Since this model relies on consistent usage for cost recovery the project would have to allow access for non-residents. This can be done in a secure manner; some EV charging companies provide their customers with key cards that can be used in facilities that require card access to enter.

Endurant recommends pursuing option 1 in this instance due to the incentives offered at the project site. The Joint Utilities of New York State offer an incentive program that will pay up to 100% of installation costs for publicly available DC fast chargers in disadvantage communities. Silo City would qualify for this program and could receive charging stations at no cost to the developer.[4]

5 Results: Business Model

Endurant identified two potential commercial options for the proposed solution. First, we considered an Energy-as-a-Service (EaaS) model. Under this offering, Endurant would design, build, own, operate, and maintain all centrally located heat pump equipment and the GLHE serving the building's heating, cooling, and domestic hot water production. Secondly, we considered a more traditional engineering, procurement, and construction (EPC) service to develop the project. The building owner would own the equipment and subcontract the various project components, as they would in the baseline scenario with conventional HVAC equipment.

5.1 Energy-as-a-Service

EaaS is a comprehensive solution that Endurant offers for the development, construction, ownership, and maintenance of bespoke energy systems. It is delivered through a long-term energy management agreement. It may include a wide array of services and products and is tailored to meet the specific needs of each project.

Endurant has decades of experience navigating the rapidly changing distributed energy landscape. They are a unique partner in that they develop the entire suite of renewable technologies. Others typically develop a single asset type (such as solar, or fuel cells) but Endurant brings experience developing multiple complimentary technologies that enable enhanced energy and Carbon Dioxide (CO) savings, as well as a deep understanding of the value streams.

As described above, developing distributed on-site energy systems enhances reliability and energy flexibility and will position the development to better adapt to future changes in the energy landscape. Localized generation can produce revenue streams, electrified heating and cooling systems can be used in demand response programs, and energy storage can support resiliency. Endurant as the EaaS partner will develop a solution that will serve as a platform for long-term value creation.

5.1.1 Endurant's EaaS Offering

- Distributed Generation Asset DBOOOM (Design, Build, Own, Optimize, Operate, Maintain).
  - Ground Source and Air Source Heat Pumps
  - Solar PV/Solar Thermal
  - Storage
  - EV Charging
  - Fuel Cells
  - Combined Heat and Power
- Demand Management
- Energy supply contracts
- Efficiency upgrades

EaaS offers more than a single technology solution, and Endurant is an energy partner supporting a customized energy solution by:

- Removing capital investment for bespoke energy solutions from client balance sheets.
- Optimizing performance and reducing operating costs.
- Monetizing underutilized space.
- Providing clean, efficient energy solutions designed to meet ESG goals and objectives.
- Managing commodities associated with energy solution.

5.1.2 EaaS scope

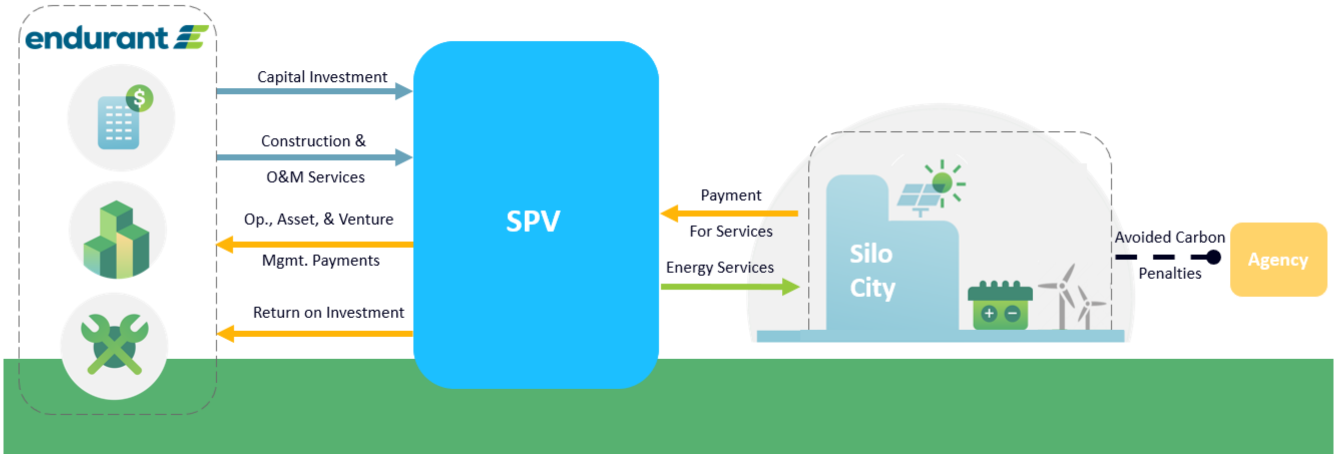
Endurant's ownership would include the GLHE and any centrally located heat pump equipment, while the building owner would own the decentralized equipment.

The EaaS scope would include the following elements:

- Detailed Design
- Installation
- Commissioning
- Operations/optimization and Maintenance
- Decommissioning

The figure below illustrates the overarching relationships and responsibilities in the EaaS business model:

Figure 11. Endurant Energy's EaaS Commercial Structure



Endurant will set up a Special Purpose Vehicle (SPV) that will develop, finance, build, own, and operate the site's energy assets including the GSHP system, solar PV, solar thermal, battery storage, and/or EV charging infrastructure. A core aim of the EaaS model is to simplify counterparty relationships: in the proposed structure, the SPV will contract directly with the building owner/operator for energy services, namely heating and cooling energy from the GSHP system. From the building owner's perspective, this relationship is similar to their relationship with the local electric and/or gas utility in the BAU case.

The EaaS structure contemplates a one-time interconnection fee and an ongoing capacity fee. The ongoing capacity fee from the building owner to the SPV encompasses the costs to operate and maintain the system and deliver energy services within the terms of the EaaS agreement. This structure offers several advantages:

- The building owner receives the benefit of installing a GSHP system without the risk of financing and owning the asset.
- Endurant is able to monetize tax benefits (such as ITC) through tax equity partnerships to improve the project economics for all stakeholders.
- Endurant can secure long-term electricity supply contracts on behalf of the project to hedge against future energy costs. These electricity supply contracts can be sourced from renewable sources, which will position the GSHP project as 100% renewable.

The EaaS business model's fundamental tenet is to maximize value to all stakeholders, as summarized in Table 18.

Table 18. EaaS Benefits Summary

Stakeholder	Benefits due to EaaS Business Model
Developer	• Lower utility/operational costs incurred to provide heating and cooling to tenants. • Low risk—since the developer is not responsible for financing and owning a complex DER project on their balance sheet. • Improves the brand value and marketability of future development projects.
Tenants	• Lower utility costs. • Access to highly efficient, fossil free, renewable heating/cooling.
Endurant	• Directly in-line with our mandate to deploy capital and own DER projects. • Builds on our expertise in GSHP design, construction, and financing.
Community	• Efficient, electric thermal energy district eliminates on-site carbon emission. • Serves as a proof-of-concept for the scalability of this model to other parts of the community.

5.2 Engineering, Procurement, and Construction (EPC)

The EPC option represents the business-as-usual approach through which the real estate developer would design, build, own, operate, and maintain the heat pump and ground loop equipment through multiple subcontracts. Value for tenants is realized via operational savings produced by the efficiencies of the GSHP system; however, the real estate developer takes on more project risk:

- Execution Risk—throughout the development process, schedules, quality, and delivery must be carefully managed to avoid costly delays.
- Economic Risk—developer must secure financing and service debt, or equity associated with the equipment capital costs.
- Operational Risk—energy assets require ongoing preventative maintenance and occasional repairs.

Risks are common in the development process, and none pose an insurmountable hurdle to the project. The company has engaged on over 400 GSHP projects since it was established and has developed a deep understanding of project risk and risk mitigation strategies.

In the company's experience, project outcomes may be impacted if the various components (energy modelling, ground loop design, mechanical design, controls strategy, and installation) are subcontracted to multiple vendors. Each one of these components interacts with others, affecting the system's performance. A successful project requires that the interplay between these components is well understood and managed. Under the EPC approach, Endurant strongly recommends that the real estate developer pursues an EPC contract that places all of the GSHP design and construction responsibilities with a single vendor. This approach is more likely to produce a reliable outcome by placing accountability with a single entity and is the best strategy for mitigating the risks outlined in this report.

5.3 Incentives and Depreciation Schedules

Several State and federal incentives are available to support the deployment of renewable technologies, including GSHP systems. This study identified the following incentives:

- New York State Clean Heat Incentive (NYSCHI)—administered through National Grid.
- Federal accelerated depreciation schedules.
- Federal Business Energy Investment Tax Credit (ITC).
- NYSERDA New Construction—Housing (PON 4337).

The following section will describe available incentives and the payout mechanism in relationship to the two ownership structures. Each incentive value is quantified in section 7.1.

5.3.1 New York State Clean Heat Incentive

The NYSCHI[5] is a statewide incentive program administered through the NYS Joint Utilities.[6] The program has a variety of incentive categories that encompass small to large scale energy projects and numerous heat pump-based technologies. This project qualifies for the Category 4—Custom Incentive since the GSHP system is not designed to meet the building's full heating load. The formula for determining the incentive value is below, and the incentive values are determined in section 7.1.

$$\{\boldsymbol{Modeled\ Code\ Compliant\ Heating}\ \textbf{and}\boldsymbol{Cooling}\ (\boldsymbol{MMBtu}) - (\boldsymbol{Modeled\ GSHX\ Energy\ Heating}\ \textbf{and}\boldsymbol{Cooling}\ (\boldsymbol{MMBtu})\}\ \boldsymbol{x}\ \$\boldsymbol{Incentive\ Value} = \boldsymbol{Cat}\ \mathbf{4} - \boldsymbol{Custom\ Incentive}$$

The application for this incentive must be submitted, reviewed, and approved by National Grid prior to the installation of the equipment. The application requires the following elements:

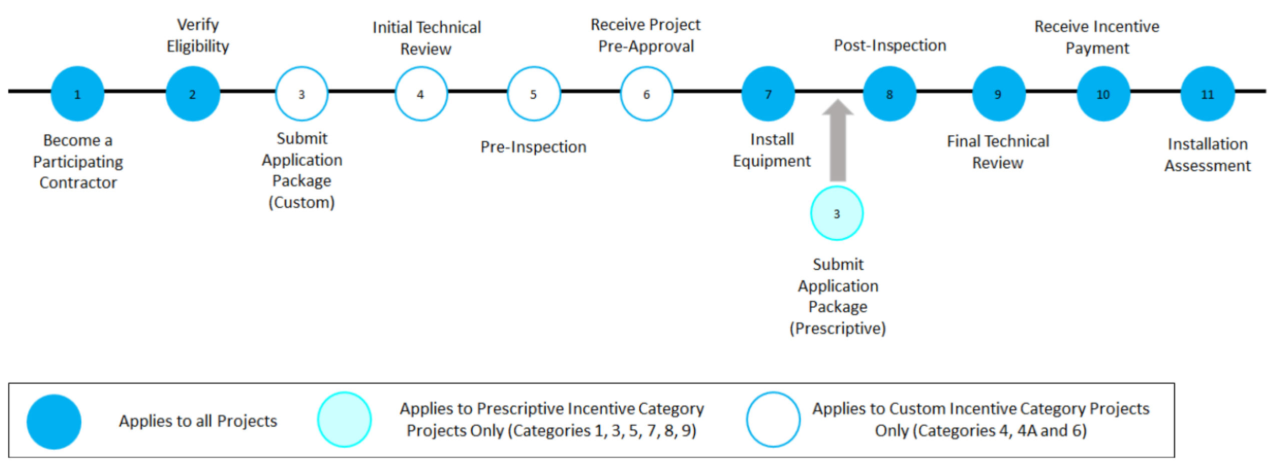
- Completed program application
- Cutsheets for proposed equipment
- Cost estimate for proposed work
- Load calculations
- Detailed scope of work

Description of baseline:

- Describe the extent of the work
- Specify type of heat pump technology
- Provide design capacity
- Specify what percentage of the design heating/cooling load heat pumps will meet
- Specify whether supplemental heating is required
  - Why addition electrification is not feasible
  - Document a controls strategy that prioritizes heat pump dispatch

- Approved Department of Buildings permit submission
- Savings analysis

Figure 12. Application and Approvals Timeline for New York State Clean Heat Incentive



5.3.2 NYSERDA PON 4337

NYSERDA's New Construction Housing Program (PON 4337) provides incentives to help achieve New York State's heat pump goals and support market development and customer adoption of low-carbon heating solutions.

Under PON 4337 there are four incentive tiers and two categories: Market Rate and Low-to-Moderate Income (LMI). Tier 1 is the lowest incentive value. Our analysis indicates that Silo City would qualify as a Tier 2 LMI building. Incentives are paid out in three milestones as defined in Table 20.

Table 19. PON 4337 Tier 2 Incentive Comparison

	Incentive per Dwelling Unit	Incentive per SF of Non-dwelling Unit Occupied Residential Space	Incentive Cap
Tier 2	$1,000	$1.00	$200,000

Table 20. PON 4337 Incentive Milestone Payment Schedule

Milestone 1: Proposed Design	Milestone 2: Open Wall	Milestone 3: As Built
Payment value: 30%	Payment value: 30%	Payment value: 40%
• Proposed design meeting eligibility thresholds. • Deliverable: Contracts between engineer and project, LMI Qualifications, Energy Models, Design Documents, Workbooks.	• 30% completion of various measures: exterior insulation, insulated concrete form, exterior insulation and finishing systems, interior insulation only, exterior insulation with interior insulation, prefabricated exterior wall assembly and modular construction. • Deliverable: Multifamily Workbook, checklists, multifamily high-rise measurement and verifications, photo documentation.	• Project Completion • Deliverables: Multifamily workbook or equivalent, photo documentation as required, as-built energy modeling files, ASHRAE path calculator or approved equivalent, proof of review by Multifamily Review Organization, HVAC functional testing checklist, testing and verification worksheets.

This program also contains an incentive for commercial space paid out at a rate up to $2 per sq. ft., capped at $250,000. This incentive can be layered on top of the residential incentives.

5.3.3 Federal Accelerated Depreciation Schedules

Geothermal assets are eligible for accelerated methods of depreciation such as Bonus Depreciation and Modified Accelerated Cost-Recovery System (MACRS). Under the federal MACRS program, companies may recover investments in technologies (including GSHPs) via depreciation deductions on an accelerated -year schedule.

Currently, bonus depreciation of 100% is available for qualified property placed in service between September 27, 2017 and January 1, 2023.[7]

5.3.4 Federal Business Energy Investment Tax Credit

The Federal Business Energy Investment Tax Credit (ITC) is a tax credit that may be claimed for qualifying investments in renewable technologies. The ITC has been extended on numerous occasions. Currently, the ITC rate for qualifying geothermal heat pumps is set at 10%.[8] It is due to expire at the end of 2023. The value of the ITC may be monetized via a reduction in federal taxes owed by the project owner. Real estate developers or project owners that have an effective tax rate of 0% or near 0% will not be able to monetize this benefit. Alternatively, there are tax equity investors who may be able monetize this tax credit via an equity partnership role in the project. Under Endurant's EaaS we can partner with tax equity investors to monetize the ITC benefit on behalf of the project.

This incentive applies only to GSHP equipment and downstream distribution equipment receiving at least 75% of the annual thermal energy from the GSHP system. For example, a fan coil unit delivering heat that is at least 75% derived from the GSHP on an annual basis would be eligible for the ITC. The ITC must be monetized within one year of initial operations and cannot be monetized before the equipment becomes operational.

It should be noted that any federal tax incentives monetized through a tax equity partner are complex to structure, are not guaranteed, and require transaction costs that erode the net value of the ITC and/or depreciation.

5.3.5 Summary of Available Incentives

The table below estimates incentive values available for the geothermal solution. A detailed analysis of the incentive impact is in section 7—Results—Impact.

Table 21. Incentive Values Associated with the Proposed GSHP Solution at Silo City

	Phase 2	Phase 3	Phase 4
PON 4337.[a]	$90,000	$79,000	$45,000[b]
NYS Clean Heat	$238,608	$535,434	$201,444
ITC	$401,103	$503,096	$189,097
TOTAL	**$729,711**	**$1,117,529**	**$435,541**

[a] These estimates represent a minimum incentive value. More detailed information related to non-dwelling unit residential occupied space will be required (i.e., community rooms, common areas etc.).

[b] Phase 4 currently does not have any design information related to residential unit count. However, we estimated Phase 4 units at 45.

5.4 Regulatory Review

The team's regulatory review identified approximately federal, State, and local entities that the project may have to interface for various permitting and regulatory approvals. Approvals for executing a GSHP project can primarily be grouped as follows:

- **Environmental permits:** Permits related to water quality standards (NYSDEC), environmental impact clearances for State-funded projects (SEQRA, CEQR), Office of Renewable Energy Siting (ORES) approval, groundwater discharge.
- **Construction permits**: Permits related to drilling (different requirements for <500 ft. and >500 ft. wells), building codes, revocable consent agreement/permits related to streets and sidewalks.
- **Land-use permits**: Clearances and permits related to landmark preservation, historic resource preservation (SHPO).
- **Energy service regulations:** Uniform heat standards for multiunit residential buildings, sub-metering regulations for electrical heat, affordable housing requirements, right-of-way easements.

Of the permits required, we are aware that some may have already been obtained as part of the overall development process. It is likely that some Authorities Having Jurisdiction (AHJs) have already been engaged. The following sections summarize anticipated hurdles and mitigating strategies to reduce regulatory risk to the project. This section is abridged; the full regulatory report can be seen in Appendix B.

5.4.1 Lack of Municipal Regulatory Regime for Geothermal Systems

Few municipalities in NYS have developed permitting guidelines for geothermal systems, and no municipality has developed guidelines for multi-property district systems. Without a permitting regime and standards for equipment, developers and municipal officials are left to navigate the various zoning, building, mechanical, environmental, and other regulations that may apply to geothermal systems but were not designed specifically for these systems.

This ad hoc approach in the absence of a dedicated geothermal permitting regime increases costs, uncertainty, and risks, and delays the approval process.

To address this challenge, project developers should start educating municipal permitting authorities and elected officials about the benefits of the geothermal features early in the development process and highlight the mitigating measures taken to reduce risks to the environment or other subsurface infrastructure as early as possible. This educational effort should commence as soon as the developer decides to proceed with a geothermal design. The project developer should also be prepared to engage with environmental and community groups interested in the project.

5.4.2 Rights-of-Way and Approvals

Developers must obtain either fee simple ownership or easements to drill and install a shared ground loop across multiple properties. Crossing property lines, streets, railroad tracks, or existing utility infrastructure will require the grant of an easement and approval by the owner or authority responsible for their operation. Granting an easement limits the property owner's ability to use his/her own property, and can adversely affect private property rights, or diminish private property values. The Joint Venture ownership across project phases should significantly reduce challenges in obtaining easements.

5.4.3 Drilling Regulatory Restrictions

NYS imposes different requirements for geothermal wells depending on if their depth is above or below 500 ft. Permitting requirements for wells over 500 feet in depth are considerably more rigorous and costly. Due to the additional permitting requirements imposed by NYS, our team elected to limit drilling to 500 ft. to avoid costs of compliance with additional regulation.

5.4.4 Submetering and Tenant Billing

If submetering is installed, the Public Service Commission requires compliance with metering, billing, dispute resolution and other regulations. Obtaining submetering approval for a new development is far less complex a process than submetering a building with existing tenants.

Presently, New York State's submetering regulations apply to electricity and electric heating services. No regulatory arrangement exists for the billing of heating services measured in thermal units. Accordingly, to simplify submetering arrangements, the project should introduce submetering prior to entering into agreements with any prospective tenants and, preferably, prior to advertising rental units.

5.4.5 Summary of Recommendations to Overcome

Several of these challenges can be addressed through contractual arrangements between the real estate developer and other stakeholders. Recommended contractual arrangements include:

Common agreement among phases. The project is presently owned and developed by a single entity, but over time may be separately incorporated, or equity interests may be sold to disparate groups of investors. Anticipating this, the developer should adopt a common agreement to govern various aspects of the project's maintenance, access, and financial responsibility. The common agreement should specifically address the ownership, operation, and maintenance of the geothermal system as the geothermal system will cross internal property boundaries and require cooperation across separated properties and ownership structures. A common agreement would govern maintenance, management, pricing, financial contributions, and other responsibilities for operating the system. A common management body, such as an owner's association or similar entity, should be established for this purpose and supported by association charges.

- **Third-party energy services**. The common agreement would facilitate the project entering into a third-party energy services agreement with a geothermal system operator. The third party could provide a turnkey solution or perform discrete tasks on behalf of the project's common management association. Any arrangements with a third-party energy services provider should require performance and compliance consistent with developer obligations to tenants and requirements that may be imposed by the New York Public Service Commission or other government agencies in relation to provision of heat to tenants.
- **Submeter billing.** The developer or a third-party energy service provider operating the system will be required to use an approved billing form and maintain billing service and dispute mechanisms as required by New York State's submetering regulations. The developer or third-party energy service provider may desire to contract with a third-party billing provider to comply with these requirements. Such arrangements must provide compliance with any applicable landlord-tenant laws.
- **Tax optimization**. The geothermal system is a depreciable asset that provides opportunities for tax-advantaged financing. The form of ownership for those assets can be separated from the project and its phases to monetize tax benefits. A separate geothermal financing structure potentially improves the financial return of the overall project; however, this must be weighed against the additional complexity and legal risk in the event of a failure to meet obligations for any reason or from legal dispute.

5.4.6 Regulatory Conclusion

While there are various regulatory considerations at play and a variety of AHJs and stakeholders that should be engaged, the team did not discover any signals in the analysis that would indicate the need to delay or close the project overall. The team did discover an issue concerning surface water heat exchange due to the regulatory complexity and challenges around quantifying the regulatory costs. The objective of this regulatory analysis is to account for risks and identify mitigating strategies. While there may not be prescriptive geothermal regulations, there are several geothermal projects located in NYS which create precedent, some of which Endurant Energy has developed. While district energy systems are less common in the multifamily space, there are many examples of district thermal systems operating on campuses in NYS.

The unabridged regulatory analysis is in Appendix B.

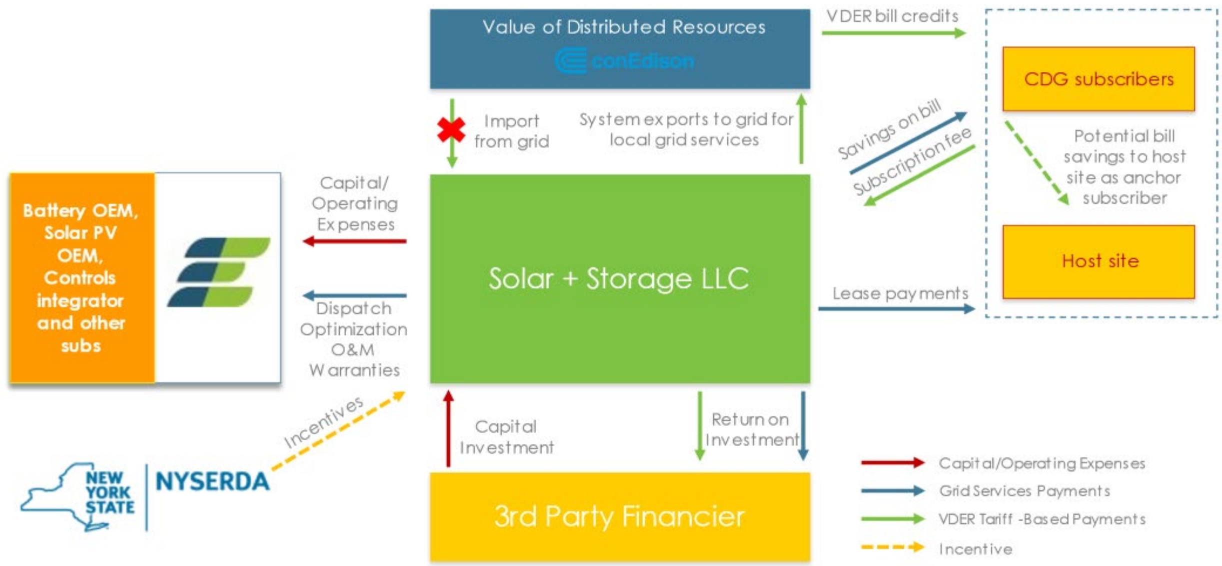
5.5 Additional Technology Business Models

5.5.1 Front-of-the-Meter Solar PV

New York State has an established program called Value of Distributed Energy Resources (VDER) that allows solar PV (optionally paired with battery energy storage) systems to connect directly to the distribution grid in front of the customer meter (FTM). An asset enrolled in the VDER program generates a monetary credit for each kilowatt-hour (kWh) of electricity injected into the grid. The VDER program has several sub-options that dictate how that monetary credit can be applied to a variety of customer bills.

Community Distributed Generation (CDG) is one version of the VDER program, which allows commercial and residential customers to "subscribe" to the output of an FTM VDER asset and see a portion of those monetary credits as savings on their bill. FTM assets deployed under the CDG VDER program offer landowners the opportunity to generate stable lease payments for use of their land (or rooftops) by third-party asset developers, as well as the opportunity for customers to subscribe to the renewable energy generated by the asset. As per the rules of the CDG VDER program, up to 40% of the total monetary credit may be allocated to a large commercial account, with the remaining 60% reserved for mass-market (residential and small business) customers. Figure 13 summarizes the third-party funded business model for the FTM CDG VDER asset.

Figure 13. Third-Party Funded FTM CDG VDER Commercial Structure



Under this business model, all credits appear as savings (or bill reductions) on each allocated subscribers' bill. The project then recovers 90%–95% of this credit as a fee (this is the primary revenue to the solar PV asset owner), leaving the remainder as savings on the subscribers' bills.

The Silo City project owner, Generation Development Group would receive a lease payment from the solar PV owner for use of their rooftop. Furthermore, the proposed GSHP's primary electric account can be designated as a subscriber to the solar PV project, thereby seeing approximately 5%–,10% reduction in electricity bills. Additionally, FTM solar PV:

- Works seamlessly with GSHP solutions as it is independent of any metering configuration.
- Offers stable and predictable cash flows in the form of lease payments, which can serve to further reduce operating expenses.

5.5.2 Behind-the-Meter Solar PV

Behind-the-Meter (BTM) solar PV projects are structured as Power Purchase Agreements (PPAs) where the off-taker pays a fixed price ($/kWh) for the output of the system.[9] PPA prices are calculated based on third-party costs of development and expected rate of return. A successful BTM PPA results in a discounted price when compared to the prevailing rates of purchasing electricity from the grid.

Under this business model, the solar PV would be connected behind the GSHP electricity meter, thereby directly supplying energy to the heat pumps and reducing the amount of energy imported from the grid. This solution has one inherent disadvantage when compared to the FTM solution, which is that it cannot be connected behind multiple meters; only a centralized geo-exchange solution integrates with a BTM solar PV solution.

A BTM PPA solar PV solution does offer one advantage over an FTM solution: since solar energy is directly feeding the GSHP meter, the solar PV array is providing clean and carbon-free electricity directly to the GSHP system.

From a purely technical perspective, this project presents a viable opportunity to deploy a modest, yet meaningful, number of solar PV arrays.

6 Results: Impact

This analysis suggests the best configuration for providing renewable heating and cooling to phases 2, 3, and 4 at Silo City include a GSHP system supplemented by a solar thermal system and gas-fired boiler. This configuration can meet the significant unbalanced heating load while balancing cost and carbon reduction. A portion of the unbalanced heating load will be supplied by solar thermal while the remaining heating loads (particularly the peak heating loads) would be supplied by a GFB. By pursuing a partial load GSHP solution rather than a full-load solution, the team avoided an estimated $9.6 million in additional GLHE costs for the district.

The team recommends locating heat pump equipment at each individual building, rather than at a central plant. This provides greater flexibility for future programming. A community source loop will interconnect each building as well as the GLHE and other thermal generators (i.e., solar thermal and GFB). This overall configuration balances initial capital costs, space availability, operational costs, and overall efficiency.

6.1 Capital Cost Summary and Comparison

Our team worked with New York State-based drilling contractors, mechanical contractors, and equipment providers to generate capital cost estimates to compare the business-as-usual costs to our proposed alternative. Capex cost estimates include heat pump equipment, installation of the GLHE, and distribution systems within the buildings. The table below summarizes capital expenditure (capex) costs by phase. The figures represent installed costs, and do not include design costs.

Table 22. Capital Costs for Business as Usual and Ground Sourced Heat Pump System

	Phase 2	Phase 3	Phase 4	TOTAL
HVAC Installation	$1,980,000	$3,623,400	$1,405,800	$7,009,200
DHW Installation	$940,500	$1,721,115	$667,755	$3,329,370
Total BAU Installation	**$2,920,500**	**$5,344,515**	**$2,073,555**	**$10,338,570**
In-Building Heating/ Cooling Distribution	$2,489,660	$4,566,036	$1,767,659	$8,823,355
DHW Distribution	$755,307	$1,385,233	$536,268	$2,676,808
Boiler and Heat Pumps	$852,828	$1,564,086	$605,508	$3,022,421
Equipment Installation	$449,570	$824,511	$319,195	$1,593,276
GLHE and Common Source Loop	$1,287,230	$2,360,779	$913,933	$4,561,942
Solar Thermal	$966,240	$715,144	$251,096	$1,932,480
Project Management	$148,500	$272,349	$105,435	$526,284
Total GSHP Installation	**$6,949,334**	**$11,688,139**	**$4,499,093**	**$23,136,566**
Incremental Cost over BAU Baseline	**$4,028,834**	**$6,343,624**	**$2,425,538**	**$12,797,996**

Without considering incentives, the GSHP solution represents a capex cost premium to the project compared to baseline HVAC capex costs. Available incentives (outlined in the table below) may be secured to reduce the financial impact of proceeding with a GSHP solution for Silo City. The incentive values are calculated based on existing building design and Endurant's preferred GSHP approach. Additional incentives are available for improved building envelope efficiency; however, due to the historic nature of the site envelope, improvements are limited by SHPO.

Table 23. Incentive Summary

	Phase 2	Phase 3	Phase 4	All Phases
NYSERDA PON 433711Fa	$90,000	$79,000	$45,000b	$214,000
NYS Clean Heat	$238,608	$535,434	$201,444	$975,486
ITC	$401,103	$503,096	$189,097	$1,093,296
TOTAL	**$729,711**	**$1,117,529**	**$435,541**	**$2,282,781**
Incremental Costs (Net Incentives)	$3,299,123	$5,226,095	$1,989,996	$10,515,214

[a] These estimates represent a minimum incentive value. More detailed information related to non-dwelling unit residential occupied space will be required (i.e., community rooms, common areas etc.). Phase 4 will require additional information.

[b] Phase 4 currently does not have any design information related to residential unit count. However, we estimated Phase 4 units at 45.

While the GSHP option does introduce incremental capital costs to the project, it also produces operational savings due to overall system efficiency.

Please note that this analysis is combined with operational costs to produce lifecycle costs in section 7.4, showing an overall reduction against BAU.

6.2 Ground Sourced Heat Pump Operating Cost Summary and Comparison

GSHP systems are far more efficient than conventional gas-fired heating and air-cooled chilling equipment. The alternative GSHP, solar thermal, and GFB system generates significant utility cost savings due to the efficiency gains over the BAU scenario. When compared to the annual electric and gas costs for the BAU case ($623,539), the alternative GSHP system offers utility cost reductions of just over 54% annually (down to $285,327).

The table below summarizes annual utility costs to operate the GSHP, solar thermal, and GFB solution for each phase.

Table 24. Annual Utility Costs for the Alternative Ground Sourced Heat Pump Solution

Building/Phase	Electricity (kWh)	Elec Utility Cost	Natural Gas (therms)	Gas Utility Cost
Phase 2	332,547	$42,705	63,519	$33,784
Phase 3	576,549	$76,609	148,634	$71,461
Phase 4	222,102	$29,899	57,258	$30,868
Total Phase 2, 3 and 4	**1,131,198**	**$149,213**	**269,411**	**$136,113**

In addition to utility cost savings, the team estimates additional operational cost savings from reduced maintenance costs. Annual maintenance costs for the BAU scenario are estimated to total approximately $453,000 across all phases. The GSHP scenario is expected to cost approximately $112,500 per year. This represents a 75% reduction in annual maintenance costs. Total operational cost savings for the GSHP solution (including utility costs and maintenance costs) are estimated to be $679,225 per year.

6.3 Carbon Savings Summary

The team achieved carbon savings by reducing annual electricity consumption by 21% and annual gas use by 19%. Annual carbon emissions were reduced by 19%.

Table 25. Annual Carbon Emissions Reductions

	Phase 2	Phase 3	Phase 4	Total Phases
BAU CO_2 Emissions (tons)	717	1,389	551	2,657
GSHP CO_2 Emissions (tons)	539	1,160	447	2,146
CO_2 Reductions (tons)	**178**	**229**	**104**	**511**

6.4 Life-Cycle Cost Analysis

Endurant conducted a 30-year life-cycle cost analysis (LCCA) for the baseline and GSHP alternative district scenario. The LCCA considers capital costs net of incentives, annual utility and maintenance costs, a 2.5% inflation rate, a 3.0% escalation on utility costs, and a 4.0% discount rate. Major equipment replacement is scheduled in year 15 and year 30.

Table 26. Life-Cycle Cost Analysis (30 years)

30- Year Life Cycle Cost Analysis	All Phases
BAU	$43,493,701
GSHP Alternative with Common Bore Field	$37,102,073

Over the first 30 years of operations, lower operating costs (including utility costs, maintenance costs, and major equipment replacement costs) result in a lower cost of operation annually. As a result, the present value of the install costs and 30 years of operational costs for the GSHP is lower than the BAU.

6.5 Unitary versus District Configuration—Costs and Benefits Analysis

A key component of this study was to quantify the benefits of a district geothermal system compared to multiple unitary geothermal systems. A unitary system would serve the same buildings; however, there would be no district connection; in other words, each phase would have an independent geothermal system. At early stages the team determined that a district system would be technically, and economically preferrable while maintaining regulatory viability. The following sub-sections articulate the financial benefits of a district geothermal system.

6.5.1 Ground Loop Heat Exchange District versus Unitary Discussion

From a technical perspective the unitary systems demonstrated no benefit. The only benefit of this approach our team discerned was to preserve independence for future building sales and reduce the need for a common agreement across the property. However, given the single developing entity for this project and the large common open space the common agreement is a relatively low hurdle. Our team determined that the costs associated with common agreements would far outweighed the operational benefits of a district geothermal system.

6.5.2 Cost Comparison—District versus Unitary Discussion

The district geothermal system compared to multiple unitary systems achieves significant annual and lifecycle benefits as demonstrated in the Table 27.

Table 27. Cost Comparison between District and Unitary Systems

	District System	Unitary Systems	District Savings
Capital Costs	$23,136,566	$26,607,050	-
Incentives	$2,282,781	$2,282,781	-
Net Capital Costs	$20,853,785	$24,324,269	14%
Utility Costs	$285,326	$308,153	7%
Maintenance Costs	$112,446	$112,446	0%
Life-Cycle-Costs	$37,102,073	$41,722,434	11%
Emissions (tons)	2,146	2,253	5%

Capital costs show the most dramatic savings due to the reduction in boreholes required. The district system eliminates 26 boreholes compared to the unitary systems, which accounts for a significant portion of the overall reduction. Conversely, the maintenance remains essentially unchanged. Since each residential and commercial suite receives an in-unit heat pump, the quantity of equipment stays the same between the district and unitary system. The capacity would increase in the unitary system; however, maintenance cost build-ups are mostly labor; therefore, the capacity-based cost increases would be minimal. The district system shows significant cost savings when compared to the unitary systems.

7 Key Findings

After concluding the environmental, economic, and regulatory analysis. This project demonstrated significant operational cost reduction and environmental benefits without any insurmountable regulatory hurdles.

Based on the cost exercises completed, the team estimates the simple payback period to be 15 years driven by the operational savings of 63% per year. The proposed solution reduces annual emissions by 19%, producing a local and global benefit. However, even if the team assumes the New York State Department of Environmental Conservation (NYS DEC) social cost of carbon of $121 per ton,[10] the payback period does not decrease significantly (less than 1.5 years). This project does achieve a meaningful lifecycle cost reduction over a 30-year period, which should be a key consideration in pursing this project. Over a 30-year period the project would achieve a 15% discount compared to the BAU system.

From a regulatory perspective, after considering site conditions and existing regulation, the team's view is that the preferred configuration does not pose any signals that might indicate the delay or end of the project. We avoided triggering certain regulations, such as drilling deeper than 500 feet, and in doing so have eased the regulatory process to the greatest extent possible from a technical perspective. The primary consideration will be the treatment of the GLHE as common resource to be shared between three buildings. Our view is that the technical benefits of connecting the GLHE between phases 2 and 3 outweigh the regulatory hurdles.

8 Lessons Learned

A variety of lessons were learned during this study. Some are representative of project specific nuances, others have sweeping market implications.

Silo City presents many unique attributes, some of which had significant implications for energy consumption and carbon savings. The historic status of the project had the most significant impact on the thermal profile, SHPO limits any changes to the façade of historic structure interior and exterior. This essentially prohibited the installation of insulation and limited any façade improvements to exterior glazing. With limited ability to improve the envelope efficiency the team had to size our solution around very high heating demands. This led to trade-offs between cost and carbon savings. More flexibility in SHPO guidance would allow for better energy efficiency optimizations and lead to more cost-effective carbon savings.

Another pressure on this project is a relatively low-incentive rate in National Grid territory under the NYS clean heat program. For reference, the Con Edison incentive program offers incentives that are 60% higher. One could reasonably expect higher labor costs in Con Edison; however, not to the extent they justify the gap of 60%. Under the current incentive landscape, a project that sits in an LMI area in Buffalo is proportionally less incentivized than a market rate project in Con Edison territory. A statewide levelized approach to incentive allocation would benefit projects located in National Grid. Based on our project experience in Con Edison and National Grid territory a more levelized incentive value would be between $160 and $180.

These two lessons learned presented the biggest obstacles to the project. Overall, the project still achieves a life-cycle benefit: however, increased incentive values would support challenges to split incentives and capex hurdles.

Appendix A. Energy Model Assumptions

A.1 Energy Model Assumptions Phase 2, 3, and 4

Envelope	• Roof assembly U- 0.038
	• External mass-wall assembly U- 0.300
	• Window assembly U-0.250; SHGC=0.380
	• Opaque door U-0.500
	• Ground floor U= F (0.52)
	• Window to wall area ratio
	  o Building A—6.4%
	  o Building B—6.6%
	  o Silo Building—3.6%

Occupancy	• ASHRAE 90.1 space-by-space method.
Interior Lighting Power Density	• Living Units 1 W/SF • Overall building 0.78 W/SF
Exterior Lighting	• Estimated exterior lighting 0.02 W/SF of buildings area ~ 3,175 Watts

Miscellaneous Loads	• Receptacles plug load per ASHRAE 90.1 space-by-space method.
	  o Living Units 0.2 W/SF
	  o Overall building 0.44 W/SF
	• Two Elevators 20kW each.

HVAC Systems	• Residential Spaces
	  o Split system DX-cooling [EER 10.2], Natural Gas Furnace -heating [92% Eff.]
	  o DOAS Unit DX-cooling [EER 9.8], Natural Gas Furnace - heating [92% Eff.], ERV 50% sensible, 50% latent effectiveness.
	• Commercial/Common Spaces
	  o VRF system cooling [COP 3.5], heating [COP 3.2].
	  o DOAS Unit DX-cooling [EER 10.8], Electrical Resistance – heating [100% Eff.]. ERV 50% sensible, 50% latent effectiveness.

Appendix B. Regulatory Roadmap

B.1 Significant Project Design Features with Regulatory Implications

This assessment considers phases 2, 3, and 4 of the Silo City project and will detail regulatory concerns, considerations, and summarize recommendations to overcome any potential hurdles. Each phase will develop different buildings, and each building or area shall be separately incorporated with their own investors. All units will be rentals.

If a common district system design is adopted, a common management agreement will be required among the buildings as a framework for cooperation in access, sharing expense, and hiring a third party to operate and maintain the system. Due to common ownership and control at the outset of the development, adoption of a common management agreement is feasible.

Silo City sits in a wetlands area that serves as habitat to endangered species. Further, based on the subsurface conditions encountered in the test borings, engineering assessment indicate the site should be classified as Seismic Site Class "D" in accordance with the Building Code of New York State (IBC 2015), a classification for severe and destructive ground shaking. The site's environmental and geologic conditions should be taken into consideration during foundation excavation and construction, and in any common management agreement, such as if future maintenance could have implications for natural habitat or ground stability.

The parties are exploring heating as a service through this project, and the ownership of the district geothermal system may be structured based on economic and tax considerations. Endurant may retain ownership of the geothermal infrastructure and the company or a special purpose entity may be a counterparty with the building development.

The developer is at the early stages of taking into account the possibility of integrating geothermal into the project development, and no permit applications for the geothermal system have started.

Although most of the project will be contained within the development, easements may be required to be procured to cross a public road and other utility infrastructure. Because this is a New York State historic site, rights of way for road crossing could require additional approvals by the New York State Historic Preservation Office.

Because the development is designated a New York State historical preservation site, all aspects of site development, including geothermal integration, must comply with preservation specifications and the developer must obtain additional approvals by the New York State Historic Preservation Office.

Standing water identified during subsurface assessment and its proximity to the Buffalo River may implicate water protection considerations. Because the site is adjacent to a navigable State-owned waterway, the Army Corps of Engineers possesses jurisdiction to approve development that could impact the water and approval of environmental permits, working with New York State Department of Environmental Conservation (NYSDEC). Any use of the waterway for geothermal equipment would require their approval.

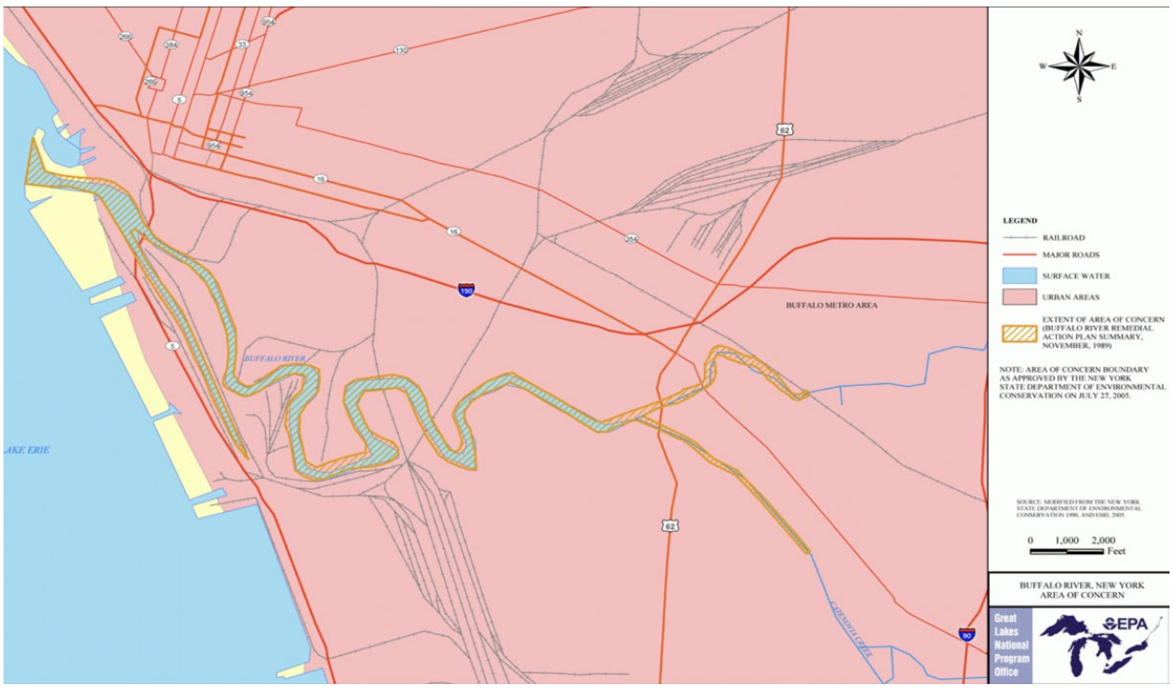
Alternative design and/or future phases may include exploitation of the adjacent Buffalo River as a thermal source using a closed ground loop design.

The system may introduce a solar PV array and/or solar thermal to the development. Depending on the economics of performance, the solar PV may be a stand-alone community solar project or may be a behind the meter system integrated with the district geothermal system to provide supplemental. A solar thermal system could be integrated with the district geothermal system to provide thermal balance in the ground loop, which in this case, would be supplemental heat due to heat-dominant loads. These will require additional permits; however, the additional permits are not expected to significantly complicate the geothermal permitting aspects of the project. The regulatory analysis focuses on the geothermal elements of the project; the solar portion of the project is not covered in this analysis.

B.1.1 Buffalo River Area of Concern

One of the most significant regulatory aspects of this project is the potential use of the Buffalo River as a thermal source. The Buffalo River, one of the principal rivers of the Niagara River Watershed, flows westerly through the City of Buffalo and discharges into Lake Erie near the head of the Niagara River. The Buffalo River has areas designated as “Areas of Concern” due to contamination resulting from a history of heavy industrial and municipal activity that led to the contamination of river-bottom sediments, poor water quality, and degradation of nearby water life habitat. The Area of Concern extends from the mouth of the river 6.2 miles upstream to the farthest point at which the backwater condition exists during Lake Erie's highest monthly average lake level. Additionally, a large extent of the Buffalo River is designated as a federal navigation channel maintained by the US Army Corps of Engineers at a depth of 22 feet below lake level datum. Routine maintenance of the federal navigation channel—including the portion of the river adjoining the Silo City project is dredged—is required by Congress on a biennial basis.

Figure B-1. Buffalo River Area of Concern (Green Hatched Area) with Silo City Indicated



A Buffalo River remedial action plan completed in 1989 by the NYS Department of Environmental Conservation in partnership with a local citizen's advisory committee governs activities concerning development of the river and its remediation and restoration. Today, the "Buffalo River Restoration Partnership," a unique public-private partnership including the Great Lakes National Program Office, Buffalo Niagara Riverkeeper, Honeywell, NYSDEC and the Corps, manages remediation efforts.[11] Since 2011, sediment navigation remediation projects have remediated more than 1 million cubic yards of contaminated sediment. Additionally, as of 2019, a total of twenty habitat restoration projects were completed in the Buffalo River Area of Concern, restoring almost 20,000 linear feet of shoreline to a more natural state, and included habitat restoration projects, bank stabilization, wetland restoration, planting of native terrestrial vegetation and the removal of invasive species.

B.2 Description of Regulatory Approach to Alternative 3: Decentralized Building Level Thermal Systems with Isolated Loads

An alternative configuration of several smaller individual systems could simplify the common management of a shared loop system among separately owned buildings following development. Individual systems would obviate the need for shared operation and maintenance of a common system. However—provided the entire development has homogenous physical conditions—a separate development, operation, and maintenance will necessarily involve duplication of effort and likely lower technology and institutional efficiencies, and thus higher costs.

Because common ownership at the time development enables a common system management agreement to be adopted, common management can be achieved cost effectively. Under these circumstances, the next-best alternative to a district system is likely sub-optimal.

Due to the sensitivity of the shoreline and its protected status as a navigation channel and natural habitat, the evaluation of alternative geothermal system designs should include systems that include and exclude river thermal exchange. The energy efficiency benefits of river geothermal must be evaluated together with the additional regulatory costs associated with using the river, and the risk that government authorities will not allow use of the river or may condition its use on measures that add cost and significantly reduce the energy benefits.

B.3 Applicable Laws and Regulations

Laws and regulations are organized as federal, State, and local; however, administration of laws is often shared at multiple levels of government and primary responsibility delegated to lower levels of government. Accordingly, laws appear in this section based on the primary level of administration.

B.4 Federal

B.4.1 Clean Water Act

The Clean Water Act establishes two types of permitting schemes: the National Pollutant Discharge Elimination System (NPDES) permit and Section 404 permits (also referred to as dredge and fill permits).

The Clean Water Act (CWA) authorizes the approval of State programs in lieu of federal administration and sets forth the underlying powers that states possess in regulating water pollution under the CWA. As described in this analysis in the federal and State jurisdiction sections, the Clean Water Act defines pollutant to include heat, and New York State water quality regulations define pollutant to include both heat and cooling discharges to regulated water sources.

State powers include the authority to issue pollution discharge permits in conformance with or stricter than federal requirements (minimum technology-based and water quality-based controls), authority to provide for public participation in the permit issuance process, authority to develop a pretreatment program to regulate indirect discharges of pollutants into municipal treatments works, and the authority to adopt State water quality standards.[12] Importantly, the CWA grants states the power to "veto" a federal permit or license by refusing to certify that the construction and operation of the permitted projects would not violate the state's water quality standards under CWA Section 401.[13]

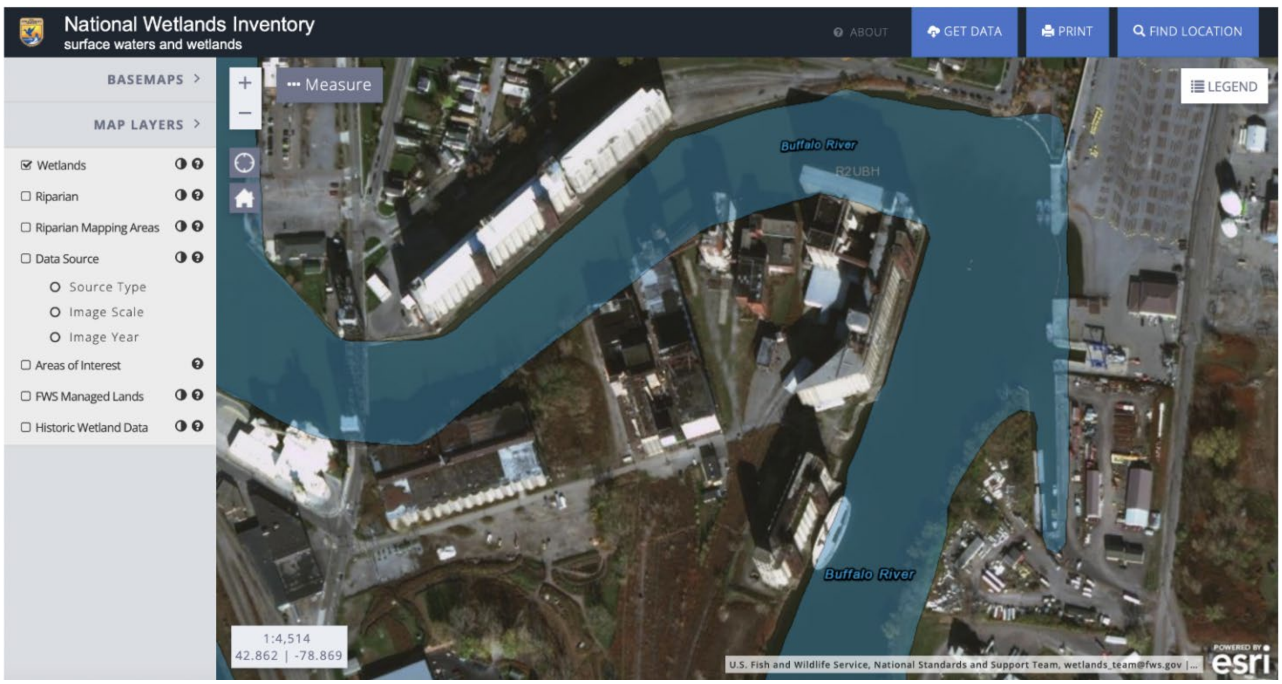
The New York Department of Environmental Conservation (NYSDEC), which administers the State's environmental laws, administers the State's SPDES program and is responsible for certifying federal projects under CWA Section 401. However, NYSDEC has not been delegated authority to implement CWA Section 404 for dredge and fill permits, and instead, the US Army Corps of Engineers is responsible for issuing Section 404 permits in New York State. Potential permitting requirements pursuant the SPDES program are discussed in the State requirements section.

Pursuant Section 404, discharge of dredged or fill material into waters of the United States is prohibited unless the action is exempted or is authorized by a permit issued by the US Army Corps of Engineers (Corps or USACE) or by the State in a few cases, with oversight by the EPA.[14]

The Corps is responsible for the day-to-day management of the 404 program. The Corps determines whether particular waters are protected under 404 through jurisdictional determinations, whether particular activities are covered by the permitting requirements, works with applicants to eliminate, reduce, and mitigate adverse impacts to protected waters, and issues and denies individual permits. The Corps ensures that any conditions imposed by the State are included in Corps permits.

Section 404 defines the landward limit of jurisdiction as the high tide line in tidal waters and the ordinary high-water mark as the limit in non-tidal waters.[15] However, when adjacent wetlands are present, the limit of jurisdiction extends to the limit of the wetland.[16] Often, a wetlands delineation is required to ascertain the boundary of the wetland and resulting extent of Corps jurisdiction.

Figure B-2. Silo City as Shown on the National Wetlands Inventory Map



The Buffalo River is a federally maintained navigable channel that is subject to the jurisdiction of the Army Corps. However, because portions of the Silo City site are also included in the National Wetlands Inventory and are located on a floodplain (both of which indicate the likely presence of adjacent wetlands that would also be subject to Corps jurisdiction), further investigation to determine if federally regulated wetlands are present on the site should be conducted.

There are no definitive maps of federally regulated wetlands or waterways, and therefore, it is often not possible to determine the Corps' jurisdiction based solely on an in-office review.[17] Often, a site inspection is the only definitive means of determining the presence/absence and extent of wetlands; a wetlands delineation may be required to ascertain the full scope of Corps' jurisdiction.[18]

Section 404 permitting requirements are associated with a wide variety of activities, ranging from those with large, complex impacts on the aquatic environmental to those having minimal impacts.[19] According to Corps regulations, the term "discharge of dredged material" means any addition of dredged material (defined as material that is excavated or dredged from waters of the United States) into—including any redeposit of dredge material other than incidental fallback—the waters of the United States.[20] The term fill material means material placed in waters of the United States where the material has the effect of replacing any portion of a water of the United States with dry land; or changing the bottom elevation of any portion of a water of the United States.[21] The discharge of fill material includes:

> …placement of fill that is necessary for the construction of any structure or infrastructure in a water of the United States; the building of any structure, infrastructure, or impoundment requiring rock, sand, dirt, or other material for its construction, site-development fills for recreational, industrial, commercial, residential, or other uses; …. intake and outfall pipes associated with power plants and subaqueous utility lines…[22]

Some examples of fill material given in the regulations include rock, sand, soil, construction debris, and materials used to create any structure of infrastructure.[23]

Accordingly, any system design using the river or adjacent wetlands, as well as any construction related activity involving excavation, drilling, trenching, and/or backfilling within the Buffalo River, including the area extending to the ordinary high-water mark and/or any adjacent wetlands would likely be a regulated activity under Section 404.

In issuing permits, the Corps must comply with Corps Section 404 regulations, EPA regulations, the National Environmental Policy Act, the federal Endangered Species Act, the National Historic Preservation Act, and the Coastal Zone Management Act, all of which may ultimately influence project design and permitting conditions. Additionally, pursuant Section 401 of the Clean Water Act, the Corps may not issue a Section 404 permit unless the State either certifies that the proposed activity will not violate State water quality standards or waives its certification authority. If the State denies a Section 401 water quality certification, the activity cannot proceed.[24] States can also impose significant conditions on the permit or project through the 401-certification process that can reduce the impacts of the activity.[25] Corps permit cannot be granted until the State Water Quality Certificate is obtained or waived. Generally, a developer will apply to Corps and the State agency at the same time so the reviews can occur concurrently.

When reviewing permits, the Corps must determine whether the proposed project is in the "public interest" by considering all relevant factors and the cumulative effects of those factors including "environmental factors such as conversation, wetlands, fish, and wildlife values, water quality, floodplain management, water conservation, energy conservation, environmental benefits and mitigation; cultural and economic factors such as historic, cultural, aesthetics, scenic and recreational values, general environmental concerns, water supply, development, navigation, and economics…" Additionally, pursuant to 40 CFR 230.10 the Corps may not issue a permit for a proposed project if there are practicable alternatives that would have less adverse impacts on the aquatic system, so long as the alternative will not have an adverse impact on the environment.

Determinations as to alternatives minimizing adverse impacts will depend on site conditions and geothermal system design. To that end, it is the applicant's burden to provide sufficient information showing that steps have been taken to consider and evaluate project alternatives that avoid impacts to aquatic environment (such as a fully land-based geothermal system that does not utilize the buffalo river and/or adjacent wetlands), that there are no practicable alternatives to the proposed project, and that steps have been taken to minimize unavoidable impacts. For projects either avoiding or having minor impacts, the stringency of the review may be modified based on the "significance and complexity of the discharge activity."[26]

Under Section 404(e), the Corps may also issue general permits to authorize activities that have only minimal individual and cumulative adverse environmental impacts.[27] A general permit "authorizes a category or categories of activities in specific geographic regions or nationwide" and "authorizes any party to engage in the sort of activity described in the permit without the need to seek project-specific authorization" or to submit in advance "specific plans, description, locations, purposes or needs of anticipated projects."[28] Typically, general permits eliminate the need for prior approval by the Corps of discharges of dredged or fill material associated with such activities,[29] and are presumed to have complied with NEPA review and EPA's Section 404(b)(1) Guidelines.[30]

Under Section 404(e), the Corps may issue general permits called “nationwide permits” to authorize activities that have only minimal individual and cumulative adverse environmental impacts.[31] The process for obtaining a nationwide permit is automatic and the person does not need to file an application for a Section 404 permit with the Corps before the person begins the discharge activity, although pre-construction notification is sometimes required.

The Nationwide Permit 51 sets out nationwide conditions for land-based renewable energy generation facilities that applies to discharges of dredged or fill material into non-tidal waters of the United States for the construction, expansion, or modification of land-based renewable energy production facilities including attendant features. “Such facilities include infrastructure to collect solar, wind, biomass, or geothermal energy, attendant features may include, but are not limited to roads, parking lots, and stormwater management facilities within the land-based renewable energy generation facility.”[32] Additionally, to qualify for the Nationwide Permit, the discharge must not cause the loss of greater than half an acre of non-tidal waters of the United States.[33]

The Nationwide Permit 51 specific to the Buffalo Division includes both general conditions applicable to all Nationwide Permits, as well as Buffalo and New York State regional conditions that must be followed. Among its conditions, the discharge must not cause the loss of greater than half acre of non-tidal waters of the United States, and no activity may cause more than a minimal adverse effect on navigation.[34] Additionally, there are several instances in which Permit 51 requires pre-construction notification including when: (a) any listed species (or species proposed for listing) or designated critical habitat (or critical habitat proposed such designation) might be affected or is in the vicinity of the activity; (b) the activity might have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National of Historic Places; (c) Rivers and Harbors Act Section 408 permission is required to alter a waterway under Corps jurisdiction; and (d) the discharge results in the loss of greater than 1/10-acres of waters of the United States.[35]

B.4.2 Rivers and Harbors Act

The Rivers and Harbors Act requires authorization from the Secretary of the Army, acting through the Corps, for the construction of any structure in or over any navigable water of the United States.[36] Pursuant Section 10, it is unlawful to build any pier, wharf, structure or “works” in a “navigable water” without authorization from the Corps.

Under the Rivers and Harbors Act, navigable waters include "those waters that are subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce." Pursuant to Corps regulations, jurisdiction under the Rivers and Harbors Act reaches laterally to the ordinary high-water mark in freshwater areas, and accordingly, wetlands are generally not within the Rivers and Harbors Act's navigable waters jurisdiction.[37] However, if work conducted in a wetland would ultimately impact a navigable water, a Section 10 permit will be required.[38]

Obtaining a Section 10 permit requires compliance with Section 404(b)(1) Guidelines Corps regulations, NEPA, Ecological Society of America (ESA), National Historic Preservation Act, and Coastal Zone Management Act.[39]

The term "structure" includes any permanent mooring structure, power transmission line, permanently moored floating vessel, piling, or any other obstacle or obstruction. Additionally, "work" includes any dredging or disposal of dredged material, excavation, filling, or other modification of a navigable water of the United States.[40]

A Section 10 permit would likely be required for any type of geothermal system involving the Buffalo River, as it is a federal navigation channel and is maintained and dredged every two to three years by the Army Corp of Engineers. Because a river-loop system is a "structure" under the Rivers and Harbors Act, authorization is required prior to construction. However, unlike Section 404 requirements pursuant the Clean Water Act, Section 10 would not be triggered by systems impacting adjacent wetlands beyond the ordinary high-water mark, so long as it would not ultimately impact the navigability of the water.

Additionally, Section 14 of the Rivers and Harbors Act codified in 33 USC 408 (commonly referred to as "Section 408") "makes it unlawful to, *inter alia*, take possession of, use, or alter any work built by the United States in a river or other waterway within the act's coverage,"[41] unless the Corps grants permission for the alteration or occupation or use of a Corps civil works project. The term "alteration" or "alter" refers to "any action by any entity other than the Corps that builds upon, alters, improves, moves, occupies, or otherwise affects the usefulness, or the structural or ecological integrity, of a Corps project. Alterations also include actions approved as "encroachments."[42]

Under the National Environmental Policy Act, which is triggered by Section 408 authorizations, reasonable alternatives need to be considered in detail. Reasonable alternatives must be feasible in light of the underlying purpose of the proposed alteration and needs of the applicant.

Because the Buffalo River is a federal navigation channel, systems using the river would need Section 408 authorization. Additionally, the Corps should be consulted to ascertain whether there are any other civil works projects located along the river or on site, such as habitat restoration projects.

B.4.3 National Environmental Policy Act—Environmental Review for Federal Issuance of Permit

When a federal agency proposes to undertake an action or grant a permit, the National Environmental Policy Act (NEPA) requires the agency to assess the effects of its action on the human environment.[43] Pursuant NEPA, federal agencies must identify and evaluate impacts of "major Federal actions significantly affecting the quality of the human environment."[44]

Under NEPA, any federal action that significantly affects the quality of the human environment requires the preparation of an Environmental Impact Statement (EIS).[45] The EIS must include all significant environmental effects associated not only with the proposed action, but also with every reasonable alternative to that action.[46] Importantly, while NEPA requires a federal agency to consider and quantify environmental impacts associated with a proposed project, it does not require that agencies modify their behavior based on the findings of their review.[47] In other words, NEPA does not require that agencies take one type of action or another based on the adverse environmental impacts.[48] However, in accordance with the Administrative Procedure Act, the sufficiency of an EIS may be subject to a citizen's challenge under NEPA.[49]

Regulations stated in the Council on Environmental Quality include four categories of "major federal action" which includes "approval of specific projects, such as construction or management activities located in a defined geographic area. Projects include actions approved by permit or other regulatory decision as well as federal and federally assisted activities."[50]

Consequently, Corps permitting authorization of the Silo City project are subject to the provisions of NEPA.

In Silo City, NEPA is triggered irrespective of whether the project incorporates any geothermal elements. Thus, while the geothermal component alone does not trigger NEPA, the application of NEPA to this project will require review of the geothermal elements' potential impact on the environment. The design of the geothermal system should therefore aim to minimize impacts on wetlands and waterways.

B.4.4 National Historic Preservation Act

Under the National Historic Preservation Act, federal agencies conducting, funding, or licensing a project must consider the impact of the project on structures or properties included in the National Register of Historic Places prior to issuing a permit for a project.

Further, under Section 106 of the National Historic Preservation Act, federal agencies "must make a reasonable, good faith effort to identify historic properties," "determine whether identified properties are eligible for listing on the National Register," "assess the effects of the undertaking on any eligible historic properties found," "determine whether the effect will be adverse," and "avoid or mitigate any adverse effects.[51] This entails consultation with the New York State Historic Preservation Office and, in certain circumstances, with the Advisory Council on Historic Preservation.[52]

State Historic Preservation officers are provided the opportunity to review and comment on all individual permit activities and the Advisory Council on Historic Preservation may review certain proposed activities that require a federal permit.[53]

The Section 106 review encourages, but does not mandate, preservation of historic properties. Instead, a Section 106 review ensures that preservation values are factored into federal agency planning and decision-making and allows the public to hold the federal agency publicly accountable for decisions that affect historic properties.

The American Elevator Complex (139 Buffalo River) is listed on the National Registry of Historic Places. Additionally, the Lake and Rail Elevator (151 Buffalo River) and the Perot Malting Elevator (145 Buffalo River) are eligible for listing. Consequently, the Corps must take into account its historic status in issuing any permit and will likely condition approval on adoption of measures to mitigate the impact of development on its historic features.

B.4.5 Endangered Species Act

The Endangered Species Act requires federal agencies to consult with the US Fish and Wildlife Service if an activity that requires federal authorization may affect endangered or threatened species or critical habitat.

According to the US Fish and Wildlife's online mapping tool, the northern long-eared Bat, a threated species, is listed at the Silo City location. This species of bat may use wetlands as roosting areas, thus geothermal installations in the wetlands could potentially be deemed as a potential threat to their habitat.

Section 7 prohibits a federal agency from engaging in any action that is likely to jeopardize the continued existence of endangered or threatened species or that destroys or adversely affects the designated critical habitat of such species.[54] To that end, Section 7 of the Endangered Species Act requires federal agencies with jurisdiction to (a) actively pursue species conservation; (b) ensure no jeopardy to a listed species; and (c) insure that areas designated under the act as "critical habitat" are not destroyed or adversely modified.

Furthermore, Section 7 requires federal agencies, before they initiate, fund, or authorize any action that could affect endangered species must first submit a written request to the US Fish and Wildlife Service and/or the National Marine Fisheries Service for a list of species and of formally designated critical habitat that may be present in any areas potentially affected, either directly or indirectly, by the proposed action.[55] If, after consultation, the agency determines a listed species "may be present," the formal consultation process results in a biological opinion prepared by either agency stating whether the permit action is likely to jeopardize the continued existence of the listed species or adversely modify designated critical habitat.[56] Formal consultation pursuant Section 7 under the Endangered Species Act is not required if the agency determines that an action will not affect listed species or designated critical habitat.[57]

If the biological opinion determines that the proposed action may jeopardize the continued existence of a species and/or may destroy critical habitat, the agency will issue a "jeopardy opinion."[58] If a jeopardy conclusion is found, the jeopardy opinion must discuss "any reasonable and prudent alternatives" to the proposed action that will minimize or avoid the action's adverse effects.[59] If the biological opinion concludes that jeopardy would occur, and that there are not reasonable alternatives, the federal agency is required to deny a permit, decline funding, or other action pursuant to the EPA Section 404(b)(1) Guidelines.[60]

B.4.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act requires federal agencies taking action on projects with a potential impact on fish and wildlife to consult with US Fish and Wildlife Service, and the head of the fish and wildlife agency in the state where the project is located, regarding the fish and wildlife impacts of permitting the project and on measure to mitigate those impacts.[61]

As part of the consultation, Fish and Wildlife Service must prepare a report that describes those impacts and makes recommendations for mitigating the damage to fish and wildlife resources, called a Wildlife Coordination Act Report.[62] In the report, Fish and Wildlife Service must (a) develop recommendations based on surveys and investigations to determine the potential impacts to wildlife resources; (b) describe the damages to wildlife attributable to the project; and (c) develop mitigation measures to prevent these damages and to improve wildlife resources.[63] The report must be included in a final Environmental Impact Statement for the project, and must be given "full consideration" by the federal permitting agency. However, the federal permitting agency is not required to adopt the Fish and Wildlife Service recommendations.[64]

B.5 New York State

B.5.1 New York Department of Conservation Water Quality Certificate under Section 401 of the Clean Water Act

Pursuant Section 401 of the Clean Water Act, a federal agency may not issue a permit unless the state either certifies that the proposed activity will not violate state water quality standard or waives its certification authority. If the state denies a 401 water-quality certification, the activity cannot proceed.[65] States can also impose significant conditions on the permit or project through the 401-certification process that can reduce the impacts of the activity.[66] Generally, a developer will apply to a federal agency and NYSDEC, which administers New York State's environmental laws and CWA water quality certification permits, at the same time, so the reviews can occur concurrently.

Accordingly, the Corps cannot issue a 404-water discharge permit until NYSDEC issues a water quality certificate or waives the requirement.

B.5.2 State Pollutant Discharge Elimination System Permit

The Clean Water Act establishes a permitting scheme that regulates the discharge of pollutants into the water of the United States and quality standards for surface waters, known as the National Pollution Discharge Elimination System (NPDES) permit program.[67] NPDES requires all facilities that discharge pollutants—which includes heat, into surface water from a point source—obtain a permit before discharging.[68] NPDES permit incorporate both water quality standards and technology-based effluent limitations to protect water quality.

The Clean Water Act authorizes the approval of State programs in lieu of federal administration and sets forth the underlying authorities that states possess in regulating water pollution under the Act. These include the authority to issue pollution discharge permits in conformance with or stricter than federal requirements.[69] Accordingly, New York State's water quality requirements contain additional requirements, including defining pollutant to include all thermal discharges—encompassing both heating and cooling discharges.

Pursuant to the Clean Water Act, "water quality standard(s) shall consist of designated uses of the navigable waters involved and the water quality criteria for such waters based on such uses."[70] Additionally, EPA regulations implementing the Act's requirements to "maintain" the chemical, physical, and biological integrity of the nation's waters requires states to include in their water quality standards and antidegradation policies.[71] Accordingly, all NPDES/State Pollutant Discharge Elimination System (SPDES) permits must include effluent limitations that restrict the quantity, quality, rates and concentration of chemical, physical, biological, and other constituents of effluents which are discharged.[72] These effluent limitations are based either upon available technology, as prescribed by the EPA, or state water quality standards, whichever is stricter.[73]

NYSDEC, which administers the State's environmental laws, defines general conditions applying to all water classifications including criteria governing thermal discharges.[74] Thermal discharges are defined as "a discharge that results or would result in a temperature change of the receiving water."[75] Pursuant to NYSDEC's criteria governing thermal discharges, "[a]ll thermal discharges to the waters of the State shall assure the protection and propagation of a balanced, indigenous populations of shellfish, fish, and wildlife in and on the body of water."[76] In addition to technological standards and criteria for mixing zones, NYSDEC regulations provide the criteria waters of the state receiving thermal discharge.

The requirement of a SPDES permit will depend on whether the geothermal system discharges to groundwater or surface water, the classification of the receiving water body and whether the system discharges heat or some type of water or heat treatment chemicals.[77] Generally, geothermal systems that discharge heat, cooling, or any water treatment chemicals into surface waters of the state must obtain a SPDES permit. Additionally, open loop residential systems with a design flow greater than 1,000 gallons per day or that use water treatment chemicals, as well as all commercial open loop systems, require a SPDES permit.

While this is typically more applicable to open-loop systems, all systems are subject to New York State's water quality standards and best use criterion set forth at 6 NYCRR Parts 649-758, including criteria for thermal discharges.[78] Because a closed-loop system may ultimately change the temperature of the receiving waterbody, consultation with NYSDEC is required to determine whether the system would require a SPDES permit.

Permits require temperature monitoring and reporting and may limit how much heat may be discharged from the system depending on the receiving waterbody's classification.

Additionally, NYSDEC's Division of Fish and Wildlife requires that the location, design, construction, and capacity of cooling and water intake structures that result in thermal discharges be equipped with best technology available (BTA) to minimize adverse environmental impacts, such as harming fish on the intake screen and the entrainment of eggs through the cooling system.

At the time of application, the division may impose additional conditions appropriate to the system, which may require the applicant to provide biological information on the water body and an analysis of available technology or operational measures that can be employed to minimize any potential impingement and entrainment. The BTA required for compliance will vary depending on the system and the water body classification, and the division will consider applicable costs when making this determination.

New York State's water quality standards establish classifications and designated uses for all waters in the State including groundwater.[79] The classification differentiates between surface and ground water and between fresh and saline waters. Best usage of the classes of waters include fish, shellfish and wildlife propagation and survival, fishing, drinking water supply and primary and secondary contact recreation.[80] Under the New York State Stream Classification System, the Buffalo River currently has a "Class C" designation. The best use of the Buffalo River has been identified as "fishing with waters suitable for fish propagation and survival" and "water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes."[81]

Accordingly, any geothermal system designs utilizing the Buffalo River, even if closed loop, will require consultation with NYSDEC to confirm that the system will not violate applicable water quality standards. NYSDEC may require a thermal impact analysis to confirm compliance with NYSDEC thermal criteria, as well as an Essential Fish Habitat (EFH) assessment to evaluate the impact of the project on local aquatic life.[82]

Separately from the geothermal system itself, a SPDES permit may also be required for discharges of dredged spoil or drilling fluids during construction into the Buffalo River. Section 402 of the CWA requires permits for stormwater discharges from construction activities, which would include geothermal drilling operations, that disturb one or more acres of land. In New York State, a SPDES General Permit for Stormwater Discharges from Construction activity is required for construction activities involving soil disturbances of one or more acres based on a common plan, and soil disturbances of less than one acre that could potentially contribute to a violation of a "water quality standard or pollutants to surface waters."[83] To qualify for the permit, permit applicants are required to develop a Stormwater Pollution Prevent Plan (SWPPP) in accordance with the requirements in the General Permit to prevent discharges of construction-related pollutants to surface waters. [84] Consultation with NYSDEC is required to determine whether discharges from drilling operations are permitted under the general permit, or whether an individual SPDES permit is required.

B.5.3 Protection of Waters Permit

In the State, a Protection of Waters permit is required for "excavation or placement of fill" in navigable waters below the mean highwater level, including adjacent and contiguous marshes and wetlands.

Because the Buffalo River is navigable, any excavation and/or installation of a river loop system will likely require a Protection of Waters permit. Additionally, similarly to CWA Section 404 and Rivers and Harbors Act Section 10 permits, depending on the impacts to the Buffalo River, NYSEC may require the applicant to demonstrate that there are no alternative designs or locations which might avoid or minimize impacts to protect the watercourse.[85]

Review time frames, procedures, and requirements for public notice for applications are different for minor and major projects. The thresholds for minor projects in navigable waters include fill of less than 100 cubic yards, maintenance dredging occurring at least once every 10 years, and excavation of an area of 5,000 sq.ft. or less.[86] For minor projects, NYSDEC must make a permit decision within 45 days of determining the application is complete.[87] Major projects are subject to public notice followed by a comment period and may require a public hearing. The process for major projects may require up to seven months based on statutory procedural requirements.[88]

B.5.4 State Environmental Quality Review Act

New York's State Environmental Quality Review Act (SEQRA) requires state and local agencies to consider environmental factors in the planning, review, and decision-making processes regarding permits, zoning changes, or government funding. SEQRA review is triggered by State projects that require some form of discretionary State or local government approval.[89] Accordingly, any permitting approvals or other authorizations at the State or local level for the geothermal system would trigger the SEQRA review process for the geothermal system. Furthermore, any funding by NYSERDA for subsequent phases of the project would likely constitute an agency action subject to SEQRA.

The SEQRA review process requires agencies to determine whether actions they directly undertake, fund, or approve may have a "significant impact" on the environment ("a determination of significance"), and if so, to prepare, or require to be prepared, an Environmental Impact Statement (EIS) that assesses the potential impacts of the proposed actions, as well as ways to avoid or mitigate those impacts.[90] The lead agency responsible for authorizing the project issues a "negative declaration" if it determines that the proposed action will not result in a significant environmental impact. This ends the SEQRA review process and can result in subsequent litigation brought by project opponents.[91] A positive declaration triggers the procedural mandates that lead to the preparation of a Final Environmental Impact Statement (EIS), which will be the basis of the final decision to fund or approve the project.[92]

The first step an agency must take is to determine whether the action is subject to SEQRA.
Type II actions, which are actions for which it has been determined not to have a significant effect on the environment, and are not subject to the SEQRA review process.[93] However, if the action does not fall within one of these exclusionary categories, then it is subject to SEQRA and the agency will need to determine whether it is a Type I action or an unlisted action, which will trigger different procedural requirements. To reach a determination of significance, the agency must prepare an Environmental Assessment Form (EAF) (either a short EAF or full EAF, depending on the action).

The short form EAF, which is used for unlisted actions deemed to have a significant effect, requires the lead agency to consider whether the proposed action would cause "an increase in the use of energy" and whether it "fails to incorporate reasonably available energy conservation or renewable energy opportunities."[94] The Full EAF also requires applicants for commercial and industrial projects to provide information about the proposed action's new or additional demand for energy, including information about the anticipated sources of energy.[95]

If the agency issues a positive declaration, the preparation of an EIS is required, which involves the preparation of a Draft Environmental Impact Statement (DEIS) that is then circulated for public review and comment.[96] In addition to "analyzing the significant adverse impacts and evaluating all reasonable alternatives," the DEIS should include an "assessment of impacts only where relevant and significant" including "impacts of the proposed action on the use and conservation of energy" and "measures to avoid or reduce both an action's impacts on climate change and associated impacts due to the effects of climate change…"[97]

B.5.5 Listed Species Regulation

Animals and plants listed under New York State regulations as endangered, threatened, special concern, or rare are protected under New York State Law. As previously explained, NYSDEC utilizes its authority under the State Environmental Quality Review Act to assess potential environmental impacts of a proposed project, including impacts to endangered and threatened animals, and to make recommendations to project proponents on how to avoid or reduce those impacts.[98] However, when a project component cannot fully avoid adverse impacts to a listed species, an incidental take permit may be required for the "taking" of a threatened or endangered species.[99]

Permitting requirements apply only to animals listed as endangered or threatened as defined in Part 182, and an incidental take permit is not required for activities affecting species of special concern.[100] Additionally, in order to trigger the permitting requirements, a proposed activity must either be likely to result in the taking of a listed animal or involve an adverse modification of occupied habitat.[101]

As previously noted, according to the USFWS' "Information for Planning and Consultation" (IPAC) online tool, the northern long-eared bat may be potentially impacted by activities at the silo city site. The northern long-eared bat is listed as a threatened species at both the federal and New York State level.[102] Furthermore, according the NYSDEC's Environmental Resource Mapper, the portion of the Buffalo River adjacent to Silo City is known to contain mussels that are "rare, endangered, or threatened" in the State.[103] NYSDEC Regional Office 9 should be contacted to confirm the presence of the long-eared bat, and to determine which species of mussels are present in the Buffalo River. Depending on the project's impacts, DEC may require an incidental takings permit.[104]

Also, according to NYSDEC's Environmental Resource Mapper, Silo City is in the vicinity of rare animals listed as special concern by New York State. While animals listed as special concern are not afforded the same protections as those listed as either threatened or endangered, impacts to rare and unlisted animals must still be assessed in the State Environmental Quality Review Act review process. If the Environmental Resource mapper reports rare or unlisted animals, NYSDEC recommends that the project proponent submit a request to NY Natural Heritage for a more detailed screening regarding which species are present and potential impacts to those species.

B.5.6 Coastal Zone Management Act

Under New York State's Coastal Management Program, actions by federal or State agencies affecting its coastlines, including permitting decisions, must be consistent with the State's coastal policies. Depending on whether a project has a significant potential impact on coastal areas, a full review may be required as a precondition to determine whether the project is consistent with State policies. The New York Department of State makes costal policy determinations for New York.

In developing the Coastal Management Plan, New York State also passed the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, which establish a statewide approach for encouraging development of the coastal area while protecting natural resources.[105] The law establishes boundaries for the State's Coastal Area by adopting a map which defines the area in which the Coastal Management Plan policies apply, and provides a set of policies which address significant coastal issues. It also offers local governments the opportunity to participate in the State's Coastal Management Plan, on a voluntary basis, by preparing and adopting local waterfront revitalization programs (LWRP), providing more detailed implementation of the State's Coastal Management Plan through use of existing municipal powers such as zoning and site plan review.[106]

A LWRP is a "locally prepared, land and water use plan and strategy for a community's natural, public, working, or developed waterfront through which critical issues are addressed."[107] Once developed, LWRPs become amendments to the State's coastal management program, and "in effect become the policies and standards of the local government, the State of New York, and the federal government." Additionally, State agencies' action must be consistent with the approved LWRP to the maximum extent practicable.[108]

The City of Buffalo Local Waterfront Revitalization Program addresses Buffalo's Local Waterfront Corridor: the area bordering Lake Erie, the Niagara River, the Buffalo River, and the Scajaquada Creek.[109] Private development located in the City of Buffalo's designated Waterfront Revitalization Area is subject to the City's Local Waterfront Consistency Law, which requires that projects that are subject to major site plan review, State environmental quality review or other local, State, or federal discretionary review procedures, must be reviewed and assessed for their consistency with the City of Buffalo Local Waterfront Revitalization Program.[110] Projects subject to minor site plan approval and/or Type II actions as defined by the New York State Environmental Quality Review Act do not require consistency review except where those actions are located in or may adversely impact:

- Coastal Erosion Hazard Area.
- Significant coastal fish and wildlife habitat, threatened or endangered species of plants or animals, and/or the Niagara River Globally Significant Bird Area.
- 100-year floodplain.
- State or federal wetlands.
- The Great Lakes Seaway Trail National Scenic Byway.
- Local, State, or federally designated historic resources.
- Officially designated parks and open spaces.
- Water dependent activities including marina operations and water borne transport.[111]

At the State level, consistency review of State agency actions is undertaken congruently with the State Environmental Quality Review Act process. At the federal level, a Federal Consistency Assessment Form is submitted to the Department of States Division of Coastal Resources.[112] At the local level, project developers must also prepare and file a completed Buffalo Coastal Assessment Form (BCAF) with the Zoning Administrator.[113]

Generally, the department's full consistency review of a proposed activity and a consistency certification for it, coordinated with other federal, State and certain municipalities takes between thirty and ninety days, but may take up to six months. The public notice and comment period is normally 30, but not less than 15, days. By federal regulation, the Department of State has six months to complete its review of a consistency certification and make a decision.

B.5.7 Office of Renewable Energy Siting Approval

Geothermal systems equal to or greater than 25 MWt (megawatt/thermal) planned capacity are subject to the permitting requirements of the Office of Renewable Energy Siting (ORES).[114] A 25 MW_{th}-equivalent geothermal system would support a small community of approximately 2,000 homes.[115] ORES regulations provide for an application process similar to Article 10 of the Public Service Law for siting major electric generating facilities, as well as uniform standards and conditions for all proposed projects. Applicants are required to work with municipal authorities in which the proposed facility is to be located, obtain several environmental approvals from ORES prior to applying, and file an application including exhibits addressing areas of impacts on land use, public health, safety and security, noise and vibration, cultural resources, endangered and threatened species, visual impacts, water quality, and wetlands. Applications are also subject to a comment period and public hearing procedures.

Under Section 94-C governing ORES decisions, the siting agency has 60 days to review an application and determine whether it complies with applicable requirements.

To determine that an application is complete, the record must contain proof the applicant consulted with the host municipalities and communities. Applicants are required to work with host municipalities in which the proposed facility is to be located, obtain several environmental approvals from ORES prior to applying, and file an application including exhibits addressing areas of impacts on land use, public health, safety and security, noise and vibration, cultural resources, endangered and threatened species, visual impacts, water quality, and wetlands.

During the Section 94-C comment period, the host municipality is to file a statement "indicating whether the proposed facility is designed to be sited, constructed, and operated in compliance with applicable local laws and regulations, if any, concerning the environment, or public health and safety."[116] Following the public comment period, the agency may set the matter for an adjudicatory hearing to hear arguments or to rule on the application.

Under Section 94-C, ORES is required to issue a permit within 12 months from the completion of the application. ORES may issue a permit only if it finds that any significant adverse environmental impacts have been avoided or minimized, that a review of applicable local zoning laws has been completed, and that the application complies with applicable laws and regulations. Under Section 94-C, in making its determination of compliance, ORES may elect to not apply local law and ordinances in favor of a uniform set of standards and conditions set out in the Regulations Implementing, Section 94-C. However, the present regulations do not provide specific guidelines for geothermal energy systems.

B.5.8 Drilling Permits

New York State imposes different requirements for geothermal wells drilled less than 500 feet and wells over 500 feet, based on permitting regimes that were designed for non-geothermal systems, but adapted for these purposes.

Wells that are less than 500 feet deep are regulated by the NYSDEC Division of Water. The Division of Water requires the submission of driller and pump installer registration and certification, and preliminary notice and well completion reports for open loop or standing column systems.[117] Completion reports are waived for closed loop geothermal systems with boreholes drilled up to 500 feet deep.[118]

The NYSDEC Division of Mineral Resources regulates the drilling, construction, operation, and plugging of geothermal wells deeper than 500 feet.[119] Wells deeper than 500 feet impose additional requirements, which are set out in the table below. Among these requirements, detailed information regarding well locations, depth, use, casing material, cementing procedures, drilling fluid, and cutting disposal methods, as well as completion of an Environmental Assessment Form, which will be used by the NYSDEC to evaluate the environmental impacts of the well, and to decide whether any "special permit conditions, a Supplemental Environmental Impact Statement, or any additional NYSDEC permits are required."[120] NYSDEC also imposes reporting requirements throughout the permitting and drilling process, and a separate permit must be obtained before a well may be permanently plugged and abandoned by the well owner.[121]

Importantly, prior to obtaining a well drilling permit for a well that may produce brine, saltwater, or other polluting fluids in sufficient quantities to harm the surrounding environment, the well owner must obtain a permit for the safe and proper disposal of such produced fluids.[122] Depending on the applicable method of disposal, NYSDEC may require the well owner to obtain additional permits for discharge and/or disposal.

NYSDEC also mandates minimum standards for all wells pursuant to the division's Casing and Cementing Practices to protect groundwater by preventing the migration of fluids.[123] However, NYSDEC imposes stricter permitting conditions for wells that will be drilled through primary and principal aquifers, as well as for wells where subsurface conditions are unknown or where high pressures are expected.[124]

The Division of Mineral Resources will also consult with the New York State Office of Parks, Recreation and Historic Preservation (NYS Parks) to determine whether the proposed location of a well is within a State-listed historic area, which would require additional permissions.[125] If applicable, NYS Parks will review the project and ensure the well will not negatively impact cultural resources.[126] The permit application process takes approximately six to eight weeks, but may take longer depending on the project. Additionally, filing fees for the application materials vary depending on the depth of the well.[127] Drilling permit requirements and restrictions under both regimes are summarized in the table below.

B.5.9 Requirements for Closed Ground Source Loops

Source: Well Owner and Applicants Information Center, NYSDEC, available at https://www.dec.ny.gov/energy/1522.html (accessed March 6, 2021); Well Operator Responsibility, NYSDEC, available at https://www.dec.ny.gov/energy/1639.html (accessed March 6, 2021); Ground Source Heat Pump Drilling Regulations Discussion, Presentation by NY-GEO (Nov. 12, 2020).

Under 500 Feet	500+ Feet
Driller and pump installer certification and registration.	
Municipalities may impose additional requirements.	
	Organizational Report (Form 85-15-12)
	Application for permit to drill well (Form 85-12-5)
	Environmental Assessment (Form 85-16-5)
	Financial Security Worksheet (Form 85-11-2)
	Certified site plan
	Casing and cementing plan
	Drilling progress reports
	Periodic drilling drift correction
	Well drilling and completion report (Form 85-15-7)
	Annual reports of status and use of well
	Incident reports of leakage or condition posing risk to environment or the health, safety, welfare, or property of any person
	Permit to plug and abandon

B.5.10 New York State Historic Preservation Office

New York's State Historic Preservation Office (SHPO) helps communities identify, evaluate, preserve, and revitalize their historic, archeological, and cultural resources. SHPO administers programs authorized by both the National Historic Preservation Act of 1966 and the New York State Historic Preservation Act of 1980. These programs, including the Statewide Historic Resources Survey, the New York State and National Registers of Historic Places, the federal historic rehabilitation tax credit, the Certified Local Government program, the State historic preservation grants program, State and federal environmental review, and a wide range of technical assistance, are provided through a network of teams assigned to territories across the State.

In carrying out these responsibilities, SHPO conducts project review, specifies conditions for modification of sites subject to their jurisdiction, and approves or assists other agencies in approving plans for modifications to historic sites.

Because the American Elevator Complex at Silo City is listed as a historic site under the National historic registry, SHPO will exercise jurisdiction and will likely condition approval on adoption of measures to mitigate the impact of development on its historic features. Accordingly, geothermal elements will be designed and constructed, included drilling, to avoid impacting historic features.

B.5.11 Uniform Heat Standards for Multiunit Residential Buildings

New York State establishes statewide standards for the provision of heat in multiunit buildings. Heating facilities must be capable of maintaining a temperature of 68 degrees Fahrenheit.

Heat must be supplied from October 1 through May 31 to tenants in multiple dwellings. If the outdoor temperature falls below 55°F between the hours of 6:00 a.m. to 10:00 p.m., each apartment must be heated to a temperature of at least 68°F. If the outdoor temperature falls below 40°F between the hours of 6:00 a.m. to 10:00 p.m., each apartment must be heated to a temperature of at least 55°F.[128]

B.5.12 Utilities Regulation

New York State's Public Service Law governs utilities and delegates the regulation of utilities to the New York Public Service Commission. The scope of the Public Service Law covers electricity, natural gas, water, and telecommunications, but does not cover geothermal or the provision of heat generally.[129] As a result, utilities are presently not permitted to own or operate geothermal assets. Also, because geothermal falls outside the scope of the law, private providers of heat services are not presently regulated under the Public Service Law.

Beyond the omission of geothermal from the Public Service Law, common law principles suggest that geothermal heat services provided on a competitive basis by a company that does not possess a monopoly or otherwise exert market power would not be deemed a utility or regulated as a utility. The historical genesis of utility regulation is rooted in concerns over market power during the early 1900s as a variant of antitrust legislation. The modern approach to defining a utility for purposes of determining whether an energy provider is deemed and regulated as a utility has been refined by the courts, deciding whether third-party power providers entering into power purchase agreements with energy users, a situation analogous to the provision of geothermal services. Multiple factors are considered in determining whether the activity constitutes provision of utility services:

- The nature of the transaction and relationship between the parties, in particular whether it is an arm's length transaction between willing buyer and willing seller.
- Whether the services are for the public or private use, determined in part by whether the provision of energy is in front or behind the meter.
- Whether the service provided is an indispensable service that generally requires public regulation. If the service is structured so that the end user has alternative grid-supplied options in addition to the service, it may be deemed non-essential or not requiring regulation.
- The presence of market power or monopoly.
- Ability to serve all members of the public.
- Ability to discriminate against members of the public.
- Actual or potential competition with other entities that are regulated in the public interest.[130]

Although no single factor is determinative, if a geothermal provider contracts on a one-to-one basis with a building or commercial user, and the building retains backup utility service for heating as an alternative option, it is unlikely that such an arrangement would be deemed as requiring regulation as a utility under common law principles.

B.5.13 HEFPA and Submetering Regulations for Electric Heat

Notwithstanding, providing geothermal services may not be regulated as a utility. A building or service provider that provides electricity and/or electric heat to residents on a submeter basis must comply with the Home Energy Fair Practices Act (HEFPA), part of the Public Service Law §§30-53, and the Department of Public Service Residential Electrical Submetering regulations,[131] pursuant to the New York Public Service Law.[132] Importantly, for purposes of submetering, electric heat services include heat services provided by electric heat pumps.[133]

HEFPA and its regulations subject covered parties to the same standards as utilities for consumer initiation and termination of service, billing and deposits, disputes over service and charges, and standards for quality of service. The submetering regulations further require that buildings apply to the New York Public Service Commission for permission to submeter, which approval may be conditioned upon requirements set by the Commission. These conditions include rate caps, and violation of Commission conditions or failure to adhere to regulations can result in reductions in rate caps,[134] sanctions, and termination of authority to submeter.[135]

For existing buildings that seek to convert from a master meter to a submeter, in order to approve the application, the Commission must make a positive determination that the proposed submetering is in the public interest and consistent with the provision of safe and adequate electric service to residents.[136] This requirement applies to rental buildings, condominiums, and cooperative buildings.

For conversion of rental buildings, the application requires notice to all residents, publication for public comment, and the Commission may consider all supplemental information submitted, including public comments.[137] Conversion of an existing building is therefore a far more cumbersome process involving actual tenants with pre-existing contractual and statutory rights that must be adjusted if submetering is to be permitted.

For buildings that are mixed rental and condominium, such as where sponsors retain ownership of certain units that are rentals, the regulations do not specify which regime is followed. The answer should follow whether the sponsor remains obligated to pay the submeter bill under the lease, or whether the payment can be passed to tenants. Contract, landlord-tenant, rent control, and other laws would be relevant to what would be permissible.

Applications for submetering must include a plan for complying with HEFPA, demonstration that submetering will comply with equipment, energy efficiency, income-based housing assistance, rate cap, and other requirements.[138]

The process is complex, requires months to complete, and the public interest finding is a relatively high standard to meet. However, submetering that supports meeting State and local climate targets by enabling geothermal technologies could be deemed to be in the public interest, provided all other requirements are also satisfied.

B.5.14 Nonelectric Heat and Cooling

While HEFPA regulates electric heat submeters, nonelectric heat and cooling fall outside of HEFPA and the submetering regulations. The absence of a specific regulatory regime means other non-energy regimes at the State and local level may set default rules without providing a clear path toward submetering residential units for these services. The following section describes these municipal landlord-tenant laws.

Nonelectric heating is allocated as a responsibility of the landlord in State and municipal law and leases, whereas cooling generally is omitted from both. This may enable bifurcated business models that more easily support cooling as a service to be offered, the provision of electric heat under HEFPA, but nonelectric heat facing barriers under local law.

Proposals to submeter geothermal will likely require the submetering regulations for electricity and electric heat to be adapted to incorporate geothermal or new regulations developed for geothermal.

B.5.15 Other Consumer/Tenant Protection Laws

Regardless of whether heat services are billed as electric heat or therms, contract law, consumer protection laws, tort laws, and other laws and regulation governing the marketing of heat services would apply.

In the context of contracting geothermal heat services for buildings and reselling them to tenants, local landlord-tenant laws would apply to protect tenant-consumers, which would necessarily expand the range of regulatory stakeholders to include municipal regulatory authorities regulating buildings and protecting tenants. Thus, New York State's Division of Homes and Community Renewal, as well as municipal tenant advocates could become actively involved, including the Buffalo Municipal Housing Authority. Other nongovernmental tenancy advocacy groups will also likely become active to influence government decision making processes.

The New York State construction code requires buildings to provide a means to heat residential units, but does not allocate in the specific responsibility for the cost of operation of those units or fuel:

> §27-740 Heating requirements. All habitable or occupiable rooms or spaces, and all other rooms or spaces…shall be provided with means of heating in accordance with the requirements of this subchapter and reference standard RS 12-1….[139]

As noted in the prior section, in the absence of a regulatory regime like HEFPA for nonelectric heating, municipal landlord tenant laws may allocate the responsibility for heating to landlords. Similarly, for existing buildings, incumbent leases will allocate the responsibility to landlords.

Absent a municipal law allocating responsibility for heating cost to landlords, navigating incumbent rights contained in leases raises contract law issues and, although HEFPA would not apply, municipal regulators may require a process similar or more onerous to that of HEFPA.

Assuming a building provider is permitted to separately provide and bill for heat, failure to provide adequate heat according to standards set in municipal regulations protecting tenants could result in violations and penalties under these laws. In turn, this could trigger contractual violations between the building owner and a third-party heat provider.

B.5.16 Affordable Housing

If a building is deemed affordable housing by the federal government, New York State, and local municipalities, regulations set maximum amounts that can be charged in multiunit residential buildings. In determining housing affordability, all housing costs must be included in the calculation. In rental units, housing costs include rent and any tenant-paid utilities. In ownership units, costs include the mortgage payment (principal and interest), property taxes and homeowner insurance, and any common charges or homeowners' association fees for condominiums or cooperatives.

The US Department of Housing and Urban Development (HUD) sets income limits annually for a variety of housing programs known as the Area Median Income (AMI) for each Metropolitan Statistical Area (MSA). MSAs are typically large cities or counties. Buffalo Municipal Housing Authority uses the AMI standard to set eligibility requirements for its funding programs for both rental and ownership housing. Affordability is broadly defined as a household paying no more than 30% of their monthly gross income toward their housing costs. The number of persons in the household determines the specific amount that may be charged for housing costs to stay within the affordability thresholds.

In addition, HUD annually publishes HOME Program Rent Limits for each MSA based on affordability for households with incomes at or below 50% AMI or up to 60% AMI.

For rental units, because both rent and utilities are included in the calculation, an arrangement between a building owner and third-party heat providers must be governed by contractual arrangements to ensure that affordability compliance thresholds are met.

B.2 Local

The City of Buffalo has not developed permitting guidelines for geothermal systems, however various local laws and regulations could apply to the geothermal aspects of the project.

Buffalo's zoning and land use is regulated by the Buffalo Green Code, which contains the Land Use Plan, Unified Development Ordinance, Local Waterfront Revitalization Plan, Brownfield Opportunity Areas, Urban Renewal Plans, and Generic Environmental Impact Statement. Depending on the design of the geothermal system, the Land Use Plan, Unified Development Ordinance, and Local Waterfront Revitalization Plan could contain provisions governing the geothermal loop, bore field, and river heat exchanger components of the project.

B.2.1 City of Buffalo Land Use Plan

The City of Buffalo Land Use Plan states that city land use policies should:

- Support reuse of existing buildings to preserve embodied energy, minimize waste, and reduce adverse environmental effects.
- Allow for renewable energy systems, such as wind, solar, geothermal, and biomass, as well as district heating and cooling systems.
- Encourage the installation of energy and water efficient building systems; along with native landscaping and rainwater collection systems that recycle water for non-potable purposes.[140]

Geothermal and district heating and cooling is allowed in light industrial zones, where Silo City is located. Assuming there are no offsite impacts, the Land Use Plan does not contain any standards specific requirements for geothermal other than a building permit.[141]

B.2.2 Unified Development Ordinance—Soil and Site Impacts

The Unified Development Ordinance is the master zoning and land use document for the City of Buffalo.[142] While the Unified Development Ordinance does not address geothermal or district heating and cooling systems directly, it addresses potential soil and site impacts from trenching and boring to install the geothermal system.

The Unified Development Plan requires stormwater pollution prevention permits when site soil is significantly disturbed:

> Any land development activity that will involve soil disturbance of one-quarter acre (10,890 sq. ft.) or more, or soil disturbance of less than one-quarter acre that is part of a larger development plan consisting of at least one-quarter acre in area, requires submission by the applicant of a Stormwater Pollution Prevention Plan (SWPPP) prepared per the requirements of the Buffalo Sewer Authority.[143]

Removal of hazardous materials removed from the site must "be transported, stored, and used in conformance with all federal, state, and local laws."[144] The process for disposal of hazardous waste is explained in the Code of the City of Buffalo:

> § 235-3 Removal of hazardous wastes.
>
> A. The Commissioner of Health shall be authorized to remove hazardous wastes from any facility in which hazardous wastes are treated, stored or disposed of and any premises on which such facility is located or any premises surrounding such facility upon a determination that such hazardous wastes have been treated, stored or disposed of in a manner which will cause such imminent and substantial harm to the public health and safety as to constitute a nuisance, unless the Commissioner determines that such removal will be done properly and expediently by the owner or operator of such facility or premises. No hazardous wastes shall be removed until the owner and operator of such facility or premises shall have been summoned by notice of not less than five days to appear before the Commissioner of Health to show cause why such removal should not be undertaken nor until such owner and operator shall have an opportunity to be heard in person or by counsel.
>
> B. The Commissioner of Health and the City of Buffalo shall have the authority to contract with third parties for the removal of hazardous wastes undertaken pursuant to Subsection A.
>
> § 235-4 Costs of removal.

> A. All costs and expenses incurred by the City in the removal of hazardous wastes pursuant to § 235-3 of this Article will be assessed against the land from which such hazardous wastes are removed.[145]

City of Buffalo officials advised that Silo City is approximately 45 feet above bedrock, on wood pilings and garbage fill, creating a high likelihood that there may be metal refuse and other obstacles in the fill. Whether hazardous or not, the fill that comprises the ground at Silo City is not suitable for reuse, so new fill must be used when covering trenches and boreholes.

B.2.3 Local Waterfront Revitalization Plan

Any local regulation relating to the shoreline or bed of the Buffalo River will be secondary to the Army Corps of Engineers and NYSDEC. Once the Corps and NYSDEC complete their review, they will contact the City of Buffalo for consistency review with the Local Waterfront Revitalization Program.

As part of the Corps review and the municipal government review, the Buffalo City Harbormaster would provide comments on work around or in the river. Both the Corps and the Harbormaster will likely be concerned that geothermal installations in the river will interfere with shipping, recreational use of the river, or the periodic dredging of the shipping channel in the Buffalo River. This assessment may depend on the availability of suitable area outside the shipping lane. The most current usage of the Buffalo River is recreational.

A system that pumps water in and out of the river may address these concerns if a riverbed-based heat exchanger is not permitted.

B.2.3 Building Code and Permitting

Buffalo adopted the New York State Uniform Fire Prevention and Building Code as its building code.[146]

The City of Buffalo's Department of Permit and Inspection Service's Permit Office issues various types of permits, including electrical, fuel devices, and plumbing permits. Prior permit approvals for geothermal systems in Buffalo have issued a "heating permit," which may be another name for a "fuel devices permit" for non-combustion technologies.[147]

The City of Buffalo advises that the geothermal mechanical contractor should apply for a general construction permit and allow for subcontractors for the drilling and trenching to be permitted underneath the supervising contractor. City code requires completed applications to be reviewed, and either accepted, in whole or in part, or rejected within 60 days after filing.[148]

B.2.4 Public Works—Street Closures

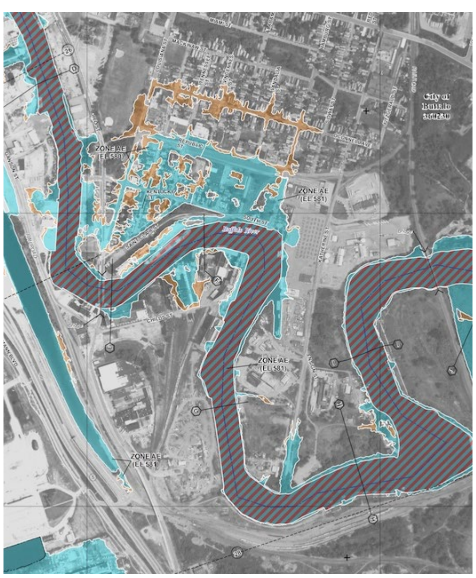
The Buffalo Geographical Information Services tool[149] confirms that Silo City Row/Childs Street is currently a private drive and not under public maintenance. Therefore, road closure and utility permits for crossing the road with the district thermal loop are not presently needed to perform trenching work.

However, if any work related to sewer heat exchangers or other unforeseen need arises that affects Ohio Street or within 15 feet of either side of Ohio Street, a road obstruction permit will be needed. The process for obtaining the permit requires an indemnification-hold harmless agreement in favor of the Buffalo Department of Public Works.[150]

B.2.5 Special Flood Hazard Areas

In New York State, local municipalities that participate in the National Flood Insurance Program regulate development in Special Flood Hazard Areas (SFHA).[151] Accordingly, all development, including buildings and other structures, mining, dredging, filling, paving, excavation, drilling or storage of equipment or materials is subject to construction regulations if it occurs within a SFHA.[152]

Figure B-3. Silo City on FEMA's Flood Insurance Rates Maps



According to FEMA's Flood Insurance Rates Maps (FIRMs) Panel 32029C0326J, portions of the Silo City site are designated as "Zone AE" and the Buffalo River is designated as a regulatory floodway.

Pursuant to Article 31 of the Buffalo City Charter, a floodplain development permit is required from the Commissions of Public Works Parks and Streets for all construction and other development undertaken in areas of special flood hazard.[153]

Additionally, "on streams with a regulatory floodway… no new construction, substantial improvements or other development in the floodway shall be permitted unless a technical evaluation by a licensed professional engineer demonstrates through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that such an encroachment shall not result in any increase in flood levels during occurrence of the base flood, or the City of Buffalo agrees to apply to [FEMA] for a conditional FIRM and floodway revision, FEMA approval is received, and the applicant provides all necessary data, analyses and mapping and reimburses the City of Buffalo for all fees and other costs in relation to the application."[154]

Article 31 also contains general standards for construction in areas of special flood hazard, as well as specific standards based on zone and structure. For instance, all new structures in areas of special flood hazard shall be anchored to prevent flotation, collapse, or lateral movement during the base flood. Additionally, "new construction and substantial improvements to structures shall be constructed with materials and utility equipment resistant to food damage…. using methods and practices that minimize flood damage."[155]

Article 31 also provides that "new and replacement electrical equipment, heating, ventilating, air conditioning, plumbing connections, and other service equipment shall be located at least two feet above the base flood elevation or be designed to prevent water from entering and accumulating within the components during a flood and to resist hydrostatic and hydrodynamic loads and stresses.[156] Electrical wiring and outlets, switches, junction boxes and panels shall be elevated or designed to prevent water from entering and accumulating within the components unless they confirm to the appropriate provisions of the electrical part of the Building Code of New York State or the Residential Code of New York State for locations of such items in wet locations.[157]

B.2.6 Use of Sewer System as Thermal Source/Sink

A variation of the geothermal system design proposes to exploit the project's sewage stream as a source and sink for heat. The proposed system would divert sewage through a bypass pipe that is coupled with a heat exchange unit. Sewage would return to the main line and travel outward to the edge of the property where it passes to the municipal sewage lines.

Buffalo Sewer Authority administers the sewer regulations.

Based on the proposed system, we assume the following:

- The system would be entirely closed without possible discharge into the environment.
- The sewage stream would not be changed by addition or removal of any of its original components, including changes in bio-chemical oxygen demand (BOD), total suspended solids (TSS), pH, fecal or total coliform bacteria, phosphate and phosphorus compounds, fats, oils, and greases of animal or vegetable origin, and the sewage stream would conform to these requirements.
- The only change in the diverted and return sewage stream would be changes in temperature.
- System cleaning and maintenance uses ordinary water and agents—and would not introduce any substances that would be prohibited.
- System operation would not involve any significant additional water use.
- System operation would not change the concentration of viscosity of waste streams.
- System design and connections to the sewer system will confirm with all applicable codes, include NYSDEC regulations, for materials and system design of sewage systems.

Regulations for sewers are primarily municipal law governing sewer use, building and construction codes, which, where appropriate draw upon or be supplemented by county, NYSDEC, New York State Plumbing Codes, and US Environmental Protection Agency requirements.

B.2.6.1 Right of way

If the sewage thermal exchange unit is entirely located on the project premises and serviced without going beyond the project premises, no easements or other property rights of way would be required for the thermal exchange unit, beyond those required for the conventional sewer system. By confining the thermal exchange system in this manner, the project confines the approval required to meet ordinary design and right-of-way requirements.

B.2.6.1 Temperature of discharge

Municipal regulations specify a default range for the temperatures of outflow in the public sewer system, which can be varied by the sewer authority if such temperatures could harm the sewer system, treatment process, or otherwise have an adverse effect. Temperatures are regulated at the point of entering the municipal system pipes and at the sewage treatment plant.

According to Buffalo City regulations:

1. Sewage streams may not exceed 150 degrees Fahrenheit (150°F) (65°C), and when reaching the publicly owned treatment works may not exceed 104 degrees Fahrenheit (104°F) (40°C).
2. Sewage streams may precipitate, solidify, or become viscous at temperatures between 0°C (32°F) and 40°C (104°F).[158]

Together these requirements would confine the use of sewage streams as a heat source and sink to outflow that enters the public sewer within the range of above 0°C (32°F) and below (150°F) (65°C). The sewer authority may specify a narrower range of temperature as part of the review process.

B.2.6.1 System Construction

Buffalo requires that the construction of sewage systems are built to contain waste and prevent it from polluting the environment. The building permitting process coordinates all related approvals. Accordingly, connections between the diversion and main line connected to the sewer must conform to regular NYSDEC requirements for sewer construction and be made watertight so that no leakage into or out of such connections shall occur.[159]

Erie County Department of Environmental Planning places additional restrictions on system design, including prohibition of pumping stations unless there is no design alternative. If the thermal exchange system requires a pump system, the project may be subject to additional requirements at the permitting stage.[160]

The system design and materials will be reviewed as part of the ordinary permitting process. Although there are no specific geothermal requirements, lack of familiarity with these systems will potentially require additional time for review.

B.3 Relevant Rrecedents

The City of Buffalo has issued "heating" permits for single-family residential geothermal systems. These heating permits may be another name for a fuel device's permit for non-combustion technologies.[161]

B.4 Authorities Having Jurisdiction

AHJ	Permit or Approval Required	Description	Estimated Time of Approval	Risks
Federal				
US Army Corps of Engineers	Approvals for activities affecting navigable waterways. Clean Water Act Section 404 Dredge and Fill Permit. Rivers and Harbours Act Section 10 Permit. Rivers and Harbours Act Section 14 ("Section 408") permission.	Navigable waterway, adjacent wetlands are within Corps jurisdiction and require Corps to delineate protected wetland to determine full scope of jurisdiction. All Corps approvals require compliance with EPA Regulations, Corps Regulations, National Environmental Policy Act, Endangered Species Act, National Historic Preservation Act, Section 401 of Clean. Water Act, and the Coastal Zone Management Act. Coordinates closely with NYSDEC and other agencies.	Concurrent with NYSDEC 60 days to 1+ years, depending on complexity.	Issues relating to impairment of habitat, navigation, and other primarily river and wetlands issues; public opposition. Available alternative designs could prevent approval of river system.
US EPA	Supervisory over Corps and NYSDEC: CZMA Clean Water Act SDWA Endangered Species Act NEPA	Can block CWA Section 404 permits if it finds project has unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.	Follows Corps review unless complications.	Corps and NYSDEC issue permits after incomplete or unsupported findings.
US Fish and Wildlife	Consultation—Endangered Species Act	Corps to consult if presence of any endangered species and if project jeopardize their existence or adversely impacts critical habitat. Silo City listed as habitat for northern long-eared bat, which uses wetlands for roosting.	Subsumed within Corps review.	Can require thermal discharges be equipped with best technology available to avoid impact on wetlands.
Housing and Urban Development	Regulation and potential enforcement.	Compliance with affordable housing rules.	Follows State process unless complications.	Public complaint or lawsuit.

B4 continued

AHJ	Permit or Approval Required	Description	Estimated Time of Approval	Risks
		State		
NYSDEC Environmental Conservation	Permits and approvals.	CWA 401 Water Quality permit SPDES Permit for water discharge, thermal extraction, potential drinking water pollution. Division of Water Approval or Division of Mineral Resource approves wells less than 500 feet or over 500 feet. Protection of Waters Permit. Listed species protection, incidental takings. NYSDEC requirements for sewer construction.	Concurrent with Corps review.	Issues relating to impairment of habitat and other primarily river and wetlands issues.
Department of State, Division of Coastal Resources	Approval	Coastal Management Program verification of consistency with State policies to protect coastal areas from degradation and to revitalize coastal areas. Different review procedures apply at the federal, State, and municipal levels.	60 days for federal consistency review.	Issues relating to impairment of habitat and other primarily river and wetlands issues; public opposition.
State Historic Preservation Office	Approval	Protected historical or cultural resources.	Concurrent with Corps review	Design decisions
NYSDOT Transportation	Road closure, Easement.	Approval to encroach on or work in road or railroad track.	Weeks	No significant risks.
Office of Renewable Energy Siting	Approval for projects over 25 $MW_{th.}$	ORES approval if geothermal system is greater or equal to 25 $MW_{th.}$	Up to 12 months.	No significant risks provided consultation with City government and compliance with laws.
Public Service Commission	Home Energy Fair Practices Act (HEFPA) and submetering approvals.	Approval of submetering applications.	6 months to 1 year.	Pricing and ability to comply with submetering service requirements. Submetering regulations not designed for nonelectric services.

AHJ	Permit or Approval Required	Description	Estimated Time of Approval	Risks
Department of Public Service	Submetering and notices.	Approval of submetering under Residential Electrical Submetering Regulations, notice of historical artefacts on project site.	6 months to 1 year.	Pricing and ability to comply with submetering service requirements. Submetering regulations not designed for nonelectric services.
New York State Homes and Community Renewal	Regulation	Provision and cost of heat, compliance with affordable housing rules.	None unless complaint.	Pricing and public opposition.
Local				
City of Buffalo Department of Permit and Inspection Service's Permit Office	Building Permit or Mechanical Permit—Heat Devices or Heating.	Geothermal reviewed in building or mechanical permit application.	Months	Design, communications
Public Works for County and/or Municipality	Road closure, Easement. Floodplain Development Permit.	Road closure, right of way to encroach or temporary work. Silo City is located in a FEMA Special Flood Hazard Area and requires a Floodplain Development Permit under Buffalo City regulations and subject to additional construction requirements.	Weeks Subsumed within local project permitting.	No significant risks Design
Harbourmaster	Consultation, potentially approval.	Use of navigable waterways.	Subsumed within Corps review.	Impediments to navigation.
Buffalo Department of Health	Approval	Impact on water and sewer system. Provision of heating services.	Subsumed within project permitting. None unless complaints.	Design Reliability of heating services.
Buffalo Sewer Authority	Approval	Connect to water or sewer systems—temperature control and impact on system operation.	Subsumed within local project permitting.	Design
Erie County Department of Environmental Planning	Approvals—sewer pumps.	Sewer system design, prohibition of pumping stations unless no design alternative.	Subsumed within project permitting.	Design
Buffalo Municipal Housing Authority	Rent regulation and tenant rights enforcement.	Provision and cost of heat, compliance with affordable housing rules.	None unless opposition.	Public opposition, compliance with regulations.
Courts	Adjudication	Landlord-tenant disputes over provision of heat and cost.	None unless opposition, then months to years.	Public opposition, force change of business model.

B.5 Nongovernmental Stakeholder Approvals or Consents

Stakeholder	Approval or Consent Required	Description	Estimated Time of Approval	Risks
Project Development Investors	Agreement by all investors to commonly managed elements of project.	Development is presently controlled by a single developer. Once subdivided, a common management agreement for the geothermal and other elements of the development among uniquely-owned buildings would be necessary or desirable.	Months Agreement should be developed once geothermal system and other infrastructure is finalized and prior to subdivision and accepting third party investors.	Acceptance of investors prior to resolution of common agreement presents several risks, including: Failure to disclose material terms resulting in investor liability. Incomplete agreement or delay in agreement could result in delay, cost and/or deadlock.
Electric and Gas Utility	Submetering	Coordinate submetering for electric heat under HEFPA.	6 months to year.	See NY Public Service Commission
All Utilities • Electricity • Gas • Water • Sewer • Cable • Telephone	Right-of-Way Franchise.	Encroach or access utility infrastructure. Confirm no interference with utility franchise agreements. Compensation, maintenance, decommissioning, and liability.	Weeks to months	Lack of regulations could require time to negotiate consent, liability and compensation.
Electrical Utility	Electric load	Electrical approval and expansion to accommodate equipment like heat pumps and exchangers.	Weeks	No significant risks
NGO/Community Buffalo River Restoration Partnership	Participation in public hearings and consultation. Oversee Buffalo River Area of Concern.	Includes: Great Lakes National Program Office, Buffalo Niagara Riverkeeper, Honeywell, NYSDEC, Corps.	Not quantifiable	Public opposition

B.7 Anticipated Challenges and Risks

B.7.1 Use of Buffalo River as a Thermal Source/Sink

The Buffalo River is a navigable waterway maintained by the US Army Corps of Engineers for lake vessel access. Additionally, northern portions of the site are listed as federal wetlands in the National Wetlands Inventory (NWI) and are located within a 100-year flood plain, both of which are indicative of the presence of a wetland. As such, any system design using the river or adjacent wetlands, as well as any construction related activity involving excavation, drilling, trenching, and/or backfilling within the Buffalo River, including the area extending to the ordinary high-water mark and/or any adjacent wetlands would likely be a regulated activity under Clean Water Act Section 404.

Given the wide range of activities regulated under 404, the likely best way to avoid the permitting requirements would be to avoid construction above the ordinary high-water line as well as adjacent wetlands. However, because it is unclear to what extent jurisdictional wetlands are present on site, a wetlands delineation is likely required to ascertain the full scope of Army Corp jurisdiction and to inform system-designs that could potentially avoid Section 404 permitting requirements. Additionally, the system could potentially be designed to qualify for a general permit if it is designed as a land-based system that will not result in a loss greater than 1/10-acre of waters of the United States (including wetlands). Notably, the permit review process for general permits is less burdensome and lengthy than individual permits.

The permitting review process for Clean Water Act Section 404 and Rivers and Harbors Act Section 10 may ultimately impact the feasibility of using a river loop system. Availability of practicable non-river alternatives that do not have an adverse impact on the environment would preclude issuing a permit for a river system.

Further, due to the use of the river as a navigable channel, the Corps may be less inclined to view favorably a system that could potentially impede on navigation. Presently, the average number of freighters using the Buffalo River ranges from between 115 and 140 vessels per year.[162] As such, the system would need to be designed in a way so as to not impede marine traffic.

B.7.2 Endangered Species Act Mitigation Measures

Formal consultation pursuant Section 7 under the Endangered Species Act is not required if the agency determines that an action will not affect listed species or designated critical habitat.[163]

Accordingly, system designs that avoid impacts to northern long-eared bat habitat will likely avoid the need for a formal consultation.

During the summer these bats use forested habitat to roost, forage, and travel, as well as adjacent or interspersed non-forested habitats such as emergent wetlands and edges of agricultural land, old fields or pastures.[164] Potential roosting habitats include live or dead trees that are generally greater than or equal to 3 inches in diameter at breast height with cracked or exfoliating bark, broken limbs, cavities, or crevices.[165] Individual trees exhibiting the aforementioned characteristic may be suitable habitat when located within 1,000 feet of other forested habitat. This bat species travels and forages along linear features such as riparian corridors, paths, forest edge, and fence rows, as well as forage along streams, wetlands, and ponds.[166] Project design should avoid impacting these habitat areas.

B.2.3 Lack of Municipal Regulatory Regime for District Geothermal Systems

In New York State, few municipalities have developed permitting guidelines for geothermal systems, and no municipality has developed guidelines for multi-property district systems.

Without a permitting regime and standards for equipment, developers and municipal officials are left to navigate the various zoning, building, mechanical, environmental, and other regulations that may apply to geothermal systems but were not designed specifically for these systems.

This ad hoc approach in the absence of a dedicated geothermal permitting regime increases costs, uncertainty, and risks, and delays the approval process. For project designs in which multiple stakeholders—property owners, utilities, and government agencies—must consent or grant approval, lack of a permitting regime and standards risks the inability of stakeholders to reach decisions or consensus, resulting in deadlock and bureaucratic paralysis. Application of zoning and other regulations not designed for geothermal systems, such as setback requirements, may even block geothermal projects altogether in dense urban and peri-urban areas where small lot sizes are common.

To address this challenge, project developers should start educating municipal permitting authorities and elected officials about the benefits of the geothermal features of the project and the measures to mitigate any potential risks to the environment or other subsurface infrastructure as early as possible. This educational effort should commence as soon as the developer has approved a proposed geothermal design and the assessment of mitigation measures is completed. The project developer should also be prepared to engage with environmental and community groups interested in the project.

B.7.4 Rights of Way and Approvals

Developers must obtain either fee simple ownership or easements in order to drill and install a shared ground loop across multiple properties. Crossing property lines, streets, railroad tracks, existing utility infrastructure all will require the grant of an easement and approval by the owner or authority responsible for their operation.

Each utility that has installed infrastructure in the subsurface should be consulted as part of the approval process to ensure that proposed designs and implementation will not disturb their operations. To safely install geothermal piping in the subsurface without interfering with other utilities will likely require site visits to individual properties by these other utilities. The costs and risk of damage incurred by these utilities will likely generate resistance to granting their approval.

Granting easements over a property limits the property owner's ability to use the property, and can adversely affect private property rights, or diminish private property values. Compensating the grant of an easement and its impact on the servient property can be difficult to value,[167] potentially resulting in deadlock in negotiations.

Without government intervention, geothermal developers must negotiate with property owners and affected utilities to grant approval, which may be conditioned upon agreement on compensation, maintenance, decommissioning, and indemnification for liability.

The costs of obtaining rights of way have been well documented for roads, pipelines,[168] telecommunications, railroads, subways and intracity surface rail, and other types of infrastructure that necessarily crosses property lines. These costs may include a one-time acquisition fee, annual fees, excessive or escalating fees,[169] and the time and cost of organizational staff and legal professionals to procure rights.

In New York State investor-owned electric and gas utilities resolve rights-of-way issues by entering into franchise agreements with municipalities.

B.7.5 Drilling Regulatory Restrictions

New York State imposes different requirements for geothermal wells drilled less than 500 feet and wells over 500 feet. Permitting requirements for wells over 500 feet in depth are considerably more rigorous and costly.

The different permitting regimes effectively limit geothermal system design to shallower depths for many developers of residential and individual building systems. Consequently, more wells must be drilled than would be required if deeper wells were employed to support the same system capacity. The greater number of wells increases overall costs due to greater drilling time, materials requirements, particularly costly well casing, expanded site restoration area, and increased production of cuttings and water.

The decision whether to drill beyond 500-foot depth requires a benefit-cost analysis of the potential additional thermal capacity and more efficient use of limited land weighed against the costs of compliance with the regulatory regime.

The project developer has elected to limit drilling to 500 feet in order to avoid the significant costs of compliance with additional regulation, foregoing a more energy efficient design.

B.7.6 Drilling Barrier Cost and Liability

Geothermal drilling operations may encounter several complicating conditions that have significant safety and regulatory consequences. Heightened operating complexities combined with traditional legal liability rules and regulatory requirements drive increasing costs for labor due to enhanced safety precautions and specialized equipment, slower work progress, more stringent permitting requirements, and higher insurance premiums.

Drilling in areas with excessive groundwater will complicate the drilling process. Saltwater produced from boring cannot be reinjected and must be removed from the site.

Unknown infrastructure or other manmade artifacts also complicate drilling, particularly in urban areas.

The Silo City site contains groundwater at relatively shallow depths and can be expected to produce excess water that must be disposed of or, if permitted, re-injected. Potential ground contamination may further complicate operations and the resulting regulatory treatment.

B.7.7 Business Model

Geothermal development can follow one or more of several business models that exhibit differing technical economies relative to transactional diseconomies. Utilizing the continuum of business models set out in the NYSERDA-sponsored Pace Energy and Climate Center “Overcoming Legal and Regulatory Barriers to District Geothermal in New York State” (2021), the present project classification is based on a “Multiple Properties—Multiple Owners Under a Common Agreement” business model.

In this model, each building sits on its own individual property for tax purposes, each building is its own entity and operates independent of the others, but all buildings are roughly identical in nature (and energy use) and share common management bringing the geothermal system and other aspects of the development under common management.

Geothermal development following this model involves more complex property rights arrangements as a system will cross property boundaries and require cooperation across properties and organizations. A common agreement for maintenance, management, pricing, and financial and other responsibilities of the system, and a common management body such as an owner's association or similar entity would be needed to be established for this purpose and supported by association charges. However, because the developer is common to all phases of the development and controls all phases, these arrangements can be adopted prior to the subdivision and sale of equity in the separate phases.

B.7.8 Submetering and Tenant Billing

If the project plans to submeter heating services so that individual tenants control their usage and pay for their heat services on an individual basis, the developer or a third-party energy services provider must apply with the Public Service Commission for approval of submetering tenant units. Public Service Commission submetering regulations require compliance with metering, billing, dispute resolution and other requirements.

Obtaining submetering approval for a new development is far less complex a process than submetering a building with existing tenants. If submetering is introduced to an existing tenant relationship, this will require additional public hearing and amendment of leases.

Presently, New York State's submetering regulations apply to electricity and electric heating services. No regulatory arrangement exists for billing heating services in measured in thermal units.

Accordingly, to simplify submetering arrangements, the project should introduce submetering prior to entering into agreements with any prospective tenants and, preferably prior to advertising rental units. Further, the project should measure and bill heat services as electric heat following established guidelines to conform to the current regulations as closely as possible. If the project proposes to measure and bill services on a submeter basis, it should at the earliest possible time consult the New York Public Service Commission and the New York Department of Public Service for guidance as this request will raise novel issues likely requiring adaptation of existing rules.

B.8 Summary of Recommendations to Overcome

Certain of these challenges can be addressed through contractual arrangements between the developer and other stakeholders. Recommended contractual arrangement include:

- **Common Agreement Among Phases**. As the project is presently owned and developed by a single entity, but over time will be separately incorporated and equity interests sold to disparate groups of investors, the developer should adopt a common agreement to govern various aspects of the project's maintenance, access, and financial responsibility.
  The common agreement should specifically address the ownership, operation, and maintenance of the geothermal system as the geothermal system will cross project internal property boundaries and require cooperation across separated properties and ownership structures. A common agreement for maintenance, management, pricing, and financial contributions and other responsibilities to operating the system, and a common management body such as an owner's association or similar entity would be needed to be established for this purpose and supported by association charges.
- **Third-Party Energy Services**. The common agreement would facilitate the project entering into a third-party energy services agreement with a geothermal system operator. The third party could provide a turnkey solution or perform discrete tasks on behalf of the project's common management association. Any arrangements with a third-party energy services provider should require performance and compliance consistent with developer obligations to tenants and requirements that may be imposed by the New York Public Service Commission or other government agencies in relation to provision of heat to tenants.
- **Submetering and Tenant Leases.** If the project plans to submeter heating services so that individual tenants control their usage and pay for their heat services on an individual basis, submetering arrangements should be approved by the Public Service Commission prior to entering into leases with any tenants. Leases should then be drafted with language clearly allocating financial responsibility for billed to the tenant.
- **Submeter Billing.** The developer or a third-party energy service provider operating the system will be required to use an approved form of bill and maintain billing service and dispute mechanisms as required by New York State's submetering regulations. The developer or third-party energy service provider may desire to contract with a third-party billing provider in order to comply with these requirements. Such arrangements must provide compliance with any applicable landlord-tenant laws.
- **Tax Optimization**. The geothermal system is a depreciable asset that provides opportunities for tax-advantaged financing. The form of ownership for those assets can be separated from the project and its phases in order to exploit tax advantages. A separate geothermal financing structure potentially improves the financial return of the overall project; however, this must be weighed against the additional complexity and legal risk in the event of a failure to meet obligations for any reasons or a legal dispute.
- **Buffalo River Restoration Partnership**. Silo City should engage with the Buffalo River Restoration Partnership. Measures to restore the Buffalo River ecosystem will likely be required as a condition of approval of permits and membership in this organization and adherence to their mission will inform the project developer of best practices and signal the project's shared commission to that mission.

Endnotes

1 Heat of compression refers to the portion of input electrical energy to the heat pump compressor that is ultimately released as heat due to mechanical inefficiency. With hermetically sealed compressors, this thermal energy is absorbed on the condenser side and can be used for space heating. In cooling mode, thermal energy is being removed from conditioned spaces and rejected to the GLHE. The amount of thermal energy rejected to the GLHE is actually 20-30% more than is removed from conditioned spaces due to the heat of compression. The same happens in heating mode. Due to the heat of compression, only 70-80% of the heat required by the conditioned spaces is extracted from the GLHE.

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5 New York State Clean Heat State-wide Heat Pump Program Manual - Version 5, October 2021 NYS-Clean-Heat-Program-Manual.pdf

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7 The Tax Cuts and Jobs Act of 2017.

8 26 U.S. Code § 48 - Energy credit.

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19 U.S. Dep't of Army & U.S. Env. Protection Agency, *Memorandum of Agreement concern Mitigation Sequence for Wetlands in Alaska under Section 404 of the Clean Water Act* at 7 (June 15, 2018), F

20 33 C.F.R. § 323.2(d)(1); The term includes any addition, including redeposit other than incidental fallback, of dredged material, including excavated material, into waters of the United States which is incidental to any activity, including mechanized land clearing, ditching, channelization, or other excavation. 33 C.F.R. § 323.2(d)(2).

21 According to Corp regulations, fill material includes "rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from minors or other excavation activities, and materials used to create any structure or infrastructure in the water of the United States. 33 C.F.R. § 323.2(e)(2).

22 40 C.F.R. § 232.2 Definitions.

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[114] Pursuant to the Accelerated Renewable Energy Growth & Community Benefit Act, S. 7508-B, A. 9508, 2020-21 Reg. Sess. (N.Y. 2020), the Office of Renewable Energy Siting is responsible for siting and permitting new major renewable energy facilities in New York State, which are defined as "any renewable energy system, as such term is defined in section sixty-six-p of the public service law… with a nameplate generating capacity of twenty-five thousand kilowatts or more". Section 66-p of the Public Service Law defines renewable energy systems as "systems that generate electricity or thermal energy through use of the following technologies: solar thermal, photovoltaics, on land and offshore wind, hydroelectric, geothermal electric, geothermal ground source heat, tidal energy, wave energy, ocean thermal, and fuel cells which do not utilize a fossil fuel resource in the process of generating electricity."

[115] A 25 MW_{th} system based on 2.93 kW_{th} per heating ton (3.517/(12,000 BTU/10,000 BTU)) would support 1,700 homes using 5-ton systems and 2,130 homes using 4-ton systems. See *Kilowatts to Refrigeration Tons Conversion*, RapidTables, available at https://www.rapidtables.com/convert/power/kw-to-ton.html (accessed April 14, 2021).

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[127] At the time of writing, minimum fees were $290. Well Permit Fee Calculator, NYSDEC (accessed Mar. 10, 2021) https://www.dec.ny.gov/energy/1779.html

[128] New York State Multiple Dwelling Law § 79; New York State Multiple Residence Law § 173.

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[130] See, e.g., SZ Enterprises, LLC D/B/A Eagle Point Solar v. Iowa Utilities Board, 850 N.W.2d 441 (Iowa 2014).

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[132] Public Service Law, §4, 53, 65 and 66.

[133] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.1.

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