Willets Point Geothermal Scoping Study

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Willets Point Geothermal Scoping Study

Final Report

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Abstract

District thermal systems can offer greater efficiency and lower emissions than conventional heating, ventilation, and air conditioning (HVAC) systems. Developing and constructing district thermal systems face challenges from initial capital costs for design and installation and uncertain regulatory pathways. Endurant Energy explored the feasibility of a thermal district system at the Willets Point development (New York, NY) to determine technical, regulatory, and lifecycle cost viability as compared to a business-as-usual approach. Endurant explored both centralized and decentralized district designs and compared life cycle costs to the business-as-usual case. Results indicate that a geothermal district system offers significant savings around operational cost and emissions. Simple payback was between 7 and 12 years when incentives were not considered. Simple payback was between 0 and 2 years when incentives were considered.

Keywords

district thermal, geothermal, energy foundation piles, ground-source heat pumps, lifecycle cost analysis, building electrification

Acknowledgements

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Executive Summary

The Related Companies (Related) engaged Endurant Energy to explore the feasibility of developing a district geothermal system to efficiently supply heating and cooling to the Willets Point development. Endurant explored various geothermal system configurations to determine a recommended solution based on initial cost, operating cost, and overall system efficiency.

This study primarily focuses on Phase 1A, which includes three residential buildings and a school. The business-as-usual (BAU) HVAC design assumes an all-electric heating and cooling variable refrigerant flow (VRF) system with electric boilers for domestic hot water production. Geothermal options deliver the benefits of all-electric systems while also operating at higher overall efficiency than conventional electric HVAC.

This report concludes that a district geothermal heating and cooling system will deliver significant value to the building owner and occupants over the lifetime of the development. Benefits from the district geothermal system include the following:

- Fully electrified buildings enable "renewable, carbon free" operations.
- Ground source heat pumps (GSHPs) qualify for significant New York State sponsored incentives and Federal Investment Tax Credits (ITC).
- Greater efficiency reduces electricity use and utility costs.
- GSHPs eliminate the need for outdoor mechanical systems required for VRF units.
- Reduced carbon emissions and associated Local Law 97 costs.
- Lower maintenance costs and longer useful life than conventional equipment.

Our analysis indicates that the geothermal design will reduce annual electricity use by 44% and annual electricity cost by 35% compared to the BAU scenario. The 30-year life-cycle costs (LCC) are summarized in Table ES-1. Both geothermal configurations offer a lower 30-year life-cycle cost than the BAU option.

Table ES-1. 30-Year Life Cycle Cost Analysis Summary

Phase 1A Scenario	30-year Life Cycle Cost
BAU (VRF and electric boiler)	$79,392,000
Geothermal (centralized)	$64,047,000
Geothermal (decentralized)	$67,450,000

Based on our analysis and assessment of site conditions, Endurant recommends a hybrid geo solution using both GSHPs and air source heat pumps (ASHP) while leveraging building foundations for use as energy piles. This hybrid design will reduce the initial cost of the geothermal system by reducing the size of the ground loop heat exchanger (GLHE) and incorporating it into the building foundations.

We also recommend pursuing a district-wide condenser loop paired with a distributed (decentralized) design that locates GSHPs in dedicated mechanical spaces within each residential unit. Each building would also contain ASHPs and electric boilers used to maintain the condenser loop within an upper and lower temperature boundary. This centralized equipment could be located on rooftops or within indoor mechanical space. This configuration most closely resembles the BAU configuration which locates dedicated variable refrigerant flow (VRF) systems within each residential unit.

Geotechnical reports indicate that building foundation pile depths will allow for the integration of the GLHE into the building foundation. The energy pile solution presents several benefits over a dedicated, vertical borefield:

- Minimal to no impact on project schedule.
- Energy piles are less capital intensive than a dedicated borefield.
- Once installed in the foundations, the GLHE loops are protected from future site work.
- Reduced excavation and material to be removed from site.

ES.1 Hybrid Approach Components and Benefits

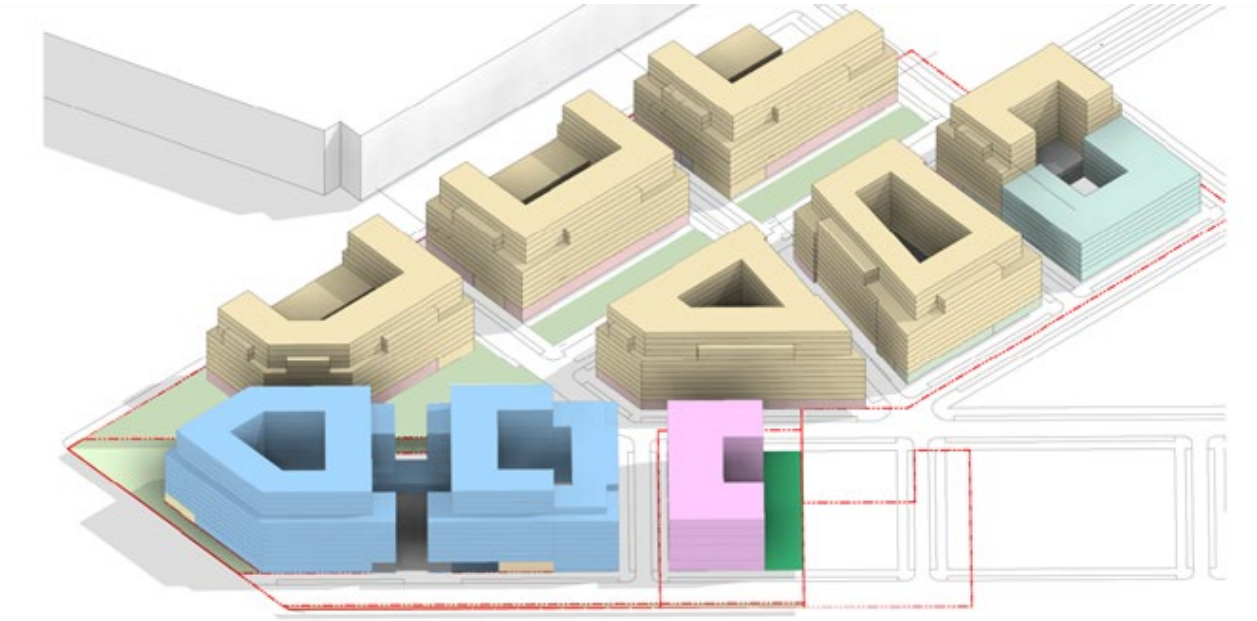
Our proposed hybrid system contains three equipment components:

1. **Ground source heat pumps**—GSHPs will be connected to a GLHE integrated into the building foundation. This resource will serve the majority of annual load but will not meet all the peak loads. A combination of ASHPs and electric boilers will be sized to deliver the remaining peak load. This will support cost containment without any meaningful sacrifices in efficiency or operating costs.
2. **Air source heat pumps**—ASHPs will be used as supplemental equipment to support peak heating and cooling loads and maintain condenser loop temperatures within set boundaries.
3. **Electric boiler**—The electric boiler will be used to provide a cost-effective means of meeting peak demands. An electric boiler serving less than 1% of the annual load will reduce the ASHP capacity requirements by nearly half.

1 Project Background

Willets Point is a 28-acre, mixed-use development located adjacent to Flushing Bay, Queens, New York. The Related Companies, L.P., a New York limited partnership and its affiliates (Related) are currently completing site remediation as they finalize the project's design and planning. Construction on Phase 1A is expected to start in quarter 3 (Q3) 2022. Phase 1A, a six-acre site, consists of three residential buildings totalling 1,100 units of affordable housing (220 of which will be set aside for low-income seniors) and a 450-seat school. The site will contain 1.2 acres of open community space and 300 parking spaces. Phase 1B will include six additional buildings, comprised of 1.7 million square feet (sq. ft.) of residential, retail, and critical facilities.

Figure 1. Massing Diagram of Phase 1A (purple, pink) and Phase 1B (tan)



2 Energy Model

2.1 Methodology

The feasibility process begins with a model to estimate thermal loads (heating and cooling) within the buildings as designed. The study team created energy models for buildings A, B, C, and D (Phase 1A) to estimate annual hourly thermal load profiles, energy consumption, and associated energy costs for the residential, commercial, and retail spaces.

All buildings were modelled using IES VE 2021 energy modelling software based on the proposed schematic design. Building envelope thermal properties, internal loads, and occupancy schedules were modelled per ASHRAE 90.1. The baseline HVAC system is assumed to be a variable refrigerant flow (VRF) system for space heating and cooling paired with a natural gas fired boiler for domestic hot water (DHW). Specific equipment efficiencies for heating and cooling are detailed in appendix. The team assumed that interior parking garage areas remain unconditioned with an exhaust rate of 0.75 cubic feet per minute (cfm)/ sq. ft.

A building schematic design for Phase 1B is currently unavailable. To estimate potential thermal load profiles for Phase 1B, Phase 1A energy models were used as a template. Phase 1B buildings were assumed to have the same shape, orientation, window to wall ratio, and envelope thermal properties as Building A. The team then used residential occupancy schedules and internal loads to generate an indicative profile that estimates thermal energy loads at every hour throughout the year for a residential building. The same thing was done using commercial occupancy schedules and internal loads for the non-residential buildings.

For the purposes of this analysis, three different mixes of use type were used for Phase 1B building area. These include 100% residential, 100% commercial, and 50% residential/50% commercial.

At the time of this report Related has not determined the space-use for Phase 1B. However, this exercise is intended to provide an indication of energy performance based on space utilization. Therefore, the team chose to model scenario A (100% residential) as it presents the greatest opportunity for simultaneous load. Simultaneous loads would occur during times when occupants demand both space cooling and domestic hot water. When deploying a GSHP solution the team can capture cooling waste heat and repurpose it for DHW production which greatly improves overall system efficiency.

2.2 Thermal Profiles

Figure 2 illustrates hourly heating, cooling, and DHW demands for all buildings in Phase 1A. The team sees consistent DHW demand throughout the year and slightly more cooling demand than heating demand. These profiles are consistent with multifamily new construction in New York City.

Figure 2. Thermal Profile Phase 1A

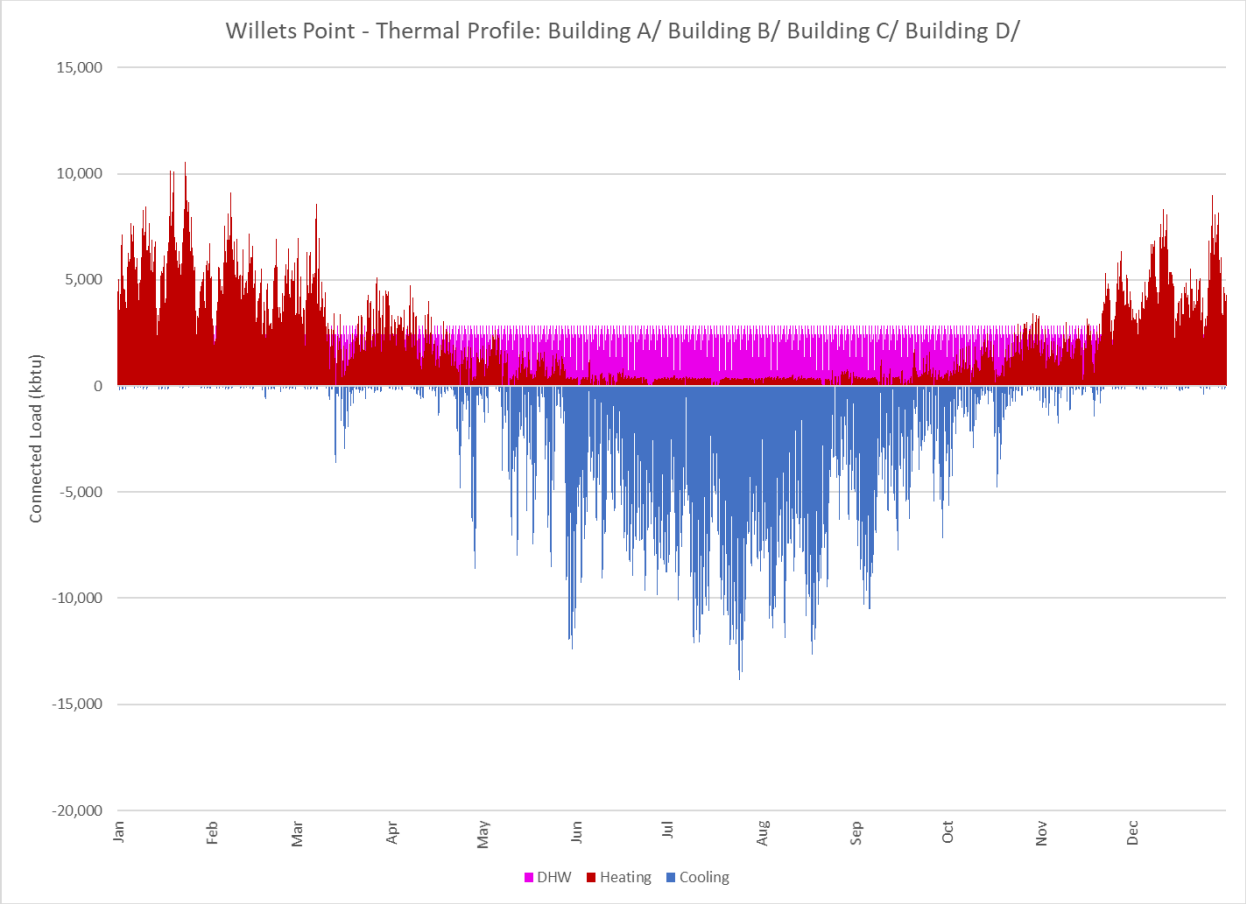
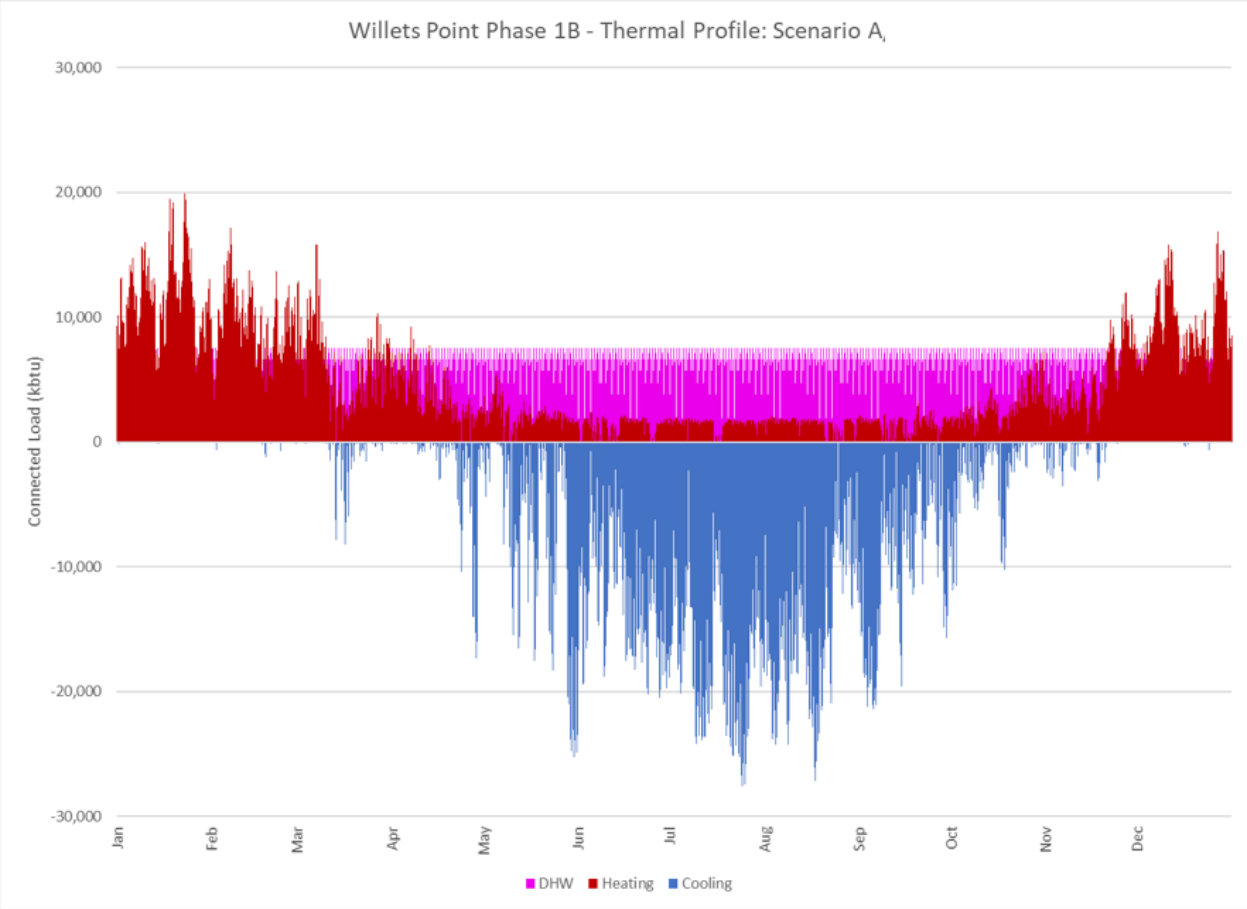


Figure 3 illustrates heating, cooling, and DHW loads for all Phase 1B buildings, which assumes residential uses across the entire phase.

Figure 3. Thermal Profile Phase 1B (100% residential)



2.3 Building Level Summary

Table 1 and Table 2 that follow summarize peak heating and cooling demands and annual loads for all buildings in Phase 1A and for Phase 1B. These are the thermal loads that we based both the business-as-usual and the geothermal costing analysis against.

Table 1. Building Level Thermal Profiles for Phase 1A

Building Metric		A	B	C	D	Total Phase 1A
Area	**(SF)**	507,966	298,403	149,796	114,800	1,070,965
Peak Heating	**(kBtu/hr)**	4,269	2,752	1,436	2,096	10,553
Peak Cooling	**(kBtu/hr)**	5,919	3,430	1,891	2,643	13,865
Peak DHW	**(kBtu/hr)**	1,427	851	482	124	2,884
Annual Heating	**(kBtu)**	7,413,220	4,139,862	2,125,904	2,412,463	16,091,449
Annual Cooling	**(kBtu)**	8,028,451	4,015,982	2,217,333	1,791,959	16,053,724
Annual DHW	**(kBtu)**	6,533,435	3,897,453	2,205,704	502,623	13,139,215

Table 2. Building Level Thermal Profile for Phase 1B

Building Metric		100% Residential	100% Commercial	50% Resi / 50% Comm
Area	**(SF)**	2,100,000	2,100,000	2,100,000
Peak Heating	**(kBtu/hr)**	19,899	23,419	20,780
Peak Cooling	**(kBtu/hr)**	27,591	37,698	32,613
Peak DHW	**(kBtu/hr)**	7,557	2,267	4,572
Annual Heating	**(kBtu)**	34,556,706	23,516,949	29,036,828
Annual Cooling	**(kBtu)**	37,424,608	33,000,523	35,212,563
Annual DHW	**(kBtu)**	34,478,703	9,194,321	21,836,512

3 Design Methodology

3.1 Technologies Considered

Endurant assessed a variety of technical solutions that could satisfy thermal demands while achieving greater efficiencies and life-cycle value as compared to a business-as-usual (BAU) design. The team explored ground source heat pumps (GSHP), air source heat pumps (ASHP), wastewater heat recovery, and surface water heat exchange to deliver thermal energy. Additionally, the potential for solar PV and battery energy storage systems (BESS) was assessed. This section will provide a brief description of each technology, its applicability at Willets Point, and the intended benefits. The remaining analysis focuses on Phase 1A. If Phase 1B programming proves to be primarily residential, the directional conclusions for Phase 1A will likely apply to Phase 1B.

3.1.1 Ground Source Heat Pumps

GSHPs are one of the most efficient heating and cooling technologies commercially available. GSHP systems require a water sourced heat pump (WSHP) containing a refrigeration loop that drives thermal exchange between a building and a ground loop heat exchanger (GLHE) via a working fluid (glycol-water solution) circulated between the GLHE and the WSHPs. Ground temperatures remain more stable than air temperatures throughout the year, which allows the GSHP system to treat the ground as a heat source in the winter and a heat sink in the summer.

GSHPs are unique in that they can deliver both heating and cooling simultaneously at high efficiencies. Simultaneous thermal demands might occur when a building requires space cooling and DHW at the same time. During these times, the water-based heat pump rejects waste heat from the cooling process and compressor heat[1] into the DHW circuit.

GSHP—Key Considerations

Pros	Cons
• Most efficient heating and cooling technology (full load coefficient of performance (COP) of between 5 and 6). • Lowest operating cost compared to conventional equipment and other technologies assessed. • Lower maintenance costs than conventional HVAC equipment. • Ability to supply heating and cooling simultaneously. • All-electric solution can reduce/eliminate associated carbon emissions. • Quieter operations than rooftop condensers.	• Higher initial capital cost. • Requires space to install GLHE.

3.1.2 Air Source Heat Pumps

ASHPs provide a flexible solution for backup heating and cooling capacity. In lieu of a GLHE, ASHPs rely on ambient air as the heat source or sink. A refrigeration loop drives heat exchange between the ambient air and working fluid. This solution performs best at moderate ambient conditions (i.e., fall and spring), while efficiency during summer and winter dwindles significantly.

ASHP—Key Considerations

Pros	Cons
• Good performance at moderate temperature (COP of 3 to 3.5 at 50°F). • All-electric solution can reduce/eliminate associated carbon emissions.	• Requires roof space. • Reduced efficiency at extreme temperatures (COP of < 2.3 at 10°F).

We expect that due to space constraints at the Willets Point site, the district thermal system design will likely need to incorporate some capacity from ASHPs. These assets may be used as a complimentary technology to a GSHP system to handle unbalanced loads and peaks that exceed the GSHP capacity. Since they do not require GLHE, they are an ideal complement to a GSHP system.

3.1.3 Wastewater Heat Recovery

Wastewater that is normally discarded into sewer lines can be diverted, separated (into liquids and solids), and passed through a heat exchanger to extract thermal energy. The average temperature of wastewater is 70°F, which provides an excellent opportunity for thermal extraction if adequate flow rates are available.

Wastewater Heat Recovery—Key Considerations

Pros	Cons
• Smaller physical footprint than GLHE of similar thermal capacity. • Can work in parallel with GLHE. • Highly efficient. • Performance not directly dictated by ambient conditions. • Low- to zero-carbon solution when coupled to GSHP.	• Thermal capacity depends on volume and flow of available wastewater. • Available thermal capacity may not fully supply demand. • Local municipality considerations if connecting into publicly owned sewer infrastructure.

At Willets Point, there are no main sewer lines to provide connection, so opportunities for viable wastewater heat recovery do not exist.

3.1.4 Surface Water Thermal Exchange

Surface water including lakes or rivers present an opportunity for thermal exchange with a GSHP system. Surface water thermal exchange operates similarly to a GLHE except that the surface water becomes the source and sink for heat rather than the ground. Surface water thermal exchange systems may be designed in conjunction with GLHE.

Surface Water Thermal Exchange—Key Considerations

Pros	Cons
• Smaller physical footprint than GLHE of similar thermal capacity. • Can work in parallel with GLHE. • Highly efficient. • Performance not directly dictated by ambient conditions. • Low- to zero-carbon solution when coupled to GSHP.	• Large • Variable rates of heat production depending on flow. • Available thermal energy may not cover load.

Regulations governing access to surface water for the purposes of thermal exchange are likely to be strict. In addition, it is likely that the applicant will need to demonstrate that the geothermal design considers alternatives to surface water as a measure of minimizing adverse environmental impacts to the aquatic environment. Our analysis at this time indicates that a combination of conventional GLHE and energy piles will likely serve a significant portion of the building's thermal loads and will be seen as an alternative to surface water thermal exchange. Based on this analysis, we do not recommend pursuing surface water thermal exchange.

3.1.5 Energy Piles

Energy piles offer an option to install GLHE capacity at lower costs than conventional vertical boreholes. The energy pile solution places geothermal loops within the foundation piles at the time of foundation pile construction. The energy piles consist of a closed-source water loop similar to a vertical GLHE, but instead are placed at the depth of the foundation pile (in this case, we assume 90-foot depths) and at locations where the foundation piles are drilled. Energy piles greatly reduce the cost of installing loops in the ground as compared to a dedicated GLHE. However, the thermal capacity of an energy pile solution may be limited by the design and depth of the foundation piles.

Energy Pile Ground Heat Exchange—Key Considerations

Pros	Cons
• Cost effective method of installing geo loops within the building footprint. • Energy pile installation does not impact foundation construction schedule. • Can work in parallel with dedicated GLHE.	• Thermal capacity is limited by the design, depth, and location of the building's foundation piles.

3.1.6 Solar PV and Battery Energy Storage

Figure 4. Architectural Rendering of Willets Point

Rooftop solar PV produces electricity from solar energy. It has been widely adopted across all building types due to its technical familiarity, relatively low costs, and ease of modular installation. In addition, utility programs in New York State allow communities to access the value of solar PV via subscription programs administered through a customer's electricity bill.

The benefits of solar PV may be limited in two ways. First, on-site solar PV requires unobstructed area to locate panels. Common areas include building rooftops, over parking spaces, or mounted at ground level on unused land. This requirement can be a significant limitation in urban areas where space (including rooftops) is at a premium. Second, solar PV is an intermittent resource that only generates electricity

as solar energy is available. The system will not generate energy during nighttime hours and production may fall during the daytime when clouds obstruct direct sunlight. Because energy production is intermittent, a solar PV system by itself cannot be relied upon to supply electricity continuously or consistently. Solar PV is often paired with BESS to increase dispatchability while operating in parallel with the grid.

Available rooftop space from Phase 1A suggests that a 295 kilowatt (kW) solar PV array could be installed. This system could generate approximately 358,000 kilowatt-hours (kWh) of electricity on an annual basis.

Solar PV—Key Considerations

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

The Endurant team conducted a comprehensive analysis of Willets Point's existing and planned infrastructure to evaluate the site's potential to host a battery energy storage system (BESS). Battery storage is a versatile technology that can provide a variety of technical and commercial values. 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 Willets Point's facilities but would connect to Con Edison's distribution network and sell energy services to the grid. In this instance, Related would receive a simple lease payment on a monthly or annual basis as compensation for letting the battery use the land. Willets Point could also subscribe to the solar PV project and use up to 40% of the energy production within the host building.

The second use case is a "behind-the-meter" model whereby the battery connects directly to Willet Point buildings. During peak demand hours, the buildings would draw power from the battery instead of the grid, minimizing grid demand for that hour (possibly even making it "zero" from the grid's perspective) and therefore minimizing the facility's electricity demand charges. In some behind-the-meter applications, the battery can also backfeed into the grid to supply electricity and services to grid operators.

Willets Point is a strong candidate for a battery storage project. With lucrative Value of Distributed Energy Resources (VDER)[2] tariff incentives in Queens, a new utility service that will likely be able to accommodate several megawatts of new storage, and the balanced load profile of the planned development, energy storage has great promise at the site. Zoning and floodplain analysis will need to be conducted and any resulting challenges will need to be resolved before confirming the viability of storage at the site. A complete and detailed explanation of the use cases and financial opportunity may be found in appendix B.

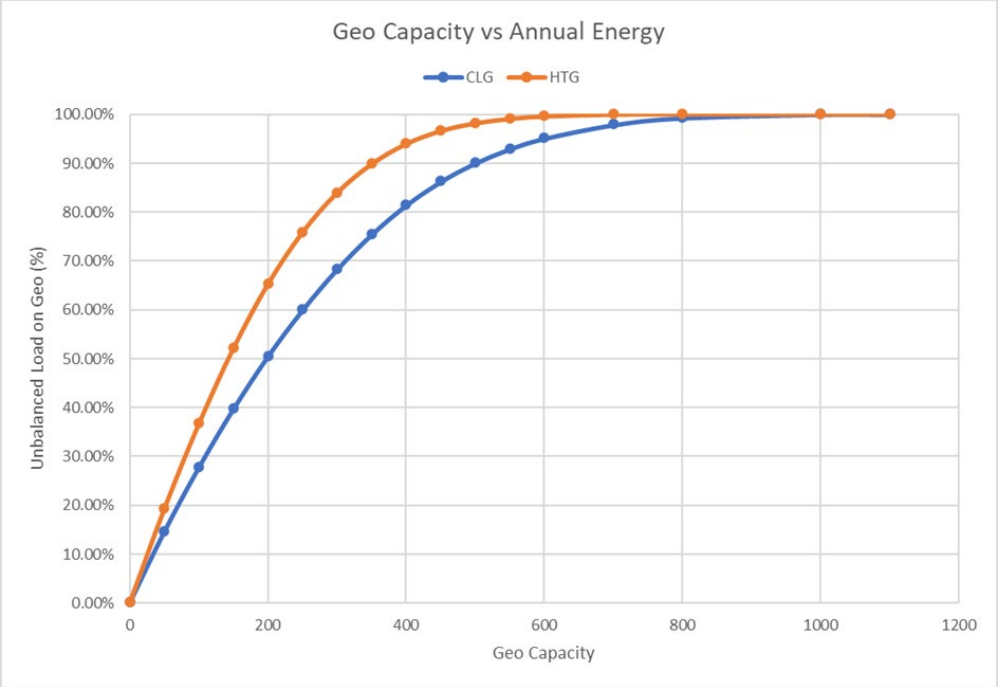
Battery Energy Storage Systems—Key Considerations

Pros	Cons
• Demand response capabilities. • Ability to shift production to more valuable hours in the day. • Value stacking revenue streams. • Limited duration backup power for critical loads.	• Cost is high and often requires incentives to make projects viable.

4 Geothermal Ground Loop Design Iterations

The ground loop heat exchanger (GLHE) and ground source heat pump (GSHP) capacities are sized based on the principle of diminishing returns. Figure 2 illustrates how the marginal increase in geothermal system satisfies diminishing unbalanced loads as the geo capacity increases. For example, a 200-ton system can cover ~50% of the unbalanced annual cooling load and ~65% of the unbalanced annual heating load. Doubling the system size to 400 tons, however, does not double the amount of load that can be served. Instead, a 400-ton system serves 80% of the unbalanced cooling load and 95% of the unbalanced heating load.

Figure 5. Unbalanced Load Satisfied by Increasing Ground Source Heat Pump System Capacity



An optimization exercise was performed for each of the buildings and for the aggregated Phase 1A thermal profile. This exercise allows for comparison between a centralized GSHP design versus a decentralized GSHP configuration for each building.

Energy piles were also investigated as part of the Phase 1A solution. A review of geotechnical reports indicated Phase 1A would require deep foundation piles. After reviewing this information, we determined we would have roughly 1,245 piles to use as GLHEs. If maximized, energy piles could deliver up to 365-tons of cooling capacity.

GLHE sized for annually balanced thermal loads run the risk of evaporator temperatures falling below operationally permissible limits during the peak heating season. This is particularly prevalent in northern climates where undisturbed ground temperatures are low (~50˚F) and seasonal heating demands are high. In these cases, extracting heat from the ground to provide space heating could result in the ground temperature falling below 40˚F which will cause the water flowing through the evaporator to freeze. To avoid this, a larger GLHE would be needed to increase the surface area for heat exchange to meet the peak heating loads. In sites where space is constrained and/or drilling costs are high, this can often be prohibitive.

This issue is alleviated by adding propylene glycol to the solution. The glycol-water GHLE solution has a lower freezing point, which allows for much lower evaporator temperatures. As a result, the same sized GHLE can now serve a larger peak heating load since more heat can be extracted from the ground without causing the evaporator fluid to freeze. Glycol therefore serves to lower the overall size of GLHE needed to serve peak heating loads and is a preferred approach in northern climates and projects where space is scarce and drilling costs are high. Our analysis suggests that a ~20% propylene glycol solution can reduce the GLHE size by up to, and in some cases more than, 50%.

Conversely, addition of glycol results in a decrease in the specific heat of the GLHE fluid. This means that for the same amount of heat transfer to/from the fluid, flow must increase (increasing pumping energy). Additionally, since the glycol solution's temperature can fall lower than pure water, the system must work to supply the same condenser temperature to satisfy heating loads by extracting heat from a GLHE with a cooler working fluid temperature. The compressor must work harder to accomplish this. The addition of glycol therefore negatively impacts the overall operational performance of the system.

The ultimate benefit of adding glycol is dependent on the interplay between lower capital costs and increased inefficiencies in operating performance. Our team tested each sizing run assuming a 17.7% glycol GLHE solution. Since the efficacy of adding glycol to the evaporator solution is highly dependent on project site conditions and location, our team recommends testing the runs without glycol as well to determine the overall benefits (or additional costs) imposed by the addition of glycol.

The process of determining the appropriate size for a GSHP system is iterative and involves studying the impact of several variables such as system cost, proportion of unbalanced load served by the geo system, operational efficiencies, and the project's overall goals and objectives related to energy and sustainability.

5 Geothermal System Configuration

The Willets Point site was evaluated for both a centralized and decentralized geothermal system design that could serve the heating and cooling loads across both phases.

5.1 Centralized Heat Pump Configuration

One design option for a district thermal system is to locate the major equipment in a central mechanical space (central plant). A thermal distribution system connects the buildings to the central plant, which supplies the heating and cooling energy to the connected buildings. This design requires either existing space or new space to house plant equipment, which we believe could be made available.

The GLHE would ideally be located as close to the central plant as possible. This will reduce trenching and lateral piping costs. The GLHE will be coupled to the central plant via a source loop. Additional heating assets, such as surface water heat exchange, can easily be coupled into the source loop as well.

The central plant option assumes a 4-pipe distribution configuration will connect each building to the central plant via hot water and chilled water supply and return. This requires a greater investment in trenching and lateral piping than a decentralized plant concept and presents an increased chance for thermal loss/gain in the distribution network. Thermal losses/gains can be minimized with insulation.

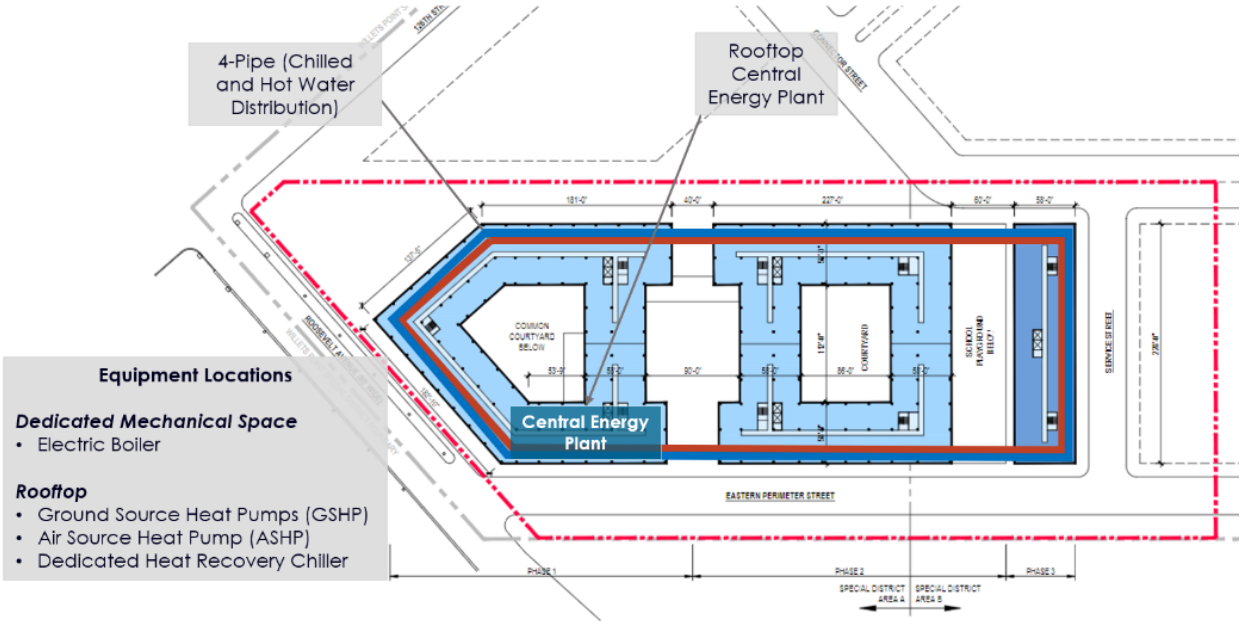
The centralized configuration may be designed to offer resiliency and reliability benefits for the connected buildings. The central plant would be designed with modular heat pumps including excess capacity. This allows for heat pumps to be taken offline for scheduled maintenance (or unscheduled maintenance) without limiting the peak thermal capacity of the system. In addition, redundant heat pumps could be used to supply thermal demands that may exceed peak design conditions. A hybrid central plant that includes both GSHPs and ASHPs provides greater flexibility and reliability than a GSHP-only design. The addition of ASHPs allows the operator to baseload the GSHPs during peak heating/cooling seasons, temper the GLHE (if needed), and allow for different modes of operation in the shoulder seasons that may increase overall system efficiency.

Pros	Cons

• Economies of scale on plant equipment.
• More efficient dispatch of plant assets.
• Reduced maintenance (fewer compressors to service).
• Greatest opportunity for simultaneous load
• Eliminates or reduces mechanical space for distributed HVAC equipment.
	• Requires dedicated central plant space in existing building design, or new central plant building.
	• 4-pipe distribution:
	  ○ Increased investment cost for site trenching and lateral piping.
	  ○ Increased investment cost at building level.
	• Increased opportunity for thermal losses in distribution.

The indicative layouts for the centralized design are shown in Figure 6.

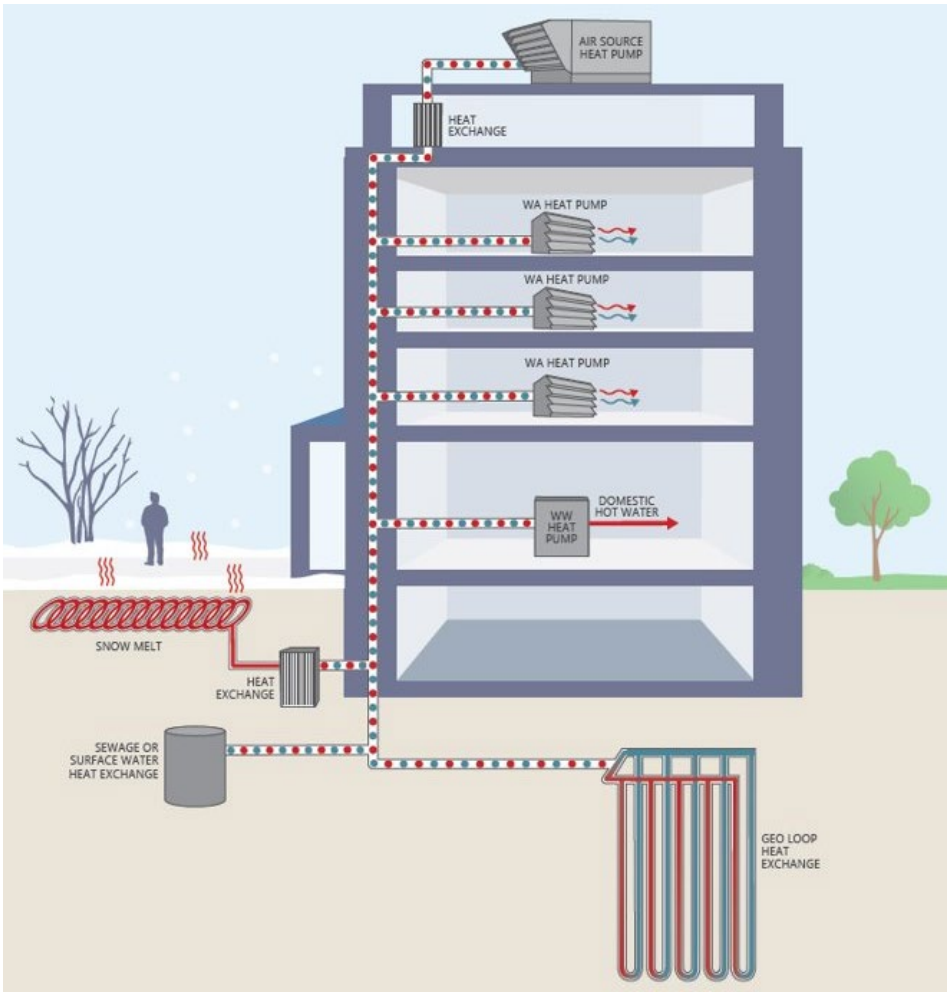
Figure 6. Centralized GSHP/ASHP Hybrid Concept (borefield layout is indicative)



5.2 Decentralized Heat Pumps with District Loop Configuration

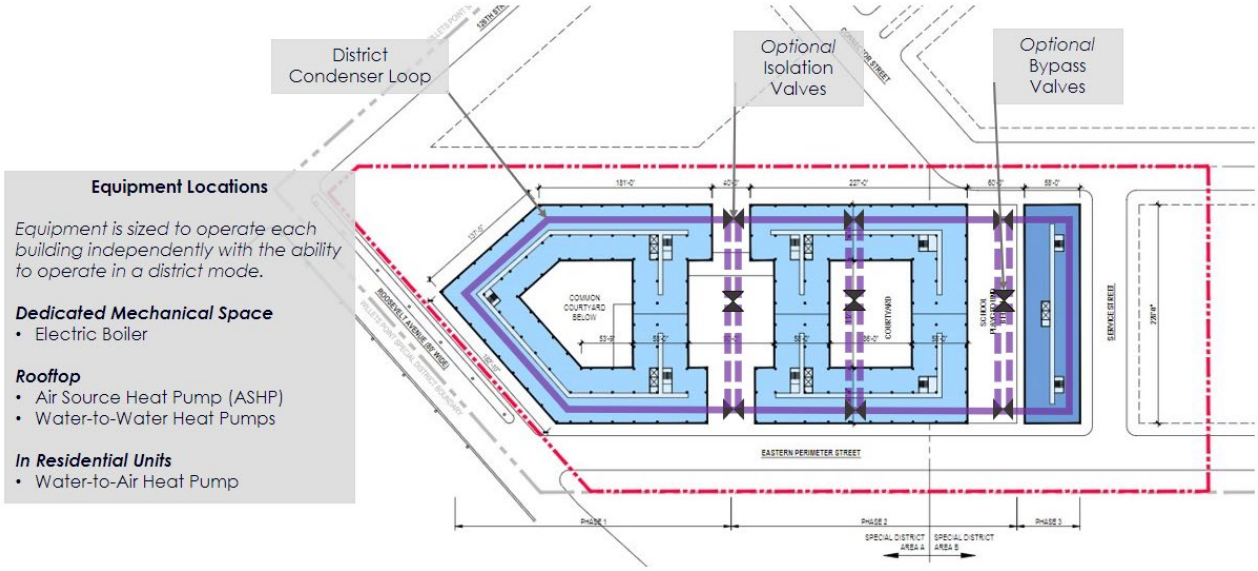
The other design option for a district thermal system is to locate heat pump equipment in mechanical spaces within each residential unit. Water-to-air heat pumps would supply thermal loads to the dwelling units and would be connected to the GLHE via a district condenser loop. Figure 7 illustrates the configuration for equipment within the building. Figure 8 illustrates the district condenser loop that would connect each building to the GLHE and allow for efficient sharing of thermal energy between buildings.

Figure 7. Decentralized Heat Pump Arrangement



The in-unit heat pump arrangement most closely mirrors the BAU design which locates dedicated VRF systems and electric boilers within each dwelling unit.

Figure 8. District Condenser Loop



The use of energy piles assumes that a GLHE will be located within each of the building foundations. Lateral piping will form a condenser loop connecting each of the GLHEs. The moderate temperature of the condenser loop will minimize the potential for thermal losses and will not require additional insulation. The decentralized configuration offers resiliency and reliability benefits beyond BAU. Since the heat pumps are distributed throughout the building, and single heat pump failure will not impact the rest of the system. In addition, the hybrid design that includes a single ASHP on each building provides greater flexibility and reliability and ensure that the condenser loop temperature remains within design conditions.

The pros and cons of a decentralized solution are summarized in the following chart.

Pros	Cons

• 2-pipe distribution:
  ○ Reduced investment cost for site trenching and lateral piping.
• Flexibility at building level:
  ○ Utilize 2-pipe condenser loop.
  ○ No need for central plant operator.
  ○ Closely resembles BAU VRF design.
  ○ Supplemental assets can be localized on roof or in dedicated mechanical space (ASHP/ electric boiler).
	• Less opportunity for “true” simultaneous load.
	• Larger investment in heat pump equipment:
	  ○ Less opportunity for economies of scale.
	  ○ Redundancy/resiliency requirements localized.
	• Increased potential for maintenance (more compressors).

6 System Costs and Benefits

6.1 Capital Costs

Capital costs for each system design are estimated in Table 3. These costs include the in-building mechanical systems and the installation of the GLHE (in the case of the two geo scenarios). The BAU HVAC design assumes VRF systems for space heating and cooling and an electric boiler for DHW.

Table 3. Capital Cost Summary

	Building A	Building B	Building C	Building D	Phase 1A
BAU HVAC	$13,902,000	$7,449,000	$3,713,000	$3,543,000	**$28,607,000**
Centralized Geo	$18,103,000	$9,699,000	$4,835,000	$4,613,000	**$37,250,000**
Decentralized Geo	$15,988,000	$8,566,000	$4,270,000	$4,074,000	**$32,898,000**

6.2 Operating Costs

Each configuration was modeled to generate an hourly profile of the electricity required to power the HVAC systems. Hourly electricity profiles (which simulate utility meter data) are run through the appropriate tariff engine that calculates the utility delivery rate in the same way that the utility calculates customer bills. Residential buildings assume Con Edison's SC 8 Rate 1 for electric service. The school (Building D) assumes SC 9 Rate 1 for electric service. In addition to utility costs, maintenance costs are estimated and included in total operating costs. The BAU electricity use and utility costs are summarized in Table 4.

Table 4. Phase 1A BAU Electricity Cost and Use

Building Metric		Building A	Building B	Building C	Building D	Phase 1A
Electricity Consumption	(kWh)	3,308,926	1,895,370	1,046,131	537,433	**6,787,860**
Electricity Cost	($/year)	$726,000	$421,000	$231,000	$149,000	**$1,527,000**
Electricity Unit Price	($/kWh)	$0.219	$0.222	$0.221	$0.277	**$0.224**

6.2.1 Centralized Plant Operating Costs

Operating costs for the centralized design are summarized in Table 5. Under a centralized configuration, all mechanical equipment is assumed to be metered and billed under a single, commercial electric account. Based on the peak electric demand (in kilowatt hours) needed to drive the system(s), the team estimates that a central plant would be metered under Con Edison's SC9 Rate 1 (General Large).

Table 5. Operating Cost Summary—Centralized Design

	BAU Phase 1A	Centralized Geo Solution
Electricity use (kWh)	6,787,860	3,687,290
Electricity cost	$1,527,000	$870,000
Annual maintenance costs	$130,000	$42,000
Total operating cost	$1,657,000	$912,000
Operational savings (Year 1)	-	$745,000

A centralized plant's inherent advantage is that it will be billed as one large commercial account. This generates slight energy efficiency gains as well as a lower unit price of electricity as fixed charges and demand charges are applied to a single aggregate account.

6.2.2 Decentralized Plant Operating Costs

Operating costs for the decentralized solutions are summarized in Table 7. Under a decentralized configuration, each building will have a dedicated mechanical space to house the necessary GSHP, ASHP, and electric boiler to supply thermal energy to the building.

The decentralized configuration will involve unit-level billing. As such, the total input energy is amortized over the total number of units. Each apartment unit is assumed to be on Con Edison's SC9 Rate 1 (Residential and Religious) service, while each commercial/retail unit is assumed to be on Con Edison's SC9 Rate 1 (General-large with peak kW demand under 1,500 kW) service.

Table 6. Operating Cost Summary—Decentralized Design

	BAU Phase 1A	Decentralized Geo Solution
Electricity use (kWh)	6,787,860	3,811,152
Electricity cost	$1,527,000	$985,000
Annual maintenance costs	$130,000	$48,000
Total operating cost	$1,657,000	$1,033,000
Operational savings (Year 1)	-	$624,000

Our analysis indicates that the centralized geo configuration offers greater savings when compared to the baseline and decentralize scenarios.

6.3 Carbon Savings

The baseline HVAC system for Willets Point is an all-electric VRF with electric boilers for supplying DHW. As such, the carbon emissions associated with HVAC operations is dependent on the fuel-mix of the local electric grid. The hybrid all-electric geothermal solutions require less electricity to supply the district's thermal demands and therefore offers reduced carbon emissions. To estimate carbon emissions, we assumed the same carbon intensity factor used in New York City's Local Law 97 (0.000288962 tons of CO_2 per kWh). Table 5 summarizes the reduction in tons of CO_2 per year for the geothermal options when compared to the baseline system.

Table 7. Summary of Annual CO_2 Reduction

	BAU	Centralized Geo	Decentralized Geo
Electricity use (kWh)	6,787,860	3,687,290	3,811,152
Annual CO_2 emissions (tons)	2,000	1,065	1,101
Annual CO_2 reduction (tons)	-	935	899

6.4 Potential Incentives

Four incentive programs are applicable for the proposed geo solutions at Willets Point. The following are descriptions of each program.

Potential incentive values will vary depending on a variety of factors. Each incentive program outlined in this section requires certain criteria to qualify. Once qualifying criteria are met, most incentive programs require a technical third-party review to verify the methodology and assumptions underlying the incentive application. Additionally, incentive funds can be exhausted or sunset.

6.5 New York State Clean Heat Incentive (NYSCHI)

The NYSCHI[3] is a statewide incentive program administered through the New York State Joint Utilities. The program has a variety of incentive categories that encompass small to large-scale energy projects and numerous heat pump-based technologies. This is a performance-based incentive that compensates the project based on energy savings generated against a standard New York State code compliant energy baseline for HVAC. The following is the formula for determining the incentive value.

{Modeled Code Compliant Heating &Cooling (MMBtu)−Modeled GSHX Energy Heating &Cooling (MMBtu)} x $Incentive Value

Willets Point will qualify for Category 4: Custom Incentives. This category pays $200 per MMBtu of energy savings generated. Within Category 4, the Category 4A– Heat Pump + Envelope allows for additional incentives if the dominant load is reduced by 5% by implementing eligible measures including:

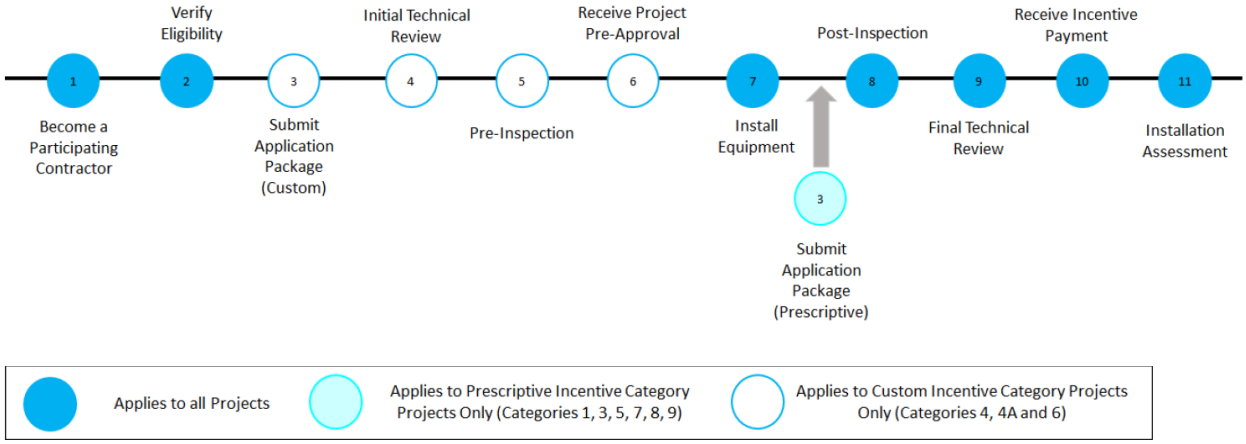
- Window replacements
- Window film
- Wall insulation
- Continuous insulation
- Window walls
- Curtain walls
- Exterior façade
- Air leakage sealing
- Air barrier continuity
- Roof insulation

The applicability of any additional incentives from Category 4A to Willets Point will depend on the eventual envelope design parameters.

The application for these incentives, followed by Con Edison's review and incentive approval, must be completed prior to the installation. The completed program application requires the following:

- 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 additional electrification is non-feasible.
        - Document a controls strategy that prioritizes heat pump dispatch.
- Approved Department of Buildings Permit Submission.

Figure 7. Application and Approvals Timeline for NYS Clean Heat Incentive



6.6 NYSERDA PON 4337—New Construction Housing Program

NYSERDA's New Construction Housing Program (PON 4337) provides support for highly efficient new construction multifamily buildings. Willets Point would qualify for this program based on the reduction in input energy needed for geothermal hybrid solutions compared to a code compliant system.

Table 8. Incentive Categories and Values for NYSERDA PON 4337

Market Rate			Performance	LMI		
Residential Space Type 1 (per Dwelling Unit)	Residential Space Type 2 (per Square Foot)	Cap on per Project Incentives, exclusive of the commercial space incentive		Residential Space Type 1 (per Dwelling Unit)	Residential Space Type 2 (per Square Foot)	Cap on per Project Incentives, exclusive of the commercial space incentive
$1,000	$1.00	$300,000	20% Threshold	$2,000	$2.00	$400,000
$2,500	$2.00	$500,000	30% Threshold	$4,000	$4.00	$600,000

Under PON 4337 there are two performance tiers (20% and 30% threshold) and two categories (Market Rate and Low-moderate income (LMI)). Incentive values increase based on performance tiers, and LMI category projects receive higher payments than Market Rate. Our analysis indicates Building A and B will be eligible for LMI incentives and Building C will be eligible for market rate incentives. Building D is not eligible.

PON 4337 also contains an additional incentive for commercial space paid out at a rate up to $2.00/SF, with a cap of $250,000 per project. This incentive can be layered on top of residential incentives. Incentives are paid out in three milestones as defined in Table 9.

Table 9. PON 4337 Incentive Milestone Payment Schedule

Milestone 1 Proposed Design	Milestone 2 Open Wall	Milestone 3 As Built
30%	30%	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.

6.7 NYSERDA PON 4614—Community Heat Pump Systems

PON 4614 is a competitive solicitation designed to support the development of district scale heat pump systems. A qualifying district contains at least two buildings with a total area of greater than 40,000 sq. ft. or at least 10 buildings of any size. The program contains four categories that support different stages of the heat pump design and development.

- **Category A**—offers up a $100,000 contribution to study a district heat pump system with no cost share required.
- **Category B**—offers up to a $500,000 contribution to the design of a district scale heat pump system with a 50% cost share required.
- **Category C**—offers up to a $4 million contribution towards the construction of a district scale heat pump system.
- **Category D**—offers up to $250,000 to support the development of best practices guidebooks for district scale heat pump projects.

6.7.1 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 qualified property (including geothermal ground source heat pumps) via depreciation deductions on an accelerated schedule. When MACRS is elected, one of the two types of systems apply: the General Depreciation System (GDS) or the Alternative Depreciation Systems (ADS), which determine the depreciation method and recovery periods used. GDS is generally used unless ADS is required by law. Under GDS, property is depreciated over 3, 5, 7, 10, 15, 20, 25, 27.5, and 39 years depending on the property class as defined by the IRS. Bonus depreciation of 100% in the first year is available for qualified property placed in service between September 27, 2017 and January 1, 2023.

6.7.2 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%. 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 Energy as a Service approach 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 GHSP 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 accelerated depreciation.

6.7.3 Summary of Incentive Value for Willets Point

The total estimated incentive value applicable to Willets Point from each of the programs identified above is summarized in Table 10. For the NYSCHI, the baseline energy use assumed New York State compliant building codes, not the BAU HVAC designs proposed for Willets Point.

Table 10. Summary of Incentives

Program	Building A	Building B	Building C	Building D	Phase 1A
NYSCHI	$2,692,200	$1,514,400	$819,600	$557,400	$5,583,600
PON 4337	$628,914	$614,602	$506,886	$0	$1,750,402
ITC*	$1,810,300	$969,900	$483,500	$461,300	$3,725,000
Total	**$5,131,414**	**$3,098,902**	**$1,809,986**	**$1,018,700**	**$11,059,002**

* Note: Pending extension of Federal ITC beyond 2023.

We also considered the NYSCHI that would be made eligible for Willets Point from the all-electric VRF design that Related has proposed, summarized in Table 10.

Table 11. Summary of NYSCH Incentives for the VRF Configuration

Program	Building A	Building B	Building C	Building D	Phase 1A
NYSCHI	$1,515,000	$867,200	$451,0000	$456,200	$3,289,400

6.8 Life-Cycle Cost Analysis

Endurant conducted a 30-year life-cycle cost analysis (LCCA) for both phases of Willets Point as outlined in the following tables. The LCCA for each scenario considers capital costs, annual utility costs, and maintenance costs for the BAU and geo solutions as well as 2.5% inflation rate, 3.0% escalation on electricity costs, and 4.0% discount rate. Major equipment replacement is scheduled in year 15 and year 30 for the VRF equipment in the BAU scenarios, and in year 20 for the geo scenarios.

Table 12. BAU Life-Cycle Cost Analysis Results for Phase 1A

HVAC Installed Cost	$28,607,000
HVAC Replacement Cost	$5,562,000
Year 1 Maintenance Costs	$130,000
Year 1 Utility Cost	$1,527,000
30-year Life-Cycle Cost	$79,392,000

Table 13. Centralized Geo Life-Cycle Cost Analysis Results for Phase 1A

HVAC Installed Cost	$37,250,000
HVAC Replacement Cost	$4,132,000
Year 1 Maintenance Cost	$48,000
Year 1 Utility Cost	$870,000
30-year Life-Cycle Cost	$64,047,000

Table 14. Decentralized Geo Life-Cycle Cost Analysis Results for Phase 1A

HVAC Installed Cost	$32,898,000
HVAC Replacement Cost	$10,516,000
Year 1 Maintenance Cost	$48,000
Year 1 Utility Cost	$985,000
30-year Life-Cycle Cost	$67,450,000

Note: Endurant Energy's communication and coordination with area and project contractors is ongoing and will increase confidence in project pricing.

We also estimated the simple payback for each using operating cost savings and the incremental cost of geothermal designs as compared to the BAU HVAC installed costs. Incentives inclusive of the New York State Clean Heat program and PON 4337 can reduce payback significantly. Incentive amounts may change based on incentive program structures and rates or as building design parameters are adjusted. Therefore, we have presented simple payback with and without the incentives as an illustration of what actual payback periods might be for the geothermal option.

Table 15. Simple Payback

	Centralized Geo	Decentralized Geo
Simple payback (no incentives)	11.7 years	6.9 years
Simple payback (with NYSCH & PON 4337)	1.8 years	0 years

6.9 Regulatory Summary

As a new development located on Flushing Bay, Willets Point offers several thermal source options. These include tapered piles in buildings and parking structure foundations. Storm water and sewage upgrades will be occurring concurrently, creating potential to connect piping between Flushing Bay and Willets Point phase 1A, allowing for a river heat exchange system, and/or an independent sewage thermal extraction system. Residential, school, and other buildings offer the potential for thermal load sharing at different times.

While this assessment focuses on Phase 1A, the development of the project in modular phases contemplates the potential for a district geothermal system that expands in similar modular fashion, sharing thermal load across the development. The residential buildings in the project would include both low-income and senior housing, which are more stringently regulated housing categories. This development contemplates enabling lower carbon heating and cooling to reduce costs and comply with New York Local Law 97, requiring carbon emissions reductions, and New York State's moratorium on new gas connections. In addition to thermal energy, the developer will consider solar PV, battery energy storage, and electric vehicle charging.

The development is located on a property that presently does not have extant streets; however, the city, MTA subway at the edge of the development, and utilities do possess certain rights impacting the property. Additionally, mapped streets will be re-established as part of the development process. Obtaining the approval of various city authorities to install a geothermal system that will be in proximity to or potentially integrate with city infrastructure presents unique regulatory challenges. As a result, implementing a district system poses certain regulatory hurdles associated with crossing public rights of way.

Prior to the 1900s, the Willets Point site was a saltwater meadow. In recent history, it has been used as a dump for coal ash and for industrial purposes. The site is also located in a flood plain. As a result, the site is a brownfield remediation site with a water table relatively close to the surface, creating potential for additional regulatory requirements. Further, the Empire State Development Agency supports the project, resulting in certain New York State regulatory requirements. And, if Flushing Bay is to be utilized as a thermal source, federal and State regulations concerning navigable waterways will be triggered.

One variation of importance is exploiting sewage pipes as a thermal source using a return loop for sewage that could slightly alter the temperature of sewage entering the New York City sewer system. Flow rates and upper/lower temperature ranges of sewage entering pipes, and potential lower temperatures of sewage, may pose regulatory concerns for city authorities.

Working with sewer, transit, and other underground infrastructure, including any water tunnels that may exist in the proximity of the project, can cause delay, and increase costs due to additional approvals required.

6.9.1 Preliminary Commercial and Regulatory Recommendations

A certain number of challenges for implementing the district system can be addressed through contractual arrangements between the developer and other stakeholders. Recommended contractual arrangement include:

- **Common Agreement Among Phases.** The project is presently owned and developed by a single entity, but over time may 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 for operating the system, and a common management body such as an owner's association or similar entity would need 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 heating 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.

6.10 Commercial Alternatives

Two commercial options are available to aide implementation of the proposed geo solution. The first is an Energy-as-a-Service (EaaS) model. Under this offering, Endurant would design, build, own, operate, and maintain all heat pump equipment and the GLHE serving the building's heating, cooling, and DHW loads. The second is a more traditional engineering, procurement, and construction (EPC) service to design and construct the project. Related Companies would own the equipment and subcontract the various project components, as they would in the baseline scenario with conventional HVAC equipment. These two business models are explored in greater detail.

6.10.1 Energy-as-a-Service

Energy-as-a-Service (EaaS) is a comprehensive solution that Endurant offers clients for the development, construction, ownership, and maintenance of bespoke energy solutions for specific sites, delivered through an energy services agreement. It may include a wide array of services and products and is tailored to meet the specific needs of each project.

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. As a Related Properties' EaaS partner, Endurant will develop a solution that will serve as a platform for long-term value creation.

6.10.2 Endurant's Energy-as-a-Service Offering

Endurant's EaaS offering includes DBOOOM (Design, Build, Own, Optimize, Operate, Maintain) services inclusive of the following:

- Ground Source and Air Source Heat Pumps
- Solar PV/Solar thermal
- Battery Energy Storage Systems (BESS)
- EV charging
- Fuel cells
- Combined Heat and Power (CHP)
- Demand management
- Energy supply contracts
- Efficiency upgrades

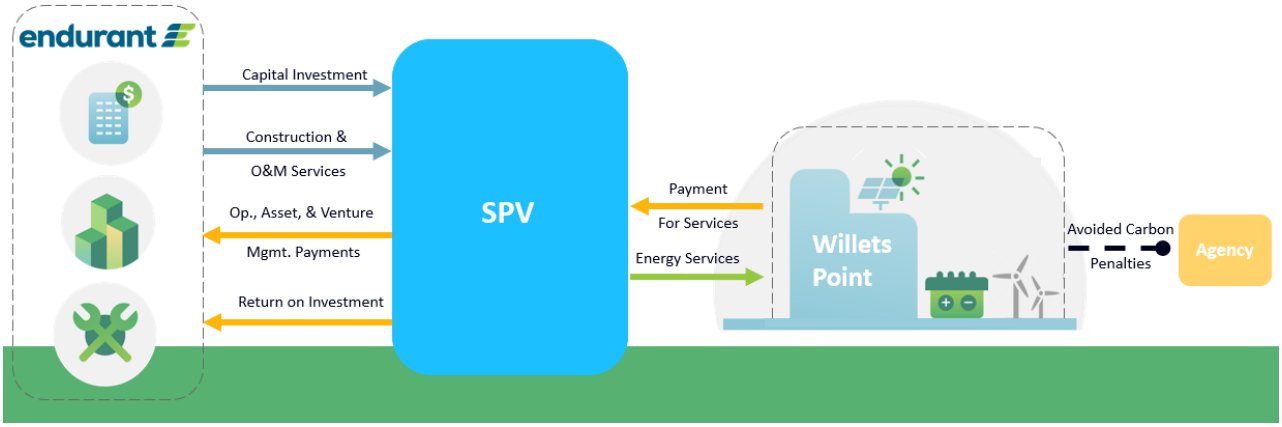
For the proposed thermal solution, Endurant's EaaS will encompass the following services:

- Detailed design
- Installation
- Commissioning
- Operations/optimization and maintenance
- Decommissioning
- Project financing

All phases are presently owned by the same entity but will be subdivided into separate tax lots within separate special purpose vehicles upon commissioning.

Figure 8 illustrates the overarching relationships and responsibilities in the EaaS business model.

Figure 8. Endurant Energy's Energy-as-a-Service Commercial Structure



Endurant will set up a special purpose vehicle (SPV) that will develop, finance, build, own, optimize and operate the proposed GSHP/ASHP system. A core component of the EaaS model is to simplify counter-party relationships. In their proposed structure, the SPV will contract directly with the building owner/operator for Energy Services, namely heating and cooling energy from the system. From the building owner's perspective, this relationship would be like their relationship with Con Edison in the BAU case, i.e., a payment in exchange for the heating energy (either gas or electricity).

The annual capacity fee includes a "turnkey" service to the building—including provision of energy as well as timely maintenance. There are unique advantages to the EaaS business model proposed here. First, the building owner receives the benefit of installing GSHP without the risk of financing and owning the asset. Second, Endurant can wrap several value-added benefits into the EaaS. These include:

- Hedged electric supply pricing, if determined to be necessary for the project.
- Monetization of tax-based benefits such as the ITC and depreciation, which serves to improve project economics for all stakeholders involved.
- Electric supply sourced from fully renewable generation, which will help position the project as 100% green and renewable.

The EaaS business model's fundamental tenet is to maximize value to all stakeholders, as summarized in Table 16.

Table 16. Energy-as-a-Service Benefits Summary

Stakeholder	Benefits of 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
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	• More efficient thermal energy means more carbon emission reductions. • Eliminate on-site emissions completely. • Serves as a proof-of-concept for the scalability of this model to other parts of the community.

6.10.3 Engineering, Procurement, and Construction

The Engineering, Procurement, and Construction (EPC) model represents the "business-as-usual" approach. Under this model, Related Companies would design, build, own, operate, and maintain the proposed solution and equipment through multiple subcontracts. Value for tenants is realized via operational savings produced by the efficiencies of the proposed system. However, Related Companies would be exposed to more project risk than when compared to the EaaS model. Three key risks are:

1. Execution Risk–throughout the development process, schedules, quality, and delivery must be carefully managed to avoid costly delays.
2. Economic Risk–Related Companies must secure financing and service debt, or equity associated with the equipment capital costs.
3. Operational Risk–energy assets require on-going preventative maintenance and occasional repairs.

Risks are common in the development process, and none pose an insurmountable hurdle to the project. Our team has engaged on over 400 GSHP projects since the founding of our company. Through this experience we have developed a deep understanding of project risk and mitigating strategies.

One common misstep we have encountered in GSHP risk management is the subcontracting of various project components to multiple vendors, including the energy modelling, ground loop design, mechanical design, controls strategy, and installation. Each of these project components interacts with one other to create an optimal GSHP system and it is therefore critical that each iteration in the design process is closely coordinated. Under the EPC approach, Endurant would strongly recommend that Related Companies pursues an EPC contract that places all the GSHP design elements under one subcontractor. This approach is more likely to produce a reliable outcome while placing accountability with one subcontractor.

7 Conclusion and Recommendations

The analysis in this report confirms that district geothermal heating and cooling will deliver significant value to the building owner and occupants over the lifetime of the development. The value from the geo system is derived from significant increases in overall system efficiency as compared to the BAU design (VRF with electric boilers). Benefits include:

- Fully electrified buildings allow for "renewable, carbon free" operations.
- GSHPs increase New York State incentives and qualify for Federal Investment Tax Credits (ITC).
- Reduction in electricity use and utility costs to occupants.
- Elimination of outdoor mechanical systems associated with VRF units.
- Reduction in carbon emissions and associated costs from Local Law 97.
- Lower maintenance costs and longer useful life than conventional equipment.

The 30-year life-cycle costs are summarized in the following chart. These LCCs do not consider the additional up-front incentives that may be secured for the geothermal systems as GSHPs qualify for more New York State incentives than VRF systems. Table 16 intentionally compares the LCCs without incentives to underscore the fact that geo systems do provide significant operational value in the long term. The LCCA results indicate that both geothermal options result in lower cost as compared to the BAU scenario over the 30-year life cycle.

Table 17. 30-Year Life Cycle Cost Analysis Summary

Phase 1A Scenario	30-year LCC
BAU (VRF and electric boiler)	$79,392,000
Geothermal (centralized)	$64,047,000
Geothermal (decentralized)	$67,450,000

The team finds that the centralized option represents the lowest life-cycle cost. However, the decentralized option offers two important benefits to the real estate developer. First, in discussions with Related, we have learned that they prefer a decentralized HVAC design for low- to moderate-income residential developments as it eliminates the need for dedicated central plant operators. In addition, the decentralized option presents a lower capex cost as compared to the centralized option. The decentralized option, therefore, combines the benefits of geothermal efficiency and the familiarity and operational advantage that Related seeks in a decentralized HVAC design while offering the least cost geothermal design. Based on these factors, we recommend a hybrid geo solution using both GSHPs and ASHPs while leveraging building foundations for use as energy piles. This hybrid design will reduce the initial

cost of the geothermal system by reducing the size of the GLHE and incorporating it into the building foundations. We also recommend pursuing a district-wide condenser loop paired with a distributed (decentralized) design that locates heat pumps in dedicated mechanical spaces within each residential unit. The ASHPs and electric boilers would be located in a central location in each building (rooftop or mechanical space) and be used to temper the condenser loop. This configuration most closely resembles the BAU configuration that would locate dedicated VRF systems within each residential unit. In this way, the geothermal system aligns more closely to the BAU HVAC design that Related intends for Willets Point, which locates HVAC mechanical systems within the residential dwelling unit.

Information from available geotechnical reports indicate that foundation piles will be deep enough to allow for the integration of the GLHE into the building foundation. The energy pile solution presents several benefits over a dedicated, vertical borefield.

- Minimal to no impact on project schedule.
- Energy piles are less capital intensive than a dedicated borefield.
- Once installed in the foundations, the GLHE loops are protected from future site work.
- Reduced excavation and material to be removed from site.

We developed the following assumptions for building foundation piles based on the available geotechnical reports:

- Steel taper piles
- 3 piles per group
- 90-foot depth
- Single geothermal loop per pile

We assumed that columns and pile caps would be positioned on a 20-foot grid across the site and there would be 3 piles per pile cap. Based on these assumptions we estimated the quantity of piles available to be used as GLHEs.

Table 18. Available GLHE per Building

Building	A	B	C	D
Pile Count	543	276	150	276
GLHE Length (ft)	48,870	24,840	13,500	24,840

The team used the overall length of loops in the GLHE to estimate thermal capacity of the geothermal system. Equipment capacities were then developed for a hybrid geothermal system. The intent of developing a hybrid solution is to reduce overall project cost by targeting the annual load served rather than the peak. We have encountered many projects where the GSHP system can meet upwards of 90% of the annual load yet would require more than double the capacity to meet the annual peak. Increasing system capacity requires adding boreholes, which is the most expensive component to a geothermal system. The hybrid solution allows us to add thermal capacity via ASHPs without the need to add boreholes. In this way, the hybrid solution delivers the benefits of GSHPs while reducing the overall costs of a GSHP-only design.

7.1 Lessons Learned

Analysis conducted during this feasibility study revealed that developers of low-moderate income (LMI) residential units prefer HVAC designs that allow for the separation of heating and cooling. This is because NYC law requires that LMI building owners provide space heating at no cost to the tenant but are not required to provide space cooling. Heat pumps, regardless of whether they are ASHPs or GSHPs provide both heating and cooling and may be thermostatically controlled by the tenant. This poses challenges when it comes to (1) controlling the level of heating delivered to the dwelling space and (2) separating the cost of heating (paid by the owner) and the cost of cooling (paid by the tenant). Some heat pump manufacturers have indicated that they intend to offer units with internal meters capable of measuring heating and cooling output separately, but this capability remains limited among heat pump options today. For this reason, LMI developers may prefer distributed heat pump designs over a centralized design as it avoids the need to meter and bill tenants for cooling. Yet, the challenge remains as to how best to deliver no-cost heating from the same equipment that delivers space cooling.

7.2 Hybrid Approach Components and Benefits

Our proposed hybrid system contains three equipment components:

1. **Ground source heat pumps.** GSHPs will be connected to a GLHE integrated into the building foundation. This resource will serve the majority of annual load but will not meet all the peak loads. A combination of ASHP's and electric boilers will be sized to deliver the remaining peak load. This will support cost containment without any meaningful sacrifices in efficiency or operating costs.
2. **Air source heat pumps.** ASHPs will be used as supplemental equipment to support peak heating and cooling loads.

3. **Electric boiler.** The electric boiler will be used to provide a cost-effective means of meeting peak demands. On this project we estimate that an electric boiler serving less than 1% of the annual load will reduce the ASHP capacity requirements by nearly half.

7.3 Hybrid Design Assumptions

The hybrid design approach yielded the following equipment capacities along with estimates for annual load served.

Table 19. Building A: Equipment Capacities and Annual Load Served

Building A							
	Simultaneous		Geothermal		ASHP		Electric Boiler
Thermal Demand	CLG	HTG	CLG	HTG	CLG	HTG	HTG
Capacity *(CLG in Tons) (HTG in MBH)*	100	1,560	150	2,340	300	2,340	1,000
Annual load *(kbtu)*	2,668,684	3,469,290	3,878,891	6,557,093	1,480,875	3,910,226	10,046
% Annual load	33%	25%	48%	47%	18%	28%	0.1%

Table 20. Building B: Equipment Capacities and Annual Load Served

Building B							
	Simultaneous		Geothermal		ASHP		Electric Boiler
Thermal Demand	CLG	HTG	CLG	HTG	CLG	HTG	HTG
Capacity *(CLG in Tons) (HTG in MBH)*	50	780	75	1,170	190	1,489	1,000
Annual load *(kbtu)*	1,167,467	1,517,706	1,872,766	3,164,523	975,750	3,330,963	24,122
% Annual load	29%	19%	47%	39%	24%	41%	0.3%

Table 21. Building C: Equipment Capacities and Annual Load Served

Building C							
	Simultaneous		Geothermal		ASHP		Electric Boiler
Thermal Demand	CLG	HTG	CLG	HTG	CLG	HTG	HTG
Capacity *(CLG in Tons) (HTG in MBH)*	25	390	40	624	108	851	500
Annual load *(kbtu)*	654,909	851,381	1,004,664	1,696,906	557,760	1,776,458	6,863
% Annual load	30%	20%	45%	39%	25%	41%	0.2%

Table 22. Building D: Equipment Capacities and Annual Load Served

Building D (School)							
	Simultaneous		Geothermal		ASHP		Electric Boiler
Thermal Demand	**CLG**	**HTG**	**CLG**	**HTG**	**CLG**	**HTG**	**HTG**
Capacity (CLG in Tons) (HTG in MBH)	15	234	100	1560	135	1,064	0
Annual load *(kbtu)*	288,547	375,112	1,333,797	2,255,107	169,615	284,868	0
% Annual load	16%	13%	74%	77%	9%	10%	0%

Appendix A. Energy Model Assumptions

A.1 Energy Model Assumptions Phase 1A Building A

Envelope	• Roof Assembly U- 0.030 • External Mass Wall assembly U- 0.078 • Window Operable assembly U- 0.420; SHGC=0.290 • Window Fixed assembly U- 0.360; SHGC=0.290 • Opaque Door U-0.31 • Ground Floor unheated U=F(0.52) • Window to wall area ratio: 39.1%
Occupancy	• Per ASHRAE 90.1 space-by-space method
Interior Lighting Power Density	• Lighting power density per ASHRAE 90.1 space-by-space method • All buildings residential living units and town houses 1.00 W/SF • Overall LPD 0.85 W/SF
Exterior Lighting	• Estimated exterior lighting 0.02 W/SF of buildings area 9,010
Miscellaneous Loads	• Receptacles plug load per ASHRAE 90.1 space-by-space method • All buildings residential living units and townhouses 0.5 W/SF • Overall building 0.45 W/SF • Five Elevators 20kW each

HVAC Systems	• Residential Spaces
	  ○ Residential tower living units
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – 100% VRF Heat Recovery
	• Residential towers and School DOAS Units
	  – Air-to-Air Heat Pump Heating [COP 3.3]
	  – Air-to-Air Heat Pump Cooling [COP 4.3]
	  – ERV 50% sensible, 50% latent effectiveness, 0.54 kW motor
	• Retail/School/Common Spaces
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – No VRF Heat Recovery
	• Back of house spaces heating only with Electrical Resistance [100% Eff.]
	• Unconditioned, ventilated interior parking garage

A.2 Energy Model Assumptions Phase 1A Building B

Envelope	• Roof Assembly U- 0.030 • External Mass Wall assembly U- 0.078 • Window Operable assembly U- 0.420; SHGC=0.290 • Window Fixed assembly U- 0.360; SHGC=0.290 • Opaque Door U-0.31 • Ground Floor unheated U=F(0.52) • Window to wall area ratio: 38.6%
Occupancy	• Per ASHRAE 90.1 space-by-space method
Interior Lighting Power Density	• Lighting power density per ASHRAE 90.1 space-by-space method • All buildings residential living units and town houses 1.00 W/SF • Overall LPD 0.85 W/SF
Exterior Lighting	• Estimated exterior lighting 0.02 W/SF of buildings area 5,385
Miscellaneous Loads	• Receptacles plug load per ASHRAE 90.1 space-by-space method • All buildings residential living units and townhouses 0.5 W/SF • Overall building 0.45 W/SF • Four Elevators 20kW each

HVAC Systems	• Residential Spaces
	  ○ Residential tower living units
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – 100% VRF Heat Recovery
	• Residential towers and School DOAS Units
	  – Air-to-Air Heat Pump Heating [COP 3.3]
	  – Air-to-Air Heat Pump Cooling [COP 4.3]
	  – ERV 50% sensible, 50% latent effectiveness, 0.54 kW motor
	• Retail/School/Common Spaces
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – No VRF Heat Recovery
	• Back of house spaces heating only with Electrical Resistance [100% Eff.]
	• Unconditioned, ventilated interior parking garage

A.3 Energy Model Assumptions Phase 1A Building C

Envelope	• Roof Assembly U- 0.030 • External Mass Wall assembly U- 0.078 • Window Operable assembly U- 0.420; SHGC=0.290 • Window Fixed assembly U- 0.360; SHGC=0.290 • Opaque Door U-0.31 • Ground Floor unheated U=F(0.52) • Window to wall area ratio: 39.7%
Occupancy	• Per ASHRAE 90.1 space-by-space method
Interior Lighting Power Density	• Lighting power density per ASHRAE 90.1 space-by-space method • All buildings residential living units and town houses 1.00 W/SF • Overall LPD 0.92 W/SF
Exterior Lighting	• Estimated exterior lighting 0.02 W/SF of buildings area 2,996
Miscellaneous Loads	• Receptacles plug load per ASHRAE 90.1 space-by-space method • All buildings residential living units and townhouses 0.5 W/SF • Overall building 0.49 W/SF • Two Elevators 20kW each

HVAC Systems	• Residential Spaces
	  ○ Residential tower living units
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – 100% VRF Heat Recovery
	• Residential towers and School DOAS Units
	  – Air-to-Air Heat Pump Heating [COP 3.3]
	  – Air-to-Air Heat Pump Cooling [COP 4.3]
	  – ERV 50% sensible, 50% latent effectiveness, 0.54 kW motor
	• Retail/School/Common Spaces
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – No VRF Heat Recovery
	• Back of house spaces heating only with Electrical Resistance [100% Eff.]
	• Unconditioned, ventilated interior parking garage

A.4 Energy Model Assumptions Phase 1A Building D

Envelope	• Roof Assembly U- 0.030 • External Mass Wall assembly U- 0.078 • Window Operable assembly U- 0.420; SHGC=0.290 • Window Fixed assembly U- 0.360; SHGC=0.290 • Opaque Door U-0.31 • Ground Floor unheated U=F(0.52) • Window to wall area ratio: 40.0%
Occupancy	• Per ASHRAE 90.1 space-by-space method
Interior Lighting Power Density	• Lighting power density per ASHRAE 90.1 space-by-space method • All buildings residential living units and town houses 1.00 W/SF • Overall LPD 0.87 W/SF
Exterior Lighting	• Estimated exterior lighting 0.02 W/SF of buildings area 2,296
Miscellaneous Loads	• Receptacles plug load per ASHRAE 90.1 space-by-space method • All buildings residential living units and townhouses 0.5 W/SF • Overall building 0.50 W/SF

HVAC Systems	• Residential Spaces
	  ○ Residential tower living units
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – 100% VRF Heat Recovery
	• Residential towers and School DOAS Units
	  – Air-to-Air Heat Pump Heating [COP 3.3]
	  – Air-to-Air Heat Pump Cooling [COP 4.3]
	  – ERV 50% sensible, 50% latent effectiveness, 0.54 kW motor
	• Retail/School/Common Spaces
	  – VRF Heating [COP 3.2]
	  – VRF Cooling [COP 3.5]
	  – No VRF Heat Recovery
	• Back of house spaces heating only with Electrical Resistance [100% Eff.]
	• Unconditioned, ventilated interior parking garage

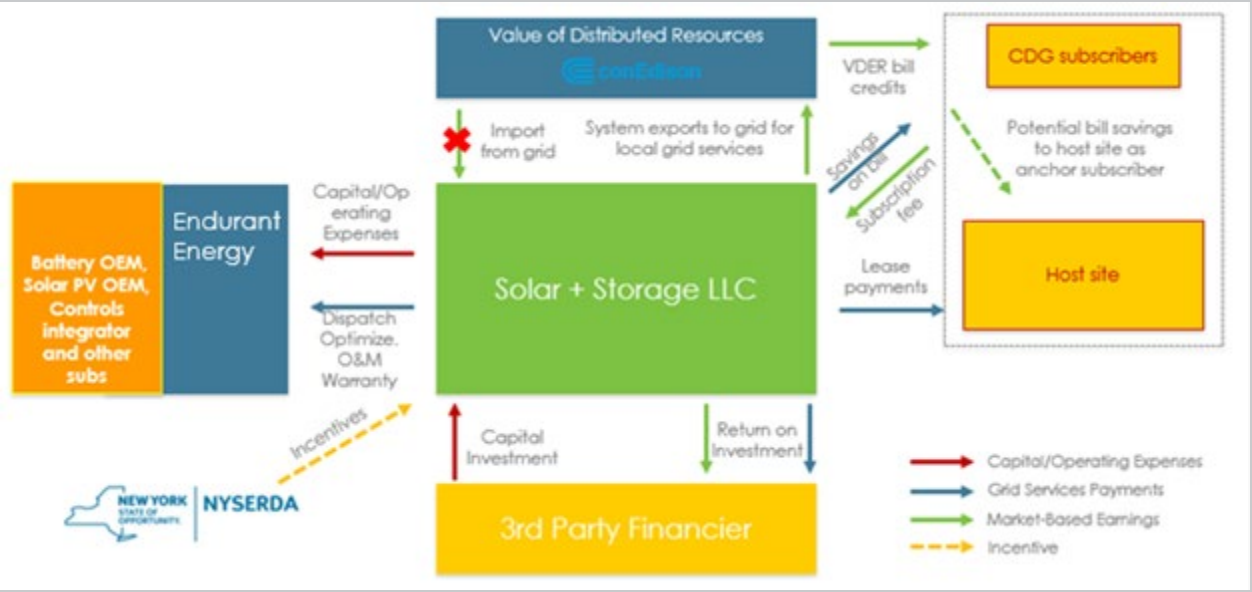
Appendix B. Solar PV and Storage Assessment

B.1 Front-of-the-Meter Community Solar PV and Storage

New York State has an established program called Value of Distributed Energy Resources (VDER) that allows solar PV (optionally paired with BESS) 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 the monetary credit can be applied to customer bills.

Community Distributed Generation (CDG) is one such version of the VDER program, which allows commercial and residential customers to "subscribe" to the output of a front-of-the-meter (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 Con Edison 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 B-1 summarizes the third-party funded business model for the FTM CDG VDER asset.

Figure B-1. Third-Party Funded Front-of-the-Meter Community Distributed Generation Value of Distributed Energy Resources 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 + BESS asset owner), leaving the remainder as savings on the subscribers' bills.

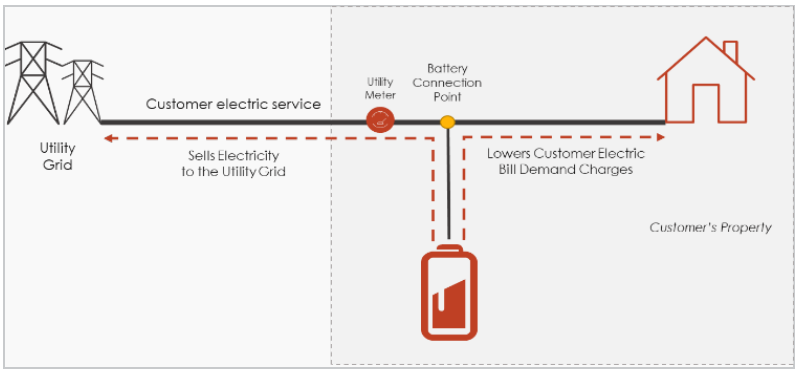
Related Companies would receive a lease payment from the third-party asset owner for use of their rooftops and/or ground space. Furthermore, if the centralized geothermal system operates under its own electric account, the account can be designated as a subscriber to the solar PV + BESS project, thereby seeing approximately 5%–10% reduction in electricity bills. FTM VDER projects offer the following advantages:

- They are technically independent of the proposed thermal solution and can therefore be pursued in parallel; however, they create *virtual* financial benefits and enhance overall value to Related Companies in the following ways:
    - Offers stable and predictable cash flows in the form of lease payments which can serve to further reduce the operating expenses associated with the thermal solution.
    - Provide savings to the Willets Point community without any out-of-pocket costs.
    - Enhance renewable energy attributes and overall marketability of the Willets Point development.
- Excess or unused credits may be shared with the wider Queens community outside of Willets Point.

B.2 Battery Storage Assessment

The Endurant team conducted a comprehensive analysis of Willets Point's existing and planned infrastructure to evaluate the site's potential 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 function as a flexible resource for utility grid operators because 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 B-2. Illustration of Energy Storage Configuration



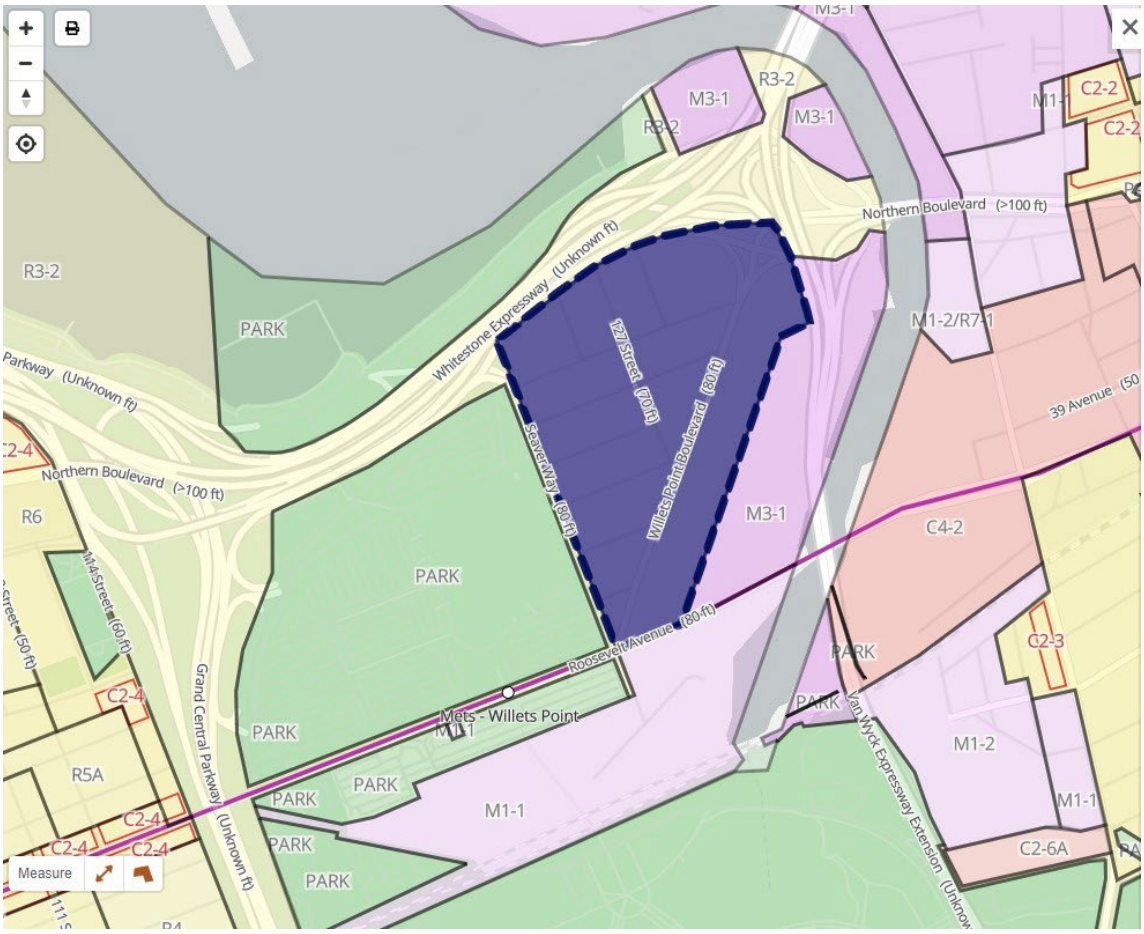
There are two main use cases for batteries in New York State. The first is a "front-of-the-meter" application where the battery would not connect to Willets Point's facilities but would connect to Consolidated Edison's distribution network and sell energy services to the grid. In this instance, the Related Companies would receive a simple lease payment on a monthly or annual basis as compensation for letting the battery use the land. In the second use case, the "behind-the-meter" model, the battery connects to Willet's facilities. During the facility's peak demand hours, the buildings would draw power from the battery instead of the grid, minimizing its demand on the grid for that hour (possibly even making it "zero" from the grid's perspective) and therefore minimizing the facility's electric bill demand charges. In some behind-the-meter applications, the battery can also backfeed into the grid to supply electricity and services to grid operators (seen in Figure B-2).

From a technical perspective, Willets Point's legacy infrastructure and planned development make the site an excellent prospect for battery storage. To start, the mixed-use plan for the property makes for a diverse, complementary load profile that makes the BESS's energy valuable in different ways at different times in the day. Further, the location's energy use at night will likely be lower, therefore, making it a more opportune time to charge at night and discharge during the day, as is typical for these systems.

If used in a behind the meter context, the complementarity of the loads comes into play. The time-of-use demand from daytime commercial loads to evening residential loads would make the battery valuable across different times of 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.

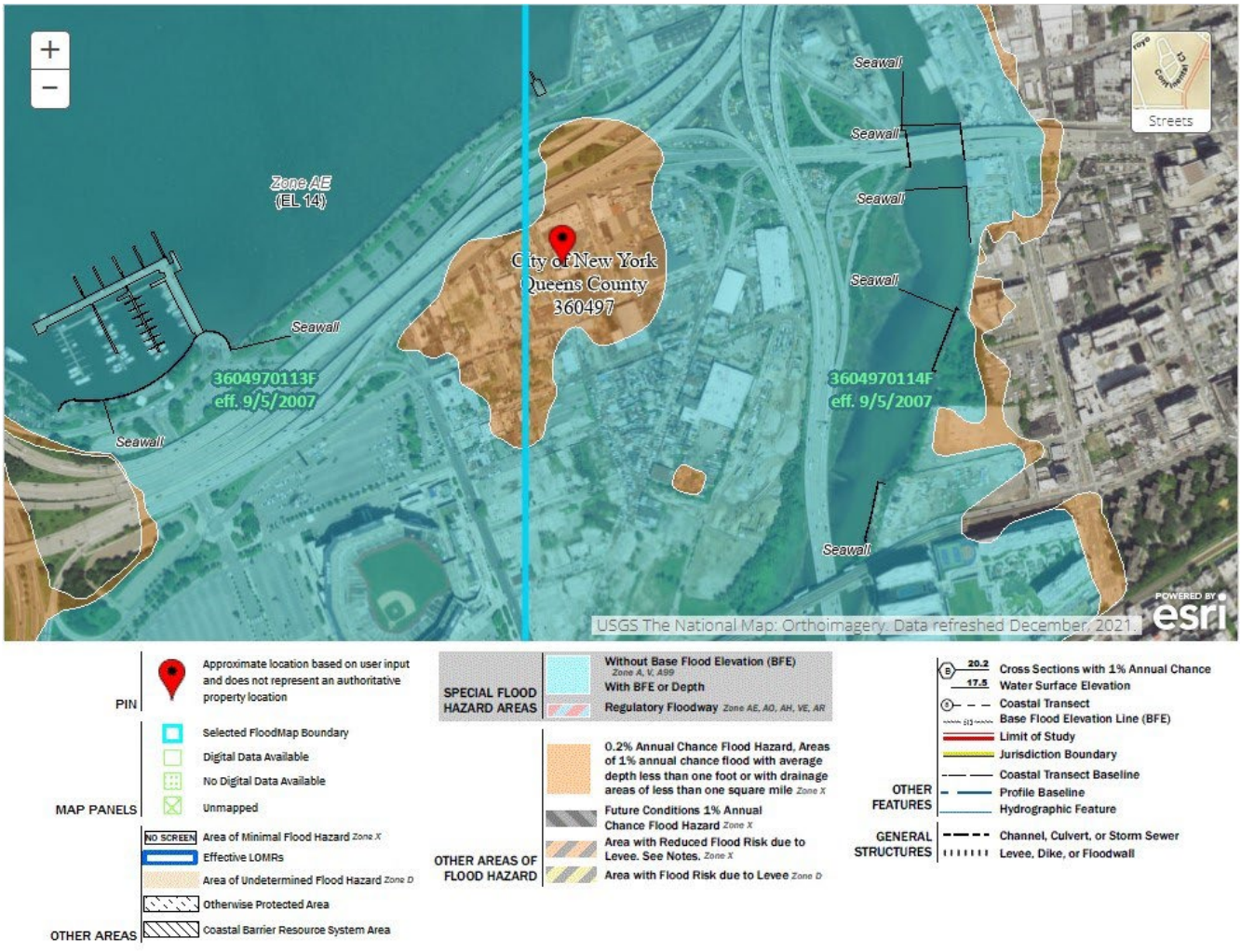
From a zoning perspective, Willet's Point is historically a combination of C-4 commercial zoning and manufacturing zoning. This will make meeting zoning requirements easier, even if the development plans to re-zone parts of the property. The map below shows the historic zoning map for the peninsula.

Figure B-3. Historic Zoning Map for Willets Point Peninsula



One potential challenge is that most of Willet's Point is within the floodplain. The degree to which this problem is detrimental depends on several factors. If Related plans to raise the elevation of the land at certain points in the development, it would be beneficial for a potential battery project. Likewise, if the site is only slightly below the floodplain, then the issue can be overcome. In any case, there are several options for resolving this issue. For example, siting the battery containers on raised scaffolding is a common solution, though it depends on how high the scaffolding would need to be. The map shows the floodplain analysis of the site.

Figure B-4. Floodplain Analysis of Willets Point



Endurant reviewed Consolidated Edison's existing distribution infrastructure to determine the grid's ability to accommodate new energy storage on the network. Willets Point is predominantly fed by the Corona Substation within the Flushing Networked grid. This part of the network as a minimal amount of hosting capacity (~12kVa), 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.

However, because the new development will certainly require distribution system upgrades at the far end of Con Edison's system, the new infrastructure would like benefit greatly from having a local peaking capacity resource at that node of the grid. Con Edison's new infrastructure could be structured to accommodate new distributed energy resources like energy storage, solar, etc. As such, given the new development context, it would be worth exploring with Con Edison what the panned distribution system upgrades are planned and how that would impact the grid's ability to accommodate the new storage system. The map shows Con Edison's existing distribution infrastructure at the site.

Figure B-5: Con Edison's Existing Distribution Infrastructure at Willets Point

With a hosting capacity limitation this low, a behind-the-meter use case that manages Willets Point's peak demand charges and time-of-use energy charges may be most applicable. Further, a behind-the-meter (BTM) BESS used for demand management may make the most sense if there are little-to-no utility service upgrades. However, if new service is installed, then a FTM system would likely be the better use case option.

From an economic perspective, energy storage is highly valuable in Queens for several reasons. First, the State's most lucrative energy storage markets are the new Value of Distributed Energy Resources (VDER) markets. These markets pay batteries (and solar + storage systems) for the locational marginal value of flexibility and demand relief that they provide to each specific node of the grid.

The Demand Relief Value (DRV) market, for instance, incentivizes assets that provide additional demand relief where it's needed the most, in the most densely populated networks (like New York City's). The Locational System Relief Value (LSRV) market, in another 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 are shown in Table B-1.

Table B-1. Value of Distributed Energy Resources Value Stack Rates

Willets Point VDER Value Stack Available Rates	
Market	Rate Price
Capacity (Alternative 3)	$4.22 ($/kW)
Environmental Component	$0.03103 ($/kWh)
Demand Reduction Value (DRV)	$0.85360 ($/kWh)
LSRV	Does not Qualify

Notably, electricity prices are relatively high in Queens compared to other areas of New York State (especially versus energy costs upstate), meaning that the economics are typically strong for DG systems in NYC. NYC's (Zone J) VDER market rates are lucrative enough to make energy storage projects viable in the city without additional incentives. However, new NYSERDA grant incentives would make the project more lucrative or make "almost-viable" projects economically viable.

Endurant also evaluated the value of energy storage assets if they were paired with solar PV. Pairing the BESS with solar PV array improves project economics under ideal conditions by making the batteries eligible for the federal Investment Tax Credit (ITC) and allowing the project to monetize the Environmental and Community Credit components of the Value Stack (VDER) markets. However, the economics at Willet's Point are still not lucrative enough to justify the investment in enough solar PV to meet the 70% charging threshold needed to secure the ITC benefits. Further, to install enough PV capacity to charge the battery would require a substantial amount of land, which is a key restriction in NYC.

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 without a new ITC or solar PV, the markets for energy storage are strong enough in Queens to make a battery project there worthwhile.

B.3 Battery Storage Conclusion

Willets Point is a strong candidate for a battery storage project. With lucrative VDER tariff incentives in Queens, new utility service that will likely be able to accommodate several megawatts of new storage, and the balanced load profile of the planned development, energy storage has great promise at the site. Zoning and floodplain analysis will need to be conducted and any resulting challenges will need to be resolved before confirming the viability of storage at the site.

Appendix C: Phase 1B Summary

This study mainly focuses on the buildings included in Phase 1A. Phase 1B is expected to follow 1A. Many of the design details and space uses for Phase 1B remain flexible. In order to estimate the geothermal opportunity for Phase 1B, we used BAU HVAC assumptions from Phase 1A (VRF and electric boilers for DHW) and assumed most of the space would be used for residential units.

Results comparing the BAU to the geothermal configurations for Phase 1B are summarized in the following tables.

Table C-1. Phase 1B: Installed Cost Comparison

	BAU Phase 1B	Geo Solution
HVAC Installed Cost	$59,433,000	$77,036,000
NYSCHI & PON 4337 Incentive	-	$7,774,400
Net Capital Cost Difference	**-**	**$9,828,600**

Table C-2 Phase 1B: Operational Cost Comparison

	BAU Phase 1B	Geo Solution
Electricity use (kWh)	16,603,607	8,884,364
Electricity cost	$3,813,000	$1,940,000
Annual maintenance costs	$270,000	$116,000
Total operating cost	$4,083,000	$2,056,000
Operational savings (Year 1)	**-**	**$2,027,000**

Table C-3 Phase 1B: Life Cycle Cost Analysis and Payback

	BAU Phase 1B	Geo Solution
HVAC Installed Cost (net incentives)	$59,433,000	$69,261,600
HVAC Replacement Cost	$11,555,000	$7,704,000
Year 1 Maintenance Cost	$270,000	$116,000
Year 1 Utility Cost	$3,813,000	$1,940,000
30-year Life-Cycle Cost	**$181,541,000**	**$128,104,000**
Simple Payback	**-**	**4.8 years**

Appendix D: District System Regulatory Roadmap

D.1 Project Background

As a new development located on Flushing Bay, Willets Point offers several thermal source options. These include tapered piles in buildings and parking structure foundations. Storm water and sewage upgrades will be occurring concurrently, creating potential to connect piping between Flushing Bay and Willets Point phase 1A, allowing for a river heat exchange system, and/or an independent sewage thermal extraction system. Residential, school, and other buildings offer the potential for thermal load sharing at different times.

While this assessment focuses on Phase 1A, the development of the project in modular phases contemplates the potential for a district geothermal system that expands in similar modular fashion, sharing thermal load across the development.

The residential buildings in the project would include both low-income and senior housing, which are more stringently regulated housing categories.

This development contemplates enabling lower carbon heating and cooling to reduce costs and comply with New York Local Law 97 requiring carbon emissions reductions, and New York's moratorium on new gas connections. In addition to thermal energy, the developer will consider solar PV, battery energy storage, and electric vehicle charging.

Table D-1. Potential Energy Solutions at Willets Point

Geothermal boreholes	Geothermal piles	ASHP	River abstraction in Flushing Bay	Sewage heat exchange
Using the 183,300 SF of space surrounding the buildings.	Using the 155,300 SF building foot prints we will use the deep tapered piles to produce heating and cooling.	With 833,241 SF in Phase 1A, there is ample space to include ASHP as part of the community system.	Through the planned stormwater upgrades or connecting to Flushing Bay (500 ft. away).	Heat exchange could be produced by tapping into the planned sewage upgrades or connecting to near-by sewage lines.

The development is located on a property that presently does not have extant streets, however the City, the MTA subway at the edge of the development, and utilities do possess certain rights impacting the property and mapped streets will be re-established as part of the development process. As a result, implementing a district system poses certain regulatory hurdles associated with crossing public rights of way, and obtaining the approval of various City authorities to install a geothermal system that will be in proximity to or potentially integrate with city infrastructure presents unique regulatory challenges.

Prior to the 1900s, the Willets Point site was a saltwater meadow. In recent history, it has been used as a dump for coal ash and for industrial purposes. The site is also located in a flood plain. As a result, the site is a brownfield remediation site with a water table relatively close to the surface, creating potential for additional regulatory requirements.

Further, the Empire State Development Agency supports the project, resulting in certain New York State regulatory requirements, and, if Flushing Bay is to be utilized as a thermal source, federal and State regulations concerning navigable waterways will be triggered.

Endurant and Related 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 is proposing a develop-build-own-operate-maintain (DBOOM) approach to this project, which could simplify maintenance and administration of the system, and presents its own legal and tax considerations. Under this configuration Endurant would be responsible for funding, installing, operating, and maintaining all on-site energy assets including thermal production, distribution, electrical generation, and storage. This allows Endurant to simplify the energy approach for the project and deliver efficient clean energy to the tenants. Alternatively, the project could operate the system, with engineering, procurement and construction performed by Endurant.

One variation of importance is exploiting sewage pipes as a thermal source using a return loop for sewage that could slightly lower the temperature of sewage entering the New York City sewer system. Flow rates and upper/lower temperature ranges of sewage entering pipes, and potential lower temperatures of sewage, may pose regulatory concerns for City authorities.

Working with sewer, transit, and other underground infrastructure, including any water tunnels that may exist in the proximity of the project, can cause delay and cost due to additional approvals required.

D.2 Alternative to District System

An alternative configuration of several smaller individual systems could reduce the degree to which the system must be planned across phases. However, separate development, operation, and maintenance will necessarily involve duplication of effort and likely lower technology and institutional efficiencies, and thus higher costs.

Because the development involves common development with common ownership at the time of development, and because a common development-wide governance agreement can be adopted if ownership is later varied, common management can be achieved cost effectively. Under these circumstances, the next-best alternative to a district system is likely sub-optimal.

D.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.

D.3.1 Federal

D.3.1.1 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 CWA allows states to assume primary enforcement and administration of permit programs if authorized by the EPA. Additionally, the CWA defines the powers that states possess in regulating water, which include the authority to issue pollution discharge permits in conformance with or stricter than federal minimum technology-based and water quality-based control requirements, 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.[4] Importantly, the CWA also 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.[5]

In New York, the New York Department of Environmental Conservation (NYSDEC) is responsible for administering the State Pollution Discharge Elimination (SPDES) program, certifying federal projects under CWA Section 401, and promulgating State water quality standards. However, NYSDEC has not been delegated authority to implement CWA Section 404 for dredge and fill permits, which is the responsibility of the US Army Corps of Engineers. Potential permitting requirements pursuant New York's SPDES program are discussed in the State requirements section.

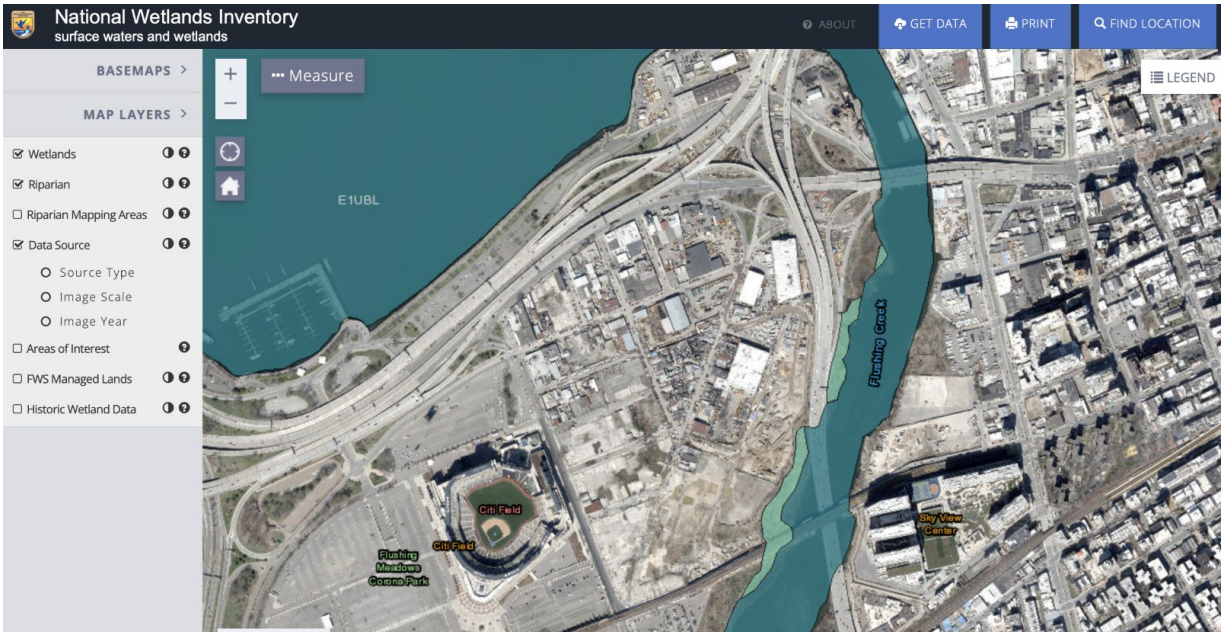
Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including adjacent wetlands. Pursuant to Section 404, discharge of dredged or fill material into waters of the US is prohibited unless the action is exempted or is authorized by a permit issued by the U.S. Army Corps of Engineers (the Corps).

"Waters of the United States" includes the following: 1. navigable waters of the United States, 2. wetlands, 3. tributaries to navigable waters of the United States, including adjacent wetlands, lakes and ponds, 4. interstate waters and their tributaries, including adjacent wetlands, and 5. all other waters of the United States where the use, degradation or destruction of these waters could affect interstate foreign commerce.[6] 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.[7] However, when adjacent wetlands are present, the limit of jurisdiction extends to the limit of the wetland.[8]

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.[9] 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.[10]

The Willet's Point site is adjacent to the western shore of Flushing Bay and the Flushing River. Flushing Bay is a tidal embayment on the south shore of the upper East River and is a navigable water subject to Army Corps jurisdiction. According to the National Wetlands Inventory Map, Flushing Bay is an "Estuarine and Marine Deepwater" habitat classified as a E1UBL by the National Wetlands Inventory Map, consisting of deep-water tidal habitats and adjacent tidal wetlands.

Figure D-1. National Wetland Inventory Map at Willets Point



There are likely no adjacent wetlands present on the Phase 1A parcel at Willet's Point. Majority of the area surrounding the Flushing Bay is urbanized and contains no wetlands, and there are no adjacent wetlands mapped on the National Wetlands Inventory Map.[11] However, there may be un-mapped vegetated intertidal marsh and mudflat wetlands along the shoreline in the Flushing Bay, which may be impacted if a system design utilizing the Flushing Bay is pursued.[12] Additionally, the site was formerly a salt marsh area that was predominantly filled and is mostly developed.[13] As such, the Corps may still require further on-site investigation to ascertain the landward limit of Army Corps jurisdiction.

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.[14] 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.[15] Discharge of fill material includes fill that is necessary to the construction of any structure or impoundment requirement rock, sand, dirt, or other material for its construction.[16]

According to Corps regulations, the term "discharge of dredged material" means any addition of material that is excavated or dredged from waters of the United State, including any redeposit of dredge material other than incidental fallback.[17]

Given the wide range of activities regulated under Section 404, it is likely that any system design utilizing the Flushing Bay or adjacent wetlands would require a Section 404 permit. While excavation or dredging alone may not trigger Section 404 requirements, any redeposit of dredged material (other than incidental fallback) or backfilling during construction within the Army Corps jurisdiction would be considered a discharge requiring a permit. Additionally, because "discharge of fill material" is defined broadly to include "the building of any structure, infrastructure or impoundment requiring rock, sand, dirt, or other material for its construction,"[18] the installation of a loop system using the Flushing Bay as a heat exchange may constitute a "discharge of fill material" pursuant 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.[19] States can also impose significant conditions on the permit or project through the 401-certification process that can reduce the impacts of the activity.[20] 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.

The Corp's review process for Section 404 permits may ultimately impact the feasibility of connecting to the Flushing Bay and overall system design. 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 Flushing Bay that there are no practicable alternatives to the proposed project, and that steps have been taken to minimize unavoidable impacts. or 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."[21]

In light of available alternative designs that do not utilize the Flushing Bay the Corps may ultimately be precluded from issuing a 404 permit under the EPA regulations. However, where a proposed project would only have minor impacts, a detailed alternative analysis may not be required.[22] Pre-application consultation with the Corps would assist in determining the scope of the alternative analysis required for the geothermal system.

D.3.1.2 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.[23] 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 8laterally 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.[24] However, if work conducted in a wetland would ultimately impact a navigable water, a Section 10 permit will be required.[25]

Obtaining a Section 10 permit requires compliance with Section 404(b)(1) Guidelines Corps regulations, NEPA, ESA, National Historic Preservation Act, and Coastal Zone Management Act.[26]

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.[27]

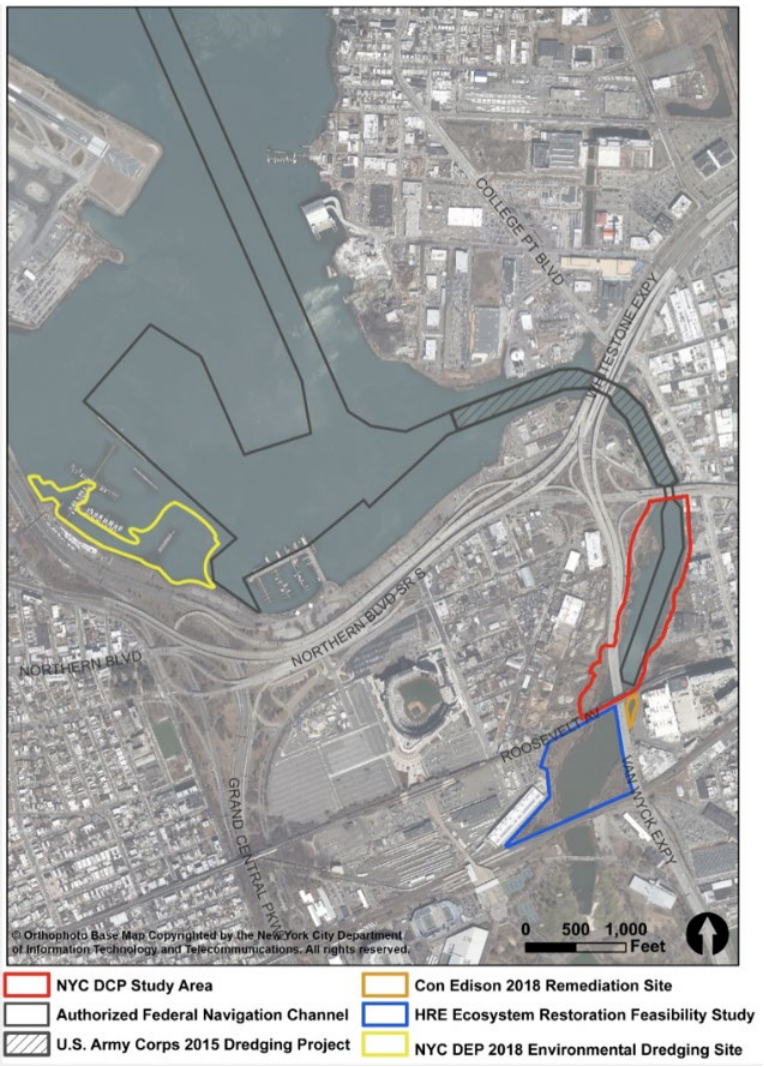
A Section 10 permit would likely be required for any type of geothermal system involving the Flushing Bay, as it is a navigable water subject to the jurisdiction of the Army Corps of Engineers. Because a river-loop system is a “structure” under the Rivers and Harbors Act, authorization is required prior to construction.

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,”[28] 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.”[29]

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.

A system using the Flushing Bay as a heat exchange will likely require Section 408 authorization from the Corps. As shown in the following figure, a federally maintained 14-foot-deep, 150-foot-wide navigational channel extends the length of Flushing Bay.[30]

Figure D-2. Flushing Bay Federal Navigation Channel



The Flushing Bay Federal Channel supports fourteen marine terminals. 1,084,000 tons of cargo is transported through the Channel annually.[31] The last maintenance dredging cycle was completed in December 2015, and additional funding was allocated to the Corps for continued maintenance during 2021.[32]

The Corps should be consulted to ascertain whether there are any other civil works projects located along Flushing Bay such as habitat restoration or shore stabilization projects that may be impacted by a geothermal system.

D.3.1.3 National Environmental Policy Act

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.[33] Pursuant NEPA, federal agencies must identify and evaluate impacts of "major Federal actions significantly affecting the quality of the human environment."[34]

The Council on Environmental Quality regulations list 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."[35] Consequently, Corps permitting authorization of the project are subject to the provisions of NEPA.

Under NEPA, any federal action that significantly affects the quality of the human environment requires the preparation of an Environmental Impact Statement (EIS).[36] The EIS must include all significant environmental effects associated not only with the proposed action, but also with every reasonable alternative to that action.[37] 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.[38] In other words, NEPA does not require that agencies take one type of action or another based on the adverse environmental impacts.[39] However, in accordance with the Administrative Procedure Act, the sufficiency of an EIS may be subject to a citizen's challenge under NEPA.[40]

If NEPA applies, whether because the geothermal component requires federal action or due to non-geothermal aspects of the project, 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.

D.3.1.4 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 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.[41] This entails consultation with the New York State Historic Preservation Office and, in certain circumstances, with the Advisory Council on Historic Preservation.[42]

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.[43]

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.

Adjacent to the property is the former Empire Millwork Corporation Building which is eligible for listing on both the State and national registry.[44] The building is located at 128-50 Willets Point Boulevard, near the intersection of Willets Point Boulevard and the entrance ramp to Northern Boulevard.[45] 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. However, it is unlikely that the geothermal system would have any potential adverse impacts on the historical site. Additionally, the New York State Office of Parks, Recreation and Historic Preservation, as well as the New York City Landmarks Preservation Commission have previously determined that the site is not sensitive for archaeological resources and does not contain any other architectural resources.[46]

D.3.1.5 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, several federally listed species are potentially present at the Willet's Point site including the Piping Plover, Red Knot, and Roseate Tern (all of which are migratory birds), as well as the Seabeach Amaranth, a threatened plant species.[47]

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.[48] 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.

Additionally, 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.[49] 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.[50] 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.[51]

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."[52] 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[53] 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.[54]

D.3.1.6 Safe Water Drinking Act

Willet's Point is located within the Brooklyn-Queens aquifer, which was designated by the EPA as a Sole Source Aquifer in 1984.[55]

Pursuant Section 1424(e) of the Safe Drinking Water Act (SDWA), EPA is authorized to designate an area as a "sole source aquifer", if it is the sole or principal drinking water resource for an area (i.e., it supplies 50 percent or more of the drinking water in a particular area), and if contamination would create a significant hazard to public health. Once designated, no federal financial assistance "through grant, contract, loan guarantee, or otherwise, may be entered into for any project which the Administrator determines may contaminate the aquifer."[56] If EPA determines the project has potential to contaminate the aquifer, EPA will impose conditions for mitigation.

The SWDA also authorizes EPA to develop minimum federal requirements for injection practices to prevent contamination of sources of drinking water through the Underground Injection Control (UIC) Program.[57] Through the UIC program, EPA regulates the construction, operation, permitting and closure of injection wells used to place fluids underground for storage or disposal.[58] In the context of geothermal, open-loop systems that discharge used wastewater to the subsurface via injection wells (i.e. return flow wells) are classified as Class V wells regulated under the UIC program.[59] Closed-loop systems are not subject to oversight and regulation by the UIC program. Notably, while Class V injection wells are generally authorized by rule under the UIC program, EPA may impose additional requirements and/or deny permits for new injection wells in sole source aquifer areas.[60]

D.3.2 State

D.3.2.1 State Clean Water Requirements

The federal Clean Water Act establishes a permitting scheme that regulates the discharge of pollutants into the waters of the United States, known as the National Pollution Discharge Elimination System (NPDES) permit program.[61] NPDES requires all facilities that discharge pollutants, including heat, into surface water from a point source obtain a permit before discharging.[62] NPDES permits incorporate both water quality standards and technology-based effluent limitations to protect water quality.

The Clean Water Act authorizes EPA to delegate enforcement authority to the states and allows states to administer their own State Pollution Discharge Elimination (SPDES) Programs upon approval from the EPA. New York's SPDES program has been approved by the EPA for the control of surface wastewater and stormwater discharges in accordance with the Clean Water Act. Notably, New York State law is also broader in scope and stricter than the federal NPDES program and requires a SPDES Permit for point source discharges of pollutants into all waters of the State including both surface waters and ground waters.

The Clean Water Act also directs states to adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters.[63] State water quality standards define the maximum allowable levels of chemical pollutants and are used as the regulatory targets for permitting, compliance, enforcement, and monitoring and assessing the quality of the state's waters. Pursuant to the CWA, "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."[64]

Additionally, EPA regulations require States to include in their water quality standards an antidegradation policy.[65]

Accordingly, effluent standards set in NPDES/SPDES permits must ensure that state water quality standards will be achieved for the receiving waters.[66] These effluent limitations are based either on technology-based standards prescribed by the EPA,[67] or on water-quality-based standards in instances when applicable technology standards would still cause an exceedance of state water quality standards for the receiving waterbody.[68] SPDES permits may also impose additional conditions such as temperature monitoring and reporting, as well as limitations on how much heat may be discharged from the system depending on the receiving waterbody's classification.

D.3.2.2 State Discharge and General Water Quality Standards Application to Geothermal

The NPDES/SPDES discharge requirements and the New York State water quality standards both potentially regulate geothermal systems. These regimes, which both flow from the Clean Water Act, can be applied separately, and potentially together, depending on the circumstances of the geothermal design and regulatory decisions by NYSDEC.

Under the SPDES program, a discharge includes thermal discharges.[69] Separately, under New York State's general water quality standards, thermal discharges are defined as "a discharge that results or would result in a temperature change of the receiving water."[70] 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."[71]

While open loop systems clearly are regulated under both regimes through issuance of a SPDES permit that authorizes the effluent discharge in accordance with general water quality requirements, for closed loop systems NYSDEC would apply general water quality standards, but it is unclear whether they would require a SPDES permit as part of its regulatory approach.

More specifically, geothermal systems that discharge heat, cooling, or water treatment chemicals into surface waters of the State must obtain 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.[72]

Under all approaches that NYSDEC might adopt, NYSDEC can require meeting technological standards for the geothermal activity in order to mitigate thermal impacts on the receiving water body, which could include criteria for mixing zones.

D.3.2.3 SPDES for Geothermal Systems

The specific requirements 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.[73] Generally, geothermal systems that discharge heat, cooling, or water treatment chemicals into waters of the State must obtain a SPDES permit. 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. Additionally, depending on the circumstances, NYSDEC may require a SPDES permit for closed-loop systems if the system "discharges" heat, or otherwise changes the temperature, of a receiving waterbody.

D.3.2.4 SPDES Permits for Construction and Stormwater Pollution

A SPDES permit might also be required for construction-related activities. 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, 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.[74] To qualify for the permit, permit applicants are required to develop a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the requirements in the General Permit to prevent discharges of construction-related pollutants to surface waters.[75]

D.3.2.5 State Water Quality Standards of General Application

Beyond the requirements under the SPDES program, New York State water quality standards always apply to geothermal and other activities even if operations are not subject to the SPDES permitting requirements, such that geothermal or other activities must not cause or contribute to any violation of water quality standards.[76] Review by NYSDEC is required to determine whether the system would violate State water quality standards or whether a SPDES permit is required.

New York's water quality standards establish classifications and designated uses for all waters in New York State including groundwater.[77] 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.[78] NYSDEC regulations also contain general conditions applying to all water classifications including criteria governing thermal discharges.[79] Pursuant NYSDEC regulations, thermal discharges are defined as "a discharge that results or would result in a temperature change of the receiving water."[80] NYSDEC's thermal discharge criteria include general and waterbody-specific standards for thermal discharges, mixing zone criteria, and additional limitations on thermal discharges that may ultimately impact system design.

Under the New York State Stream Classification System, Flushing Bay is designated as a "Class I" waterbody. Class I waters "shall be suitable for fish, shellfish, and wildlife propagate and survival" and best usages of Class I waters are secondary contact and fishing.[81] Accordingly, any geothermal system designs utilizing the Flushing Bay 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]

Additionally, according to Langan's Geotechnical Engineering Study, groundwater was observed on-site at depths of 4-8 feet. Accordingly, review by NYSDEC is required to ensure that the system will not violate applicable State water quality standards for groundwater and NYSDEC's thermal discharge criteria.

At the time of review, NYSDEC may also 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 adverse impacts caused by the thermal discharge.

Specifically, for open loop systems or closed involving a water bypass, 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. These requirements could apply, for example, to geothermal systems that utilizes a bypass or diversion of State waters in high volumes.

D.3.2.6 NYSDEC 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. States can also impose significant conditions on the permit or project through the 401-certification process that can reduce the impacts of the activity. Generally, a developer will apply to federal agency and NYSDEC, which administers New York State's environmental laws and administers 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.

D.3.2.7 Protection of Waters Permit

In New York, 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 Flushing Bay 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 Flushing Bay, NYSDEC may require the applicant to demonstrate that there are no alternative designs or locations which might avoid or minimize impacts to protect the watercourse.[83]

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 square feet or less.[84] For minor projects, NYSDEC must make a permit decision within 45 days of determining the application is complete.[85] Major projects are subject to public notice followed by a comment period and may require a public hearing. The major projects process may require up to seven months based on statutory procedural requirements.[86]

D.3.2.8 Tidal Wetlands Permit

NYSDEC regulates all tidal wetlands and adjacent areas pursuant the Tidal Wetlands Act of 1973 (TWA). The TWA requires the NYSDEC to establish a map of all tidal wetlands in the State, and to promulgate regulations for the use and development of tidal wetlands and their adjacent areas.[87] It also prohibits most activities which would change, alter or otherwise affect the character of a tidal wetland unless the activity is authorized under a permit or otherwise authorized by DEC.[88]

Tidal wetlands are defined as "those areas which border on or lie beneath tidal waters, such as, but not limited to, banks, bogs, salt marsh, swamps, meadows, flats or other low lands subject to tidal action, including those areas now or formerly connected to tidal waters…"[89] All tidal wetlands within the State have been mapped and classified by DEC, and the maps are on file at the office of each county clerk and at DEC's regional offices. Each tidal wetland is classified as either a coastal fresh marsh; an intertidal marsh; a coastal shoal, bar or flat; a littoral zone; or a high marsh or salt meadow.[90] In addition to mapped tidal wetlands, NYSDEC also regulates activities occurring within "adjacent areas". Adjacent areas run landward to the nearest of one of several upland points enumerated pursuant Section 661.4(b)(1) and may extend up to 300 feet inland from a wetland (or 150 feet inland in New York City).

According to the New York State Tidal Wetlands Map, Flushing Bay is a tidal wetland mapped as a littoral zone. The online mapping tool is a digital rendition of the official 1974 wetlands inventory maps of the New York; however, the map is unable to indicate the exact boundaries of wetlands present at the site. The tidal wetland boundary line will need to be determined through a field inspection and may differ from the boundary line depicted on the map. NYSDEC recommends applicants contact their regional DEC office to request a jurisdiction determination to establish the limits of the wetlands and adjacent areas, on site.

Under Title 4 of the Tidal Wetlands Act, once an area is designated a wetland and mapped, almost any activity in that area requires a permit. Regulated activities include "any form of draining, dredging, excavation and removal… of soil, mud, sand, shells, gravel or other aggregate from any tidal wetland; any form of dumping, filling or deposition… of any soil, stones, sands, gravel, mud or fill of any kind; the erection of any structures or roads, the driving of any pilings or placing of any obstructions whether or not changing the ebb and flow of the tide."[91]

NYSDEC imposes different restrictions on activities depending on the category of wetlands present on site. DEC regulations list specific types of uses, designates compatibility with each class of wetland, and specifies the type of permit or authorization required before an activity may be undertaken in each class.[92] Depending on the designation of a specific use, the applicant may also be required to provide additional application materials such as a more detailed analysis demonstrating the potential impacts of a project, and a showing that the project will not have undue adverse impacts on present or potential wetland values.

Pursuant 6 N.Y.C.R.R.R 661.5, dredging, filling, disposal or dredged material, and certain installations of electric, gas, sewer, water or other utilities are all "presumptively incompatible uses" requiring a permit. Additionally, any type of regulated activity not listed in 661.5, requires a permit. As such, any components of the geothermal system installed within the tidal wetlands and/or adjacent areas present at Willets Point will likely require a permit.

Importantly, proposed activities must meet permit issuance standards and comply with the use guidelines set forth in 6 NYCRRR 661.5. DEC regulations also impose additional restrictions on the use and development of tidal wetlands and adjacent areas include minimum lot sizes and setbacks, maximum lot coverage (both of buildings and of impervious surfaces), septic systems and drainage. 6 N.Y.C.R.R. § 661.6(a). However, NYSDEC may grant variants to these restrictions in certain instances.[93]

The Tidal Wetlands Permit issuance standards require applications to avoid or minimize impacts to wetlands. Additionally, applications are subject to review under SEQR, and the State Historic Preservation Act.[94]

D.3.2.9 Lands Now or Formerly Underwater

In New York, most navigable waters, and the beds of navigable waters, owned by the State are held in trust by the New York State Office of General Services (OGS). Pursuant to the NY Public Lands Law, "no wharf, dock, pier, jetty, platform, breakwater, mooring or other structure shall be constructed, erected, anchored, suspended, placed … on or above state-owned lands underwater unless a lease, easement, permit or other license" is obtained from OGS. Because Flushing Bay is owned by the State, authorization from OGS will be required for installation of a loop system.[95]

All application materials required for permits for activities affecting waterways (i.e. water protection permit, tidal wetlands permit, Section 404 permit) should be forwarded to OGS which will then review the application to determine if a license, easement or permit is required.[96] The applicant will then need to apply for the appropriate approval. OGS encourages applicants to request a pre-application conference with the OGS Bureau of Land Management to determine applicable requirements.[97]

Prior to approving a grant, easement, permit or license to interest in lands underwater, OGS must ascertain the probable effects of the proposed structure on the public interest in state-owned lands underwater in consultation with the DEC, DOS, and OPR&HP.[98] In making this determination, OGS must consider several factors including the environmental impacts, and "consistency with the public interest for purposes of fishing, bathing, access to navigable waters and the need of the owners of private property to safeguard their property." Generally, the State discourages non-water dependent uses of public lands (uses that could take place on the adjoining upland lands).[99] Depending on the geothermal system's impacts on Flushing Bay, OGS could deny authorization in light of land-based alternatives.

D.3.2.10 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 New York projects that require some form of discretionary State or local government approval.[100]

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.[101] 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.[102] 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.[103]

An action is subject to review under SEQRA if any State or local agency has authority to issue a discretionary permit, license, or other type of approval for that action, as well as if an agency funds or directly undertakes a project. Consequently, any State or local approvals such as issuing a permit, will trigger the provisions of SEQRA. Additionally, any funding by NYSERDA for subsequent phases of the project would likely constitute an agency action subject to SEQRA.

Once there is an "agency action" the agency must determine whether the action is subject to SEQRA. Type II actions, which are action for which it has been determined not to have a significant effect on the environment, are not subject to the SEQRA review process.[104] 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."[105] 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.[106]

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.[107] 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…"[108]

D.3.2.11 Listed Species Regulation

As previously explained, several listed species are potentially present on site. At the New York State level, the Piping Plover and Roseate Tern are listed as endangered, and the Red Knot and Seabeach Amaranth are listed as threatened.

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.[109] 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.[110]

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.[111] Additionally, 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.[112]

D.3.2.12 Coastal Zone Management Act

Under New York's Coastal Management Program, actions by federal or State agencies affecting New York's coast, 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 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.[113] 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.[114]

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".[115] 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.[116]

New York City's Local Waterfront Revitalization Program (NYC WRP) is a long-term land and water use management program for the City's waterfront resources along the New York Harbor; the Hudson, Bronx, Harlem, and East Rivers; the Arthur Kill and Kill Van Kull and all their many tributaries; and, the Atlantic Ocean.[117]

The policies set forth in the NYC WRP provide general goals for the city's waterfront as a whole and more specific goals for portions of the waterfront that have notable characteristics.[118] The NYC WRP consolidates 56 city and State policies into ten categories:

- Residential and commercial redevelopment.
- Water-dependent and industrial uses.
- Commercial and recreational boating.
- Coastal ecological systems.
- Water quality.
- Flooding and erosion.
- Solid waste and hazardous materials.
- Public access.
- Scenic resources.
- Historical and cultural resources.[119]

Additionally, The WRP sets forth five types of special area designations: the Special Natural Waterfront Areas, the Significant Maritime and Industrial Areas (SMIAs), the Arthur Kill Ecologically Sensitive Maritime and Industrial Area (ESMIA), the Priority Marine Activity Zones (PMAZs), and the Recognized Ecological Complexes (RECs).[120] Within each of these areas, certain policies set forth in the WRP may be prioritized over other policies.[121]

Federal, State, and local actions, which include funding, permitting, and other approvals, affecting the Coastal Zone are reviewed to assess the consistency of a proposed activity or project with the policies set forth in the NYC WRP. Willet's Point is in the boundaries of NYC's WRP, and as such, federal, State, and local actions pertaining to the geothermal system are subject to consistency review.

At the city level, all local discretionary actions within the Coastal Zone and subject to CEQR are reviewed for consistency with the policies of the WRP by the Department of City planning.[122]

State agency actions that are likely to affect the achievement of the policies and purposed of the WRP must be undertaken in a manner consistent to the maximum extent practicable with its policies.[123] At the state level, consistency review of state agency actions is undertaken congruently with the State Environmental Quality Review Act process. State agencies are also required to provide timely notice to the affected local government whenever an identified action will occur within an area covered by an approved LWRP. The local government will then evaluate whether proposed action to determine whether the proposed action is consistent with the LWRP.

At the federal level, consistency review is undertaken by NYDOS. 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 render a decision.

D.3.2.13 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.[124] Completion reports are waived for closed loop geothermal systems with boreholes drilled up to 500 feet deep.[125]

The NYSDEC Division of Mineral Resources regulates the drilling, construction, operation, and plugging of geothermal wells deeper than 500 feet.[126] Wells deeper than 500 feet impose additional requirements, which are set out in the Table D-2. 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 State, or any additional NYSDEC permits are required."[127] 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.[128]

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.[129] 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.[130] 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.[131]

The Division of Mineral Resources will also consult with the New York's State Historic Preservation Office (SHPO) within the New York State Office of Parks, Recreation and Historic Preservation to determine whether the proposed location of a well is within a State-listed historic area, which would require additional permissions.[132] If applicable, SHPO will review the project and ensure the well will

not negatively impact cultural resources.[133] 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.[134] Drilling permit requirements and restrictions under both regimes are summarized in the Table D-2.

Table D-2. 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 (November 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) and deposit of required financial security starting at $2,500 per well over 500 feet
	Certified site plan
	Casing and cementing plan
	Drilling progress reports
	Periodic drilling drift correction[135]
	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

D.3.2.14 New York State Historic Preservation Act

New York's State Historic Preservation Office (SHPO) within the New York State Office of Parks, Recreation and Historic Preservation 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. Project sponsors are required, to the fullest extent practicable consistent with other provisions of the law, avoid or mitigate adverse impacts to such properties, to fully explore all feasible and prudent alternatives, and give due consideration to feasible and prudent plans that will avoid or mitigate adverse impacts.[136] Accordingly, geothermal elements be designed and constructed, including drilling, to avoid impacting historic features.

As previously noted, the former Empire Millwork Corporation Building which is eligible for listing on both the state and national registry is adjacent to Willets Point. The building is located at 128-50 Willets Point Boulevard, near the intersection of Willets Point Boulevard and the entrance ramp to Northern Boulevard. Consequently, consultation with SHPO may be required as part of the SEQRA review process.

D.3.2.15 Uniform Heat Standards for Multi-Unit Residential Buildings

New York State establishes statewide standards for the provision of heat in multi-unit buildings. Heating facilities must be capable of maintaining a temperature of 68°F.

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 am to 10 pm, 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 am to 10 pm, each apartment must be heated to a temperature of at least 55°F.[137]

D.3.2.16 Utilities regulation

New York'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.[138] 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 anti-trust 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.[139]

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.

D.3.2.17 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,[140] pursuant to the New York Public Service Law.[141] Importantly, for purposes of submetering, electric heat services include heat services provided by electric heat pumps.[142]

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,[143] sanctions and termination of authority to submeter. [144]

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.[145] 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.[146] 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 that 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.[147]

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.

D.3.2.18 Non-electric Heat and Cooling

While HEFPA regulates electric heat submeters, non-electric 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 towards submetering residential units for these services. As described in the following section, these include municipal landlord-tenant laws.

Non-electric 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 non-electric heat facing barriers under local law.

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

D.3.2.19 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 building contracting geothermal heat services and on-selling 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 NYC Department of Housing Preservation and Development and NYCHA. Other non-government 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….[148]

As noted in the prior section, in the absence of a regulatory regime like HEFPA for non-electric 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.

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.

D.3.2.20 Affordable Housing

If a multi-unit residential building is deemed affordable housing, New York State and local municipal regulations set maximum amounts that can be charged to residential tenants. 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. NYC Department of Housing Preservation and Development and NYCHA, which finance housing and administer their own affordability programs, 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 towards 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.

D.3.3 Local

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

D.3.3.1 Building Code and Permitting

The building permitting process reviews mechanical and construction approvals. Although no specific requirements for geothermal systems are provided by regulation, the geothermal elements will be reviewed for mechanical, structural, and other standard requirements.

D.3.3.2 CEQR

As authorized by New York's SEQRA, New York City formulated a separate "City Environmental Quality Review" (CEQR) process by which city agencies may disclose and review the potential environmental effects of discretionary actions which impact the urban environment in particular.[149] CEQR adapts the SEQRA review process to the urban setting and is required when a proposed discretionary action will be approved, funded, or undertaken by a city agency and will take place in New York City.[150] Similarly to SEQRA, CEQR requires agencies to study the environmental consequences of their actions and to take all feasible measures to avoid, minimize, and mitigate damage to the environment.[151] Some of the primary practical differences between CEQR and SEQRA are that CEQR provides guidance on selection of a lead agency, adds public scoping requirements, uses City-created forms for assessments, and promotes the use of the City's detailed CEQR Technical Manual in conducting environmental reviews.[152]

D.3.3.3 Drilling and Excavation Permit

If a multi-unit residential building is deemed affordable housing, New York State and local No person may drill or excavate in a corridor within the City of New York, to a depth greater than fifty (50) feet below ground surface in the borough of the Bronx or on or north of 135th Street in the borough of Manhattan; or greater than 100 feet in the borough of Brooklyn, Queens or Staten Island or south of 135th Street in the borough of Manhattan or to any depth within 200 feet horizontal distance of a water tunnel, without obtaining a permit from the Department.[153]

Drilling beyond these depths require submission of a pre-application for proposed drilling and/or excavation to NYC Department of Environmental Protection Bureau of Water and Sewer Operations.[154] Within 10 days from receipt of a pre-application assessment submission, the Department will notify the applicant as to whether the proposed drilling and/or excavation requires a permit or is located in a No Drilling/ Excavation Zone.[155] If the proposed drilling and/or excavation is located in a corridor, defined as a block that has any part of its boundary falling within five hundred feet horizontal distance from any centerline of any water tunnel or shaft as measure at or near the surface, a permit from the NYC Department of Environmental Protection Bureau of Water and Sewer Operations permitting office is required.[156]

For drilling/excavation located in a corridor, NYC Department of Environmental Protection will issue a permit within thirty days from receipt of an application and processing fee if it determines that the drilling and/or excavation will not impair the stability of a water tunnel or shaft and complies with all other applicable standards and requirements.[157] NYC Department of Environmental Protection will not issue a permit for drilling/ excavation in a No Drilling and/or Excavation zone. Permits are not required if the drilling/excavation will not take place in a corridor.[158]

NYC Department of Environmental Protection will not issue a permit for drilling/ excavation in a No Drilling and/or Excavation zone. A No Drilling and/or Excavation zone means "a boundary area defined as two hundred feet (200') on either side of the centerline of a water tunnel and vertical distances of one hundred fifty feet (150') above the crown of a water tunnel and one hundred and fifty feet (150') below the invert of a water tunnel; or, except as otherwise indicated, two hundred feet on either side of the centerline of a water tunnel shaft.[159]

D.3.3.4 New York City Department of Environmental Protection—Proximity to Water Tunnels

Prior to drilling geothermal boreholes, NYC Department of Environmental Protection requires a letter addressed to the Bureau of Water and Sewer Operations stating their depth and use, and a map showing their locations. NYC Department of Environmental Protection will issue a letter stating if boreholes are located within 500 feet of a city water tunnel or associated structure and if drift monitoring and reporting are required.

The locations of subsurface water infrastructure should be checked for all boroughs with the Bureau of Water and Sewer Operations.[160] Additionally, currently, a 72-inch water main runs along Roosevelt Boulevard, but construction of a new water main was proposed to support redevelopment of the Willet's Point district.[161] These plans should be consulted in designing the geothermal system.

This process should require approximately four weeks to complete in most cases, however site complexities may require longer periods.

D.3.3.5 Local Waterfront Revitalization Plan

As previously noted, Willet's Point is in the boundaries of NYC's Waterfront Revitalization Plan, and as such, federal, state, and local actions pertaining to the geothermal system are subject to consistency review.

Proposed actions that are subject to City Environmental Quality Review (CEQR), Uniform Land Use Review Procedures (ULURP), or other local, state, or federal discretionary review procedures, and that are within New York City's Coastal Zone, must be reviewed and assessed for their consistency with the New York City Waterfront Revitalization Program.[162] The New York City Consistency Assessment Form (CAF) should be completed for any local, state or federal permit application The Form and accompanying information are used by the New York State Department of State, and the New York City Department of City Planning in their review of the application's certification of consistency.[163] NYC City Planning Commission's actions subject to CEQR are reviewed by the City Planning Commission acting as the City Coastal Commission. Consistency determinations for all other City agency actions are undertaken by the Lead City Agency, but the City Coastal Commission must concur with the determination.[164] At the state level, consistency review is undertaken concurrently with the SEQRA review process, but the state agency must notify NYC Department of City Planning, which will then conduct their own evaluation of the proposed action.[165]

D.3.3.6 NYC Department of Transportation—Streets/Sidewalks

If any part of the geothermal system is installed under a City street or sidewalk, the building owner must enter into a revocable consent agreement with the New York City Department of Transportation Bureau of Franchises.[166] A revocable consent is the grant of right to an individual or organization to construct

and maintain certain structures on, over, or under the inalienable property (streets and sidewalks) of the City.[167] Generally revocable consents are granted for a term of ten years, but may be renewed. However, the City retains the right to revoke consent at any time.[168]

Obtaining a revocable consent agreement can take up to 6 months,[169] and can cost $100-$750 in filing fees and additional costs as high as $1,200 for NYCDOT to publish notice of public hearing as part of the consideration process.[170]

Additionally, if construction of the geothermal system requires use of adjoining sidewalks or streets as a work area for equipment and material storage, a permit may be required from the NYCDOT Office of Construction Mitigation and Coordination.[171] Three categories of construction-related permits for work on a sidewalk/street may be potentially relevant:

- **Street opening permit** applies to openings/excavations or other work in a street that may cause damage to the street surface.[172]
- **Building operations/construction activity permit** applies to construction related activity that takes place within and adjacent to the street, such as placement of materials, equipment and temporary structures on the street or sidewalk, or movement of construction equipment across roadways and sidewalks.[173]
- **Sidewalk construction permit** applies to any repairs, replacements or new sidewalk installations.[174]

There is one permit application form for all three permits. Permit applications can be submitted through the NYCStreets Permit Management System and require about four weeks.[175]

All permits that are required by other state and federal agencies must be in place before the NYCDOT issues a permit.[176]

D.3.3.7 NYC Office of Parks and Recreation

NYC Department of Parks and Recreation (NYC Parks) requires a permit for any construction work that affects assets under the jurisdiction or control of NYC parks, which may include natural areas, adjacent sidewalks and roadways, monuments, and concessions.[177] Project proponents must first submit the scope and design of the project for approval, and a subsequent construction permit upon approval from NYC Parks.[178]

There are no city-owned parks located on the Willet's Point Parcel. However, the Flushing Bay Promenade, a 1.4-mile city-owned public park, extends along the entire shoreline of Willet's Point. NYC Parks should be consulted if a system designed utilizing the Flushing Bay is pursued.

Additionally, as a condition of approval for the LaGuardia AirTrain project, the Port Authority of New York and New Jersey committed to making significant improvements to the Promenade including new walkways, landscaping, additional public activity areas, public art installations, upgraded street lighting and improved public access. The Port Authority is currently working with NYC Parks in the planning stages of the projects. Plans for the new Promenade should be considered in designing the geothermal system.

The permit can only be issued for a limited amount of time (usually for the duration of construction), which in most cases cannot exceed two years, and the area must be restored to NYC Parks' satisfaction at the conclusion of the construction period.[179] Additionally, if construction may affect any tree under Parks jurisdiction, a tree work permit must be obtained by NYC Parks before issuing a construction permit.[180]

Generally, it takes NYC Parks up to six weeks upon receipt of a complete permit application to review a permit.[181]

D.3.3.8 MTA Approvals

The Metropolitan Transportation Authority, which includes the New York City Transit Authority, the Long Island Rail Road and Metro North, and the Port Authority of New York and New Jersey, must be informed of planned drilling/excavation located within 200 feet from their transportation structures, including tunnels, substations, ventilation buildings and stations.[182] If approval is required, the owner and drilling firm may also have to procure additional insurance coverage and vibration monitoring may be required depending on the proximity to the site.[183]

The MTA "7" subway line runs aboveground along Roosevelt Avenue and adjacent to the Willet's Point site. As such, MTA approval is likely to be required prior to drilling.

Applications are submitted to MTA, and require:

- Site plan showing the proposed drilling locations in relation to transportation structures.
- Review to verify the transportation structures' location.

Plan review and approval, or finding of no impact, is conducted through the MTA's External Partner Program. The program will coordinate with developers and engineers if necessary to modify design to protect MTA infrastructure.[184]

D.3.3.9 New York City Noise Code - Construction Noise Mitigation Plan

NYC Department of Environmental Protection regulates construction noise that may be triggered by drilling activities that create noise, vibrations, or dust. A construction noise mitigation plan may be required as part of the application to the NYC Department of Buildings for a construction permit. Operation outside the hours of 7 am to 6 pm requires a variance. Copies of the plans must also be available on site for inspection.

D.3.3.10 Groundwater Discharge Permits

The NYC Department of Environmental Protection issues permits for the temporary disposal of drilling fluids and ground water to the City sewers generated during drilling/construction.[185]

For discharges of 10,000 gallons of groundwater per day or less, a Self-Certification form must be submitted to the Bureau of Customer Services.[186] If the discharge exceeds 10,000 gallons of groundwater per day into a public sewer, a groundwater discharge permit from the Department's Bureau of Customer Services is required. Prior approvals from the Bureau of Water and Sewer Operations and Bureau of Wastewater Treatment are also required.[187] Bureau of Wastewater Treatment will review the water quality of the proposed discharge to determine if pre-treatment is necessary and Bureau of Water and Sewer Operations reviews the proposed water quantity discharge to ensure that the local sewer mains have the capacity to handle the discharge.[188]

Discharges to storm sewers must be approved by NYSDEC prior to applying for a discharge permit from the Bureau of Customer Services.[189]

Average approval time from the Bureau of Wastewater Treatment is two to four weeks, although approval from the Bureau of Water and Sewer Operations may take longer.

D.3.3.11 Special Flood Hazard Areas

In New York, local municipalities that participate in the National Flood Insurance Program regulate development in Special Flood Hazard Areas (SFHA).[190] 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.[191]

Willet's Point is located in Zone AE, and as such, must be designed to meet the A-Zone construction standards in the New York City Building Code Appendix G. Pursuant G103.1, all site development activities, including grading, filling, utility installation and drainage modification, must be designed in accordance with Appendix G and ASCE 24, to minimize flooding.[192]

Additionally, a permit from the Commissioner of Buildings of the City of New York is required prior to commencing construction. A detailed site plan is required as part of the application and all applications involving utility or mechanical work must include a certification by the applicant that "all heating, ventilation, air conditioning, plumbing, electrical and other services and equipment within the structure or site will be located or constructed …in accordance with ASCE 24".[193]

D.3.3.12 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.

NYC Department of Environmental Protection 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 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.

D.3.3.13 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.

D.3.3.14 Sewer Connection Permit

New York City will require a sewer connection permit for the development to connect to the City sewer system, issued by the Bureau of Water and Sewer Operations. Additionally, a sewer certification is required for any new connection to a City sewer, a private sewer, a private drain, a septic system, or an approved outlet Sewer certification may also be required for an alteration or renovation that increases the sanitary and/or storm flow generated on the site.[194] The purpose of a sewer availability certification is to verify the adequacy of the existing abutting sewer to receive site storm and sanity discharge from a development.[195]

Although the proposed geothermal system will not change flows to the City sewer, the installation of this equipment will require disclosure and may raise requests for further information that may delay the issuance of the sewer connection permit.

D.3.3.15 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 New York City regulations:

1. Sewage streams may not exceed 150 degrees Fahrenheit (150° F) (65° C).
2. Sewage streams should be above freezing so as not to be ice.[196]
3. New York City does not specify default temperatures for the temperature of streams at the point of reaching the treatment plant.

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.

D.3.3.16 System Construction

The construction of sewage systems must be built to contain waste and prevent it from polluting the environment. 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. New York City sewer construction requirements would apply to the heat exchange component of the project's proposed sewer system.

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.

D.3.3.17 NYC Building Decarbonization Requirements

New York City's Local Law 97 of 2019 requires buildings over 25,000 square feet in ten categories of building classes to reduce greenhouse gas emissions by 40% by 2030, and 80% average reduction by 2050.

For multi-family housing, including cooperatives, condominiums, and rental buildings, the law sets some of the most stringent reduction requirements effective in 2024 with further reductions required in 2029, calculated on an emissions per square foot basis.

As a simple rule of thumb, residential buildings of 25–30 units or more will very likely trigger the 25,000 square feet threshold requirements. Group R-2 multifamily housing is subject to emissions caps of 0.00675 tCO_2e per square foot from 2024–2029, and 0.00407 tCO_2e per square foot from 2029P–2034.[197]

Buildings failing to comply face penalties, unless they qualify for exception, and may be required to purchase carbon offsets in a yet to be established market at an uncertain price.

Almost 26 thousand buildings in NYC are subject to the law.

Local Law 97 builds on prior New York City laws that require buildings to insulate pipes and install energy efficient lighting, and phase out dirtier forms of fuel oil, eventually eliminating all heavy fuel oils by 2030, requiring all new boiler or burner installations utilize natural gas, ultra-low sulfur 2 oil, biodiesel, or steam. Local Law 97's separate requirements effectively further require the phase out of natural gas or, at very least, penalizes its continued use.

The proposed geothermal system will help avoid or reduce penalties under Local Law 97.

D.3.4 Relevant Precedents

Saint Patrick's Cathedral in New York City installed a closed-loop geothermal system with boreholes deeper than 500 feet. This project has different characteristics than this project, however it is useful precedent for New York City that can be drawn upon with City officials and permitting authority.

D.3.5 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.	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.

Section D.3.5 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 .	45 days for minor projects. 90 days for major projects. 150 days for major projects if public hearing required.	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 and/or SEQRA review.	Design decisions
NYSDOT Transportation	Road closure, Easement	Approval to encroach upon or work in road or railroad track.	Weeks	No significant risks
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 non-electric services.

Section D.3.5 continued

Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued
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 non-electric 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				
NYC Department of Buildings	Building Permit	Geothermal reviewed in building or mechanical permit application.	Months	Design, communications
NYC Department of Environmental Protection	Permits and approvals Verification of underground water tunnels	Must be notified of drilling (depth and use of the wells, and a map). Groundwater discharge permit for drilling fluids. Drilling and excavation permit for depths exceeding 50 ft. Connect to water or sewer systems – temperature control and impact on system operation. Verify location of underground water tunnels and other infrastructure with Bureau of Water and Sewer Operations in all boroughs.	Subsumed within local project permitting.	Design
NYC 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

Section D.3.5 continued

Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued	Section D.3.5 continued
NYC Department of Transportation	Revocable Consent/Permits Road and sidewalk closures	Revocable consent agreements for installations under sidewalks. Street/sidewalk permits for construction-related activity. Road closure, right-of-way to encroach or temporary work.	4 weeks	Design
NYC Department of Parks and Recreation	Permits	Construction permit for drilling in public park. Tree work permit for city-owned trees.	6 weeks	Design
NYC Landmark Preservation Commission	Consultation/potential investigation	Possible presence of archaeological resources. Archaeological field testing/permits may be required.	10 days	Design
Metropolitan Transportation Authority	Notification/approval	Must approve drilling within 200 feet of a transportation structure.		Design
NYC Department of Housing Preservation and Development and NYCHA	Rent regulation and tenant rights enforcement	Provision and cost of heat, compliance with affordable housing rules.	None unless opposition	Public opposition, compliance with regulations.
NYC Department of Planning	Floodplain Development Permit	Project is located in a FEMA Special Flood Hazard Area.	Subsumed within local project permitting.	System must be designed in accordance with NYC Building Code Appendix G and ASCE 24.
Harbourmaster	Consultation, potentially approval	Use of navigable waterways.	Subsumed within Corps review.	Impediments to navigation.
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.

D.3.6 Non-Governmental 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	Encroachment or access across utility infrastructure. Confirm no interference with utility franchise agreements. Agreement on compensation, maintenance, decommissioning, and liability.	Weeks to months	Negotiations in absence of default regulations could require time to negotiation consent and agreement on 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	Participation in public hearings and consultation		Not quantifiable	Public opposition

D.4 Anticipated Challenges and Risks

D.4.1 Use of Flushing Bay as a Thermal Source/Sink

The Flushing Bay 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 Flushing Bay or adjacent wetlands, as well as any construction related activity involving excavation, drilling, trenching, and/or backfilling, 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 Flushing Bay as a navigable channel, the Corps may be less inclined to view favorably a system that could potentially impede on navigation. As such, the system would need to be designed in a way so as to not impede marine traffic.

D.4.2 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.[198]

Accordingly, system designs that avoid impacts to Piping Plover, Red Knot, Roseate Tern (all of which are migratory birds), and Seabeach Amaranth (a threatened plant species) habitat will likely avoid the need for a formal consultation. Project design should avoid impacting these habitat areas.

D.4.3 Drilling—Brine Production

The project subsurface contains groundwater that may contain brine. A well drilling permit for a well that may produce brine, saltwater, or other polluting fluids in sufficient quantities to harm the surrounding environment must obtain a permit for the safe and proper disposal of such produced fluids.[199] Depending on the applicable method of disposal, NYSDEC may require the well owner to obtain additional permits for discharge and/or disposal.

D.4.4 Brooklyn-Queens Aquifer

Located below Willet's Point, is the Brooklyn's-Queens aquifer, which consists of four main aquifers: the Upper Glacial, the Jameco, the Magothy, and the Lloyd.[200] The Queens County groundwater system, formerly operated by the Jamaica Water Supply Company, was purchased by New York City in 1996.[201] The system was operated by the City and supplied drinking water to a roughly 5.5 square mile area of NYC until 2007.[202] According to the Long Island Commission for Aquifer Protection (LICAP), the aquifer has not supplied drinking water since 2007, and all water used for drinking supply comes from the three upstate watersheds.[203] LICAP is a bi-county entity formed between Nassau and Suffolk Counties to address both quality and quantity issues facing long island's aquifer system and to advocate for a coordinated regional approach to groundwater system management. While LICAP does not have any direct approval authority over Willet's point, the Commission is tasked with managing Long Island's drinking water which could be adversely impacted by changes to the Brooklyn-Queens aquifer.[204] As such, it is likely that LICAP would play an active role in the environmental review process.

D.4.5 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.

D.4.6 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.

The costs of acquiring rights of way can be expensive and time-consuming. 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 its own 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,[205] 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,[206] 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,[207] 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.

D.4.7 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.

New York City further imposes additional restrictions at more shallow depths and within the vicinity of a water tunnel and or shaft, without obtaining permits.

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 the State's 500-foot depth threshold 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.

D.4.8 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.

D.5 Business model

D.5.1 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 is classified as a "Single Property—Single Owner—Multiple Users" business model.

In this model, a single-property owner hosts a geothermal system on a single property that serves multiple users or tenants. This presents the simplest of property rights and permitting arrangements but allows the system operator to increase revenues by serving multiple tenants. College campus geothermal systems fall under this model. This model is advantaged by simple and low-cost legal and administrative arrangements.

If Endurant retains ownership of the geothermal component of the project, this project also may follow a "Single Property—Build-Own-Operate-Transfer (BOOT)" business model.

A variant of the single property model is for an energy service provider to build, own, and operate the geothermal system on a single property owned by a third-party, and to eventually transfer ownership and operation of the system at a contractually specified point in time to the property owner. These build-own-operate-transfer or "BOOT" arrangements are commonly used to finance capital intensive infrastructure projects.

D.5.2 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's submetering regulations apply to electricity and electric heating services. No regulatory arrangement exists for billing heating services in measured 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.

D.6 Evolving Regulation of HFCs and Implications for Certain Geothermal Systems

D.6.1 American Innovation and Manufacturing Act of 2020

The American Innovation and Manufacturing Act of 2020 (AIM Act) directs the EPA to promulgate regulations that will reduce U.S. HFC production and consumption by approximately 85% by 2035.[208] Specifically, the Act directs the EPA to: phase down the production and consumption of 18 HFCs listed in the Act through an allowance allocation and trading program, establish requirements for the management of listed HFCs and HFCs substitutes, and facilitate the transition to next-generation technologies by restricting the use of listed HFCs in a specific sector or subsectors.[209]

The phase-down requirements of the AIM Act are directed towards companies that produce and/or import bulk HFCs, as well as companies that use HFCs in the following six applications: propellants in metered dose inhalers, defense sprays, structural composite preformed polyurethane foam for marine use and trailer use, etching of semiconductor material or wafers and the cleaning of chemical deposition chambers within the semiconductor manufacturing sector, mission-critical military end uses, and onboard aerospace fire suppression.[210]

The AIM Act also grants EPA authority to restrict either fully, partially, or on a graduated schedule, the use of HFCs in specific sectors or subsectors. EPA may do so by initiating its own rulemaking procedures either on its own accord or a person may petition EPA to promulgate a rule restricting use of HFCs in a particular sector or subsectors.[211] On October 8, 2020 EPA announced that it is granting or partially granting 11 petitions that were filed under the AIM Act to restrict the use of HFCs in the refrigeration and air conditioning, aerosols, and foam sectors. EPA will have two years to promulgate regulations (through public comment and rulemaking procedures) addressing these petitions.

D.6.2 New York State Law—SNAP Rules 20 and 21

Prior to the passage of the AIM act, relying on its authority to regulate ozone depleting substances under the Title VI of the Clean Air Act, in 2015 EPA attempted to restrict the use of HFCs through the Clean Air Act's Significant New Alternative Policy (SNAP) program by promulgating SNAP Rules 20 and 21. The rules removed HFCs from the list of acceptable substitutes for ozone depleting substances, and specifically listed HFCs as unacceptable in certain end-use applications such as refrigerators and certain air-conditioners. EPA was responding to recent science demonstrating that HFCs measurably contribute to the breakdown of the ozone layer both directly and indirectly as a catalyst due to their high global warming potential. However, upon judicial review the D.C. Court of Appeals held EPA had exceeded its authority under the SNAP program in requiring manufacturers that had already replaced ozone-depleting substances with HFCs at a time when they were listed as safe substitutes, as they were prior to the 2015 reclassification deemed non-ozone-depleting substances under Section 612 of the Clean Air Act. The court vacated the EPA's 2015 reclassification of HFCs and remanded to the EPA to determine if it possesses authority to conclude that a manufacturer's past decision to replace an ozone- depleting substance with HFCs is no longer lawful.[212]

In response, several states acted on their own to adopt SNAP Rules 20 and 21 reimposing EPA's restrictions on HFCs. For example, in 2018, California passed the California Cooling Act adopting SNAP 20 and 21 into their own state regulations. Other states including New York have followed California's lead by enacting similar restrictions on HFCs. Additionally, in 2020, New York promulgated regulations adopting SNAP 20 and 21.

NYSDEC regulations ban the sale, installation, and commercial use of certain HFC refrigerants in new or retrofitted food refrigeration equipment, large air conditioning equipment (chillers), and vending machines, as well as place prohibitions on substances used as aerosol propellants and foam-blowing agents in new consumer products.[213] The regulations do not require currently functioning equipment to be replaced or altered, but Part 494 requirements may apply at the end of its useful life.

D.6.3 Implications for Geothermal

The potential for evolving regulations to impact maintenance costs and replacement of regulated refrigerants at the end of life of equipment or those refrigerants should be considered when making investment decisions concerning technology selection today.

Although EPA has already authorized a number of refrigerants with lower global warming potentials for air-conditioner end-uses under the SNAP program[214] pursuant to its expanded authority under AIM, regulatory requirements are fast evolving as some states such as California are taking further action to impose restrictions on refrigerant's based on their GWP level.[215]

Further complicating matters, many next-generation refrigerants pose other environmental and regulatory risks, such as increased level of flammability compared to those commonly in use today.[216] Further, these refrigerants cannot be used as "drop-in" replacements for equipment that is currently in use until equipment manufacturers develop systems that can accommodate these new refrigerants and state building codes are developed specifying acceptable uses.[217]

Given the uncertainty concerning rapidly evolving regulations governing HFCs and the issues surrounding safe and effective HFC substitutes, hydronic or other systems that eliminate the use of refrigerants altogether might prove to be an economic and futureproof choice today when the full life cycle of technology options and the risks posed by uncertain regulation are considered.

D.7 Summary of Recommendations to Overcome

A certain number 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 may 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 heating 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'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.

Endnotes

[1] Heat of compression refers to the portion of input electrical energy to the compressor that gets released as thermal energy due to mechanical inefficiency. With hermetically sealed compressors, this thermal energy is absorbed on the condenser side and can be directed for space heating or DHW. 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 factor. The same happens in heating mode. Due to the heat of compression factor from the heat pump, only 70-80% of the thermal energy required by the conditioned spaces is extracted from the GLHE.

[2] Value of Distributed Energy Resources (VDER) is a mechanism established by the New York State Public Service Commission to compensate distributed energy resources (DERs) for the value their energy provides to the local electric grid.

[3] New York State Clean Heat Program, https://cleanheat.ny.gov/

[4] Clean Water Act, 33 U.S.C. §§ 1251-1387; Colburn T. Cherney & Karen M. Wardzinski, *State & Federal Roles Under the Clean Water Act*, 1 NAT. RESOURCES & ENV. 19, 19-20 (1986).

[5] Jason Bressler, Blocking Interstate Natural Gas Pipelines: How to Curb Climate Change While Strengthening the Nation's Energy System, 44 COLUM. J. OF ENV. LAW 137, 140 (2019).

[6] U.S. Army Corps of Engineers, New England District, *Are You Planning Work in a Waterway or Wetland?,* https://www.nae.usace.army.mil/Portals/74/docs/regulatory/Forms/WorkInWaterway2014.pdf (last accessed Oct. 12, 2021).

[7] U.S. Army Corps of Engineers, New England District, *Are You Planning Work in a Waterway or Wetland?,* https://www.nae.usace.army.mil/Portals/74/docs/regulatory/Forms/WorkInWaterway2014.pdf (last accessed Oct. 12, 2021).

[8] U.S. Army Corps of Engineers, New England District, *Are You Planning Work in a Waterway or Wetland?,* https://www.nae.usace.army.mil/Portals/74/docs/regulatory/Forms/WorkInWaterway2014.pdf (last accessed Oct. 12, 2021).

[9] U.S. Army Corps of Engineers, *Wetlands- What You Should Know Before You Buy or Build* (May 2019), https://www.lrb.usace.army.mil/Portals/45/docs/regulatory/DistrictInfo/FactSheets/NY-Wetlands_What_You_Should_Know_Revised_13MAY2019.pdf?ver=2019-05-13-150727-513.

[10] U.S. Army Corps of Engineers, *Wetlands- What You Should Know Before You Buy or Build* (May 2019), https://www.lrb.usace.army.mil/Portals/45/docs/regulatory/DistrictInfo/FactSheets/NY-Wetlands_What_You_Should_Know_Revised_13MAY2019.pdf?ver=2019-05-13-150727-513.

[11] The City of New York Dep't of Envtl. Protection, Bureau of Wastewater Treatment, *Flushing Bay Facility Plan Report* at 4-34 (Aug. 2011), https://www1.nyc.gov/assets/dep/downloads/pdf/water/nyc-waterways/flushing-bay/flushing-bay-wwfp.pdf.

[12] New York City Office of the Deputy Mayor for Economic Development, *Final Generic Impact Statement: Willet's Point Development* Plan (Sept. 2008), https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAwN1wwN0RNRTAxNFFcZWlzXGZpbmFsX2Vpc1wwN0RNRTAxNFFfRkVJU18wOTEyMjAwOC5wZGY1&signature=29f70bf21d6f77d40f14c016e60ccc8e07b4dfc7.

[13] New York City Office of the Deputy Mayor for Economic Development, *Final Generic Impact Statement: Willet's Point Development* Plan (Sept. 2008), https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAwN1wwN0RNRTAxNFFcZWlzXGZpbmFsX2Vpc1wwN0RNRTAxNFFfRkVJU18wOTEyMjAwOC5wZGY1&signature=29f70bf21d6f77d40f14c016e60ccc8e07b4dfc7.

[14] 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), https://www.environmentallawandpolicy.com/wp-content/uploads/sites/452/2018/07/MOA.pdf

[15] 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).

[16] U.S. Army Corps of Engineers, New England District, *Are You Planning Work in a Waterway or Wetland?,* https://www.nae.usace.army.mil/Portals/74/docs/regulatory/Forms/WorkInWaterway2014.pdf (last accessed Oct. 12, 2021).

[17] 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).

[18] 33 C.F.R. § 323.1.

[19] Melissa Samet, American Rivers Nat'l. Wildlife Fed'n., *A Citizen's Guide to the Corps of Engineers* 81(2009), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf.

[20] Melissa Samet, American Rivers Nat'l. Wildlife Fed'n., *A Citizen's Guide to the Corps of Engineers* 81(2009), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf.

[21] Environmental Law Institute, The Federal Wetland Permitting Program: Avoidance and Minimization Requirements (Mar. 2008), https://www.lrl.usace.army.mil/Portals/64/docs/regulatory/Permitting/ELI.pdf

[22] According to Army Corp guidance, "minor impacts are associated with activities that generally would have little potential to degrade the aquatic environment and include one, and frequently more, of the following characteristics: are located in aquatic resources of limited natural function; are small in size and cause little direct impact; have little potential for secondary or cumulative impacts; or cause only temporary impacts." US EPA, Regulatory Guidance Letter 93-02, Guidance on Flexibility of the 404(b)(1) Guidelines and Mitigation Banking (Aug. 23, 1993), https://www.nap.usace.army.mil/Portals/39/docs/regulatory/rgls/rgl93-02.pdf.

[23] William Funk, 4 Environmental Law Practice Guide § 19.04 (Matthew Bender LexisNexis 2021).

[24] William Funk, 4 Environmental Law Practice Guide § 19.04 (Matthew Bender LexisNexis 2021).

[25] William Funk, 4 Environmental Law Practice Guide § 19.04 (Matthew Bender LexisNexis 2021).

[26] California State Water Resources Control Board, *Supplemental Information for USACE Permitting Requirements*, Appendix E (2015), https://www.waterboards.ca.gov/waterrights/water_issues/programs//bay_delta/california_waterfix/exhibits/exhibit3/docs/RDEIRS/Ap_E_SuppInfo.pdf

[27] William Funk, 4 Environmental Law Practice Guide § 19.04 (Matthew Bender LexisNexis 2021).

[28] 33 U.S.C. 408.

[29] U.S. Army Corps of Engineers, Water Resource Policies and Authorities, EC 1165-2-216, Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 U.S.C. 408 at 2 (September 30, 2015) https://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1165-2-216.pdf.

[30] New York City Dep't. of Envtl. Protection, Propose Environmental Dredging of Flushing Bay Per Administrative Consent Order (CO2- 20110512-25), Environmental Impact Statement (Dec. 2012), https://www1.nyc.gov/assets/dep/downloads/pdf/environmental-reviews/environmental-dredging-flushing-bay/13dep012q-environmental-assessment-statement.pdf.

[31] U.S. Army Corps of Engineers, New York District, FACT SHEET: Flushing Bay and Creek, New York (March 3, 2021), https://www.nan.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/487364/fact-sheet-flushing-bay-and-creek-new-york/ (last visited Jan. 6, 2021).

[32] U.S. Army Corps of Engineers, New York District, FACT SHEET: Flushing Bay and Creek, New York (March 3, 2021), https://www.nan.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/487364/fact-sheet-flushing-bay-and-creek-new-york/ (last visited Jan. 6, 2021).

[33] Kenneth M. Bogdan & Albert I. Herson, 5 California Environmental Law & Land Use Practice § 68.06 (Matthew Bender LexisNexis 2021).

[34] Nina M. Hart & Linda Tsang, Cong. Rsch. Serv., IF11549, The Legal Framework of the National Environmental Policy Act (2021), https://sgp.fas.org/crs/misc/IF11549.pdf.

[35] 40 C.F.R. § 1508.18.

[36] Nina M. Hart & Linda Tsang, Cong. Rsch. Serv., IF11549, The Legal Framework of the National Environmental Policy Act (2021), https://sgp.fas.org/crs/misc/IF11549.pdf.

[37] 40 C.F.R. § 1502.14. (2020).

[38] Steven M Siros, et al., Pipeline Projects, *The evolving Role of Greenhouse Gas Emissions Analyses Under NEPA*, 41 ENERGY L. J. 47, 52 (2020).

[39] Sierra Club v. FERC, 867 F.3d 1357 (D.C. Cir. 2017).

[40] Jason Bressler, Blocking Interstate Natural Gas Pipelines: How to Curb Climate Change While Strengthening the Nation's Energy System, 44 COLUM. J. OF ENV. LAW 137, 158 (2019).

[41] Antonio Rossmann & Roger B. Moore, 5 California Environmental Law & Land Use Practice § 71.30 (Matthew Bender LexisNexis 2021)

[42] See generally 33 C.F.R. § 325, app. C, § 2(a) and 36 C.F.R. §§ 800.5, 800.10.

[43] Consensus Building Institute, *Navigating the Clean Water Act § 404 Application Process: Information to Assist Permit Applicants* 5 (February 2018), https://www.cbi.org/assets/news/EPA_TSD_Final.pdf.

[44] New York City Office of the Deputy Mayor for Economic Development, *Final Generic Impact Statement: Willet's Point Development* Plan (Sept. 2008), https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAwN1wwN0RNRTAxNFFcZWlzXGZpbmFsX2Vpc1wwN0RNRTAxNFFfRkVJU18wOTEyMjAwOC5wZGY1&signature=29f70bf21d6f77d40f14c016e60ccc8e07b4dfc7.

[45] New York City Office of the Deputy Mayor for Economic Development, *Final Generic Impact Statement: Willet's Point Development* Plan (Sept. 2008), https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAwN1wwN0RNRTAxNFFcZWlzXGZpbmFsX2Vpc1wwN0RNRTAxNFFfRkVJU18wOTEyMjAwOC5wZGY1&signature=29f70bf21d6f77d40f14c016e60ccc8e07b4dfc7.

[46] New York City Office of the Deputy Mayor for Economic Development, *Final Generic Impact Statement: Willet's Point Development* Plan (Sept. 2008), https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAwN1wwN0RNRTAxNFFcZWlzXGZpbmFsX2Vpc1wwN0RNRTAxNFFfRkVJU18wOTEyMjAwOC5wZGY1&signature=29f70bf21d6f77d40f14c016e60ccc8e07b4dfc7.

[47] The Roseate Tern is listed as endangered at the federal level, whereas the Piping Plover, Red Knot, and Seabeach Amaranth are listed as threatened. At the New York State level, the Piping Plover and Roseate Tern are listed as endangered, and the Red Knot and Seabeach Amaranth are listed as threatened.

[48] Thomas J. Schoenbaum & Richard B. Stewart, The Role of Mitigation and Conservation Measures in Achieving Compliance with Environmental Regulatory Statutes: Lessons From Section 316 of the Clean Water Act, 8 N.Y.U. Envtl. L.J. 237, 258 (2000).

[49] Melissa Samet, American Rivers Nat'l. Wildlife Fed'n., *A Citizen's Guide to the Corps of Engineers* 148-150 (2009), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf.

[50] Kenneth M. Bogdan & Albert I. Herson, 5 California Environmental Law & Land Use Practice § 68.06 (Matthew Bender LexisNexis 2021).

[51] U.S. Envtl. Protection Agency, Office of Water, Memorandum on Endangered Species Act Section 7(a)(2) Consultation for State and Tribal Clean Water Act Section 404 Program Approvals, https://www.oregon.gov/dsl/WW/Documents/ESAconsultationpolicyfor404-20200827.pdf

[52] Melissa Samet, American Rivers Nat'l. Wildlife Fed'n., *A Citizen's Guide to the Corps of Engineers* 148-150 (2009), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf.

[53] Melissa Samet, American Rivers Nat'l. Wildlife Fed'n., *A Citizen's Guide to the Corps of Engineers* 148-150 (2009), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf.

[54] Kenneth M. Bogdan & Albert I. Herson, 5 California Environmental Law & Land Use Practice § 68.06 (Matthew Bender LexisNexis 2021).

[55] 49 CFR 2950 (Jan. 1984).

[56] 42 U.S.C. § 300h-3(e).

[57] U.S. Envtl. Protection Agency, Safe Drinking Water Act Underground Injection Control (UIC) Program (2001), https://ndep.nv.gov/uploads/water-wpc-permitting-stormwater-uic-docs/uic-poster-epa04.pdf

[58] U.S. Envtl. Protection Agency, Protecting Underground Sources of Drinking Water from Underground Injection (UIC), https://www.epa.gov/uic.

[59] U.S. Envtl. Protection Agency, The Class V Underground Injection Control Study, Heat Pump and Air Conditioning Return Flow Wells (Volume 19)(1999).

[60] 42 U.S.C. § 300 h-3(a).

[61] Ken Krich et al., Biomethane from Dairy Waste: A Sourcebook for the Production and Utilization of Renewable Natural Gas in California, USDA Rural Devel., at 135 (July 2005).

[62] Ken Krich et al., Biomethane from Dairy Waste: A Sourcebook for the Production and Utilization of Renewable Natural Gas in California, USDA Rural Devel., at 135 (July 2005).

[63] Ohio Envtl. Protection Agency, *Water Quality Standards Program*, https://www.epa.ohio.gov/dsw/wqs/index (last accessed Oct. 13, 2021).

[64] 33 U.S.C. § 1313(c)(2)(A); NYS Dep't of Envtl. Conservation, Division of Environmental Planning and Protection, Clean Water Act Section 401 Certification for Commercial Vessel and Large Recreation Vessel General Permit (Nov. 3, 2008, https://www.nwf.org/Regional-Centers/~/media/PDFs/Regional/Great-Lakes/DEC_VGP_401_Certification_final.ashx.

[65] NYS Dep't of Envtl. Conservation, Division of Environmental Planning and Protection, Clean Water Act Section 401 Certification for Commercial Vessel and Large Recreation Vessel General Permit (Nov. 3, 2008, https://www.nwf.org/Regional-Centers/~/media/PDFs/Regional/Great-Lakes/DEC_VGP_401_Certification_final.ashx.

[66] Knauf Shaw LLP, *Clean Water Regulation* at 8, https://www.nyenvlaw.com/wp-content/uploads/2015/05/Chapter-4-Clean-Water-Regulation.pdf (last accessed Sept. 27, 2021).

[67] Technology based standards are "performance standards" developed by the EPA within a specific industrial category aimed at determining what levels of discharge pollutant by pollutant, can be achieved using the most cost-effective set of available pollution prevention and control techniques applicable to those types of facilities. Each subcategory of dischargers within an industrial category are required to meet these end of pipe limits, regardless of the condition of the water into which they discharge. Technology standards differ based on the type of pollutant and whether the discharge is new or existing at the time the standards is established. EPA, *Watershed Academy Web, Introduction to the Clean Water Act*, https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=2734&object_id=2738 (last accessed Oct. 12, 2021).

[68] Since meeting the technology standards does not guarantee that a discharge will not create or contribute to exceedance of the state's ambient water quality standards for the receiving waterbody, regulators must examine the impact of a discharge on water quality even though the discharge will be restricted by the applicable technology limit. If the regulator determines that exceedance is possible even with the applicable technological requirements in place, a more stringent effluent limit (a water quality based effluent limit) must be incorporated into the permit. New York Water Environment Association, Regulatory Overview and Legal Responsibilities, in Handbook on Wastewater Management at 4-56 (Jan. 2013), https://efc.syr.edu/wp-content/uploads/2015/03/Chapter4-web.pdf.

[69] Nat. Assoc. of State Dep't of Ag. Res. Found., Nat. Cen. For Ag. Law Res. & Info., *State Environmental Laws Affecting New York Agriculture* 6, https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf

[70] 6 N.Y.C.R.R. § 700.1.

[71] 6 N.Y.C.R.R. § 704.1.

[72] 6 N.Y.C.R.R. Parts 649-758.

[73] Heat is considered a pollutant pursuant to 6 N.Y.C.R.R. Part 704.

[74] NYSDEC, Permit No. GP-0-20-001, SPDES General Permit for Stormwater Discharges from Construction Activity (January 28, 2020), https://www.dec.ny.gov/docs/water_pdf/constgp020001.pdf.

[75] Stormwater Permit for Construction Activity, NYSDEC, https://www.dec.ny.gov/chemical/43133.html (Accessed September 28, 2021).

[76] Nat'l. Assoc. of State Dep't. of Ag. Rsch. Found., Nat'l. Center for Ag. Law Rsch. & Info., *State Environmental Laws Affecting New York Agriculture*, https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf.

[77] New York Water Environment Association, Regulatory Overview and Legal Responsibilities, in Handbook on Wastewater Management at 4-56 (Jan. 2013), https://efc.syr.edu/wp-content/uploads/2015/03/Chapter4-web.pdf.

[78] NYS Dep't of Envtl. Conservation, Division of Environmental Planning and Protection, Clean Water Act Section 401 Certification for Commercial Vessel and Large Recreation Vessel General Permit (Nov. 3, 2008, https://www.nwf.org/Regional-Centers/~/media/PDFs/Regional/Great-Lakes/DEC_VGP_401_Certification_final.ashx.

[79] Nat'l. Assoc. of State Dep't. of Ag. Rsch. Found., Nat'l. Center for Ag. Law Rsch. & Info., *State Environmental Laws Affecting New York Agriculture*, https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf.

[80] 6 N.Y.C.R.R. 700.1

[81] City of New Yorl Dep't of Envtl. Protection, Bureau of Wastewater treatment, Combined Sewer Overflow Long Term Control Plan for the Flushing Bay (Dec. 2016), https://www.dec.ny.gov/docs/water_pdf/csoflushingbay.pdf.

[82] NYC Office of Sustainability, *Geothermal Pre-Screening Tool* at 6 (January 2018), https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/RIVERWATER-ASSESSMENT-FINAL-RPT.pdf.

[83] *Protection of Waters*: Application Procedures, https://www.dec.ny.gov/permits/6333.html (accessed September 28, 2021).

[84] 6 N.Y.C.R.R. Part 621. Excavation or Fill in Navigable Waters, NYSDEC, https://www.dec.ny.gov/permits/6548.html (accessed September 28, 2021).

[85] *Getting an Environmental Permit*, NYSDEC, https://www.dec.ny.gov/permits/6230.html (accessed September 28, 2021).

[86] *Getting an Environmental Permit*, NYSDEC, https://www.dec.ny.gov/permits/6230.html (accessed September 28, 2021).

[87] N.Y. Env't. Conserv. Law § 25–0201; N.Y. Env't. Conserv. Law § 25–0302.

[88] N.Y. Env't. Conserv. Law § 25–0401(1)

[89] N.Y. Env't. Conserv. Law § 25-0103)

[90] 6 N.Y.C.R.R. § 661.2.

[91] N.Y. Env't. Conserv. Law § 25–0401(2)

[92] 6 N.Y.C.R.R.R. 661.5

[93] *Tidal Wetlands Permit Program*: Application Procedures, NYSDEC, https://www.dec.ny.gov/permits/6357.html (last accessed Oct. 19, 2021).

[94] Waterways, Coastlines, &Wetlands Permits, NYSDEC, https://www.dec.ny.gov/permits/96314.html (last accessed Oct. 19, 2021).

[95] N.Y. Public Lands Law § 75.

[96] *Lands Now or Formerly Underwater*, New York Dep't of State, Office of General Services, https://ogs.ny.gov/real-estate/lands-now-or-formerly-underwater (last accessed Oct. 19, 2021).

[97] *Lands Now or Formerly Underwater*, New York Dep't of State, Office of General Services, https://ogs.ny.gov/real-estate/lands-now-or-formerly-underwater (last accessed Oct. 19, 2021).

[98] 9 N.Y.C.R.R. § 271-1.1.

[99] *Lands Now or Formerly Underwater*, New York Dep't of State, Office of General Services, https://ogs.ny.gov/real-estate/lands-now-or-formerly-underwater (last accessed Oct. 19, 2021).

[100] Matthew Ahrens, et al., *Climate Change Considerations Under SEQRA: DEC's New Policy*, 29 THE N.Y. ENVT'L LAWYER 34, 34 (Fall 2009), https://www.lw.com/thoughtLeadership/climate-change-considerations-under-seqra-new-york-policy.

[101] Matthew Ahrens, et al., *Climate Change Considerations Under SEQRA: DEC's New Policy*, 29 THE N.Y. ENVT'L LAWYER 34, 35 (Fall 2009), https://www.lw.com/thoughtLeadership/climate-change-considerations-under-seqra-new-york-policy.

[102] Matthew Ahrens, et al., *Climate Change Considerations Under SEQRA: DEC's New Policy*, 29 THE N.Y. ENVT'L LAWYER 34, 35 (Fall 2009), https://www.lw.com/thoughtLeadership/climate-change-considerations-under-seqra-new-york-policy.

[103] 6 N.Y.C.R.R. § 617.9 (b)(5)(iii)(e)

[104] 1 Environmental Impact Review in New York § 3.01 (2021)

[105] 2 Environmental Impact Review in New York § 5.12 (2019)

[106] 2 Environmental Impact Review in New York § 5.12 (2019)

[107] Mark A Chertok et. al, Environmental Law: Developments in the Law of SEQRA, 96 Syracuse L. Rev. 773, 778 (2019).

[108] 6 N.Y.C.R.R. § 617.9(b)(1).

[109] *New York's Endangered Species Regulations,* NYSDEC, https://www.dec.ny.gov/animals/68645.html (accessed September 28, 2021).

[110] *New York's Endangered Species Regulations,* NYSDEC, https://www.dec.ny.gov/animals/68645.html (accessed September 28, 2021).

[111] *New York's Endangered Species Regulations,* NYSDEC, https://www.dec.ny.gov/animals/68645.html (accessed September 28, 2021).

[112] National Oceanic and Atmospheric Administration, N.Y.S. Dep't of State, New York State Coastal Management Program and Final Environmental Impact Statement https://dos.ny.gov/system/files/documents/2021/04/ny_cmp_dec2020_w-bookmarks_working_topost.pdf.

[113] National Oceanic and Atmospheric Administration, N.Y.S. Dep't of State, New York State Coastal Management Program and Final Environmental Impact Statement https://dos.ny.gov/system/files/documents/2021/04/ny_cmp_dec2020_w-bookmarks_working_topost.pdf.

[114] N.Y.S. Dep't of State, Office of Planning and Development, *Local Waterfront Revitalization Program*, https://video.dos.ny.gov/opd/programs/WFRevitalization/LWRP.html (accessed September 27, 2021).

[115] Patricia E. Salkin, *Integrating Local Waterfront Revitalization Planning into Local Comprehensive Planning and Zoning,* 22 Pace Envtl. L. Rev. 207, 216 (September 2005), https://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1141&context=pelr

[116] N.Y.S. Dep't of State, Office of Planning and Development, *Local Waterfront Revitalization Program*, https://video.dos.ny.gov/opd/programs/WFRevitalization/LWRP.html (accessed September 27, 2021).

[117] *New York City Local Waterfront Revitalization Program,* NY Dep't of State, https://dos.ny.gov/location/new-york-city-local-waterfront-revitalization-program (accessed September 30, 2021).

[118] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[119] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[120] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[121] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[122] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[123] *New York City Waterfront Revitalization Program, Part 1: Program Description* (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf (accessed September 30, 2021).

[124] *Geothermal Wells*, NYSDEC, available at https://www.dec.ny.gov/lands/61176.html (accessed March 10, 2021).

[125] *Geothermal Wells*, NYSDEC, available at https://www.dec.ny.gov/lands/61176.html (accessed March 10, 2021).

[126] N.Y. Env't Conserv. Law § 23-0305(14).

[127] *Geothermal Systems & Their Application in New York City,* NYC Office of Sustainability at 36 (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf; *Well Permitting Requirements*, NYSDEC, available at https://www.dec.ny.gov/energy/1783.html (accessed March 10, 2021).

[128] *Well Permitting Requirements*, NYSDEC, available at https://www.dec.ny.gov/energy/1783.html (accessed March 10, 2021).

[129] 6 NYCRR § 554.1(c).

[130] *Designing & Drilling Your Well Permit*, NYSDEC available at https://www.dec.ny.gov/energy/1628.html (accessed March 10, 2021).

[131] 6 NYCRR § 554.1(c).

[131] *Designing & Drilling Your Well Permit*, NYSDEC available at https://www.dec.ny.gov/energy/1628.html (accessed March 10, 2021).

[132] *Geothermal Systems & Their Application in New York City,* NYC Office of Sustainability at 37 (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[133] *Geothermal Systems & Their Application in New York City,* NYC Office of Sustainability at 37 (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[134] *Well Permit Fee Calculator*, NYSDEC (accessed March 10, 2021) https://www.dec.ny.gov/energy/1779.html

[135] NYSDEC Division of Minerals requires that drillers demonstrate that wells do not drift beneath adjacent properties for which the applicant has not received permission from the property owner, by performing angular deviation and directional surveys at 100 ft. intervals during drilling using a gyroscope or other approved method. NYC Department of Design & Construction, Office of Sustainable Design, *Geothermal Heat Pump Systems Manual: A Design and Installation Guide for New York City Projects* (2012), p. 127.

[136] 9 N.Y.C.R.R. § 428.1

[137] New York State Multiple Dwelling Law § 79; New York State Multiple Residence Law § 173. See also, New York City Administrative Code § 27-2029.

[138] Section 5(1)(b)-(c) of the Public Service Law.

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

[140] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.

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

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

[143] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.2(b)(2).

[144] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.8.

[145] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.3(a)(3), 96.4(c).

[146] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.3.

[147] Title 16 Department of Public Service, Chapter II Electric Utilities, Part 96.5.

[148] 2006 New York Code - Heating Requirements, §27-740.

[149] Off. Of Envtl. Quality, Exec. Off. Of the President, Memorandum Introducing Federal National Environmental Policy Act practitioners to the City of New York's City Environmental Quality Review, https://ceq.doe.gov/docs/laws-regulations/state_information/NYC_NEPA_Comparison_16Dec2015.pdf

[150] Off. Of Envtl. Quality, Exec. Off. Of the President, Memorandum Introducing Federal National Environmental Policy Act practitioners to the City of New York's City Environmental Quality Review, https://ceq.doe.gov/docs/laws-regulations/state_information/NYC_NEPA_Comparison_16Dec2015.pdf

[151] Off. Of Envtl. Quality, Exec. Off. Of the President, Memorandum Introducing Federal National Environmental Policy Act practitioners to the City of New York's City Environmental Quality Review, https://ceq.doe.gov/docs/laws-regulations/state_information/NYC_NEPA_Comparison_16Dec2015.pdf

[152] Off. Of Envtl. Quality, Exec. Off. Of the President, Memorandum Introducing Federal National Environmental Policy Act practitioners to the City of New York's City Environmental Quality Review, https://ceq.doe.gov/docs/laws-regulations/state_information/NYC_NEPA_Comparison_16Dec2015.pdf

[153] 15 R.C.N.Y. § 57-03.

[154] 15 R.C.N.Y. § 57-04.

[155] 15 R.C.N.Y. § 57-04.

[156] 15 R.C.N.Y. § 57-04.

[157] 15 R.C.N.Y. § 57-04.

[158] 15 R.C.N.Y. § 57-04.

[159] 15 R.C.N.Y. § 57-03.

[160] NYC Department of Design & Construction, Office of Sustainable Design, Geothermal Heat Pump Systems Manual: A Design and Installation Guide for New York City Projects (2012), Appendix D.

[161] Langan Engineering, Remedial Action Work Plan, Willet's Point Development – Operable Unit 1 (Phase 1A) (May 2021), https://www.dec.ny.gov/data/DecDocs/C241146/Work%20Plan.BCP.C241146.2021-05-11.Remedial%20Action%20Work%20Plan%20Final.pdf.

[162] NYC Dep't of City Planning, New York City Local Waterfront Revitalization Program, Appendix C (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015appc.pdf

[163] NYC Dep't of City Planning, New York City Local Waterfront Revitalization Program, Appendix C (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015appc.pdf

[164] NYC Dep't of City Planning, New York City Local Waterfront Revitalization Program, Appendix C (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015appc.pdf

[165] NYC Dep't of City Planning, New York City Local Waterfront Revitalization Program, Appendix C (2016), https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015appc.pdf

[166] NYC Dep't of Trans., *Revocable Consents*, https://www1.nyc.gov/html/dot/html/infrastructure/revconif.shtml (accessed September 30, 2021).

[167] *Revocable Consents*, NYC Dep't, of Trans., https://www1.nyc.gov/html/dot/html/infrastructure/revconif.shtml (accessed September 30, 2021).

[168] *Revocable Consents*, NYC Dep't, of Trans., https://www1.nyc.gov/html/dot/html/infrastructure/revconif.shtml (accessed September 30, 2021).

[169] Petition Form For A New Revocable Consent https://www1.nyc.gov/html/dot/downloads/pdf/petition_form_new_revocable_consent.pdf, accessed 9/30/2021

[170] *Revocable Consents*, NYC Dep't, of Trans., https://www1.nyc.gov/html/dot/html/infrastructure/revconif.shtml (accessed September 30, 2021).

[171] *Street Works Manual, General Provisions for Construction Permits,* NYC Dep't, of Trans., http://streetworksmanual.nyc/chapter-three/general-provisions-construction-related-permits (accessed September 30, 2021).

[172] *Street Works Manual, General Provisions for Construction Permits,* NYC Dep't, of Trans., http://streetworksmanual.nyc/chapter-three/general-provisions-construction-related-permits (accessed September 30, 2021).

[173] *Street Works Manual, General Provisions for Construction Permits,* NYC Dep't, of Trans., http://streetworksmanual.nyc/chapter-three/general-provisions-construction-related-permits (accessed September 30, 2021).

[174] *Street Works Manual, General Provisions for Construction Permits,* NYC Dep't, of Trans., http://streetworksmanual.nyc/chapter-three/general-provisions-construction-related-permits (accessed September 30, 2021).

[175] NYC Streets Permit Management System, https://nycstreets.net/Public/SignIn/Index (accessed October 4, 2021).

[176] NYC Office of Sustainability, *Geothermal Systems & Their Application in New York City* (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[177] *Construction Permits*, NYC Dep't. of Parks and Recreation, https://www.nycgovparks.org/permits/construction (accessed September 30, 2021).

[178] *Construction Permits*, NYC Dep't. of Parks and Recreation, https://www.nycgovparks.org/permits/construction (accessed September 30, 2021).

[179] *Construction Permits*, NYC Dep't. of Parks and Recreation, https://www.nycgovparks.org/permits/construction (accessed September 30, 2021).

[180] *Construction Permits*, NYC Dep't. of Parks and Recreation, https://www.nycgovparks.org/permits/construction (accessed September 30, 2021).

[181] *Construction Permits*, NYC Dep't. of Parks and Recreation, https://www.nycgovparks.org/permits/construction (accessed September 30, 2021).

[182] NYC Office of Sustainability, *Geothermal Systems & Their Application in New York City* (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[183] NYC Office of Sustainability, *Geothermal Systems & Their Application in New York City* (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[184] MTA Buildings Near Transit, https://new.mta.info/agency/construction-and-development/building-near-transit (accessed September 30, 2021).

[185] NYC Department of Design & Construction, Office of Sustainable Design, Geothermal Heat Pump Systems Manual: A Design and Installation Guide for New York City Projects (2012).

[186] *Water & Sewer Forms, De Watering, Pretreatment, & Scavenger Waste,* NYC Dep't of Envtl. Protection, https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page (accessed September 30, 2021).

[187] *Water & Sewer Forms, De Watering, Pretreatment, & Scavenger Waste*, NYC Dep't of Envtl. Protection, https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page (accessed September 30, 2021).

[188] NYC Office of Sustainability, *Geothermal Systems & Their Application in New York City* (February 2015), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf.

[189] *Water & Sewer Forms, De Watering, Pretreatment, & Scavenger Waste,* NYC Dep't of Envtl. Protection, https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page (accessed September 30, 2021).

[190] *Floodplain Construction Requirements*, NYSDEC, https://www.dec.ny.gov/lands/40576.html (accessed September 28, 2021).

[191] *Floodplain Construction Requirements*, NYSDEC, https://www.dec.ny.gov/lands/40576.html (accessed September 28, 2021).

[192] NYC Building Code 2014, Appendix G, Section G103.1.

[193] NYC Building Code 2014, Appendix G, Section G104.5.

194 *Sewer Certification and Connection Permits*, NYC Dep't of Envtl. Protection, https://www1.nyc.gov/site/dep/about/sewer-connections.page (accessed September 30, 2021); "No connection to the sewerage system including but not limited to conveyance through hard pipe, hose, or channel shall be made without the written approval of the Commissioner and compliance with the terms and conditions of such approval." 15 R.C.N.Y. § 19-02.

195 NYC Dep't of Envtl. Protection, *Bureau of Water & Sewer Operations (BWSO), Overview of Sewer Certification and Sewer Connection Permitting Process* (2011), https://www1.nyc.gov/assets/dep/downloads/pdf/about/water-and-sewer-forms/overview-sewer-certification-process.pdf

196 Rules of the City of New York, Chapter 19: Use of the Public Sewers, Section 19.03(1)(a).

197 Local Laws of the City of New York for the Year 2019 No. 97, pp. 9-12.

198 David P. Ross, U.S. Env. Protection Agency, Office of Water, Memorandum on Endangered Species Action Section 7(a)(2) Consultation for State and tribal Clean Water Act Section 404 Program Approvals (2020) https://www.oregon.gov/dsl/WW/Documents/ESAconsultationpolicyfor404-20200827.pdf.

199 6 NYCRR § 554.1(c).

200 New York City Dep't of Envt'l. Protection, CEQR No. 15DEP029Q, Draft Environmental Impact Statement, In City Water Supply Resiliency (Nov. 2017).

201 Long Island Commission for Aquifer Protection, Groundwater Resources Management Plan (Dec. 2019), https://licaponline.com/wp-content/uploads/2020/10/SCWA-GRMP-2019.pdf.

202 Long Island Commission for Aquifer Protection, Groundwater Resources Management Plan (Dec. 2019), https://licaponline.com/wp-content/uploads/2020/10/SCWA-GRMP-2019.pdf.

203 Committee to Review the New York City Watershed Protection Program, Water Science and technology Board, Division on Earth and Life Studies, Review of the New York City Watershed Protection Program (2020), https://www.ncbi.nlm.nih.gov/books/NBK566290/pdf/Bookshelf_NBK566290.pdf.

204 Recently, New York City conducted a study to assess the potential of reactivating the dormant water supply wells in Queens as part of its "In-City Water Supply Resiliency Plan." The Plan would have allowed for the pumping of approximately 62 million gallons of water per day on a short-term emergency basis. The city has since abandoned these plans following push back from Nassau County residents concerning possible impacts reactivation of the aquifer would have on the greater Long Island aquifer. However, NYC did apply for the re-issuance of water withdrawal permits that were set to expire in 2017, for the 68 wells in Queens. According the NYC, although it does not have plans to re-activate any wells in the immediate future, the permits are necessary for emergencies situations in which drinking supply cannot be distributed from up-state. The permits have not yet been granted, and are undergoing environmental review. Long Island Commission for Aquifer Protection, State of Aquifer: 2020 Update (2020); Long Island Commission for Aquifer Protection, Groundwater Resources Management Plan (Dec. 2019).

205 Oxana Šnajberg, *Valuation of Real Estate with Easement*, PROCEDIA ECONOMICS & FINANCE 25 at 420-27 (2015).

206 E. Shashi Menon, Transmission Pipeline Calculations & Simulations Manual (2015).

207 Lisa Gonzales, *All Aboard for Reformed Railroad Right-of-Way Crossing Rules*, COMMUNITY NETWORKS (February 19, 2019), available at https://muninetworks.org/content/all-aboard-reformed-minnesota-railroad-right-way-crossing-rules (accessed March 7, 2021).

208 42 U.S.C. §7675.

209 86 Fed. Reg. 55,116 (2021).

210 EPA, Final Rule – Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the American Innovation and Manufacturing (AIM) Act (Sept. 2021), https://www.epa.gov/system/files/documents/2021-09/hfc-allocation-final-rule-faq-sept2021.pdf.

211 EPA, EPA Acts on Petitions to Cut Climate-Damaging HFCs, Will Begin AIM Act Rulemaking Process (Oct. 8, 2021), https://www.epa.gov/newsreleases/epa-acts-petitions-cut-climate-damaging-hfcs-will-begin-aim-act-rulemaking-process.

212 Mexichem Fluor, Inc. v. Environmental Protection Agency, 866 F.3d. 451 (D.C. Cir. 2017).

213 6 N.Y.C.R.R. Part 494.

214 Specifically, SNAP rule 23 lists R-452B, R-454A, R-454B, R-454C and R-457A as acceptable substitutes, subject to use conditions, for use in residential and light commercial air condition and heat pumps for new equipment; and R-32 as acceptable subject to use conditions, for use in residential and light commercial AC and heat pumps (other than self-contained room air conditioners) for new equipment. EPA, Snap Regulations, https://www.epa.gov/snap/snap-regulations (Accessed Dec. 15, 2021).

[215] For instance, the California Air Resources Board (CARB) has established a GWP limit of 750 for new room air conditioning equipment and dehumidifiers in 2023, new chillers used for air conditioning in 2024, new residential and commercial stationary air conditioning equipment in 2025, and new variable refrigerant flow systems in 2026/. Daikin, *Driving the Next Generation of Refrigerants* (Apr. 2021), https://www.northamerica-daikin.com/assets/resources/r-32/Driving-the-Next-Generation-of-Refrigerants.pdf.

[216] Daikin, *Driving the Next Generation of Refrigerants* (Apr. 2021), https://www.northamerica-daikin.com/assets/resources/r-32/Driving-the-Next-Generation-of-Refrigerants.pdf.

[217] Chris Forth, *The Transition to Low- GWP Refrigerants in the Unitary Market*, White Paper (May 2021), https://www.york.com/-/media/project/jci-global/york-sites/united-states-york/insights/files/low-gwp-white-paper.pdf

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