# Spring Creek Towers Geothermal Scoping Study

Final Report | Report Number 25-16 | December 2025

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# Spring Creek Towers Geothermal Scoping Study

***Final Report***

Prepared for

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# Abstract

Spring Creek Towers (SCT) is an expansive apartment complex spanning 153 acres in the Spring Creek section of Brooklyn, in New York City. When SCT was initially constructed, electricity and thermal energy were generated on-site from a central energy plant (CEP), which is still in operation today. SCT is developing a decarbonization plan. Part of that plan considers the electrification of thermal energy production. This study assessed the feasibility of developing a thermal energy network across the SCT campus. The team explored various technical solutions that could meet the thermal demands while achieving greater efficiency. Multiple solutions were assessed, each relying on sources of thermal energy including nearby groundwater discharge lines, the adjacent Water Resource Recovery Facility (WRRF), and conventional boreholes installed in open spaces across SCT's campus. The study recommends that SCT consider electrification of the thermal energy network in tandem with a lower-carbon source of electricity or connection to Consolidated Edison, Inc. (Con Edison). Any electrification of thermal energy that relies on the existing CEP will increase gas use and carbon emissions.

# Keywords

thermal energy network (TEN), ground-source heat pump, campus decarbonization

# Acknowledgements

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# Acronyms and Abbreviations

| | |
|---|---|
| < | less than |
| > | greater than |
| ≥ | greater than or equal to |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| AIM Act | American Innovation and Manufacturing Act of 2020 |
| AMI | Area Median Income |
| ASHP | air-source heat pump |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| BAU | business as usual |
| Btu | British thermal units |
| Btu/h/ft/°F | British thermal units per foot per degree Fahrenheit |
| Btu/kWh | British thermal units per kilowatt-hour |
| Capex | capital expenses |
| CEA | Critical Environmental Area |
| CEP | central energy plant |
| CEQR | City Environmental Quality Review |
| $CO_2$ | carbon dioxide |
| Con Edison | Consolidated Edison, Inc. |
| COP | coefficient of performance |
| Corps | U.S. Army Corps of Engineers |
| CSO | combined sewer overflow |
| CT | cooling tower |
| CWA | Clean Water Act |
| DEC | New York State Department of Environmental Conservation |
| DEIS | Draft Environmental Impact Statement |
| DEP | New York City Department of Environmental Protection |
| DHW | domestic hot water |
| DOT | New York City Department of Transportation |
| EAF | Environmental Assessment Form |
| EFH | Essential Fish Habitat |
| EFLH | Equivalent Full Load Hours |
| EIS | Environmental Impact Statement |
| EPA | U.S. Environmental Protection Agency |
| ESMIA | Ecologically Sensitive Maritime and Industrial Area |
| FCU | fan coil units |

| | |
|---|---|
| FEIS | Final Environmental Impact Statement |
| FEMA | Federal Emergency Management Agency |
| FHM | Flood Hazard Mapper |
| FTEs | full-time employees |
| Gateway NRA | Gateway National Recreation Area |
| GHX | ground heat exchanger |
| GIS | geographic information system |
| GLHE | ground loop heat exchanger |
| GPM | gallons per minute |
| GSHP | ground-source heat pump |
| GTE | groundwater thermal exchange |
| GWP | global warming potentials |
| HFC | hydrofluorocarbon |
| HHW | heating hot water |
| HRE | Hudson Raritan Estuary |
| HUD | U.S. Department of Housing and Urban Development |
| HVAC | heating, ventilation, and air conditioning |
| IRA | Inflation Reduction Act of 2022 |
| IRS | Internal Revenue Service |
| ITC | investment tax credit |
| kBtu | kilo-British thermal unit |
| LCC | lifecycle cost |
| LCCA | lifecycle cost analysis |
| Local Law 97, LL97 | New York City Local Law 97 (LL97 in tables) |
| LWRP | Local Waterfront Revitalization Programs |
| MGD | million gallons per day |
| MMBtu | million British thermal units |
| MMBtu/hr | million British thermal units per hour |
| MS4 | municipal separate storm sewer systems |
| MSA | Metropolitan Statistical Area |
| MTA | Metropolitan Transportation Authority |
| MW | megawatt |
| MWh | megawatt hour |
| $MW_{th}$ | megawatt thermal |
| NEPA | National Environmental Policy Act |
| NOAA | National Oceanic and Atmospheric Administration |
| NOPR | Notice of Proposed Rulemaking |
| NPDES | National Pollutant Discharge Elimination System |
| NWI | National Wetlands Inventory |

| | |
|---|---|
| NYC Parks | New York City Department of Parks and Recreation |
| NYC | New York City |
| NYCDEC | New York City Department of Environmental Conservation |
| NYCHA | New York City Housing Authority |
| NYCTA | New York City Transit Authority |
| NYS Parks | New York State Office of Parks, Recreation and Historic Preservation |
| O&M | operations and maintenance |
| ORES | Office of Renewable Energy Siting |
| PICV | pressure independent control valve |
| PMAZs | Priority Marine Activity Zones |
| POCs | pollutants of concern |
| RECs | Recognized Ecological Complexes |
| SCT | Spring Creek Towers |
| SEQR | State Environmental Quality Review Act |
| sf | square foot, feet |
| SFHA | Special Flood Hazard Areas |
| SHGC | solar heat gain coefficient |
| SHPO | State Historic Preservation Office |
| SMIAs | Significant Maritime and Industrial Areas |
| SNAP | Significant New Alternative Policy |
| SPDES | State Pollution Discharge Elimination System |
| SWMP | Stormwater Management Program |
| SWPPP | Stormwater Pollution Prevention Plan |
| $tCO_2e$ | tons of carbon dioxide equivalent |
| $tCO_2e/sf$ | metric tons of carbon dioxide equivalent per square foot |
| TEN | thermal energy network |
| Treasury | U.S. Department of the Treasury |
| USFWS | U.S. Fish and Wildlife Service |
| V | volt |
| W/sf | watts per square foot |
| WRP | Waterfront Revitalization Programs |
| WRRF | wastewater resource recovery facility |
| WSHP | water source heat pump |
| WWTP | wastewater treatment plant |

# Executive Summary

Spring Creek Towers (SCT) spans 153 acres in the Spring Creek section of Brooklyn in eastern New York City. The complex includes 46 apartment buildings, 5,881 residential units, 8 indoor parking garages, a sports center, a school, a major shopping center, and open spaces featuring playgrounds and athletic fields.

When SCT was initially constructed, a central energy plant (CEP) generated electricity and thermal energy on-site. The CEP remains operational, and SCT has never connected to the local distribution company, Consolidated Edison, Inc. (Con Edison), for electricity. Instead, SCT has relied exclusively on the CEP and ancillary equipment for power and thermal energy. National Grid supplies the natural gas that powers the CEP.

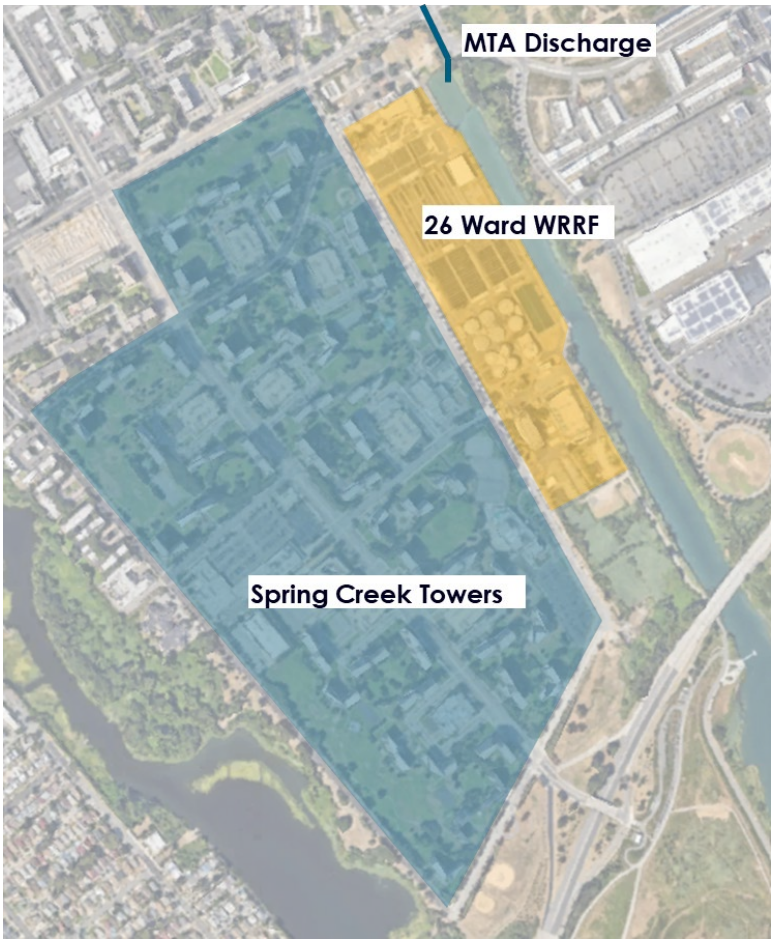
The team evaluated various technical solutions to meet SCT's thermal demands more efficiently. Each solution draws on thermal sources, including nearby groundwater discharge lines owned by the Metropolitan Transportation Authority (MTA), the adjacent Water Resource Recovery Facility (WRRF), and conventional boreholes installed in existing open spaces across SCT's campus. Figure ES-1 illustrates the thermal resources surrounding the SCT campus.

**Table ES-1. 25-Year Lifecycle Cost: Continued Central Energy Plant Operations**

| Scenario | Capex Net ITC | O&M | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|
| BAU | — | $10,200 | $8,236 | $4,438 | $27,000 | $512,584 |
| MTA with CT | $45,018 | $11,200 | $8,344 | $5,861 | $15,518 | $603,676 |
| MTA with ASHP | $42,386 | $11,200 | $8,892 | $6,362 | $15,200 | $601,846 |
| Geo | $56,433 | $11,200 | $8,473 | $6,192 | $15,840 | $615,788 |
| WRRF | $37,140 | $11,200 | $8,875 | $5,946 | $9,360 | $591,803 |

In each scenario, the all-electric thermal systems result in higher lifecycle costs over 25 years compared to current operations. This is primarily due to SCT's unique situation and the way the campus is currently operated. Because the campus relies on the existing gas-fired CEP, introducing electric heating and cooling systems increases reliance on the existing CEP and the natural gas required to fuel it. Continued reliance on the CEP for electricity would likely trigger a New York City Local Law 97 (Local Law 97) penalty, estimated between $4.4 million and $6.4 million.

**Figure ES-1. Map of Spring Creek Towers Campus and Surrounding Thermal Resources**




The analysis indicates that thermal systems linked to either the MTA discharge line or the WRRF require the least energy input and emit the least carbon emissions. If SCT connects electrically to the local utility and decommissions the CEP, the business-as-usual (BAU) scenario produces the highest emissions, 33,009 tons of carbon dioxide equivalent (tCO2e), while the WRRF scenario results in the lowest emissions (26,802 $tCO_2e$).

Converting SCT to an all-electric heating and cooling district will require a significant infrastructure overhaul, including the installation of new distribution systems and connections to each building. Given the recent implementation of Local Law 97, SCT may benefit from interconnecting to Con Edison and transitioning away from the current gas-fired CEP. Annual Local Law 97 penalties of $4.4 million to $6.4 million will eventually outweigh the cost of interconnection. Annual carbon emissions would decrease by approximately 50% to 60%.

**Table ES-2. 25-Year Lifecycle Cost: Transfer to Con Edison Electric**

All values in $1,000.

| Scenario | Capex Net ITC | O&M | Con Edison Electric | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|---|
| BAU | — | $2,550 | $17,019 | $1,514 | — | $11,632 | $471,397 |
| MTA with CT | $45,018 | $3,050 | $21,668 | $494 | — | $15,518 | $609,931 |
| MTA with ASHP | $42,386 | $3,050 | $23,237 | $159 | — | $15,200 | $608,283 |
| Geo | $56,433 | $3,050 | $22,038 | $505 | — | $15,840 | $621,964 |
| WRRF | $37,140 | $3,050 | $23,188 | $0 | — | $9,360 | $598,464 |

The study recommends the following action:

- Explore interconnection costs and timelines with Con Edison. While initially expensive, this step will enable SCT to reduce carbon emissions, avoid penalties under Local Law 97, and source carbon-free electricity from the grid.
- Consider the WRRF option, which will lower carbon emissions and future-proof the SCT against rising carbon penalties.
- Monitor the clarification from the U.S. Department of the Treasury (Treasury) regarding the definition of "geothermal heat pump equipment" to include wastewater heat exchange systems. The WRRF option would likely become the least costly solution.

SCT must complete the transition to an electric, district thermal system in phases. Residents will continue using energy from the CEP until the new system is designed, constructed, and stabilized.

As an initial phase, SCT should implement a district thermal system in a subset of residential towers to reduce capital needs, shorten timelines, and minimize community disruption. Phase 1 operations will provide feedback to guide future implementation phases. Major Phase 1 activities include:

- Begin preliminary negotiations with MTA and the New York City Department of Environmental Protection (DEP) to determine SCT's thermal energy access costs.
- Determine which district thermal system to pursue based on capital expenses (Capex) and/or access fees from MTA or DEP.
- Identify garages for Phase 1 deployment based on proximity to thermal resources. For example, Garage A and Garage B are ideal for connection to MTA water. Garage B and Garage E suit connection to DEP water. Garage C suits a standalone geothermal system.
- Proceed with final design, construction, and building retrofit. Implement a robust data monitoring system.
- Collect and analyze operational data. Use the results to inform the full transition to fossil-free heating and cooling across the SCT campus.

# 1 Project Background

Spring Creek Towers (SCT) spans 153 acres in the Spring Creek section of Brooklyn in eastern New York City. The campus includes 46 apartment buildings, 5,881 residential units, 8 indoor parking garages, a sports center, a school, a major shopping center, and open spaces featuring playgrounds and athletic fields.

SCT seeks various strategies to improve the efficiency of its existing energy infrastructure and reduce carbon emissions and energy costs. This report analyzes the costs, benefits, and environmental outcomes of converting SCT's heating and cooling system to an all-electric, ground-source heat pump (GSHP)-driven thermal energy network (TEN). By connecting GSHPs to nearby thermal resources, SCT will eliminate the need for fossil-fired heating and cooling. This study considers thermal resources such as the dewatering discharge line owned and operated by the Metropolitan Transportation Authority (MTA), New York City's 26th Ward Wastewater Resource Recovery Facility (WRRF), and/or vertical boreholes installed on campus.

**Figure 1. Spring Creek Towers Central Energy Plant and Thermal Distribution Networks**

## 1.1 Existing Conditions

When SCT originally constructed the site, it generated electricity and thermal energy on-site from a central energy plant (CEP). The CEP remains operational, and SCT has never connected to the local electricity distribution company, Consolidated Edison, Inc. (Con Edison). Instead, SCT has relied on the CEP and ancillary equipment for power and thermal energy. National Grid supplies natural gas that powers the CEP.

### 1.1.1 Central Energy Plant and Garages

The CEP houses and operates gas-fired boilers that generate steam. This steam produces electricity, hot water, and chilled water, which the CEP distributes to eight garages across the campus. At each garage, secondary distribution systems carry primary energy from the CEP to connected buildings.

**Table 1. Distribution of Supplied Residential Buildings, Units, and Area by Garage**

| Garage | No. of Supplied Buildings | Residential Units | Area (sf) |
|---|---|---|---|
| A | 5 | 780 | 805,450 |
| B | 4 | 502 | 482,350 |
| C | 8 | 1,168 | 1,212,226 |
| D | 3 | 442 | 419,930 |
| E | 5 | 652 | 678,423 |
| F | 5 | 612 | 633,133 |
| G | 10 | 1,173 | 1,100,156 |
| H | 6 | 552 | 564,675 |
| **Total** | **46** | **5,881** | **5,896,343** |

Over the past five years, SCT has installed new condensing boilers at each of the eight garages. These boilers supply heating hot water (HHW) and domestic hot water (DHW) to connected buildings. At the conclusion of this project, the CEP no longer supplies HHW and DHW to buildings but continues to supply electricity and chilled water.

The cooling tower (CT) at the CEP follows a 3-year repair cycle, which commences every 5 years. The CT operates at maximum capacity during summer, but extended summer heatwaves cause insufficient heat rejection.

Each garage also houses electrical switchgear that receives electricity from the CEP at 4,160 volts (V). The system then steps down and distributes electricity to each connected building.

### 1.1.2 Terminal Units within Residential Towers

SCT delivers thermal energy to 5,881 apartments via 18,000 terminal fan coil units (FCUs). A 2019 assessment of SCT's existing distribution infrastructure identified significant imbalances. The report concluded that various piping sizes and distribution designs, combined with a lack of flow control, create highly variable flow to FCUs. Depending on the FCU location, residential spaces may be over- or under-heated or cooled. The lack of FCU flow control results in excessive pumping energy (electricity) on the secondary distribution loops. Replacing FCUs with pressure-independent control valves (PICVs) would remedy this imbalance.

# 2 Thermal Profile

Geothermal analysis and system design rely on an hourly thermal model that represents space heating, space cooling, and DHW loads. Space use, occupancy schedules, and building conditions (such as insulation values and fenestration) shape the building's thermal profile.

## 2.1 Thermal Profile Methodology

The team generated hourly thermal energy profiles for the entire campus, including space heating, space cooling, and DHW, using IES VE 2021 energy modelling software. The team used best estimates for envelope thermal properties, insulation, internal loads, occupancy schedules, and thermal losses from the distribution infrastructure originating from the CEP. Historic data and qualitative information from SCT's facility operations team also informed the model.

Estimating SCT's campus thermal loads required interpreting available data. The utility's natural gas meter, which supplies the steam boilers at the CEP, provided the most reliable metered data. That natural gas is the source of electricity, space heating, space cooling, DHW, and cooking gas used on campus. Some hot water meters exist, but the team lacks confidence in their calibration or accuracy.

## 2.2 Thermal Profile Results

Figure 2 and Table 2 summarize the results of our modelling exercise. The model produced hourly profiles for space heating, cooling, and DHW. SCT's distribution system allows delivery of either space heating or cooling to tenants, but not both. This energy model reflects this limitation.

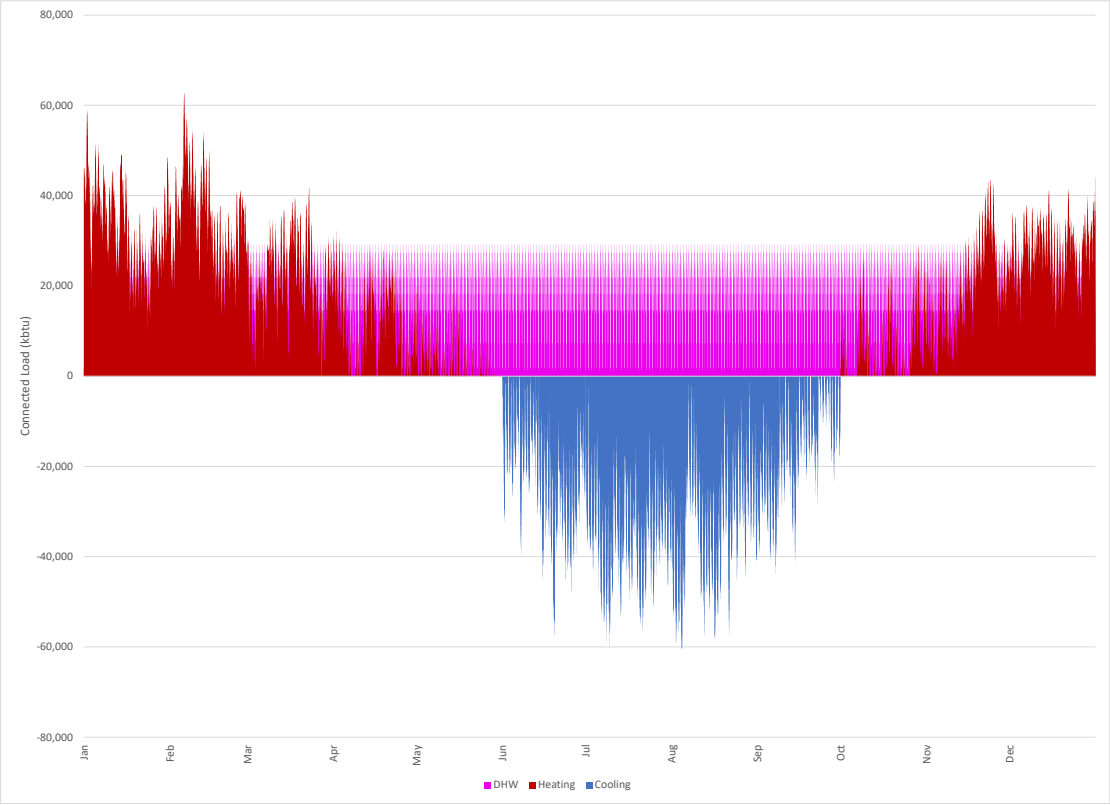
**Table 2. Monthly Thermal Energy Loads for Space Heating, Cooling, and Domestic Hot Water**

Values given in million British thermal units (MMBtu).

| Month | Space Heating | Space Cooling | DHW |
|---|---|---|---|
| Jan | 23,634 | 0 | 11,304 |
| Feb | 22,479 | 0 | 10,210 |
| Mar | 15,189 | 0 | 11,304 |
| Apr | 7,145 | 0 | 10,939 |
| May | 1,635 | 0 | 11,304 |
| Jun | 0 | 14,647 | 10,939 |
| Jul | 0 | 25,057 | 11,304 |
| Aug | 0 | 23,051 | 11,304 |
| Sep | 0 | 10,360 | 10,939 |
| Oct | 3,589 | 0 | 11,304 |
| Nov | 13,114 | 0 | 10,939 |
| Dec | 20,216 | 0 | 11,304 |
| **Total** | **107,001** | **73,115** | **133,090** |

Figure 2 presents the hourly profile for each thermal demand.

**Figure 2. Hourly Thermal Load Profile**



The team took thermal loads in Table 2 from overall campus loads and apportioned them by area in square feet (sf) to buildings served by each garage. This approach provides the best estimate of thermal loads that a future TEN would serve, assuming the system is divided into smaller districts (likely by garage) instead of relying on a single existing CEP.

Figure 3 illustrates the initial thermal load estimates, which indicate a significant imbalance between heating and cooling. Geothermal systems are typically sized for balanced loads to avoid significant ground heat exchanger (GHX) temperature fluctuations over time. Therefore, the team would size the geothermal system to supply a balanced portion of the total heating and cooling loads. Conventional equipment, such as air-source heat pumps (ASHPs), boilers, chillers, and/or CTs, would supply supplemental heating and cooling.

**Figure 3. Annual Heating and Cooling Load Duration Curve**

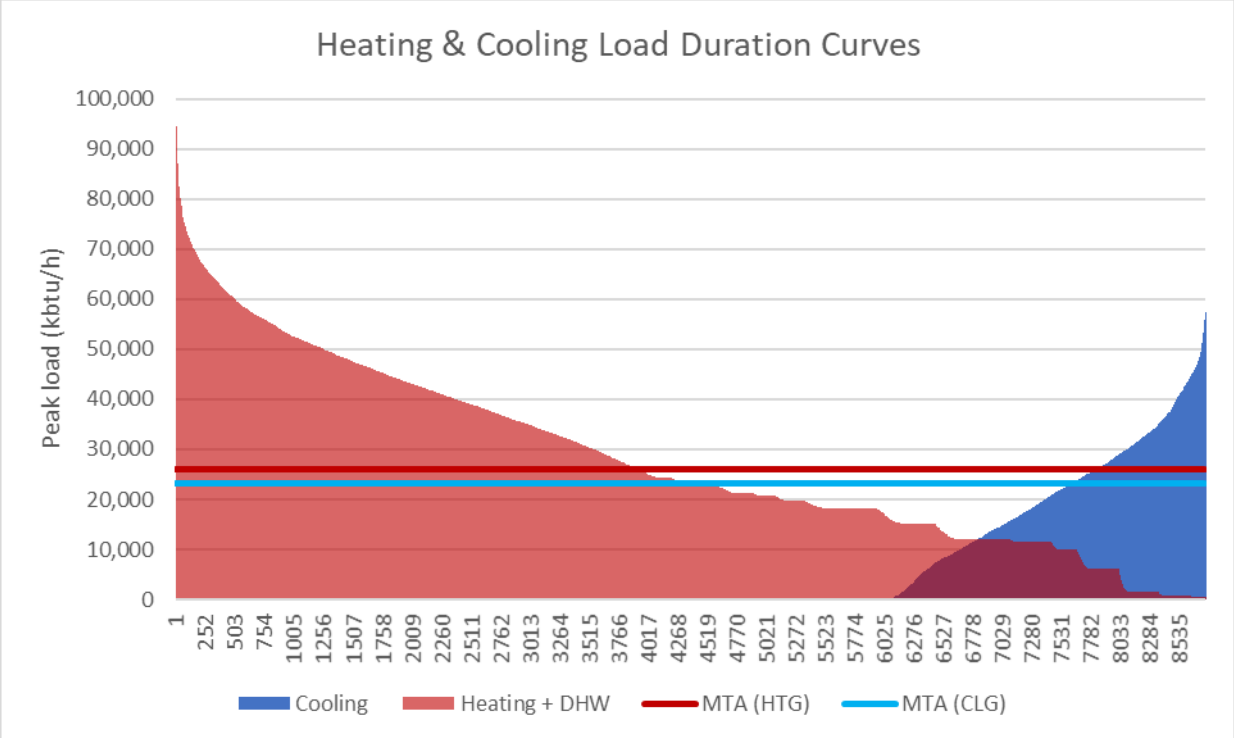


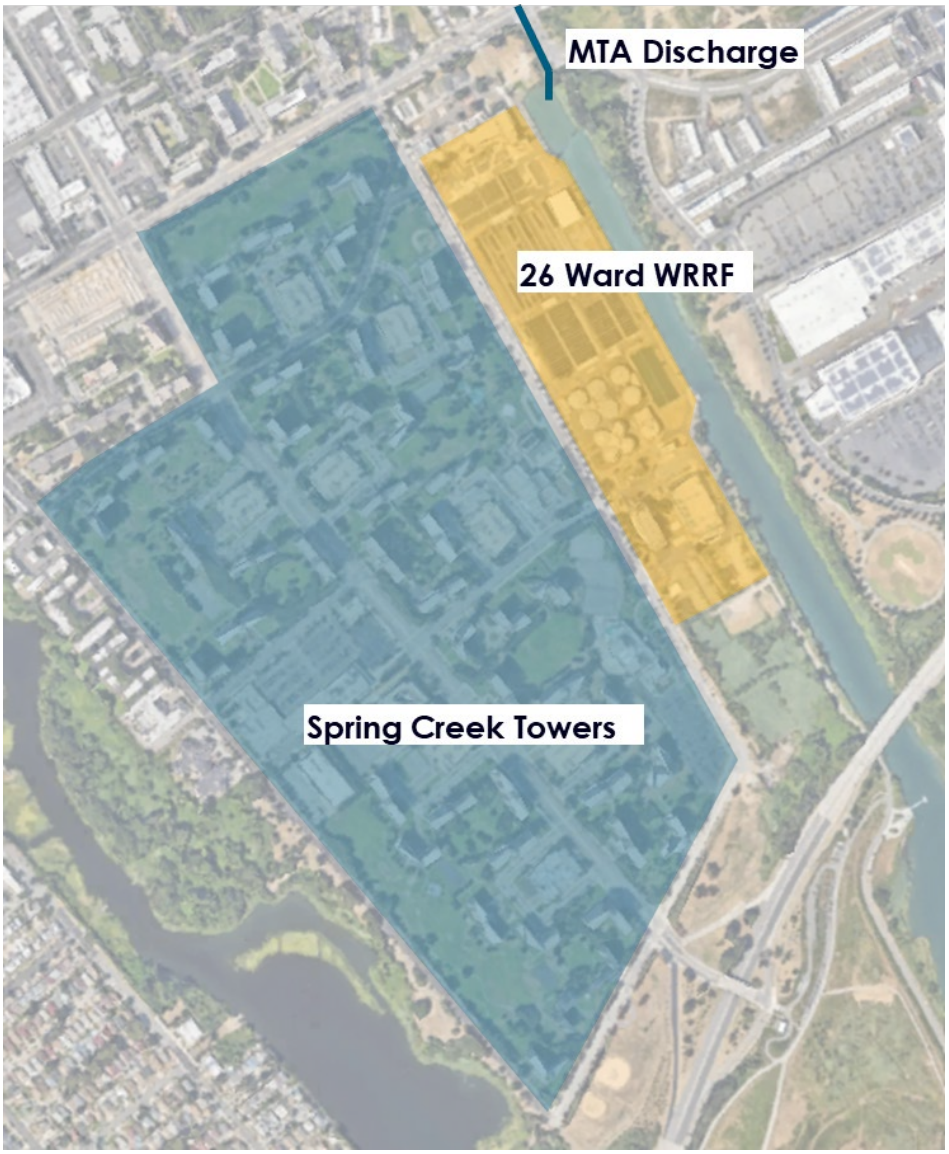
**Table 3. Annual and Peak Thermal Loads by Garage for Space Heating, Cooling, and Domestic Hot Water**

| Garage | Heating | | Cooling | | DHW | |
|---|---|---|---|---|---|---|
| | Annual (MMBtu) | Peak (MMBtu/hr) | Annual (MMBtu) | Peak (MMBtu/hr) | Annual (MMBtu) | Peak (MMBtu/hr) |
| A | 14,218 | 8.4 | 9,573 | 7.9 | 17,951 | 3.9 |
| B | 8,642 | 5.1 | 5,859 | 4.8 | 10,651 | 2.3 |
| C | 20,524 | 12.3 | 14,523 | 11.9 | 27,106 | 5.9 |
| D | 7,800 | 4.6 | 5,170 | 4.3 | 9,215 | 2.0 |
| E | 11,704 | 7.1 | 8,472 | 6.9 | 15,258 | 3.3 |
| F | 10,348 | 6.2 | 7,391 | 6.1 | 14,181 | 3.1 |
| G | 20,539 | 12.1 | 13,779 | 11.4 | 24,234 | 5.3 |
| H | 10,425 | 6.2 | 6,998 | 5.8 | 12,925 | 2.8 |
| Sports Club | 2,799 | 2.2 | 1,349 | 2.5 | 1,571 | 00.3 |
| **Total** | **107,001** | **62.6** | **73,115** | **60.5** | **133,090** | **29.2** |

# 3 Design Methodology

The team evaluated various technical solutions to satisfy the thermal demands across the SCT campus while improving efficiency. They examined multiple thermal energy sources, including the MTA discharge line, the adjacent WRRF, and conventional boreholes installed in existing open spaces. Figure 3 illustrates the thermal resources located near the SCT campus.

**Figure 4.Map of Discharge Line at East New York Wellfield, Neighborhood View**



SCT residents have historically received electricity, heating, cooling, and DHW from the natural gas-fired CEP. In recent years, localized natural gas boilers have replaced the CEP as the source of space heating and DHW. The CEP continues to supply electricity and chilled water to SCT residents. Electrifying heating and cooling will add between 5–6 megawatts (MW) of electric demand to the existing generators within the CEP. Because no other electricity source is available at the site, the team must consider this additional electric demand. The CEP's electric generating assets are likely to need replacement or rebuilding within the next decade. While a CEP repowering falls outside the scope of this study, it remains relevant when considering the long-term impacts of a primarily electric district thermal system.

The team based initial conceptual designs for a thermal district on water-source heat pumps (WSHPs) that would draw thermal energy either from the MTA pumped groundwater system, a connection to the 26th Ward WRRF, or a dedicated GHX within SCT. The team proposed locating heat pumps, circulating pumps, and other equipment at the garage locations. The following section discusses each option.

## 3.1 Pumped Groundwater Thermal Exchange

The MTA operates numerous wellfields and pump rooms to continuously remove groundwater and protect transit facilities throughout New York City. To prevent flooding, the MTA uses both deep and shallow wells. The New York City Transit Authority (NYCTA) commissioned a study of three well stations to assess the potential beneficial reuse of pumped water, such as for heating and cooling, irrigation, and once-through cooling of electric transformers.[1]

The eight deep wells in East New York Wellfield emerged as a potential thermal energy source for nearby buildings. Each well is connected to a dedicated pump room located near the Van Siclen Avenue subway station. The system pumps groundwater to a single discharge line that runs south along Schenck Avenue, ultimately discharging into Hendrix Creek and Jamaica Bay. The discharge point lies approximately 800 feet east of the SCT campus.

**Figure 5. Map of Discharge Line at East New York Wellfield, Street View**

*Source: Mueser Rutledge (2011).* [2]


**Table 4. Groundwater Heat Recovery: Key Considerations**

| Pros | Cons |
|---|---|
| • Requires smaller physical footprint than borehole design of similar thermal capacity<br>• Operates in parallel with borehole GHX<br>• Delivers high efficiency<br>• Maintains performance regardless of ambient conditions<br>• Enables low- to zero-carbon solution when coupled with a WSHP | • Depends on volume and flow rate of available groundwater for thermal capacity<br>• Fails to fully meet building thermal demand under some conditions<br>• Requires permits to connect to NYCTA infrastructure and discharge into public waterways<br>• Involves ongoing fees paid by SCT to access thermal energy from NYCTA infrastructure |

The MTA groundwater thermal exchange (GTE) concept involves installing a heat exchanger near the East New York Wellfield discharge line. The system would use the heat exchanger to absorb or reject heat to the MTA groundwater discharge line and Hendrix Creek.

The design includes a new 2-pipe ambient loop to circulate thermal energy between the discharge line and the SCT campus, as shown in Figure 5. This ambient loop would connect each WSHP pump room and distribute thermal energy across the campus. The garages adjacent to the newly installed boiler plants would house the pump rooms.

WSHPs would supply heating and cooling to connected buildings. However, the MTA discharge line's thermal capacity would fall short of meeting peak thermal loads. ASHPs installed alongside WSHPs at each garage would supply excess heating and cooling demand. Existing boilers would remain to provide peak heating capacity, operating only a few hours per year. The model estimates that boilers would supply approximately 31% of the heating energy for connected buildings.

**Table 5. Annual Boiler Load by Distribution Network**

| | Heating Boiler | | | |
|---|---|---|---|---|
| Garage | **MMBtu** | **Percent** | **Hours** | **EFLH** |
| A | 9,596 | 29% | 4,147 | 1,252 |
| B | 8,834 | 45% | 4,937 | 2,478 |
| C | 15,226 | 31% | 4,525 | 1,605 |
| D | 5,634 | 32% | 4,070 | 2,038 |
| E | 8,643 | 31% | 4,035 | 2,010 |
| F | 7,071 | 28% | 4,290 | 1,393 |
| G | 14,333 | 31% | 4,072 | 1,411 |
| H | 7,759 | 32% | 4,427 | 1,474 |
| Sports Club | 6 | 0% | 41 | 13 |
| **Combined** | **77,103** | **31%** | **4,947** | **1,657** |

This configuration offers several benefits to SCT residents. It replaces aging cooling infrastructure with a modern, efficient, and reliable system. It also avoids the cost and space constraints of drilling conventional boreholes. The distributed pump room design mirrors the recent boiler plant configuration, reducing thermal losses compared to the existing CEP and allowing SCT facility staff to operate and maintain the system efficiently. This hybrid system eliminates the need for a CT and reduces reliance on gas-fired boilers. WSHPs and ASHPs together would supply most of the heating and cooling demands. Figure 6 illustrates this concept.

**Figure 6. Map of MTA Pumped Groundwater Thermal Exchange Design**

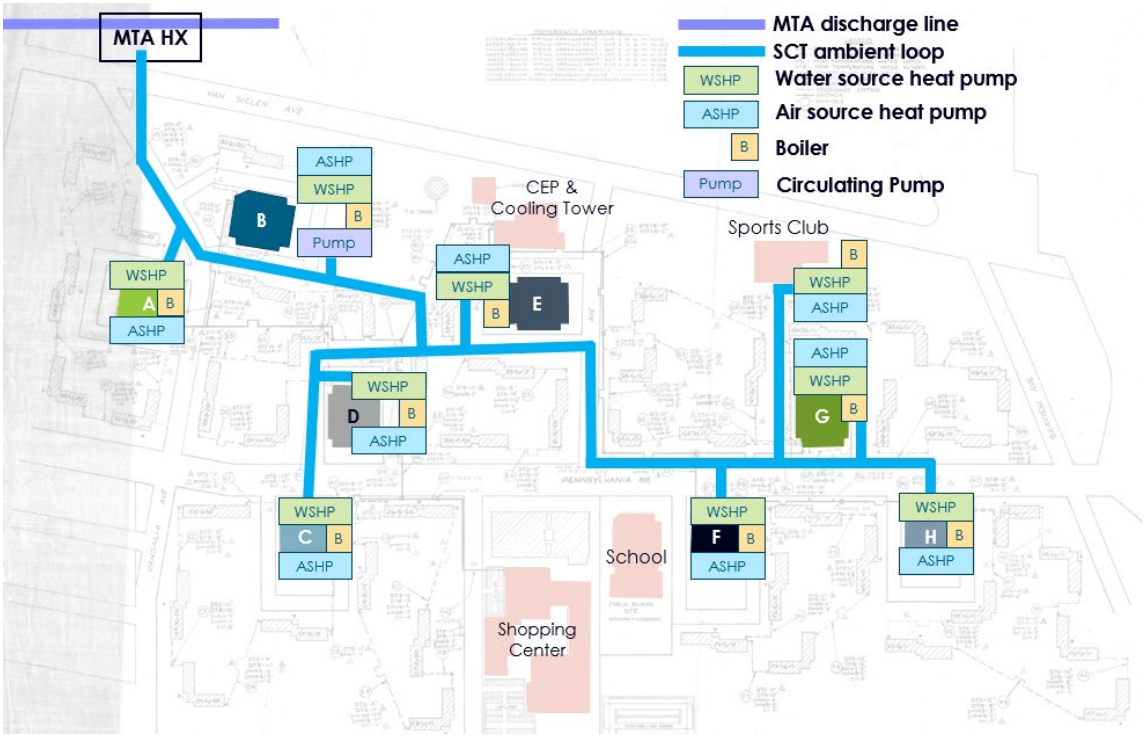



Table 5 summarizes the peak loads (capacity) and annual heating and cooling loads by garage. It also shows the contribution from each thermal resource required to meet the heating and cooling needs of the buildings. The table identifies "Simultaneous" loads, which are heating and cooling demands that occur at the same time and which the GSHP can satisfy in simultaneous mode without extracting from or rejecting heat to the MTA resource or the atmosphere.

**Table 6. Annual Peak Thermal Loads by Garage with Resource Contributions**

| | CLG | HTG | CLG | HTG | CLG | HTG | HTG |
|---|---|---|---|---|---|---|---|
| Garage A | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 210 | tons | 240 tons | 3,425 MBH | 250 tons | 2,029 MBH | 7,053 MBH |
| Annual load (kBtu) | 3,177,950 | 4,131,335 | 3,694,542 | 18,529,368 | 452,387 | 6,506,695 | 3,709,516 |
| % annual load | 43% | 13% | 50% | 56% | 6% | 20% | 11.3% |
| | CLG | HTG | CLG | HTG | CLG | HTG | HTG |
| Garage B | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 125 tons | — | 150 tons | 2,076 MBH | 165 tons | 1,364 MBH | 4,130 MBH |
| Annual load (kBtu) | 1,895,542 | 2,464,205 | 2,330,078 | 11,158,815 | 287,683 | 4,146,679 | 1,962,704 |
| % annual load | 42% | 12% | 52% | 57% | 6% | 21% | 9.9% |

**Table 6. (continued)**

| Garage C | CLG | HTG | CLG | HTG | CLG | HTG | HTG |
|---|---|---|---|---|---|---|---|
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 317 tons | | 376 tons | 5,022 MBH | 412 tons | 3,364 MBH | 10,140 MBH |
| Annual load (kBtu) | 4,814,233 | 6,258,503 | 5,745,327 | 27,167,941 | 663,340 | 10,296,634 | 4,710,227 |
| % annual load | 43% | 13% | 51% | 56% | 6% | 21% | 9.7% |
| **Garage D** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 108 tons | | 130 tons | 1,860 MBH | 141 tons | 1,152 MBH | 3,685 MBH |
| Annual load (kBtu) | 1,645,683 | 2,139,388 | 2,051,630 | 9,949,603 | 266,444 | 3,584,282 | 1,811,372 |
| % annual load | 42% | 12% | 52% | 57% | 7% | 20% | 10.4% |
| **Garage E** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 178 tons | | 223 tons | 2,886 MBH | 250 tons | 2,032 MBH | 5,632 MBH |
| Annual load (kBtu) | 2,733,515 | 3,553,569 | 3,441,906 | 15,483,589 | 390,814 | 6,001,433 | 2,426,883 |
| % annual load | 42% | 13% | 52% | 56% | 6% | 22% | 8.8% |
| **Garage F** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 166 tons | | 194 tons | 2,539 MBH | 212 tons | 1,728 MBH | 5,238 MBH |
| Annual load (kBtu) | 2,500,487 | 3,250,634 | 2,905,388 | 13,831,297 | 322,360 | 5,314,398 | 2,437,334 |
| % annual load | 44% | 13% | 51% | 56% | 6% | 21% | 9.8% |
| **Garage G** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 285 tons | | 350 tons | 4,912 MBH | 390 tons | 3,174 MBH | 9,589 MBH |
| Annual load (kBtu) | 4,341,334 | 5,643,734 | 5,542,655 | 26,206,551 | 711,693 | 9,676,720 | 4,476,247 |
| % annual load | 41% | 12% | 52% | 57% | 7% | 21% | 9.7% |
| **Garage H** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 150 tons | | 176 tons | 2,510 MBH | 182 tons | 1,480 MBH | 5,120 MBH |
| Annual load (kBtu) | 2,296,189 | 2,985,046 | 2,720,322 | 13,526,246 | 331,639 | 4,726,542 | 2,677,644 |
| % annual load | 43% | 12% | 51% | 57% | 6% | 20% | 11.2% |
| **Garage: Sports** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 20 tons | | 83 tons | 770 MBH | 115 tons | 941 MBH | 767 MBH |
| Annual load (kBtu) | 239,433 | 311,262 | 918,357 | 2,850,315 | 191,127 | 911,870 | 34,867 |
| % annual load | 18% | 8% | 68% | 69% | 14% | 22% | 0.8% |

This configuration delivers heating and cooling while significantly reducing the need for natural gas combustion within the boilers. Although the system would still partially rely on natural gas boilers for peak heating, adding WSHPs and ASHPs marks a major step toward reducing carbon emissions. Electricity for WSHPs and ASHPs would still come from the CEP's natural gas-fired generation. However, increased electrification of heating and cooling could reduce carbon emissions through greater CEP efficiency or integration of renewable electricity generation.

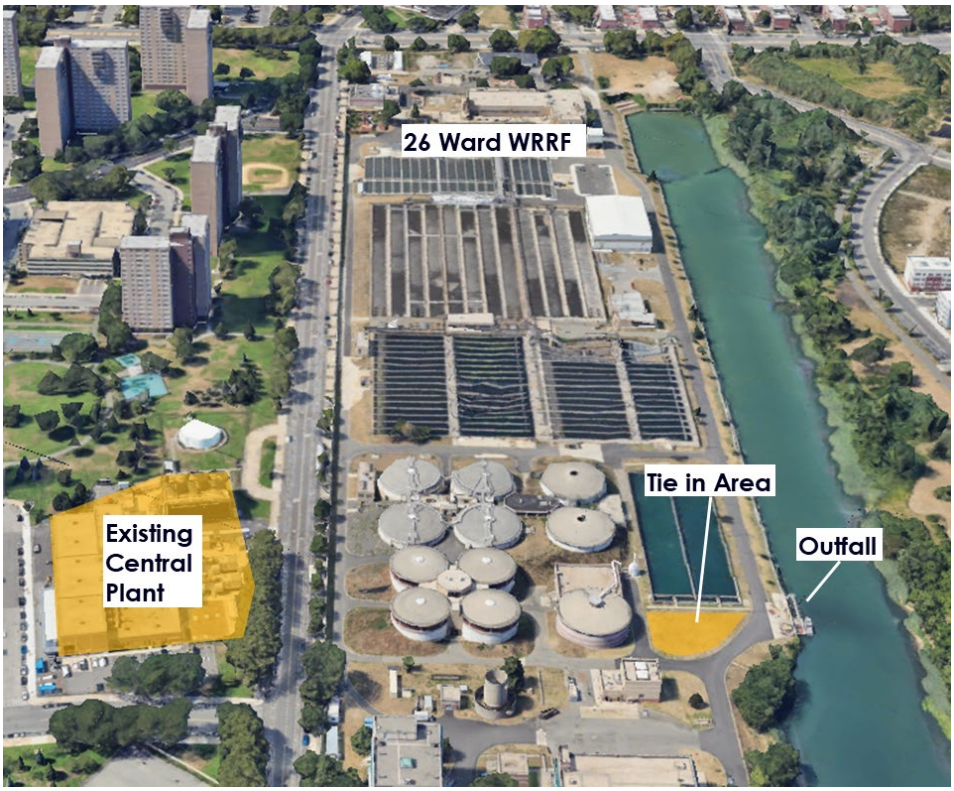
## 3.2 Wastewater Heat Recovery

The New York City Department of Environmental Protection (DEP) operates the 26th Ward WRRF adjacent to the SCT campus. The facility handles up to 85 million gallons per day (MGD). Thermal energy can be extracted or rejected at various stages in the treatment process. When connected to a WSHP, treated water flow provides a thermal resource to heat and cool nearby buildings. The proximity of the 26th Ward WRRF to SCT presents a unique opportunity to tap into this thermal resource and supply heating and cooling to SCT residents.

**Table 7. Wastewater Heat Recovery: Key Considerations**

| Pros | Cons |
|---|---|
| • Requires smaller physical footprint than borehole design of similar thermal capacity<br>• Operates in parallel with borehole GHX<br>• Delivers highly efficiency<br>• Maintains performance regardless of ambient conditions<br>• Enables low- to zero-carbon solution when coupled with a WSHP | • Depends on the volume and flow rate of available wastewater for thermal capacity<br>• Fails to fully meet building demand under some conditions<br>• Requires permits to connect to DEC infrastructure and manage effluent temperature impacts<br>• Involves ongoing fees SCT paid to access thermal energy from DEP infrastructure |

**Figure 7. Wastewater Resource Recovery Facility Proposed Tie-in Location**

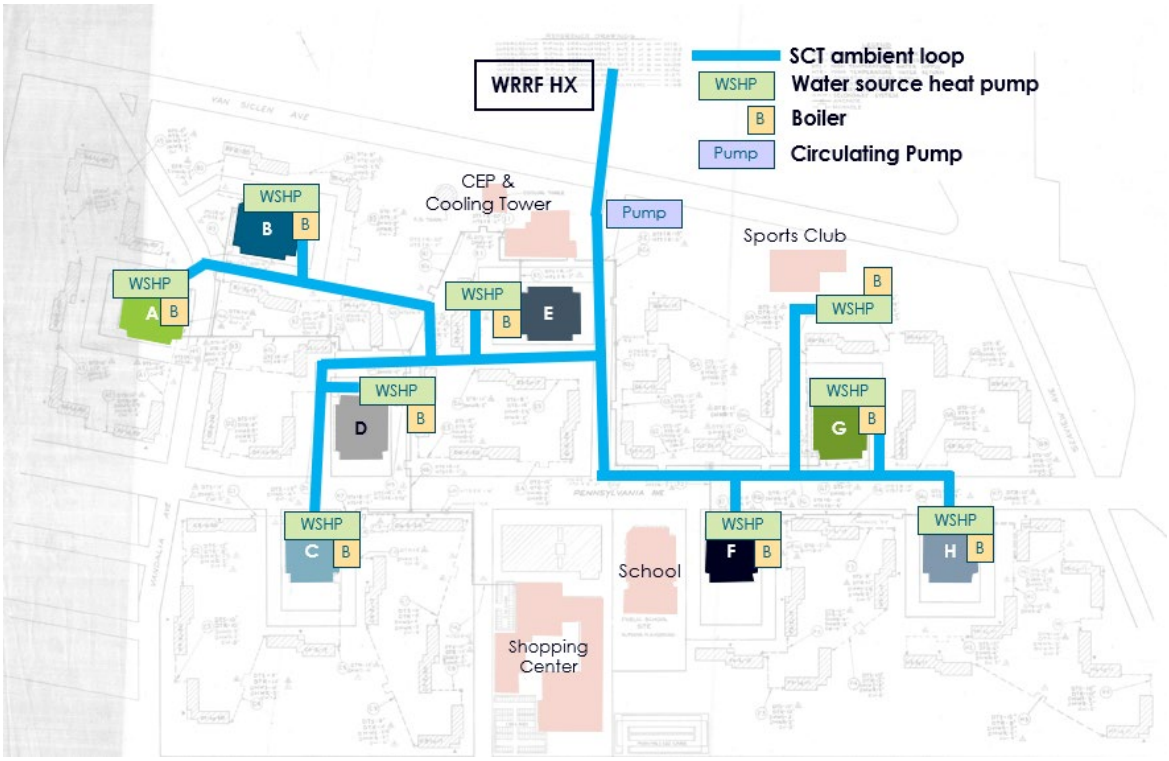



The WRRF configuration mirrors the GTE option, using a heat exchanger to intercept a flow of treated wastewater before final outfall into Hendrix Creek. The 26th Ward WRRF offers key advantages over the GTE, particularly in the flow rate and location. The 85 MGD flow of water serves as a thermal resource capable of supplying energy to the SCT campus. Figure 7 illustrates the proximity of the 26th Ward WRRF to the SCT CEP.

The team secured flow and temperature data from a recent study conducted at the 26th Ward WRRF. The dataset includes hourly flow data from 2019, 2020, and 2021, indicating an average flow of 51.6 MGD throughout the year. This equates to approximately 35,000 gallons per minute (GPM). A flow of 35,000 GPM provides enough thermal energy to meet 100% of SCT's demand, eliminating the need for supplementary heat from boilers or cooling from chillers or ASHPs. This configuration would eliminate the boilers and ASHPs required with the GTE and ground loop heat exchanger (GLHE) options.

The location of the WRRF tie-in point also lies closer to SCT's existing CEP than the MTA discharge line, reducing pipe installation costs. The distance between the 26th Ward WRRF tie-in point and SCT's existing CEP is approximately 1,000 feet.

**Figure 8. Wastewater Resource Recovery Facility Design**




## 3.3 Ground-Source Heat Pumps

GSHPs rank among the most efficient heating and cooling technologies commercially available. This technology relies on a WSHP with a refrigeration loop that facilitates thermal exchange between a GHX and a working fluid (glycol-water solution) contained within the GHX. Because ground temperatures remain more stable than air temperatures throughout the year, the GSHP uses the ground as a heat source in the winter and a heat sink in the summer.

Developing a WSHP solution uniquely allows the system to exploit simultaneous thermal demands, such as when a building needs space cooling and DHW at the same time. A water-based heat pump rejects waste heat from the cooling process into the DHW circuit, which increases the system's overall efficiency.

**Table 8. Ground-Source Heat Pumps: Key Considerations**

| Pros | Cons |
|---|---|
| • Delivers highest efficiency of all HVAC technologies (COP up to 5.0, equipment- and condition-dependent)<br>• Offers lowest operating cost compared to conventional HVAC equipment<br>• Involves lower maintenance costs than conventional HVAC equipment<br>• Supplies simultaneous heating and cooling<br>• Provides low- to zero-carbon solution when powered by electricity<br>• Operates more quietly than rooftop condenser systems | • Requires higher Capex<br>• Requires greater space than ASHPs or pumped groundwater/wastewater heat recovery systems |

Air-source heat pumps (ASHPs) provide a flexible solution for backup heating and cooling capacity. In place of a GHX, ASHPs use ambient air as the heat source or sink. A refrigeration loop drives heat exchange between the ambient air and the working fluid. This solution performs best under ambient conditions (i.e., fall and spring), while efficiency drops significantly during summer and winter.

**Table 9. Air Source Heat Pumps: Key Considerations**

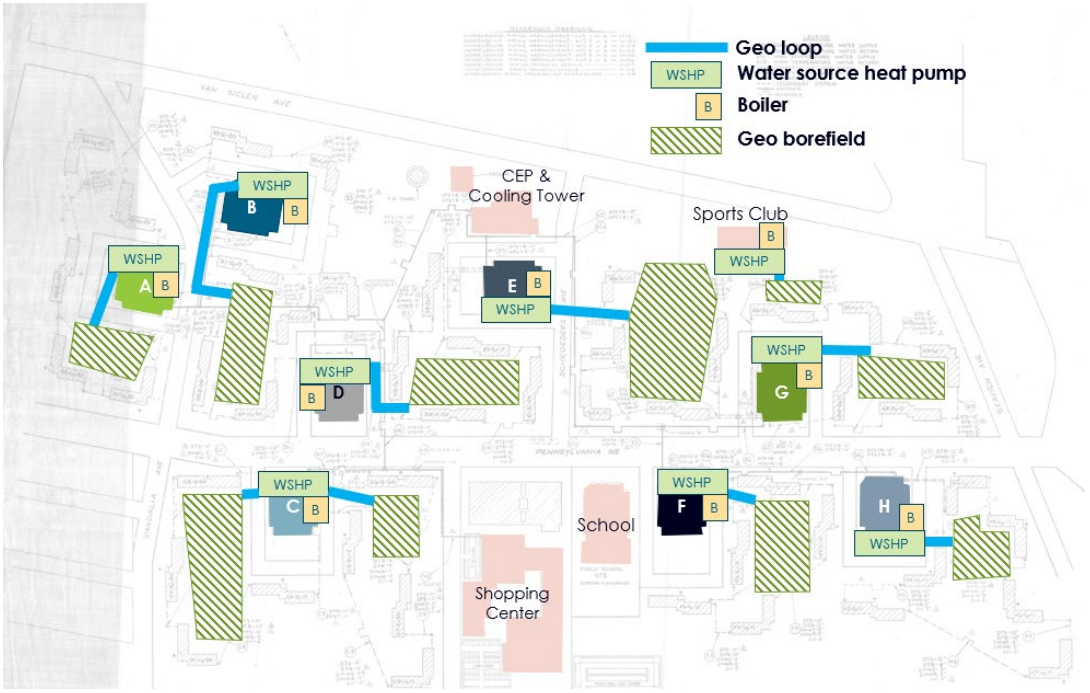
| Pros | Cons |
|---|---|
| • Delivers good performance at moderate ambient temperatures (COP of 3.0–3.5 at 50°F)<br>• Provides low- to zero-carbon solution when powered by electricity<br>• Involves the lowest cost among all-electric HVAC systems | • Requires outdoor space (typically roof area) to locate condenser units<br>• Experiences reduced efficiency at extreme ambient temperatures (COP <2.3 at 10°F) |

Because thermal imbalances exist across SCT, a geothermal district thermal system must incorporate some capacity from ASHPs. These assets can complement a GSHP system to manage unbalanced loads and peaks that exceed the GSHP capacity. Since ASHPs do not require a GHX, they are an ideal complement to GSHP systems. For this study, the model assumes the site conditions listed in Table 10 as the basis for the geothermal model.

**Table 10. Assumed Geothermal Conditions**

| Geothermal Property | Assumed Value |
|---|---|
| Thermal Conductivity | 1.4 Btu/(hr×ftx°F) |
| Thermal Diffusivity | 1.0 sf2/day |
| Undisturbed Ground Temperature | 52.0°F |

**Figure 9. District Geothermal Thermal Energy Network**




The geothermal configuration illustrated in Figure 9 provides an alternative to the MTA and WRRF options. The geothermal design avoids access to the MTA groundwater system and instead uses the thermal exchange with the ground through dedicated vertical geothermal borefields. Ideally, the GHX is situated as close as possible to the source or energy loop. A 2-pipe distribution system thermally connects the buildings and GLHE. The 2-pipe supply/return design reduces investment in lateral piping and trenching as compared to the GTE design.

**Table 11. Annual Peak Thermal Loads by Garage**

| Garage A | CLG | HTG | CLG | HTG | CLG | HTG | HTG |
|---|---|---|---|---|---|---|---|
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 210 tons | | 240 tons | 3,425 MBH | 250 tons | 2,029 MBH | 7,053 MBH |
| Annual load (kBtu) | 3,177,950 | 4,131,335 | 3,694,542 | 18,529,368 | 452,387 | 6,506,695 | 3,709,516 |
| % annual load | 43% | 13% | 50% | 56% | 6% | 20% | 11.3% |
| **Garage B** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 125 tons | | 150 tons | 2,076 MBH | 165 tons | 1,364 MBH | 4,130 MBH |
| Annual load (kBtu) | 1,895,542 | 2,464,205 | 2,330,078 | 11,158,815 | 287,683 | 4,146,679 | 1,962,704 |
| % annual load | 42% | 12% | 52% | 57% | 6% | 21% | 9.9% |

**Table 11. (continued)**

| Garage C | CLG | HTG | CLG | HTG | CLG | HTG | HTG |
|---|---|---|---|---|---|---|---|
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 317 tons | — | 376 tons | 5,022 MBH | 412 tons | 3,364 MBH | 10,140 MBH |
| Annual load (kBtu) | 4,814,233 | 6,258,503 | 5,745,327 | 27,167,941 | 663,340 | 10,296,634 | 4,710,227 |
| % annual load | 43% | 13% | 51% | 56% | 6% | 21% | 9.7% |
| **Garage D** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 108 tons | — | 130 tons | 1,860 MBH | 141 tons | 1,152 MBH | 3,685 MBH |
| Annual load (kBtu) | 1,645,683 | 2,139,388 | 2,051,630 | 9,949,603 | 266,444 | 3,584,282 | 1,811,372 |
| % annual load | 42% | 12% | 52% | 57% | 7% | 20% | 10.4% |
| **Garage E** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 178 tons | — | 223 tons | 2,886 MBH | 250 tons | 2,032 MBH | 5,632 MBH |
| Annual load (kBtu) | 2,733,515 | 3,553,569 | 3,441,906 | 15,483,589 | 390,814 | 6,001,433 | 2,426,883 |
| % annual load | 42% | 13% | 52% | 56% | 6% | 22% | 8.8% |
| **Garage F** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 166 tons | — | 194 tons | 2,539 MBH | 212 tons | 1,728 MBH | 5,238 MBH |
| Annual load (kBtu) | 2,500,487 | 3,250,634 | 2,905,388 | 13,831,297 | 322,360 | 5,314,398 | 2,437,334 |
| % annual load | 44% | 13% | 51% | 56% | 6% | 21% | 9.8% |
| **Garage G** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 285 tons | — | 350 tons | 4,912 MBH | 390 tons | 3,174 MBH | 9,589 MBH |
| Annual load (kBtu) | 4,341,334 | 5,643,734 | 5,542,655 | 26,206,551 | 711,693 | 9,676,720 | 4,476,247 |
| % annual load | 41% | 12% | 52% | 57% | 7% | 21% | 9.7% |
| | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| **Garage H** | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 150 tons | — | 176 tons | 2,510 MBH | 182 tons | 1,480 MBH | 5,120 MBH |
| Annual load (kBtu) | 2,296,189 | 2,985,046 | 2,720,322 | 13,526,246 | 331,639 | 4,726,542 | 2,677,644 |
| % annual load | 43% | 12% | 51% | 57% | 6% | 20% | 11.2% |
| **Garage: Sports** | **CLG** | **HTG** | **CLG** | **HTG** | **CLG** | **HTG** | **HTG** |
| | Simultaneous | | MTA | MTA | ASHP | ASHP | Conventional Boiler |
| Capacity | 20 tons | — | 83 tons | 770 MBH | 115 tons | 941 MBH | 767 MBH |
| Annual load (kBtu) | 239,433 | 311,262 | 918,357 | 2,850,315 | 191,127 | 911,870 | 34,867 |
| % annual load | 18% | 8% | 68% | 69% | 14% | 22% | 0.8% |

# 4 Financial Analysis

The financial analysis evaluates both operating and capital costs for each district thermal alternative compared to the business-as-usual (BAU) operation. It also evaluates carbon emissions and Local Law 97 carbon emissions costs for each scenario, assuming continued reliance on the CEP and considering a potential electric interconnection to Con Edison as well as CEP decommissioning.

## 4.1 Operating Costs

The analysis separates operating costs into energy (utility) costs and operator and maintenance costs. Energy costs are unique at the SCT campus. SCT currently generates and distributes electricity from its gas-fired central plant. Therefore, scenarios that assume continued CEP operation derive electricity costs from the plant's operating expenses and not from a Con Edison delivery tariff.

This analysis presents electricity use for each configuration and estimates current equipment operating costs using SCT's average cost to generate electricity (see Appendix A for methodology and results).

Rather than focus on nominal costs, the analysis compares relative costs between configurations. As fossil fuel-based power and heating costs rise in New York City, SCT may eventually choose to connect to the local electricity grid. If this transition occurs, SCT will fully electrify its heating and cooling systems, thereby reducing associated carbon emissions.

**Table 12. Additional Energy for Heating, Cooling, and Hot Water by Configuration**

| Metric | MTA with CT & Boilers | MTA with ASHP | Geothermal | WRRF |
|---|---|---|---|---|
| Electricity from CEP | 18,595 MWh | 24,871 MWh | 20,076 MWh | 24,676 MWh |
| Electric Capacity | 5.0 MW | 5.5 MW | 6.1 MW | 5.2 MW |
| Gas to Garage Boilers | 81,970 MMBtu | 26,355 MMBtu | 83,807 MMBtu | 0 MMBtu |

Table 12 summarizes the energy inputs required to power the various district thermal system options and the garage boilers. The electricity required to power these systems adds to what the CEP currently produces. The electricity capacity represents the estimated additional capacity (MW) required beyond what the CEP currently generates. Table 13 summarizes the CEP's electricity output, natural gas inputs, and carbon emissions for the BAU and each alternative scenario. The table shows total annual figures for the entire SCT campus.

**Table 13. Carbon Emissions for Heating, Cooling, and Hot Water by Configuration**

| Scenario | CEP Electricity (MWh) | Gas to Garage Boilers (MMBtu) | Gas to CEP (MMBtu) | Carbon Emissions[a] ($tCO_2e$) |
|---|---|---|---|---|
| BAU | 68,075 | 251,131 | 985,169 | 65,660 |
| MTA with CT and Boilers | 86,670 | 81,970 | 1,254,272 | 70,968 |
| MTA with ASHP | 92,946 | 26,355 | 1,345,098 | 72,838 |
| Geothermal | 88,151 | 83,807 | 1,275,705 | 72,204 |
| WRRF | 92,751 | 0 | 1,342,276 | 71,288 |

[a] Carbon emissions assume the natural gas factor from Local Law 97: 0.00005311 $tCO_2$ per kBtu of natural gas. A heat rate of 14,472 Btu/kWh is used to estimate electricity generation efficiency.

The analysis also considered the energy use and carbon emissions profile of the BAU and alternative configurations, assuming SCT connects electrically to Con Edison. In this case, we assume the utility supplies both electricity and gas, using emissions factors from by Local Law 97 for the 2024 calendar year. As the grid becomes cleaner, SCT's emissions from Con Edison electricity will continue to decline. Table 7 estimates carbon emissions using 2024 emissions factors from Local Law 97 (2024) and projected 2030 emissions after an 80% reduction.

**Table 14. Carbon Emissions for Heating, Cooling, and Hot Water by Configuration Assuming Con Edison Utility Connection**

| Scenario | Con Edison Electricity (MWh) | Gas to Garage Boilers (MMBtu) | Gas to CEP (MMBtu) | Carbon Emissions[a] | |
|---|---|---|---|---|---|
| | | | | 2024 ($tCO_2e$) | 2030 ($tCO_2e$) |
| BAU | 68,075 | 251,131 | 0 | 33,009 | 17,272 |
| MTA with CT and Boilers | 86,670 | 81,970 | 0 | 29,398 | 9,362 |
| MTA with ASHP | 92,946 | 26,355 | 0 | 28,258 | 6,771 |
| Geothermal | 88,151 | 83,807 | 0 | 29,923 | 9,545 |
| WRRF | 92,751 | 0 | 0 | 26,802 | 5,360 |

[a] Carbon emissions assume the natural gas factor from Local Law 97: 0.00005311 tCO2 per kBtu of natural gas. Emissions from electricity use are calculated using the 2024 Local Law 97 factor: 0.000288962 tCO2 per kWh. For 2030, electricity emissions are assumed to be reduced by 80%, 0.00005779 tCO2 per kWh).

We estimate the campus's emissions limit to be approximately 49,100 tCO2e. (This estimate uses the 2024–2029 intensity limit of 0.00675 metric tons of carbon dioxide equivalent per square foot ($tCO_2e$/sf) for multifamily properties and a gross multifamily area of 7,274,115 sf. By transitioning to Con Edison electricity, campus buildings can avoid or reduce Local Law 97–related emissions penalties, keeping annual emissions below 49,100 $tCO_2e$. However, each scenario in Table 6 assumes continued CEP power would exceed the emissions limits.

Table 8 estimates annual penalties for exceeding those limits set forth by Local Law 97 and using the published price of $268 per $tCO_2e$ for emissions that exceed the allowed limit.

**Table 15. Annual Penalties Related to Local Law 97 Emissions Limits Assuming Continued Central Energy Plant Operations**

| Scenario | Carbon Emissions from CEP and Garage Boilers ($tCO_2e$)[a] | Emissions Exceeding LL97 Limits (tCO2e)[a] | Local Law 97 Penalty[a] |
|---|---|---|---|
| BAU | 65,660 | 16,560 | $4,438,000 |
| MTA with CT and Boilers | 70,968 | 21,868 | $5,861,000 |
| MTA with ASHP | 72,838 | 23,738 | $6,362,000 |
| Geothermal | 72,204 | 23,104 | $6,192,000 |
| WRRF | 71,288 | 22,188 | $5,946,000 |

[a] Local Law penalties assume $268/tCO2e exceeding the building emissions allowance. This table does not consider Section 321 alternative compliance.

Section 321 of Local Law 97 provides alternative compliance pathways for certain buildings. This section allows affordable housing buildings to complete 13 prescriptive energy conservation measures and report to the Department of Buildings to avoid 2025 penalties. Since SCT is a Mitchell-Lama Housing Project, it should qualify for this pathway and prevent the penalties summarized in Table 11. Nonresidential buildings, such as the sports club and retail building, likely still need to comply with Section 321 and pay for emissions exceedances. Because Con Edison electricity carries lower emissions factors than the CEP, these buildings would benefit most from early electrical interconnection with Con Edison.

The analysis indicates that both the MTA with CT and boilers and the WRRF configurations require the least additional energy and emit the lowest amount of added carbon. Assuming SCT connects to the local utility, the BAU scenario emits the most carbon emissions (33,009 tCO2e), while the WRRF scenario emits the least (26,802 tCO2e).

The analysis assumes the same operator costs for all configurations. It includes 11 full-time employees (FTEs), with total staffing costs, including benefits, estimated at $17.5 million per year. In scenarios where the CEP remains operational, we assume SCT will not need to hire additional staff. Instead, we carry the same operations and maintenance (O&M) costs as the BAU case, but add $1 million per year for additional maintenance associated with the district thermal system. If SCT switches to electricity delivery from Con Edison, it could significantly reduce costs by shutting down the CEP.

## 4.2 Capital Costs

We developed capital cost estimates for each system configuration based on major components (as seen in Table 16). We reasonably assume that both the MTA and the DEC (WRRF) would require payments for access to thermal energy from their discharge infrastructure. While the team has not yet begun negotiations or reviewed similar agreements, we estimate a reasonable thermal access fee.

We assume the MTA (or DEC) would own the tie-in infrastructure at their discharge facility. If the MTA (or DEC) invests $7.4 million to install the tie-in infrastructure, we assume they would expect an annual payment of approximately $1 million over 25 years (with a 3% annual increase) to justify the investment and earn a 10% return.

**Table 16. Capital Costs by Configuration**

All values in $1,000.

| Capital Cost Component | MTA with CT & Boilers | MTA with ASHP | Geothermal | WRRF |
|---|---|---|---|---|
| MTA/WRRF Tie-in | $7,288 | $7,302 | — | $7,308 |
| Pumps | $20,418 | $19,563 | $19,390 | $20,472 |
| Mechanical Equipment | $20,508 | $20,126 | $21,211 | $12,402 |
| Horizontal Distribution | $26,815 | $23,653 | $6,460 | $21,717 |
| Borefield | — | — | $46,994 | — |
| **Total** | **$75,029** | **$70,644** | **$94,054** | **$61,900** |

Both MTA options have similar pricing, which is expected given their similar design and distribution requirements. The geothermal solution incurs the highest Capex due to the drilling and installation of borefields. The WRRF solution is the most cost-effective because it requires shorter distribution piping and eliminates borefield installation.

## 4.3 Incentives

The U.S. Department of the Treasury (Treasury) and the Internal Revenue Service (IRS) offer investment tax credits (ITCs) for commercial geothermal systems under Section 48 of the Internal Revenue Code. Under the Inflation Reduction Act of 2022 (IRA), qualifying geothermal heat pump equipment may earn a base ITC of 6%. Projects that meet prevailing wage and apprenticeship requirements qualify for a bonus rate of 30%. Additional bonus (10% each) are available for:

- Projects that meet domestic content requirements
- Projects located in energy communities (as defined by the U.S. Department of Energy)

A project can earn a 10% bonus for each of these categories. For example, if both bonuses are satisfied, geothermal heat pump equipment that qualifies for a 30% ITC would instead qualify for a 50% ITC.

On November 22, 2023, the Treasury released a Notice of Proposed Rulemaking (NOPR) and solicited public comment. One proposed rule significantly impacts how ITC credits apply to projects with multiple owners. The NOPR provides an example scenario where taxpayer X and taxpayer Y each own "separate components of a geothermal heat pump equipment, which taken together is a unit of energy property."[3] Because no single taxpayer owns a complete unit of energy property, therefore, neither qualifies for the Section 48 tax credit.

For the SCT thermal energy networks, Treasury's rule requires one (or multiple) taxpayers to own the entire unit of energy property to claim a Section 48 credit. If one taxpayer owns the distribution system and others own the heat pumps, then none qualify under Section 48.

Since the passage of the Inflation Reduction Act and the 2023 NOPR, the geothermal industry has requested further guidance from the Treasury on qualifying investments and bonus categories. The geothermal industry has also submitted comments advocating for multiparty ownership eligibility under Section 48. As of this writing, Treasury has not finalized the rules.

For this analysis, we discounted the ITC value because SCT likely cannot monetize the tax credits directly, and the mechanism for transferability remains uncertain. Also, eligibility for the MTA dewatering configuration or WRRF configuration is unclear based on the proposed rule's language. Without a clear path to monetization, SCT likely would not pursue the requirements to secure a 40% tax credit.

For illustrative purposes, we estimated the value of the ITC assuming SCT identifies a reasonable path to monetize it. The ITC rate in Table 10 assumes the project satisfies the prevailing wage and apprenticeship requirements and meets the domestic content requirements. We also believe the MTA and WRRF options qualify as "other underground working fluid," as introduced in the Treasury's proposed rule to expand the definition of "geothermal heat pump equipment."[4] Based on this assumption, we consider the MTA and WRRF options eligible for the federal ITC. However, until the Treasury adopts the proposed rules, uncertainty remains about whether nontraditional systems (such as dewatering infrastructure or WRRF) can qualify for the ITC under Section 48.

**Table 17. Estimated Investment Tax Credit Values**

All values in $1,000.

| Cost Metrics | MTA with CT & Boilers | MTA with ASHP | Geothermal | WRRF |
|---|---|---|---|---|
| Capital Cost (pre-ITC) | $75,029 | $70,644 | $94,054 | $61,900 |
| ITC Rate | 40% | 40% | 40% | 40% |
| ITC Value | $30,012 | $28,258 | $37,622 | $24,760 |
| Capital Cost (net ITC) | $45,018 | $42,386 | $56,433 | $37,140 |

# 5 Lifecycle Cost Analysis

We used the capital costs and operating costs for each configuration to estimate each system's lifecycle costs over a 25-year period. To compare these lifecycle costs (LCC) to the BAU scenario from Milestone 1, we keep the same escalation rates. We escalate O&M costs at 2.5% and gas costs at 3.0%. We assume a discount rate of 4.0%.

**Table 18. Central Energy Plant Lifecycle Costs without Investment Tax Credits**

Lifecycle costs over 25 years for continued CEP operations, excluding ITCs. All values in $1,000. Others provided Local Law 97 penalty estimates for sports club and retail.

| Configuration | Capex Net ITC | O&M | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|
| BAU | — | $10,200 | $8,236 | $910 | $27,000 | $434,609 |
| MTA with CT | $75,029 | $11,200 | $8,344 | $910 | $15,518 | $524,206 |
| MTA with ASHP | $70,644 | $11,200 | $8,892 | $910 | $15,200 | $520,180 |
| Geo | $94,054 | $11,200 | $8,473 | $910 | $15,840 | $543,654 |
| WRRF | $61,900 | $11,200 | $8,875 | $910 | $9,360 | $507,051 |

**Table 19. Central Energy Plant Lifecycle Costs with Investment Tax Credits**

Lifecycle costs over 25 years for continued CEP operations, with ITCs applied. All values in $1,000. Others provided Local Law 97 penalty estimates for sports club and retail.

| Configuration | Capex Net ITC | O&M | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|
| BAU | — | $10,200 | $8,236 | $910 | $27,000 | $434,609 |
| MTA with CT | $45,018 | $11,200 | $8,344 | $910 | $15,518 | $492,248 |
| MTA with ASHP | $42,386 | $11,200 | $8,892 | $910 | $15,200 | $491,922 |
| Geo | $56,433 | $11,200 | $8,473 | $910 | $15,840 | $506,032 |
| WRRF | $37,140 | $11,200 | $8,875 | $910 | $9,360 | $482,291 |

In each case, the alternatives show higher lifecycle costs over 25 years. This unique situation at SCT, combined with the current campus operations, primarily drives this outcome. Because the campus relies on the existing gas-fired CEP, new electric heating and cooling systems increase reliance on the existing CEP and the gas it requires.

We also considered lifecycle costs associated with the campus being connected to Con Edison for electricity delivery, which are summarized in Tables 20 and 21. We assume a significant reduction in O&M costs (because the CEP would no longer be operating).

**Table 20. Con Edison Lifecycle Costs, without Investment Tax Credits**

Lifecycle costs over 25 years for systems connected to Con Edison's electric grid, excluding ITCs. Assumes a $15-million interconnection cost. All values in $1,000. Others provided Local Law 97 penalty estimates for sports club and retail.

| Configuration | Capex Net ITC | O&M | Con Edison Electric | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|---|
| BAU | $15,000 | $2,550 | $17,019 | $1,514 | $40 | $11,632 | $487,281 |
| MTA with CT | $75,029 | $3,050 | $21,668 | $494 | $40 | $15,518 | $640,826 |
| MTA with ASHP | $70,644 | $3,050 | $23,237 | $159 | $40 | $15,200 | $637,425 |
| Geo | $94,054 | $3,050 | $22,038 | $505 | $40 | $15,840 | $660,470 |
| WRRF | $61,900 | $3,050 | $23,188 | $0 | $40 | $9,360 | $624,108 |

**Table 21. Con Edison Lifecycle Costs, with Investment Tax Credits**

Lifecycle costs over 25 years for systems connected to Con Edison's electric grid, with ITCs applied. Assumes a $15-million interconnection cost. All values in $1,000. Others provided Local Law 97 penalty estimates for sports club and retail.

| Configuration | Capex Net ITC | O&M | Con Edison Electric | Natural Gas | LL97 Penalty | Replacement (Year 20) | 25-Year LCC |
|---|---|---|---|---|---|---|---|
| BAU | $15,000 | $2,550 | $17,019 | $1,514 | $40 | $11,632 | $487,281 |
| MTA with CT | $45,018 | $3,050 | $21,668 | $494 | $40 | $15,518 | $610,814 |
| MTA with ASHP | $42,386 | $3,050 | $23,237 | $159 | $40 | $15,200 | $609,168 |
| Geo | $56,433 | $3,050 | $22,038 | $505 | $40 | $15,840 | $622,848 |
| WRRF | $37,140 | $3,050 | $23,188 | $0 | $40 | $9,360 | $599,348 |

These lifecycle costs assume an interconnection cost with Con Edison of $15 million. We do not have confirmation of the cost or a timeline because Con Edison currently faces capacity constraints in the SCT area. We did not estimate the cost of decommissioning the existing CEP. Con Edison would determine the final interconnection cost, which could vary depending on its assessment at the time.

The 25-year lifecycle costs associated with connecting to Con Edison's electric grid exceed the costs of remaining on the existing CEP. This primarily results from the price difference between gas and retail electricity from Con Edison. For example, if SCT continues to rely exclusively on its CEP, the annual cost of CEP gas and operations is approximately $15.9 million (see Table 18). If SCT connects to Con Edison's electric grid, the cost for Con Edison electric and maintenance is approximately $19.5 million. Table 16 compares the unit price of electricity when generated in-house versus purchased

from Con Edison. When we factor in the Local Law 97 penalty, CEP generation becomes more expensive per unit than the grid. However, if the Local Law 97 penalty decreases or future legislation mandates a complete phase-out of natural gas, switching to Con Edison's electric grid may eventually become the more economical option. Table 18 compares fuel and operating costs on a unit basis, excluding interconnection costs and CEP decommissioning costs.

**Table 22. Electricity Unit Price Comparison**

Comparison of electricity unit prices between CEP generation and Con Edison grid connections. All values in $1,000. Assumes annual SCT electricity use of 68,075 MWh.

| Configuration | Gas/Electric Cost | CEP Opex | Unit Price without LL97 | LL97 Penalty | Unit Price with LL97 |
|---|---|---|---|---|---|
| Continued CEP | $8,236 | $10,200 | $0.271/kWh | $910 | $0.284/kWh |
| Con Edison Connection | $17,019 | $2,550 | $0.287/kWh | $40 | $0.288/kWh |

# 6 Regulatory Summary

The majority of SCT sits in an R5 zoning district. Together, the buildings form the largest public housing apartment complex in the nation. BSC Owner LLC, which owns and operates SCT, provides steam central heating and cooling in its on-site power plant and provides these services to all buildings on the campus. SCT currently includes heating and cooling services in the rent paid by tenants, and does not bill them separately. Similarly, the replacement geothermal heating and cooling services will continue to be included in resident rents and will not be submetered or billed separately.

A major regulatory consideration concerns the project's potential impact on permitted discharges into nearby tributaries. The MTA's "Feasibility Study for the Beneficial Re-Use of Groundwater Extraction from New York City Transit Deep Wells and Well Points" (MTA Study) notes that a single discharge line from the MTA's East New York Wellfield connects to a storm sewer that releases at the head of Hendrix Creek.

Because the project is located near Jamaica Bay and two tidal tributaries that support tidal wetlands, and because DEP continues restoration work on the Hendrix Creek wetlands, DEP will likely identify and assess all potential impacts of the proposed geothermal system on the success of the Hendrix Creek Wetland Restoration Project. Agencies must determine whether any aspect of the system's construction or operation constitutes a discharge of fill material. If construction involves excavating or backfilling Hendrix Creek, or if operation requires support structures to connect the geothermal system to the MTA discharge line, these actions may trigger the need for a CWA Section 404 permit. Similarly, if the system's operation and discharge into Hendrix Creek causes potential changes to the Hendrix Creek shoreline, the U.S. Army Corps of Engineers (Corps) may require a CWA Section 404 permit. The Corps' review process for Section 404 permits may ultimately impact the feasibility of using Hendrix Creek and the overall system design. In addition, compliance will be required with federal regulations under the National Environmental Policy Act (NEPA) and the Endangered Species Act. New York State administers permits for the discharge of pollutants (including heat) through the State Pollution Discharge Elimination System (SPDES), under the authority of the U.S. Environmental Protection Agency (EPA). The proposed designs will also trigger the State Environmental Quality Review (SEAR) process and may require the preparation of an Environmental Impact Statement (EIS).

Other regulatory review, approvals, and permits may become necessary if the project connects to infrastructure that discharges water into Hendrix Creek. Appendix B lists and discusses these in detail.

# 7 Recommendations

Converting the SCT campus to an all-electric heating and cooling district will require a massive effort to install new distribution infrastructure across the campus and connect it to each building. Given the relatively recent requirements under Local Law 97, the SCT campus would also benefit from an interconnection to Con Edison and a transition away from the current gas-fired central energy plant. Annual Local Law 97 penalties, ranging from $4.4 million to $6.4 million, will become increasingly costly and will eventually exceed the cost of interconnection. Establishing an electrical connection to Con Edison would reduce annual carbon emissions by approximately 50% to 60%. To move forward effectively, SCT should take the following steps as part of Phase 1 implementation:

- Continue exploring interconnection costs and timelines with Con Edison. Although initially potentially costly, interconnecting electrically with Con Edison will allow SCT to reduce carbon emissions, avoid Local Law 97 penalties, and procure carbon-free electricity from the grid. A phased approach to connecting with Con Edison may prove beneficial. For example, the sports club and the retail buildings, which are likely not exempt from Local Law 97 penalties, may benefit from Con Edison interconnection because they would incur lower Local Law 97 penalties due to Con Edison's lower Local Law 97 carbon emissions coefficient.
- Consider the WRRF option because it will lower associated carbon emissions to the lowest levels among all options, thereby future-proofing the campus against rising carbon penalties.
- Anticipate clarification from the Treasury regarding the definition of "geothermal heat pumps equipment" to include wastewater heat exchange systems. If the Treasury expands this definition to include sewer and wastewater heat exchange, the WRRF option will likely become the least costly option.

SCT must complete the transition to an electric district thermal system in phases. Residents will continue to occupy the towers and rely on energy from the CEP until SCT designs, constructs, and stabilizes an alternative system.

As an initial phase, SCT should implement a district thermal system at a subset of residential towers to reduce capital requirements, limit the construction schedule, and minimize community impact to a manageable level. Phase 1 operations will generate feedback to inform how SCT implements subsequent phases of the campus transition. Major activities of Phase 1 include:

- Commence preliminary negotiations with MTA and DEP to determine a range of costs for SCT to access thermal energy.
- Determine which district thermal system to pursue based on capital costs and/or access fees for MTA or DEP thermal energy.

- Identify target garages for a Phase 1 project based on ease of access to thermal resources. For example, Garages A and B would be ideal Phase 1 candidates for connection to MTA water. Garages B and E would be ideal for connecting to DEP water. Garage C would be ideal for a standalone geothermal system in Phase 1.
- Proceed to final design, construction, and building retrofit. Ensure SCT implements a robust data monitoring system.
- Collect and analyze operational data. Use data to inform subsequent phases to fully transition SCT to fossil-free heating and cooling.

# Appendix A. Baseline Energy Cost and Energy Model Assumptions

When SCT was initially constructed, the on-site central energy plant (CEP) supplied utilities (electricity and thermal energy) to the apartments. The campus has never been connected to an electric utility. Instead, the gas-fired CEP generates electricity and thermal energy for the entire campus.

**Figure A-1. Central Energy Plant, Primary Distribution Garages, and Secondary Distribution Loops**


The CEP houses boilers that generate steam, which in turn generates electricity, hot water, and chilled water. The system distributes these services to eight garages across the campus. Each garage then uses a secondary distribution system to deliver energy from the CEP to its connected buildings.

**Table A-1. Garages and Supplied Buildings**

| Garage | No. of Supplied Buildings | Supplied Residential Units | Supplied Area (sf) |
|---|---|---|---|
| A | 5 | 780 | 805,450 |
| B | 4 | 502 | 482,350 |
| C | 8 | 1,168 | 1,212,226 |
| D | 3 | 442 | 419,930 |
| E | 5 | 652 | 678,423 |
| F | 5 | 612 | 633,133 |
| G | 10 | 1,173 | 1,100,156 |
| H | 6 | 552 | 564,675 |
| **Total** | **46** | **5,881** | **5,896,343** |

Over the past three years, SCT has installed new condensing boilers at each of the eight garages. Once SCT completes the boiler project (June 2022), the new condensing boilers will supply heating hot water (HHW) and domestic hot water (DHW) to connected buildings. The CEP will no longer supply HHW and DHW but will continue to supply electricity and chilled water.

The original cooling tower (CT) at the CEP still operates. Every 5 years, the SCT initiates a 3-year CT repair cycle. The CT operates at maximum capacity during the summer, but it cannot reject enough heat during prolonged summer heatwaves.

Each garage also contains electrical switchgear that receives electricity from the CEP at 4,160 volts (V). The switchgear steps down the voltage and distributes electricity to connected buildings.

SCT delivers thermal energy to 5,881 apartments through 18,000 fan coil units (FCUs). A 2019 assessment of SCT's distribution infrastructure revealed significant systemwide imbalances.[5] The report concluded that inconsistent piping sizing, outdated distribution designs, and the absence of flow control resulted in highly variable flow at FCUs. As a result, residential spaces may become overheated or undercooled, depending on the FCU location. The lack of flow control also causes excessive pumping energy (electricity) on the secondary distribution loops. To remedy this imbalance, SCT would need to replace FCUs with pressure-independent control valves (PICVs). SCT used IES VE 2021 energy modelling software to generate hourly thermal energy profiles for the entire campus, encompassing space heating, space cooling, and DHW. The model used best estimates for envelope thermal properties, insulation, internal loads, occupancy schedules, and thermal losses from the CEP. Historic data provided by SCT, along with qualitative input from SCT's facility operations team, informed the model.

**Table A-2. Energy Model Assumptions**

| Category | Assumption |
|---|---|
| **Envelope** | • Roof assembly U-value: 0.063<br>• External mass wall assembly U-value: 0.156<br>• Operable window U-value: 0.55; SHGC = 0.4<br>• Window-to-wall area ratio:<br>  ○ L1: 18.1%<br>  ○ L2: 20.7%<br>  ○ Z1: 22.2%<br>  ○ Z2: 20.6%<br>• Sports Club: 13.0% |
| **Occupancy** | • Per ASHRAE 90.1 space-by-space method |
| **Interior Lighting Power Density** | • Per ASHRAE 90.1 space-by-space method<br>• Residential units and townhouses: 1.00 W/sf |
| **Miscellaneous Loads** | • Receptacle plug loads per ASHRAE 90.1 space-by-space method |

To estimate thermal loads for the SCT campus, the team interpreted available data. The most reliable metered data came from the natural gas meter that supplies the CHP's system and boilers. This natural gas provides all electricity, space heating, space cooling, DHW, and cooking gas for the campus. Although some British thermal units (Btu) meters track hot water use, the team lacked confidence in their calibration or accuracy.

The model produced hourly profiles for space heating, cooling, and DHW, as summarized in Table A-3.

**Table A-3. Monthly Thermal Loads**

| Month | Space Heating (MMBtu) | Space Cooling (MMBtu) | DHW (MMBtu) |
|---|---|---|---|
| Jan | 28,708 | 0 | 9,420 |
| Feb | 27,154 | 0 | 8,508 |
| Mar | 19,121 | 0 | 9,420 |
| Apr | 9,660 | 0 | 9,116 |
| May | 2,580 | 0 | 9,420 |
| Jun | 0 | 10,656 | 9,116 |
| Jul | 0 | 20,143 | 9,420 |
| Aug | 0 | 18,774 | 9,420 |
| Sep | 0 | 7,040 | 9,116 |
| Oct | 5,074 | 0 | 9,420 |
| Nov | 16,871 | 0 | 9,116 |
| Dec | 24,778 | 0 | 9,420 |
| **Total** | **133,945** | **56,612** | **110,909** |

An hourly profile of each thermal demand is illustrated in Figure A2 below.

**Figure A-2. Hourly Thermal Load Profile**

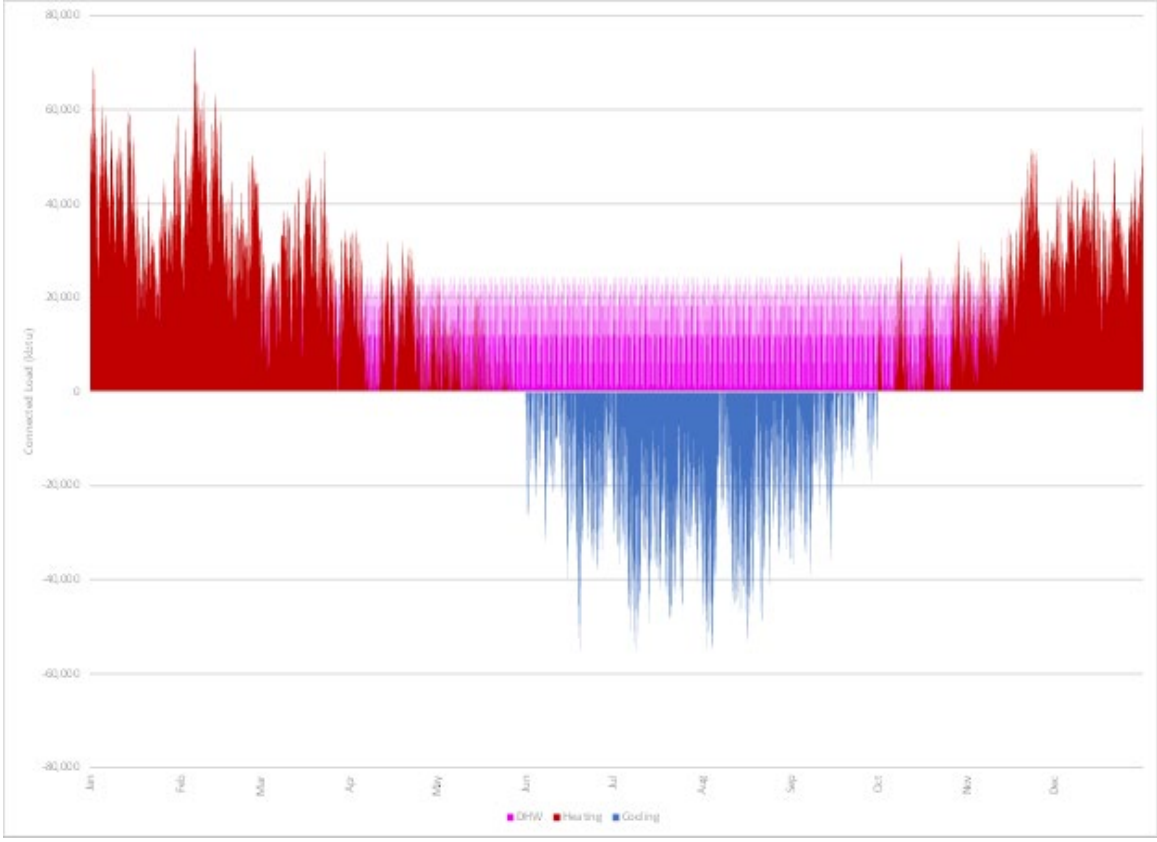



Table A4 summarizes the annual and peak heating, cooling, and DHW loads by garage. Because the CEP currently supplies all cooling, garage-level cooling estimates rely on projections. These estimates will help evaluate distributed geothermal system opportunities. Garage boilers supply the heating and DHW loads.

**Table A-4. Annual and Peak Thermal Loads by Garage**

| Garage | Heating | | Cooling | | DHW | |
|---|---|---|---|---|---|---|
| | Annual (MMBtu) | Peak (MMBtu/hr) | Annual (MMBtu) | Peak (MMBtu/hr) | Annual (MMBtu) | Peak (MMBtu/hr) |
| A | 17,918 | 9.8 | 7,325 | 7.2 | 14,959 | 3.3 |
| B | 10,857 | 6.0 | 4,513 | 4.5 | 8,876 | 1.9 |
| C | 25,845 | 14.4 | 11,223 | 11.3 | 22,588 | 5.0 |
| D | 9,806 | 5.3 | 3,964 | 3.9 | 7,679 | 1.7 |
| E | 14,750 | 8.3 | 6,566 | 6.7 | 12,715 | 2.8 |
| F | 13,016 | 7.3 | 5,728 | 5.8 | 11,818 | 2.6 |
| G | 25,809 | 14.0 | 10,596 | 10.5 | 20,195 | 4.4 |
| H | 13,145 | 7.2 | 5,348 | 5.3 | 10,770 | 2.4 |
| Sports Club | 2,799 | 2.2 | 1,349 | 2.5 | 1,309 | 0.3 |
| **Total** | **133,945** | **73.0** | **56,612** | **57.3** | **110,910** | **24.3** |

The lifecycle cost analysis for the business-as-usual (BAU) scenario combines all campus energy costs into CEP operations, including natural gas, maintenance, repairs, and labor. SCT's facilities team provided 2020–2021 operating budgets and 2023 gas costs projections.

The team used 2022 operating costs and 2023 gas projections to estimate total CEP and garage boiler operational costs. Table A-5 summarizes annual baseline energy generation and natural gas use. In addition, the team included the total energy that the CEP generates and that the campus consumes. Because the CEP generates electricity and thermal loads simultaneously, the analysis accounts for both electricity and thermal energy. In the future, the garage boilers will generate space heating and DHW, but the CEP will continue producing chilled water using waste heat from electric generation.

**Table A-5. Central Energy Plant Annual Energy Generation and Natural Gas Use**

| Energy Type | Annual Energy |
|---|---|
| Electricity | 68,075 MWh |
| Space Heating | 133,945 MMBtu |
| Space Cooling | 56,612 MMBtu |
| DHW | 110,910 MMBtu |
| CEP Natural Gas | 985,169 MMBtu |
| Garage Boilers Natural Gas (Heating, DHW) | 251,131 MMBtu |
| $CO_2$ Emissions | 65,660 tons $CO_2$ |

**Table A-6. Central Energy Plant Annual Operating Costs**

| Description | Annual Cost |
|---|---|
| CEP Natural Gas Cost (Electricity & Cooling) | $5,938,600 |
| Garage Natural Gas Cost (Heating & DHW) | $2,296,900 |
| Operations & Maintenance | $10,200,000 |
| BAU Annual Cost | $18,435,500 |

Endurant conducted a 25-year lifecycle cost analysis (LCCA) for the CEP, as summarized in Table A7. The study considers annual operational expenses under a BAU scenario, including operations and maintenance (O&M) costs (escalated at 2.5%) and gas costs (escalated at 3.0%). A discount rate of 4.0% is applied. Additionally, a $27 million replacement cost is assumed in year 20, based on recent boiler plant installation costs across the eight garages.

**Table A-7. 25-Year Lifecycle Cost, Central Energy Plant, Business as Usual**

| Description | Value |
|---|---|
| Year 1 O&M | $10,200,000 |
| Year 1 Natural Gas | $8,235,500 |
| Replacement Cost in Year 20 | $27,000,000 |
| 25-year Lifecycle Cost | $414,500,000 |

Endurant also evaluated the BAU operating costs and lifecycle costs (LCC) for each of the eight garages. The CEP supplies electricity and cooling for SCT's 46 buildings. To estimate annual and lifecycle costs at the garage level, the team apportioned the total campus costs based on the area served by each garage. Summaries of operating costs, carbon emissions, and lifecycle costs at the garage level are provided in Tables A8 and A9.

**Table A-8. Annual Operating Cost and Emissions by Garage, Business as Usual**

| Garage | Portion of CEP Gas Cost | Garage Gas Cost | O&M Cost | Annual Cost | $CO_2$ Emissions |
|---|---|---|---|---|---|
| A | $811,000 | $314,000 | $1,393,000 | **$2,518,000** | 8,969 |
| B | $486,000 | $188,000 | $834,000 | **$1,508,000** | 5,371 |
| C | $1,221,000 | $472,000 | $2,097,000 | **$3,790,000** | 13,499 |
| D | $423,000 | $164,000 | $726,000 | **$1,313,000** | 4,676 |
| E | $683,000 | $264,000 | $1,174,000 | **$2,121,000** | 7,555 |
| F | $638,000 | $247,000 | $1,095,000 | **$1,980,000** | 7,050 |
| G | $1,108,000 | $429,000 | $1,903,000 | **$3,440,000** | 12,251 |
| H | $569,000 | $220,000 | $977,000 | **$1,766,000** | 6,288 |

**Table A-9. 25-Year Lifecycle Cost by Garage, Business as Usual**

| Garage | Year 1 O&M | Year 1 Gas | Replacement | LCC |
|---|---|---|---|---|
| A | $1,393,000 | $1,125,000 | $3,688,000 | $56,600,000 |
| B | $834,000 | $674,000 | $2,209,000 | $33,900,000 |
| C | $2,097,000 | $1,693,000 | $5,551,000 | $85,200,000 |
| D | $726,000 | $587,000 | $1,923,000 | $29,500,000 |
| E | $1,174,000 | $948,000 | $3,107,000 | $47,700,000 |
| F | $1,095,000 | $884,000 | $2,899,000 | $44,500,000 |
| G | $1,903,000 | $1,537,000 | $5,038,000 | $77,300,000 |
| H | $977,000 | $789,000 | $2,586,000 | $39,700,000 |

# Appendix B. Complete Regulatory Roadmap

## B.1 Basis for Establishing a District Energy System

Spring Creek Towers (SCT) spans 7 million square feet (sf) in the Spring Creek section of Brooklyn in eastern New York City. The 153-acre campus includes 8 housing sections, a sports facility, a shopping mall, two schools, and a community center. It contains 5,881 residential units housing approximately 20,000 low- and middle-income residents. Most of SCT is in an R5 zoning district. Together, the buildings form the largest public housing apartment complex in the U.S.

BSC Owner LLC owns and operates SCT and currently supplies steam central heating and cooling to all the facilities from its on-site power plant.

The project explores a unique and innovative solution by accessing a pumped water discharge line operated by the Metropolitan Transportation Authority (MTA) as a thermal resource for SCT. The MTA operates three large-scale graywater discharge pipelines citywide that pump thousands of gallons of water per minute at relatively stable temperatures. The concept involves diverting discharge water from one of the lines through a series of heat exchangers and heat pumps to deliver heating and/or cooling to nearby SCT facilities before returning it to the same MTA discharge pipe slightly further downstream, albeit slightly warmer or cooler than at the point of diversion (see Figure B-1).

SCT lies within 2,000 feet of an MTA discharge line, presenting a rare opportunity to convert a waste stream into a valuable renewable thermal energy resource. Endurant expects to extract enough thermal energy from the MTA discharge line to meet the load requirements of multiple buildings.

SCT currently includes heating and cooling services in rents, with no separate billing. Similarly, the geothermal heating and cooling services that will replace the current system will be included in the rent and will not be submetered or billed separately.

**Figure B-1. Map of Spring Creek Towers and Surrounding Areas**

*Source: Google Maps.*


Hendrix Creek, a tributary of Jamaica Bay, sits to the east of SCT and runs adjacent to New York City Department of Environmental Protection (DEP) property. The following section discusses Hendrix Creek's ecological features and regulatory classifications. According to the MTA New York City Transit Authority (NYCTA) study "Feasibility Study for the Beneficial Re-use of Groundwater Extraction from New York City Transit Deep Wells and Well Points" (MTA Study), the single discharge line from the MTA's East New York Wellfield meets with a storm sewer that releases at the top of Hendrix Creek.

To the west of SCT, across Louisiana Avenue, runs Fresh Creek and is the centerpiece of the Fresh Creek Nature Preserve managed by New York City Department of Parks and Recreation (NYC Parks). Like Hendrix Creek, Fresh Creek shares common regulatory classifications, although it appears to include more extensive functioning tidal wetlands.

Across the Belt Parkway, the Shirley Chisholm State Park lies adjacent to Jamaica Bay. This 407-acre coastal green space occupies the former Pennsylvania and Fountain Avenue landfills, which operated from 1956 to 1983. Its wetlands, marshes, and grasses provide habitat for migratory bird species.

Search of data maps identified a State Pollution Discharge Elimination System (SPDES) permit for the DEP's 26th Ward Wastewater Treatment Plant into Hendrix Creek.[6, 7] The DECinfo Locator shows combined sewer overflow (CSO) discharge points at the head of both Hendrix Creek and Fresh Creek.

The MTA Study identified the East New York Wellfield discharge line, which flows into Hendrix Creek, as the primary point of connection. The study confirms that "water can be tapped from anywhere on the discharge line for service to [a] potential facility."[8] Fresh Creek's designation as a New York City (NYC) nature preserve and the location of the NYCTA/MTA discharge line make Hendrix Creek the more viable discharge location. However, a stormwater discharge location at the head of Fresh Creek could provide an alternative potential thermal source. Therefore, this analysis considers both tributaries' classifications and potential regulatory implications.

### B.1.1 Description of Regulatory Approach to Decentralized Building-level Thermal Systems with Isolated Loads

Because SCT already owns common infrastructure and operates under unified ownership, it can implement a central system efficiently. Any alternative approach using separate systems would likely produce suboptimal results compared to a district system.

A configuration of several smaller, individual systems offers no clear advantages in infrastructure or institutional arrangements. Such a setup would only be justified if economic or regulatory constraints favor a smaller, less ambitious project.

If SCT cannot access MTA thermal resources, the project would be limited to the heating and cooling loads supported by on-site boreholes. Drilling deeper than 500 feet would enhance the geothermal system's energy performance. Historically, securing permits for boreholes deeper than 500 feet triggered onerous regulatory hurdles. However, a rulemaking process and legislative changes at the State level are currently extending the 500-foot regulator limit.[9] Given the potential to meet larger loads with deeper borehole, pursuing the extended regulatory pathway may be worthwhile if MTA thermal resources are unavailable.

## B.2 Applicable Laws and Regulations

This section organizes applicable laws and regulations by federal, State, and local levels. However, multiple levels of government often share primary responsibility for administering these laws. Therefore, this section arranges them according to the level primarily responsible for administration.

### B.2.1 Federal Laws and Regulations

#### *B.2.1.1 Clean Water Act*

The Clean Water Act (CWA) 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 responsibility for administering and enforcing permit programs if the U.S. Environmental Protection Agency (EPA) authorizes them to do so. The CWA also defines states' powers in regulating water, including authority to issue pollution discharge permits that conform to (or exceed) federal technology- and water quality-based standards, involve public participation; regulate indirect discharges of pollutants into municipal treatment works; and adopt water quality standards.[10]

Importantly, the CWA empowers states to veto federal permits or licenses by refusing to certify, under Section 401, that a proposed construction project complies with state water quality standards.[11]

In New York State, the Department of Environmental Conservation (DEC) administers SPDES, certifies federal projects under CWA Section 401, and sets State water quality standards. However, the U.S. Army Corps of Engineers (Corps), not DEC, administers Section 404 permits in New York State.

Section 404 regulates discharges of dredged or fill material into U.S. waters, including adjacent wetlands. Section 404 prohibits such discharges unless the action is exempt or the Corps has authorized it.

"Waters of the United States" include:

1. Navigable waters
2. Wetlands
3. Tributaries to navigable waters, including adjacent wetlands, lakes, and ponds
4. Interstate waters and their tributaries, including adjacent wetlands
5. Other waters whose use, degradation, or destruction could affect interstate commerce[12]

Section 404 defines the landward limit of jurisdiction as the high tide line in tidal waters and the ordinary high-water mark in non-tidal waters.[13] However, if wetlands are adjacent, jurisdiction extends to the wetland boundary.[14]

Federal and State mapping tools show waterways on three sides of the project site that support tidal wetlands.

According to the National Wetlands Inventory (NWI), Fresh Creek and Hendrix Creek include estuarine and marine deepwater habitats and wetlands.[15] The NWI classifies tidal wetlands north of the Belt Parkway in Hendrix Creek as E2EM5P. Fresh Creek contains both E2EM5P and E2EM1P wetlands.[16] South of the Belt Parkway, connected wetlands within Shirley Chisholm State Park include E2EM5P, E2EM1P, and E2US1N.[17] The NWI also identifies a freshwater emergent wetland on the DEP's neighboring land that briefly overlaps the SCT's southeastern property line.[18]

The DEC info Locator geographic information system (GIS) tool also classifies Hendrix Creek and Fresh Creek as Regulatory Tidal Wetlands Areas.[19] The following State section discusses tidal wetlands regulations under the DEC program.

A wide variety of activities trigger Section 404 permitting requirement, ranging from those with large, complex impacts on the aquatic environment to those with minimal impacts.[20] The term "fill material" refers to material placed in U.S. waters, where it replaces any portion of a water body with dry land or changes the bottom elevation of any portion of that water.[21] The "discharge of fill material" includes fill that is necessary to constructing any structure or impoundment, including rock, sand, dirt, or other material required for construction.[22]

According to Corps regulations, the term "discharge of dredged material" means any addition of material that is excavated or dredged from U.S. waters, including any redeposit of dredge material other than incidental fallback.[23]

Both Hendrix Creek and Fresh Creek contain tidal wetlands. DEP established the Hendrix Creek Wetland Restoration Project to restore 6,500 sf of salt marsh and 48,000 sf of upland habitat. The project aims to "establish 5,000 sf of salt marsh and 42,000 sf of upland to provide spawning, foraging, and life support habitats for various" aquatic and avian species.[24]

Given the project's proximity to Jamaica Bay and two tidal tributaries that support tidal wetlands, as well as DEP's efforts to restore the Hendrix Creek wetlands, DEP will likely identify and assess all potential impacts of the proposed geothermal system on the success of the Hendrix Creek Wetland Restoration Project. Project planners must consider whether any part of the system's construction or operation may constitute a discharge of fill material.

If the construction involves excavation or backfilling within Hendrix Creek, or if the geothermal system requires supporting structures to connect to the NYCTA/MTA discharge line, these actions may trigger the need for a CWA Section 404 permit. Similarly, if operating the system and discharging into Hendrix Creek causes changes to the shoreline, the Corps may require a Section 404 permit.

When issuing permits, the Corps must comply with Section 404 regulations, EPA regulations, the National Environmental Policy Act NEPA), the 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. Under Section 401, the Corps cannot issue a Section 404 permit unless the State certifies that the activity complies with water quality standards or waives that certification authority. If the State denies certification, the Corps must reject the application, and the activity cannot proceed.[25] States can also impose significant conditions on the permit or project through the Section 401 certification process to reduce the activity's environmental impacts.[26] The Corps cannot issue a Section 404 permit until the State either grants or waives the water quality certificate. Typically, developers apply to both the Corps and the relevant State permitting agency simultaneously, allowing both reviews to proceed concurrently.

The Corps' Section 404 permit review process may ultimately influence the feasibility of using Hendrix Creek and the overall system design. When reviewing a permit application, the Corps must evaluate whether the proposed project serves the "public interest" by considering all relevant and cumulative factors. These include "environmental factors such as conversion, 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.…"[27] Additionally, under 40 CFR § 230.10, the Corps may not issue a permit if practicable alternatives exist that would cause less harm to the aquatic system, as long as those alternatives do not result in other adverse environmental impacts.

Determining which alternatives minimize adverse impacts will depend on site conditions and geothermal system design. The applicant bears the responsibility to provide sufficient information demonstrating that they have considered and evaluated project alternatives that avoid impacts to aquatic environments (such as a fully land-based geothermal system that does not use the Hendrix Creek tributary). The applicant must also show that no practicable alternatives to the proposed project exist and that steps have been taken to minimize unavoidable impacts. For projects that either avoid impacts or result in only minor impacts, the Corps may adjust the stringency of its review based on the "significance and complexity of the discharge activity."[28]

Since available alternative designs do not utilize Hendrix Creek, the Corps may ultimately decide not to issue a Section 404 permit under EPA regulations. However, when a proposed project would only have minor impacts, an agency may not require a detailed alternative analysis.[29] Preapplication consultation with the Corps helps determine the scope of the alternative analysis required for the geothermal system.

Depending on the location and magnitude of the wetlands present on site, the system could potentially meet the criteria for a general permit if it does not result in a loss greater than 1/10-acre of U.S. waters (including wetlands). Notably, the permit review process for general permits is less burdensome and lengthy than individual permits.

Under Section 404(e), the Corps may also issue general permits to authorize activities that cause only minimal individual and cumulative adverse environmental impacts.[30] A general permit authorizes parties, either within specific geographic regions or nationwide, to engage in activities specified in the permit without needing to obtain project-specific authorization, or to submit specific plans for anticipated projects in advance.[31] Typically, general permits eliminate the need for the Corps' prior approval for discharges of dredged or fill material associated with such activities,[32] and they are presumed to comply with NEPA review and EPA's Section 404(b)(1) Guidelines.[33]

Nationwide Permit 51 sets nationwide conditions for land-based renewable energy generation facilities, which apply to discharges of dredged or fill material into nontidal U.S. waters for the construction, expansion, or modification of land-based renewable energy production facilities, including associated features. "Such facilities include infrastructure to collect solar, wind, biomass, or geothermal energy, attendant features may include, but are not limited to, roads, parking lots, and stormwater management facilities within the land-based renewable energy generation facility."[34] To qualify for the nationwide permit, the discharge must not cause the loss of more than half an acre of non-tidal U.S. waters.[35]

### B.2.1.2 National Environmental Policy Act

When a federal agency proposes to undertake an action or grant a permit, the NEPA requires the agency to assess the effects of its action on the human environment.[36] Pursuant to NEPA, federal agencies must identify and evaluate impacts of "major federal actions significantly affecting the quality of the human environment."[37]

Under NEPA, any federal action that significantly affects the quality of the human environment requires the preparation of an Environmental Impact Statement (EIS).[38] The EIS must include all significant environmental effects associated not only with the proposed action, but also with every reasonable alternative to that action.[39] Importantly, while NEPA requires a federal agency to consider and quantify environmental impacts associated with a proposed project, it does not require agencies to take one type of action or another based on the findings of its review.[40] In other words, NEPA does not require agencies to take one type of action or another based on the adverse environmental impacts.[41] However, under the Administrative Procedure Act (APA), citizens may challenge the sufficiency of an EIS under NEPA.[42]

The Council on Environmental Quality regulations list four categories of "major federal action" that include "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."[43]

Consequently, if the project requires Corps permitting authorization, the project becomes subject to the provisions of NEPA. If NEPA applies, the project review must consider the geothermal elements' potential impact on the environment. The design of the geothermal system should therefore aim to minimize impacts on wetlands and waterways.

### B.2.1.3 Endangered Species Act

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

Section 7 prohibits federal agencies 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.[44]

To that end, Section 7 of the Endangered Species Act requires federal agencies with jurisdiction to (1) actively pursue species conservation; (2) ensure no jeopardy to a listed species; and (3) ensure that areas designated under the act as "critical habitat" remain intact and are not adversely modified.

Additionally, Section 7 requires federal agencies, before initiating, funding, or authorizing any action that could affect endangered species, to submit a written request to the USFWS 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.[45]

According to the USFWS's online mapping tool, two threatened and one endangered species of birds and the threatened flowering plant Seabeach Amaranth, may be affected by activities at the project site.[46] Additionally, more than 20 species of migratory bird are likely to be present at the project site. These results are not surprising, given that nearby Jamaica Bay serves as an important ecosystem for migratory birds. However, no critical habitats or protected fish hatcheries are present. The project team may need to consult with USFWS to confirm the project will not cause potential impacts, directly or indirectly, on any of the species identified.

If, after consultation, the agency determines a listed species "may be present," the formal consultation process results in a biological opinion prepared by the respective agency stating whether the permit action is likely to jeopardize the continued existence of the listed species or adversely modify designated critical habitat.[47] Formal consultation pursuant to Section 7 of the Endangered Species Act is not required if the agency determines that an action will not affect listed species or designated critical habitat.[48]

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."[49] 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.[50] If the biological opinion concludes that jeopardy would occur, and that no reasonable alternatives exist, EPA Section 404(b)(1) Guidelines require the federal agency to deny a permit and decline funding or other action.[51]

### *B.2.1.4 Fish and Wildlife Coordination Act*

The Fish and Wildlife Coordination Act requires federal agencies taking action on projects with potential impacts on fish and wildlife to consult with USFWS, as well as the head of the fish and wildlife agency in the state where the project is located, regarding the fish and wildlife impacts of permitting the project and on measures to mitigate those impacts.[52]

As part of the consultation, USFWS must prepare a report that describes those impacts and makes recommendations for mitigating the damage to fish and wildlife resources, called a Wildlife Coordination Act Report.[53] In the report, USFWS must (1) develop recommendations based on surveys and investigations to determine the potential impacts to wildlife resources; (2) describe the damages to wildlife attributable to the project; and (3) develop mitigation measures to prevent these damages and to improve wildlife resources.[54] The federal permitting agency must include the report in a final EIS for the project, and must give it "full consideration." However, the federal permitting agency does not have to adopt USFWS recommendations.[55]

The National Oceanic and Atmospheric Administration (NOAA) Essential Fish Habitat (EFH) mapper shows the EFH for the Smooth Hound Shark extends from Jamaica Bay into Hendrix Creek until the Bay Parkway and into Fresh Creek past the Belt Parkway until halfway between the north side of Hornell Loop and the south side of Freeport Loop.[56] The EFH for the Sand Tiger Shark covers all of Jamaica Bay and stops at the mouth of each tributary. Consultation may be required to consider potential impacts of the geothermal project on the habitat of these shark species.

### *B.2.1.5 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 U.S. water.[57] Pursuant to Section 10, entities may not build any pier, wharf, structure or "works" in a "navigable water" without authorization from the Corps.

The Corps regulates Hendrix Creek, Fresh Creek, and Jamaica Bay as navigable waters under the Rivers and Harbors Act.[58] The lead permitting review agency would address and Rivers and Harbors Act requirements along with all other regulatory requirements.

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,"[59] 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."[60]

NEPA, which Section 408 authorizations trigger, requires consideration of reasonable alternatives in detail. Reasonable alternatives must be feasible in light of the underlying purpose of the proposed alteration and the applicant's needs.

The boundaries of the Jamaica Bay federal navigation channel extend the full length of Fresh Creek and Hendrix Creek. Any geothermal system using these waters would require Section 408 authorization. Additionally, the Corps should be consulted to ascertain whether any other civil works projects are located along the river or on-site, such as habitat restoration projects. In addition to historical and ongoing ecosystem restoration projects on Jamaica Bay's Marsh Islands and at Spring Creek Park east of Hendrix Creek, [61] a civil works restoration project in Fresh Creek, recommended in the "Final Hudson Raritan Estuary (HRE) Feasibility Study Report," will likely occur at an unspecified future date.[62] Alternatively, although the HRE report identified Hendrix Creek as having restoration potential, but it did not recommend it as a restoration site.[63]

## B.2.2 State Laws and Regulations

### *B.2.2.1 State Clean Water Requirements*

The federal CWA establishes a permitting scheme that regulates the discharge of pollutants into U.S. waters, known as the NPDES permit program.[64] NPDES requires all facilities that discharge pollutants, including heat, into surface water from a point source to obtain a permit before discharging.[65] NPDES permits incorporate both water quality standards and technology-based effluent limitations to protect water quality.

The CWA authorizes EPA to delegate enforcement authority to the states and allows states to administer their own SPDES permit programs upon EPA approval. The EPA has approved New York State's SPDES program for controlling surface wastewater and stormwater discharges in accordance with

the CWA. Notably, New York State law is broader in scope and stricter than the federal NPDES program, and it requires a SPDES permit for point source discharges of pollutants into all State waters, including both surface waters and groundwaters.

The CWA also directs states to adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters.[66] State water quality standards define the maximum allowable levels of chemical pollutants and serve as the regulatory targets for permitting, compliance, enforcement, 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."[67]

Additionally, EPA regulations require states to include an antidegradation policy in their water quality standards.[68]

Accordingly, effluent standards set in NPDES and SPDES permits must ensure that state water quality standards will be met for the receiving waters.[69] These effluent limitations rely either on technology-based standards prescribed by the EPA[70] or on water-quality-based standards when applicable technology standards would still cause an exceedance of state water quality standards for the receiving waterbody.[71] SPDES permits may also impose additional conditions such as temperature monitoring and reporting, as well as limitations on how much heat the system may discharge, depending on the receiving waterbody's classification.

### *B.2.2.2 State Discharge and General Water Quality Standards Application to Geothermal*

The NPDES and SPDES discharge requirements and the New York State water quality standards both potentially regulate geothermal systems. These regimes, which originate from the CWA, can be applied separately or together, depending on the circumstances of the geothermal design and regulatory decisions made by DEC.

Under the SPDES program, regulators define a discharge to include thermal discharges.[72] Separately, under New York State's general water quality standards, regulators define thermal discharges as "a discharge that results or would result in a temperature change of the receiving water."[73] Pursuant to

DEC'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."[74]

While regulators clearly apply both regimes to open-loop systems through the issuance of a SPDES permit that authorizes the effluent discharge in accordance with general water quality requirements, for closed-loop systems DEC applies general water quality standards, but they have not made clear 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 requirement typically applies more to open-loop systems, New York State applies its water quality standards and best use criterion set forth at 6 NYCRR Parts 649–758 to all systems, including the criteria for thermal discharges.[75]

Under all approaches that DEC might adopt, it can require geothermal systems to meet technological standards in order to mitigate thermal impacts on the receiving waterbody, which could include criteria for mixing zones.

### *B.2.2.3 State Pollution Discharge Elimination System 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 waterbody, and whether the system discharges heat or some type of water or heat treatment chemicals.[76] Generally, geothermal systems that discharge heat, cooling, or water treatment chemicals into State waters 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, DEC may require a SPDES permit for closed-loop systems if the system "discharges" heat or otherwise changes the temperature of a receiving waterbody.

### *B.2.2.4 State Pollution Discharge Elimination System Permits for Construction and Stormwater Pollution*

Construction-related activities might also require a SPDES permit. CWA Section 402 requires permits for stormwater discharges from construction activities, including geothermal drilling operations, that disturb one or more acres of land. In New York State, projects must obtain a SPDES General Permit for

Stormwater Discharges from Construction activity when they involve soil disturbances of one or more acres based on a common plan, or soil disturbances of less than one acre that could potentially violate a water quality standard or contribute pollutants to surface waters.[77]

To qualify for the permit, applicants must develop a Stormwater Pollution Prevention Plan (SWPPP) in accordance with general permit requirements to prevent discharges of construction-related pollutants to surface waters.[78]

If removed soil contains any element that could cause contaminated stormwater runoff during construction, including but not limited to lead, arsenic, pesticides, asbestos, or garbage and debris, the SWPPP must establish an adequate plan to prevent runoff and discharge into surrounding surface water bodies.

### *B.2.2.5 State Water Quality Standards of General Application*

New York State always applies its water quality standards to geothermal and other activities, even when they are not subject to the SPDES permitting requirements, so geothermal or other activities must not cause or contribute to any violation of water quality standards.[79] DEC must review the system to determine whether to would violate State water quality standards and whether a SPDES permit is required.

New York State's water quality standards establish classifications and designated uses for all waters within the State, including groundwater.[80] The best uses of these water classes include fish, shellfish, and wildlife propagation and survival; fishing; drinking water supply; and primary and secondary contact recreation.[81] DEC regulations also establish general conditions that apply to all water classifications, including criteria governing thermal discharges.[82] DEC defines thermal discharges as "a discharge that results or would result in a temperature change of the receiving water."[83] Its thermal discharge criteria include general and waterbody-specific standards, mixing zone criteria, and additional limitations that may ultimately impact system design.

Under the New York State Stream Classification System, Hendrix Creek and Fresh Creek currently have a Class I designation. The best uses of Class I waters include secondary contact recreation and propagation of fish and fishing.[84] Geothermal system must not inhibit the ability of these water bodies to support wildlife or to provide opportunities for contact recreation and fishing. Accordingly, geothermal

system designs that use Hendrix Creek or Fresh Creek, even if closed loop, require consultation with DEC to confirm that the system will not violate applicable water quality standards. DEC may require a thermal impact analysis to confirm compliance with thermal criteria, as well as an EFH assessment to evaluate the impact of the project on local aquatic life.[85]

At the time of review, DEC may also impose system-specific conditions, which may require the applicant to provide biological information on the waterbody and an analysis of available technology or operational measures to minimize any adverse impacts caused by the thermal discharge.

### *B.2.2.6 DEC Water Quality Certificate under Section 401 of the Clean Water Act*

Under CWA Section 401, a federal agency cannot issue a permit unless the State certifies that the proposed activity will not violate State water quality standard or waives its certification authority. If the State denies a Section 401 water quality certification, the activity cannot proceed.[86] States may also impose significant conditions on the permit or project through the 401-certification process to reduce the activity's impacts.[87]

Generally, a developer applies to the federal agency and DEC, which administers New York State's environmental laws and Section 401 certification, at the same time so that both reviews proceed concurrently. Accordingly, the Corps cannot issue Section 404 discharge permit until DEC issues a Water Quality Certificate or waives the requirement.[88]

Review of the provided documentation did not determine whether NYCTA/MTA or DEP holds a Section 401 water quality certification in relation to the discharge of water the into Hendrix Creek.

### *B.2.2.7 Protection of Waters Permit*

In New York State, applicants must obtain a Protection of Waters permit for "excavation or placement of fill"[89] in navigable waters below the mean high-water level, including adjacent and contiguous marshes and wetlands.

Because Fresh Creek and Hendrix Creek are navigable, any excavation or installation of a geothermal system could require a Protection of Waters permit. Additionally, like CWA Section 404 and Rivers and Harbors Act Section 10 permits, DEC may require the applicant to demonstrate that no alternative designs or locations would better avoid or minimize impacts to protect the watercourse.[90]

Review time frames, procedures, and public notice requirements differ for minor and major projects. 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 sf or less.[91] For minor projects, DEC must make a permit decision within 45 days after determining the application is complete.[92] Major projects require public notice and a comment period, and they may require a public hearing. The major project review process may take up to 7 months based on statutory requirements.[93]

### *B.2.2.8 State Environmental Quality Review Act*

New York State's SEQR requires State and local agencies to consider environmental factors in the planning, review, and decision-making processes regarding permits, zoning changes, or government funding. SEQR review applies to New York State projects that require discretionary State or local government approval.[94]

The SEQR process requires agencies to determine whether actions they directly undertake, fund, or approve may significantly impact the environment. If so, they must prepare, or require to be prepared, an EIS to assesses the potential impacts and ways to avoid or mitigate them.[95] If the lead agency determines the proposed action will not cause a significant environmental impact, it issues a "negative declaration," which ends the SEQR process and may lead to litigation from project opponents.[96] A positive declaration triggers procedural mandates that lead to preparation of a Final Environmental Impact Statement (FEIS), which forms the basis of the final decision to fund or approve the project.[97]

An action becomes subject to SEQR, if any State or local agency must issue a discretionary permit, license, or other approval, or if an agency provides funding or directly undertakes a project. Consequently, any State or local approval, such as a permit, triggers SEQR. Additionally, any NYSERDA funding for subsequent phases of the project likely constitutes an agency action subject to SEQR.

Once an "agency action" occurs, the agency must determine whether SEQR applies. Type II actions, those previously determined not to have a significant environmental effect, are not subject to SEQR.[98] If the action does not fall within one of the exclusionary categories, the lead agency must classify it as a Type I or an Unlisted action, which then triggers different procedural requirements.

To reach a determination of significance, the agency must prepare an Environmental Assessment Form (EAF), either a short or full version depending on the action.

The short EAF, used for Unlisted actions deemed to have a significant effect, requires the lead agency to consider whether the action would cause "an increase in the use of energy" and whether it "fails to incorporate reasonably available energy conservation or renewable energy opportunities."[99] The full EAF also requires applicants for commercial and industrial projects to provide information about the new or additional demand for energy, including anticipated sources of energy.[100]

If the agency issues a positive declaration, the applicant must prepare a Draft Environmental Impact Statement (DEIS) for public review and comment.[101] The DEIS must "analyze the significant adverse impacts and evaluate all reasonable alternatives."[102] It must assess 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 . . . ."[103]

The DECinfo Locator GIS tool indicates that the entire length of both tributaries lies within the Jamaica Bay Critical Environmental Area (CEA).[104] Under subdivision 6 NYCRR 617.14(g) of the SEQR regulations, local and county governments may designate geographic areas within their boundaries "with exceptional or unique character" as CEAs. Such character includes:

- "A benefit or threat to human health;
- A natural setting such as fish and wildlife habitat, forest and vegetation, open space, and areas of important aesthetic or scenic quality;
- Agricultural, social, cultural, historic, archeological, recreational, or educational values; or
- An inherent ecological, geological, or hydrological sensitivity that may be adversely affected by any change."[105]

Kings, Queens, and Nassau counties established the Jamaica Bay CEA in February 1990. Once designated, the CEA must be considered during SEQR review of Type I or Unlisted actions. If the short or full EAFs identify proposed actions within or adjacent to the designated CEA, the lead agency is required to "evaluate the magnitude of potential adverse impacts to the [environmental characteristics] of the CEA" during SEQR review.[106]

### *B.2.2.9 Listed Species Regulation*

New York State law protects animals and plants that State regulations list as endangered, threatened, special concern, or rare. As previously explained, DEC uses its authority under SEQR 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 mitigate those impacts.[107] However, when a project component cannot fully avoid adverse effects on a listed species, the agency may require an incidental take permit for the "taking" of a threatened or endangered species.[108]

These permitting requirements apply only to animals listed as endangered or threatened, as defined in Part 182, and activities that affect species of special concern do not require an incidental take permit.[109] Additionally, to trigger the permitting requirements, the proposed activity must likely result in the taking of a listed animal or involve an adverse modification of occupied habitat.[110]

According to DEC's Environmental Resource Mapper, the project lies in the vicinity of rare animals listed as special concern by New York State. When the Environmental Resource Mapper reports rare or unlisted animals, DEC recommends that the project proponent submit a request to the New York Natural Heritage Program for a more detailed screening regarding the species present and potential impacts on those species. Although animals listed as special concern do not receive the same protections as those listed as either threatened or endangered, the SEQR process still requires an assessment of impacts to rare and unlisted animals.

While no rare plants or animals are found at the project site, the southern half of the site sits within a half mile of the significant natural community of Jamaica Bay. New York State also identifies Fresh Creek (and all of Jamaica Bay) as a significant coastal fish and wildlife habitat.[111] The SEQR process will likely need to assess any project impacts on these nearby habitats of importance.

### *B.2.2.10 Coastal Zone Management Act*

Under New York State's Coastal Management Program, federal or State agencies must ensure that their actions, including permitting decisions, align with the State's coastal policies when those actions affect New York State's coast. Depending on the project's potential to significantly impact coastal areas, a full review may be required as a precondition to determine consistency with State policies. The New York State Department of State makes these coastal policy determinations.

In developing the Coastal Management Plan, New York State also passed the Waterfront Revitalization of Coastal Areas and Inland Waterways Act, which establishes a statewide approach to encourage coastal development while protecting natural resources.[112] The law defines the boundaries of the State's coastal area by adopting a map showing where the Coastal Management Plan policies apply and providing a set of guidelines to address significant coastal issues. It also offers local governments the opportunity to

voluntarily participate in the State's Coastal Management Plan by preparing and adopting Local Waterfront Revitalization Programs (LWRP), which provide more detailed implementation using local powers such as zoning and site plan review.[113]

An 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".[114] 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."[115] Additionally, State agencies must act consistently with the approved LWRP to the maximum extent practicable.[116]

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

The WRP establishes general goals for the city's waterfront and specific goals for areas with notable characteristics.[118] The program consolidates 56 city and State policies into 10 categories:

1. Residential and commercial redevelopment
2. Water-dependent and industrial uses
3. Commercial and recreational boating
4. Coastal ecological systems
5. Water quality
6. Flooding and erosion
7. Solid waste and hazardous materials
8. Public access
9. Scenic resources
10. Historical and cultural resources[119]

The WRP also establishes five types of special area designations:

1. Special Natural Waterfront Areas
2. Significant Maritime and Industrial Areas (SMIAs)
3. Arthur Kill Ecologically Sensitive Maritime and Industrial Area (ESMIA)
4. Priority Marine Activity Zones (PMAZs)
5. Recognized Ecological Complexes (RECs)[120]

Within these areas, the WRP prioritizes certain policies over others.[121]

The entire project site falls within the WRP boundary and lies within an area designated as an SMIA.[122] The WRP includes the periphery of Jamaica Bay within its boundary. However, Jamaica Bay itself, as a federally owned property and within the Gateway National Recreation Area (NRA) is excluded from the State's and City's coastal area jurisdiction. The National Park Service manages this waterbody.[123]

Everything south of the Belt Parkway lies part of the Gateway NRA and falls outside the City's coastal area.[124] This places the Hendrix Creek and Fresh Creek coastline within the City's jurisdiction under WRP. The plan designates this zone as "Reach 17," which covers Jamaica Bay and Rockaway. For this reach, the WRP identifies goals that include preserving salt marshes, supporting restoration plans in nearby Spring Creek, and improving maintenance and public access in Fresh Creek. The plan does not identify specific goals for Hendrix Creek.[125]

Federal, State, and local agencies review funding, permitting, and other approvals for projects in the coastal zone to ensure consistency with WRP policies. State agencies must act in a manner consistent, to the maximum extent practicable, with WRP policies when their actions may affect the achievement of those policies.[126] At the State level, the SEQR process includes the consistency review. State agencies must also provide timely notice to affected local governments when an action will occur in an area covered by an approved LWRP. The local government then evaluates whether the proposed action aligns with the LWRP.

The Department of State generally takes between 30 and 90 days to complete a full consistency review and issue a consistency certification. This process is coordinated with other federal, State, and certain local agencies, and may take up to 6 months in some cases. The public notice and comment period is normally 30 days, but not less than 15, days. By federal regulation, the Department of State has 6 months to complete its review of a consistency certification and render a decision.

### *B.2.2.11 Office of Renewable Energy Siting Approval*

Geothermal systems with a planned capacity equal to or greater than 25 megawatt thermal ($MW_{th}$) fall under the permitting requirements of the Office of Renewable Energy Siting (ORES).[127] A 25-$MW_{th}$-equivalent geothermal system can serve a small community of approximately 2,000 homes.[128] ORES regulations provide an application process similar to Article 10 of the Public Service Law for siting major electric generating facilities, establishing uniform standards and conditions for all proposed projects. Applicants must work with municipal authorities where they plan to locate the facility, obtain several environmental approvals from ORES before applying, and file an application that

includes exhibits addressing land use impacts, public health, safety and security, noise and vibration, cultural resources, endangered and threatened species, visual impacts, water quality, and wetlands. These applications undergo public comment and hearing procedures.

Under Section 94-C, which governs ORES decisions, the siting agency must determine within 60 days whether an application meets applicable requirements.

To confirm completeness, the record must demonstrate that the applicant consulted with host municipalities and communities. Applicants must obtain environmental approvals and submit comprehensive applications to ORES before proceeding with their project.

During the Section 94-C comment period, the host municipality must file a statement "indicating whether the proposed facility is designed to be sited, constructed and operated in compliance with applicable local laws and regulations, if any, concerning the environment, or public health and safety."[129] Following this period, the agency may schedule an adjudicatory hearing to evaluate or rule on the application.

ORES must issue a permit within 12 months of deeming the application complete. The agency may issue the permit only after determining that the project avoids or minimizes significant adverse environmental impacts, completes a review of applicable local zoning laws, and complies with relevant laws and regulations. In making its determination, ORES may elect not to apply local law and ordinances in favor of the uniform standards and conditions set out in Section 94-C regulations. However, the current regulations do not include specific guidelines for geothermal energy systems.

### *B.2.2.12 Drilling Permits*

New York State imposes different requirements for geothermal wells based on whether they are drilled less than or more than 500 feet deep, using permitting regimes originally designed for nongeothermal systems but adapted for these purposes.

DEC's Division of Water regulates wells less than 500 feet deep. The Division of Water requires driller and pump installer registration and certification, as well as the submission of preliminary notice and well completion reports for open-loop or standing column systems.[130] The agency waives completion reports for closed-loop geothermal systems with boreholes up to 500 feet deep.[131]

DEC's Division of Mineral Resources regulates the drilling, construction, operation, and plugging of geothermal wells deeper than 500 feet.[132] These wells must meet additional requirements, outlined in Table B-1, including detailed information about well locations, depth, use, casing material, cementing procedures, drilling fluid, and cutting disposal methods. Applicants must also complete an EAF, which DEC uses to evaluate the environmental impacts and determine whether any "special permit conditions, a Supplemental Environmental Impact State[ment], or any additional DEC permits are required."[133]

DEC also requires ongoing reports throughout the permitting and drilling process. Before a well owner may permanently plug and abandon a well, they must obtain a separate permit.[134]

Before obtaining a drilling permit for a well that may produce brine, saltwater, or other polluting fluids in harmful quantities, the well owner must obtain a permit for safe and proper fluid disposal.[135] Depending on the disposal method, DEC may require additional discharge or disposal permits.

DEC enforces minimum standards for all wells through its Casing and Cementing Practices to protect groundwater by preventing the migration of fluids.[136] However, DEC 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.[137]

The Division of Mineral Resources consults with New York's State Historic Preservation Office (SHPO), located within the New York State Office of Parks, Recreation and Historic Preservation (NYS Parks), to determine whether the proposed well location falls within a State-listed historic area, which would require additional permissions.[138] If it does, SHPO reviews the project to ensure it does not harm cultural resources.[139] The permit application process takes approximately 6 to 8 weeks, but may take longer depending on project complexity. Additionally, fees vary based on well depth.[140] Table B-1 summarizes drilling permit requirements and restrictions under both regimes.

**Table B-1. Requirements for Closed Ground Source Loops**

*Source: DEC (2021a, 2021b), NY-GEO (2020).*

| Requirements | Well Depth | |
|---|---|---|
| | <500 Feet | ≥500 Feet |
| Driller and pump installer certification and registration | Yes | — |
| Municipalities may impose additional requirements | Yes | — |
| Organizational Report (Form 85-15-12) | — | Yes |
| Application for permit to drill well (Form 85-12-5) | — | Yes |
| Environmental Assessment Form (Form 85-16-5) | — | Yes |
| Financial Security Worksheet (Form 85-11-2) and deposit of required financial security starting at $2,500 per well over 500 feet | — | Yes |
| Certified site plan | — | Yes |
| Casing and Cementing Plan | — | Yes |
| Drilling progress reports | — | Yes |
| Periodic drilling and drift correction[141] | — | Yes |
| Well drilling and completion report (Form 85-15-7) | — | Yes |
| Annual reports of status and use of well | — | Yes |
| Incident reports of leakage or condition posing risk to the environment or the health, safety, welfare, or property of any person | — | Yes |
| Permit to plug and abandon | — | Yes |

### *B.2.2.13 Uniform Heat Standards for Multiunit Residential Buildings*

New York State establishes statewide standards that require heating facilities in multiunit buildings to maintain a temperature of 68 degrees Fahrenheit (ºF). From October 1 through May 31, building owners must supply heat to tenants in multiple dwellings. If the outdoor temperature falls below 55°F between 6:00 a.m. and 10:00 p.m., they must heat each apartment to at least 68°F. If the outdoor temperature falls below 40°F during that same period, they must heat each apartment to at least 55°F.[142]

### *B.2.2.14 Affordable Housing*

If a multiunit residential building qualifies as affordable housing, New York State and local municipal regulations limit the amount that owners may charge tenants. Authorities must include all housing costs in the affordability calculation. For rental units, this includes rent and any tenant-paid utilities. For ownership units, this consists of the mortgage payment (principal and interest), property taxes, homeowners insurance, and any common charges or homeowners' association fees for condominiums or cooperatives.

The U.S. Department of Housing and Urban Development (HUD) annually sets income limits known as the Area Median Income (AMI) for each Metropolitan Statistical Area (MSA), which typically corresponds to large cities or counties. New York City Department of Housing Preservation and Development and New York City Housing Authority (NYCHA), which fund and manage affordability programs, use the AMI to set eligibility for rental and ownership housing. They define affordability as housing costs that do not exceed 30% of a household's monthly gross income. The number of people in a household determines the maximum allowable housing cost under these thresholds.

HUD also annually publishes HOME Program Rent Limits for each MSA based on affordability for households earning at or below 50% or up to 60% AMI. For rental units, these calculations include both rent and utilities. Therefore, if building owners arrange third-party heat provision, they must execute contracts that ensure compliance with affordability thresholds.

## B.2.3 Local

Although New York City has not developed permitting guidelines for geothermal systems, various local laws and regulations still apply.

### *B.2.3.1 Building Code and Permitting*

The building permitting process includes reviews for mechanical and construction approvals. While regulations do not specifically address geothermal systems, their components are reviewed under standard mechanical, structural, and construction requirements.

### *B.2.3.2 City Environmental Quality Review*

New York City uses the City Environmental Quality Review (CEQR) process, authorized under New York State's SEQR, to evaluate the environmental impacts of discretionary city actions.[143] CEQR adapts SEQR for an urban context. When a city approves, funds, or undertakes a project within city limits,[144] CEQR requires that agency to assess and disclose potential environmental consequences. Agencies must also take all feasible measures to avoid, minimize, and mitigate damage to the environment.[145]

CEQR differs from SEQR in that it provides lead agency guidance, requiring public scoping, and using city-specific forms and the CEQR Technical Manual.[146]

Given Spring Creek Towers' location, officials must determine whether DEC or DEP will serve as the lead agency for permitting and environmental review. Based on the project site's location, DEP will most likely act as lead agency. Because NYSERDA funds the project, a necessary city approval may trigger CERQ review.

Potential permit approvals include tapping into NYCTA/MTA infrastructure, discharging thermal water through a DEP-regulated stormwater outlet into Hendrix Creek, or obtaining a DEP drilling or excavation permit. The project may also require routing system pipes across DEP property and public roads regulated by the New York City Department of Transportation (NYCDOT). If DEP is determined to be the lead agency, it will assume responsibility for most or all regulatory reviews otherwise assigned to DEC.[147]

### *B.2.3.3 Drilling and Excavation Permit*

No person may drill or excavate in a corridor within New York City to a depth greater than 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 shaft, without obtaining a permit from the DEP.[148]

Drilling beyond these depths requires submission of a preapplication to DEP's Bureau of Water and Sewer Operations.[149] Within 10 days of receiving the preapplication, DEP will notify the applicant whether a permit is required or if the location falls within a No Drilling/Excavation Zone.[150] 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 500 feet horizontal distance from any centerline of any water tunnel or shaft as measure at or near the surface," a permit from the DEP's Bureau of Water and Sewer Operations permitting office is required.[151]

If the proposed drilling and/or excavation is in a corridor, the DEP may issue a permit within 30 days, provided the proposed work does not impair water tunnel or shaft stability and complies with all applicable standards and requirements.[152] Permits are not required outside of a corridor zone.[153] No permit will be issued for work in a No Drilling/Excavation Zone, defined as "a boundary area . . . 200 feet on either side of the centerline of a water tunnel and vertical distances of 150 feet above the crown of a water tunnel and 150 feet below the invert of a water tunnel; or, except as otherwise indicated, 200 feet on either side of the centerline of a water tunnel shaft."[154]

### B.2.3.4 Proximity to Water Tunnels

Prior to drilling geothermal boreholes, DEP requires a letter to the Bureau of Water and Sewer Operations stating planned depth, use, and mapped locations of the boreholes. The NYCDEP will then respond, stating whether the boreholes fall within 500 feet of any New York City water tunnel or structure and whether drift monitoring or reporting is required.

Subsurface infrastructure locations for all boroughs should be confirmed with the Bureau of Water and Sewer Operations.[155] This process typically takes approximately 4 weeks to complete, but site-specific complexities may extend the review periods.

### B.2.3.5 Office of Parks and Recreation

A permit is required for any work affecting NYC Parks' assets, which include natural areas, sidewalks, roadways, monuments, and concessions.[156] Project proponents must submit a scope and design for approval, followed by a construction permit application.[157]

Permits are time-limited (typically to the construction period, which lasts up to 2 years) and include a restoration requirement at the conclusion of the construction period.[158] If tree disturbance is anticipated, a tree work permit is also required.[159] Impacts on Fresh Creek or the Fresh Creek Nature Preserve will require additional approval from NYC Parks. NYC Parks typically takes up to 6 weeks to review a complete permit application.[160]

### B.2.3.6 Metropolitan Transportation Authority Approvals

The MTA, which includes the NYCTA, the Long Island Rail Road and Metro-North Railroad, and the Port Authority of New York and New Jersey, must be informed of planned drilling and/or excavation within 200 feet of its infrastructure, including tunnels, stations, substations, and ventilation buildings.[161] Approvals may require additional insurance and vibration monitoring depending on the proximity to the site.[162]

Applications include:

- A site plan showing drilling locations relative to MTA structures
- Verification of proximity to transportation assets

Review is conducted through the MTA's External Partner Program, which may require design modifications to protect MTA infrastructure.[163]

### *B.2.3.7 New York City Noise Code: Construction Noise Mitigation Plan*

DEP regulates construction noise that may result from drilling activities generating noise, vibrations, or dust. A construction noise mitigation plan may be required as part of the application to the New York City Department of Buildings for a construction permit. Work conducted outside the permitted hours of 7:00 a.m. to 6:00 p.m. requires a variance. Copies of the mitigation plan must also be kept on-site and made available for inspection at all times. [164]

### *B.2.3.8 Groundwater Discharge Permits*

DEP issues permits for the temporary disposal of drilling fluids and groundwater generated during drilling and construction into the City sewer system.[165]

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.[166] Discharges exceeding 10,000 gallons of groundwater per day into a public sewer require a Groundwater Discharge Permit from the Bureau of Customer Services. Prior approvals from both the Bureau of Water and Sewer Operations and the Bureau of Wastewater Treatment are also required.[167] The Bureau of Wastewater Treatment evaluates the water quality of the proposed discharge to determine whether pretreatment is necessary. At the same time, the Bureau of Water and Sewer Operations reviews the discharge volume to ensure that the local sewer mains can accommodate the additional flow.[168]

Discharges to storm sewers must first be approved by the DEC before an application can be submitted to the Bureau of Customer Services for a discharge permit.[169] The average approval time from the Bureau of Wastewater Treatment is typically 2 to 4 weeks, although review and approval from the Bureau of Water and Sewer Operations may take longer.

### *B.2.3.9 Special Flood Hazard Areas*

In New York State, local municipalities participating in the National Flood Insurance Program (NFIP) regulate development within Special Flood Hazard Areas (SFHA).[170] As a result, development that occurs within a SFHA (including the construction of buildings and other structures, mining, dredging, filling, paving, excavation, drilling, or the storage of equipment or materials) is subject to applicable construction regulations.[171]

According to the Federal Emergency Management Agency (FEMA) flood maps, Hendrix Creek and Fresh Creek north of the Belt Parkway are classified as Flood Zone AE, areas identified as high risk for flooding

with a base flood elevation of 8 feet. Under FEMA's map, the eastern side of the DEP property along Hendrix Creek, the western end of Starrett City Park, and parts of the east bank of Fresh Creek Nature Preserve are all located within areas that have a "1% annual chance of flood[ing]."[172] FEMA flood maps do not extend these areas onto the project site.

The New York City Flood Hazard Mapper (FHM) reports slightly different elevations for Flood Zone AE, indicating base flood elevations between 10 and 11 feet for both tributaries. According to the FHM, Flood Zone AE extends onto DEP property on the western side of Hendrix Creek, with "0.2 PCT Annual Chance Flood Hazard Zone" reaching portions of Van Siclen Avenue and extending onto the project site at and immediately south of Schroeders Avenue.[173]

Within an "AE" zone or a numbered "A" zone may include a designated "regulatory floodway," the channel of a river, and adjacent land areas reserved to discharge the 100-year flood without raising flood elevations.[174] According to FEMA classifications, the project site lies outside the regulatory floodway.

Seawalls line both Hendrix Creek and Fresh Creek.

### *B.2.3.10 Stormwater and Sewer System Connection*

Project designs that connect to municipal stormwater systems must comply with local stormwater permitting regimes developed under the CWA. These stormwater permit requirements set standards for floatable materials, nutrients, toxics, metals, other solid pollutants, and even heat (under New York State's 6 NYCRR Part 750-1.2a) apply.[175]

The CWA's NPDES/SPDES regime regulates stormwater discharges into protected waters from one of two types of storm sewer systems: combined or separate.

### *B.2.3.11 Combined Stormwater and Sewer Systems*

Historically, many New York State municipalities used combined sewer systems, where both stormwater and sanitary wastewater travel through a single pipe to a wastewater treatment plant (WWTP).[176] During heavy rainfall, combined systems may overflow, discharging into protected surface waters through a combined sewer overflow (CSO) outlet. This design ensures that WWTPs do not receive flows beyond their designed capacity, thereby preventing pollution of nearby surface waters.

Because CSOs can degrade water quality, they are regulated under the CWA's NPDES/SPDES program.[177] Under the EPA's CSO Control Policy, municipalities with CSOs must hold discharge permits and implement best management practices for pollution reduction.[178] In New York State, the DEC issues SPDES permits for all WWTPs and CSOs under its jurisdiction.

### *B.2.3.12 Separate Stormwater and Sewer Systems*

In contrast, separate storm systems use distinct pipes for stormwater and sanitary wastewater, eliminating cross-contamination. These are common in newer or suburban areas, and many older combined systems have been partially replaced with separate systems wherever possible.

Separate systems are generally referred to as municipal separate storm sewer systems (MS4) under 40 CFR 122.26(b)(4). Amendments to the CWA in 1987 extended NPDES/SPDES regulations to MS4s, leading to the creation of a SPDES general permit.[179] Municipalities with MS4s in urbanized or specifically designated areas must obtain an individual MS4 SPDES permit that addresses the stormwater discharges or seek a waiver from DEC.[180] An MS4 permit may designate bodies of water as impaired if they fail to meet DEC water quality standards for use (e.g., fishing) and pollutants of concern (POCs). Discharges not fully composed of stormwater (or not allowed under a SPDES permit or municipal rules) are considered illicit discharge.

Construction projects in MS4 zones generally require an SWPPP that has been reviewed and approved as part of the SPDES process, prior to submitting a Notice of Intent to DEC.

During the development stage, the municipality should be consulted to determine which stormwater permits apply to the project site, particularly concerning potential sewer system connections for thermal sources and outlets, and whether the proposed design alternatives require compliance with, or approval under, existing stormwater or wastewater SPDES permits.

New York City primarily relies on combined sewer systems, although it also uses MS4s, private systems, and direct drainage.[181] At the SCT site, combined system pipes and CSOs appear present, potentially affecting the geothermal system design. Mapping tools for the area surrounding SCT show CSO outlets at the headwaters of Hendrix Creek and Fresh Creek. Additionally, the 26th Ward WTTP, located on DEP property directly adjacent to the project site, operates under SPDES Permit No. NY0026212.[182]

In 2015, New York City established the MS4 to comply with CWA Phase 1 stormwater permitting requirements. The City issued its first MS4 SPDES permit in August 2015, establishing stormwater discharge requirements.

To implement these standards, the City developed and continues to manage its Stormwater Management Program (SWMP). The City renewed the MS4 SPDES Permit No. NY0287890 in August 2022, with validity extending through August 2027.[183] The 2022 MS4 permit is publicly available.[184]

According to the DEP MS4 mapping tool, the southern portion of the project site drains into MS4 Drainage Area 26W-604. The DEP property east of the project site, which borders and discharges into Hendrix Creek, falls within MS4 Drainage Area 26th Ward WWTP. Each waterbody contains multiple MS4 outfall locations.

The MS4 Permit and prior annual reports identify Hendrix Creek as an impaired water segment due to three POCs: pathogens from fecal matter, nutrients such as nitrogen, and floatables such as garbage and refuse.[185] While stormwater permitting typically focuses on pollutants such as floatable materials (e.g., garbage, oil, and grease), settleable solids, nutrients (nitrogen), and metals, the 2022 MS4 permit explicitly cites the 6 NYCRR Part 750-1.2a definition of "pollutant," which includes heat.[186]

If SCT uses the storm sewers and/or sanitary sewers as a thermal source or sink, or if water used in the geothermal system is discarded through a CSO or MS4 outfall into a protected waterbody subject to a SPDES permit, the design of the geothermal system may trigger SPDES CSO or MS4 permitting requirements. Project planners should review relevant SPDES stormwater permits for sewers and outfalls to assess whether the proposed system design requires a permit, waiver, or specific approval.[187]

### *B.2.3.13 Temperature of Discharge*

Municipal regulations specify a default range for the temperatures of effluent entering the public sewer system, which the sewer authority may restrict 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:

- Effluent may not exceed 150ºF, or 65 degrees Celsius (°C)
- Effluent must be above freezing (32ºF or 0ºC) so it is not ice[188]
- No specific maximum or minimum temperatures are defined at the sewage treatment plant intake

These constraints limit the use of sewage streams as heat sources and sinks to outflow that enters the public sewer between 32ºF (0°C) and 150°F (65°C). The sewer authority may impose more restrictive limits as part of the review process.

### *B.2.3.14 System Construction*

Sewer infrastructure must be constructed to securely contain waste and prevent environmental contamination. Accordingly, connections between the diversion and main line connected to the sewer must conform to regular DEC requirements for sewer construction and be made watertight, preventing leaks into or out of the system.

New York City's sewer construction requirements will apply to any proposed heat exchange components within the sewer system.[189] Although no specific geothermal requirements exist for geothermal integration, unfamiliarity with these systems may result in longer review times during the permitting process. All materials, including design and materials, will be reviewed as part of the ordinary permitting process.

### *B.2.3.15 New York City Local Law 97 Compliance*

New York City's Local Law 97 of 2019 requires buildings over 25,000 sf in 10 designated building classes to reduce greenhouse gas emissions by 40% by 2030 and achieve an average 80% reduction by 2050.

Affordable housing developments receive certain exemptions that delay compliance until 2035; however, all buildings will ultimately need to meet decarbonization requirements by then. For multifamily housing, including cooperatives, condominiums, and rental buildings, the law sets some of the most stringent standards, with initial caps taking effect in 2024 with further reductions in 2029. These caps are measured in metric tons of carbon dioxide equivalent per square foot ($tCO_2e$/sf).

As a general guideline, residential buildings with 25 to 30 units or more are likely to exceed the 25,000 sf threshold requirements. Group R-2 multifamily housing must limit emissions to 0.00675 $tCO_2e$/sf from 2024 to 2029, and 0.00407 $tCO_2e$/sf from 2029 to 2034.[190]

Noncompliant buildings may face penalties unless they qualify for an exception. They may also need to purchase carbon offsets in a future market at an uncertain price. Almost 26,000 buildings across New York City fall under the law's requirements.

Local Law 97 builds on prior New York City laws that require pipe insulation, energy-efficient lighting, and the gradual phase-out of the dirtier forms of fuel oil. By 2030, all heavy fuel oils must be eliminated. New boiler or burner installations must use 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 the very least, penalize its continued use.

Installing a geothermal system will support compliance with Local Law 97 and help avoid or reduce potential penalties.

## B.3 Relevant Precedents

Saint Patrick's Cathedral in New York City installed a closed-loop geothermal system with boreholes deeper than 500 feet. While the project differs significantly in scope and context from the current one, it serves as a useful precedent for geothermal development in New York City. It may inform discussions with City officials and permitting authorities.

**Table B-2. Permitting and Regulatory Review Requirements and Risks**

| Level | AHJ | Permit, Approval, or Action Required | Purpose & Description | Estimated Timeframe | Risks & Considerations |
|---|---|---|---|---|---|
| Federal | US Army Corps of Engineers (Corps) | • Obtain CWA Section 404 Dredge and Fill Permit<br>• Obtain Rivers and Harbors Act Section 10 Permit<br>• Obtain Rivers and Harbors Act Section 14 (Section 408) permission | • Approves activities in, over, and under navigable waterways<br>• Delineate protected wetlands<br>• Ensure compliance with EPA regulations, Corps, NEPA, Endangered Species Act, National Historic Preservation Act, CWA Section 401 of Clean Water Act, CZMA<br>• Coordinates with DEC and other agencies | Concurrent with DEC; 60 days to 1+ years, depending on complexity | • Trigger habitat, navigation, and wetlands issues<br>• Encounter public opposition<br>• Require alternative designs |
| | U.S. Environmental Protection Agency (EPA) | • Issue permits under:<br>○ CZMA<br>○ CWA<br>○ SDWA<br>○ Endangered Species Act<br>○ NEPA | • Oversee Corps and DEC decisions<br>• Block CWA Section 404 permits if adverse impacts on water supply, shellfish beds and fisheries, wildlife, or recreation | Follows Corps review unless complications arise | • Block or delay projects with incomplete or unsupported findings |
| Federal | US Fish and Wildlife Service (USFWS) | • Participate in Endangered Species Act consultation | • Evaluate effects on endangered species and critical habitat<br>• Recommend best available technology for thermal discharges | Subsumed within Corps review | • Require additional mitigation or design adjustments |
| Federal | U.S. Department of Housing and Urban Development (HUD) | • Enforce affordable housing compliance | • Ensure project compliance with affordable housing standards and heat provision | Follows State process unless complications arise | • Trigger complaints or legal challenges |
| State | New York State Department of Environmental Conservation (DEC) | • Obtain CWA 401 Water Quality Certification<br>• Obtain SPDES Permit<br>• Obtain Protection of Waters Permit<br>• Obtain well approval (based on depth)<br>• Obtain sewer construction approval<br>• Comply with listed species protection | • Regulate water discharge and thermal extraction<br>• Prevent potential drinking water pollution<br>• Approve well construction<br>• Protect habitat and river systems<br>• Provide requirements for sewer construction | • 45 days, minor projects<br>• 90 days, major projects<br>• 150 days, major projects with public hearing | • Raise habitat and wetland concerns<br>• Delay major projects |

**Table B-2. (continued)**

| Level | AHJ | Permit, Approval, or Action Required | Purpose & Description | Estimated Timeframe | Risks & Considerations |
|---|---|---|---|---|---|
| State | New York State Department of State (DOS), Division of Coastal Resources | • Obtain Coastal Management Program consistency approval | • Verify consistency with State coastal protection policies<br>• Coordinate federal, state, and municipal review processes | 60 days for federal consistency review | • Trigger habitat and wetlands concerns<br>• Attract public opposition |
| State | New York State Department of Transportation (DOT) | • Obtain road closure, easement, or encroachment approval | • Authorize work within or near State roads and railroad tracks | Weeks | • Pose minimal risk |
| State | Office of Renewable Energy Siting (ORES) | • Obtain project approval for systems over ≥25 $MW_{th}$ | • Regulate pricing and ensure heat is adequately provided in residential developments | Up to 12 months | • Present low risk with compliance and coordination |
| State | New York State Homes and Community Renewal (HCR) | • Enforce housing and heating regulations | • Regulate pricing and ensure heat is adequately provided in residential developments | None unless complaints arise | • Raise affordability concerns<br>• Trigger public opposition |
| Local | New York City Department of Buildings | • Obtain building or mechanical permit | • Review geothermal system as part of construction application | Months | • Create design and communications issues |
| Local | New York City Department of Environmental Protection (DEP) | • Submit notification of drilling (depth, use, map)<br>• Obtain groundwater discharge permit<br>• Obtain drilling/excavation permit (>50 ft)<br>• Request water/sewer connection approval<br>• Verify location of underground infrastructure | • Protect water infrastructure<br>• Manage system operation and discharge impacts<br>• Prevent interference with tunnels or mains | Subsumed within local project permitting | • Encounter design and infrastructure conflicts |
| Local | New York City Department of Health | • Obtain system impact approval (if needed)<br>• Respond to complaints | • Ensure health and safety of water and sewer systems<br>• Ensure health and safety of heating services | Subsumed within project permitting | • Face design or service reliability concerns<br>• Trigger complaint-driven action |
| Local | New York City Department of Transportation (DOT) | • Obtain revocable consent and permits for underground installations<br>• Obtain road and sidewalk closure permits | • Authorize street and sidewalk work or encroachments for construction | 4 weeks | • Require design concerns |

**Table B-2. (continued)**

| Level | AHJ | Permit, Approval, or Action Required | Purpose & Description | Estimated Timeframe | Risks & Considerations |
|---|---|---|---|---|---|
| Local | Metropolitan Transportation Authority (MTA) | • Notify and obtain approval for drilling within 200 feet of structures | • Protect MTA infrastructure from potential subsurface impacts | TBD | • Require additional design safeguards |
| Local | New York City Department of Housing Preservation and Development (HPD) and New York City Housing Authority (NYCHA) | • Enforce rent regulations and tenant rights | • Ensure provision and pricing of heat comply with affordable housing rules | None unless opposition arises | • Encounter regulatory hurdles or public opposition |
| Local | New York City Department of City Planning | • Obtain Floodplain Development Permit | • Comply with FEMA requirements for Special Flood Hazard Area<br>• Subject to additional construction requirements | Weeks; subsumed within local project permitting | • Pose minimal risk |
| Local | Harbormaster | • Conduct consultation and obtain approval | • Ensure navigable waterways remain unobstructed | Subsumed within Corps review | • Present navigation-related concerns |
| Courts | Courts | • Respond to legal disputes | • Adjudicate landlord-tenant conflicts over heating service or costs | None unless disputes arise, then months to years | • Result in legal liability<br>• Public opposition<br>• Force change to business model |

**B-3. Nongovernmental Stakeholder Approvals or Consents**

| Stakeholder | Approval or Consent Required | Description | Estimated Timeframe | Risks |
|---|---|---|---|---|
| Residents Association | • Participate in public hearings<br>• Engage in consultation processes | • Voice concerns during public review<br>• Influence project design or approvals through organized feedback | Not quantifiable | • Trigger public opposition<br>• Delay or block project through advocacy or media campaigns |

## B.4 Anticipated Challenges and Risks

### B.4.1 Stormwater Infrastructure

Using storm sewers and/or sanitary sewers as a thermal source or sink, or discarding water from the geothermal system through a CSO or MS4 outfall into a protected waterbody subject to a SPDES permit, may trigger potential considerations under existing SPDES CSO or MS4 permits and regimes.

During the system design development stage, the project team should evaluate whether the various combined or separate sewers are viable thermal sources and sinks. They should also identify any approval requirements triggered by the geothermal system's potential use of a CSO or MS4 outlet regulated under a SPDES stormwater permit. This includes confirming whether the East New York Wellfield stormwater discharge line at the head of Hendrix Creek releases through a CSO or MS4 outlet, and identifying the applicable SPDES permit regulating that outlet to ensure protection of water quality standards in Hendrix Creek.[191]

DEP can confirm applicable SPDES stormwater permits for sewers and outfalls and whether the proposed system design requires a waiver or approval under those permits.[192]

### B.4.2 Environmental Regulation of Waterways and Wetlands

The Corps maintains all surrounding surface water bodies, including Hendrix Creek and Fresh Creek, which are navigable waterways. Portions of these surrounding water bodies are listed in the National Wetlands Inventory (NWI) as federal wetlands and lie within a 100-year floodplain, indicating the presence of a wetland.

As such, any system design that uses Hendrix Creek, Fresh Creek, or adjacent wetlands, as well as any construction activity such as excavation, drilling, trenching, or backfilling in areas extending to the ordinary high-water mark or adjacent wetlands, will constitute a regulated activity under CWA Section 404.

The design and construction team should plan the system to minimize potential environmental impacts to the greatest extent possible, including soil disturbance, brine production, and the release of water at nonambient temperatures.

### B.4.3 Endangered Species Act Mitigation Measures

The agency does not need to undertake formal consultation under Section 7 of the Endangered Species Act if it determines the action will not affect listed species or designated critical habitat.[193]

### B.4.4 Drilling: Brine Production

The project site's subsurface contains groundwater that may contain brine. Any well that produces brine, saltwater, or polluting fluids in harmful quantities must obtain a permit for the safe and proper disposal of such fluids.[194] Depending on the disposal method, DEC may require additional permits for discharge and/or disposal.

### B.4.5 Lack of Municipal Regulatory Regime for District Geothermal Systems

Few municipalities in New York State have developed permitting guidelines for geothermal systems, and none have done so for multi-property district systems.

Without a permitting regime and equipment standards, developers and municipal officials must interpret zoning, building, mechanical, environmental, and other regulations not originally intended for geothermal systems. This ad hoc approach increases costs, delays approvals, and raises uncertainty and risks.

For project designs that require the consent or approval of multiple stakeholders, such as property owners, utilities, and government agencies, a lack of a permitting regime and standards risks the inability of stakeholders to reach a decision or consensus, resulting in deadlock and bureaucratic paralysis. Zoning regulations, which are not specifically designed for geothermal systems, such as setback requirements, may even block geothermal projects altogether in dense urban and peri-urban areas with small lot sizes.

To address this challenge, developers should begin educating municipal permitting authorities and elected officials about the geothermal system's benefits and mitigation measures as early as possible. This outreach should start as soon as the developer approves the geothermal designs and completes the risk mitigation assessment. Developers should also be prepared to engage with environmental and community groups interested in the project.

### B.4.6 Rights-of-Way and Approvals

Developers must obtain either fee simple ownership or easements to drill and install a shared ground loop across multiple properties. To cross property lines, streets, railroad tracks, or existing utility infrastructure, obtaining an easement is essential, along with approval from the respective property owners or authorities responsible for those areas.

Acquiring rights-of-way can be a time-consuming and costly process. Each utility with subsurface infrastructure must participate in the approval process to ensure that proposed designs and implementation will not disturb their operations. These utilities will likely need to visit individual properties to assess how the installation may impact their infrastructure. The cost and risk of damage to their systems may cause these utilities to be reluctant to grant approval.

Granting easements over a property limits the owner's ability to use their property and can adversely affect private property rights or diminish property values. Valuing compensation for easements and their impact on the servient property can be challenging,[195] potentially resulting in negotiation deadlock.

Without government intervention, geothermal developers must negotiate with property owners and affected utilities for approvals, which may depend on reaching agreements on compensation, maintenance, decommissioning, and liability indemnification.

Other infrastructure sectors, such as roads, pipelines,[196] telecommunications, railroads, subways, and intracity surface rail, have documented similar rights-of-way acquisition costs. These costs may include a one-time acquisition fee, annual fees, excessive or escalating fees,[197] as well as the time and costs associated with organizational staff and legal professionals to procure the rights. In New York State, investor-owned electric and gas utilities resolve rights-of-way issues through franchise agreements with municipalities.

### B.4.6 Drilling Regulatory Restrictions

New York State applies different requirements for geothermal wells drilled to depths less than 500 feet and those drilled to depths over 500 feet. Wells deeper than 500 feet must meet more rigorous and costly permitting requirements.

New York City applies additional restrictions at shallower depths and near water tunnel shafts, without obtaining permits.

These permitting regimes often effectively limit geothermal system developers, particularly those developing residential and individual building systems, to drilling to shallower depths. Consequently, developers must drill more wells than needed if they could use deeper wells to meet the same system capacity. This increases overall costs due to greater drilling time, additional materials (particularly costly well casing), larger site restoration area, and increased production of cuttings and water.

Developers must evaluate whether drilling beyond the State's 500-foot depth threshold offers enough thermal capacity and land-use efficiency to justify the added compliance costs.

The project developer has elected to limit drilling to 500 feet to avoid significant costs, choosing to forego a more energy-efficient design.

### B.4.7 Drilling Barrier Cost and Liability

Geothermal drilling operations may encounter complicating conditions that raise safety and regulatory concerns. These increased complexities, combined with traditional legal liability rules and regulatory requirements, lead to higher labor costs due to enhanced safety precautions, specialized equipment, slower work progress, more stringent permitting, and higher insurance premiums.

Drilling in areas with excessive groundwater complicates the drilling process. Developers must remove saltwater produced during boring because they cannot reinjected it. Unknown infrastructure or other manufactured artifacts, especially in urban areas, also complicate drilling.

### B.4.8 Business Model

Geothermal development may follow several business models, each with varying technical economies and transactional diseconomies. The current project follows 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 model simplifies property rights and permitting arrangements, enabling the system operator to increase revenues by serving various tenants. College campus geothermal systems fall under this model. This model benefits from simple and low-cost legal and administrative arrangements.[198]

### B.4.9 Evolving Regulation of Hydrofluorocarbons and Implications for Certain Geothermal Systems

#### *B.4.9.1 American Innovation and Manufacturing Act of 2020*

The American Innovation and Manufacturing Act of 2020 (AIM Act) directs the EPA to promulgate regulations that reduce U.S. hydrofluorocarbon (HFC) production and consumption by approximately 85% by 2035.[199] The AIM 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 managing listed HFCs and HFCs substitutes, and facilitate the transition to next-generation technologies by restricting listed HFCs in specific sectors or subsectors.[200]

The AIM Act targets 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 and trailer use, semiconductor etching and cleaning, mission-critical military end uses, and onboard aerospace fire suppression.[201]

The AIM Act authorizes the EPA to restrict HFC use fully, partially, or on a graduated schedule in specific sectors or subsectors. The EPA may do so by initiating its rulemaking procedures independently or in response to a petition to the EPA.[202] On October 8, 2020, the EPA granted or partially granted 11 petitions to restrict the use of HFC in the refrigeration, air conditioning, aerosol, and foam sectors. The EPA has 2 years to promulgate related regulations through public comment and rulemaking.

### *B.4.9.2 New York State Law: Significant New Alternative Policy Rules 20 and 21*

Before Congress passed the AIM Act, the EPA relied on its authority to regulate ozone-depleting substances under Title VI of the Clean Air Act. In 2015, the 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. These 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.

The EPA's actions were based on recent scientific findings demonstrating that HFCs contribute measurably to the breakdown of the ozone layer, both directly and indirectly as a catalyst, due to their high global warming potential.[203] However, upon judicial review, the D.C. Court of Appeals held that the EPA exceeded its authority under the SNAP program in requiring manufacturers, who had already replaced ozone-depleting substances with HFCs at a time when HFCs were listed as safe substitutes, to make further changes. At that time, HFCs were classified as non-ozone-depleting substances under Section 612 of the Clean Air Act.

As a result, the court vacated the EPA's 2015 reclassification of HFCs and remanded the issue back to the EPA to determine whether it possesses the authority to conclude that a manufacturer's past decision to replace an ozone-depleting substance with HFCs is no longer lawful.[204]

States like California responded by independently adopting SNAP Rules 20 and 21 reimposing EPA's restrictions on HFCs. In 2018, California passed the California Cooling Act, adopting SNAP 20 and 21 into its state regulations. Other states, including New York State, enacted similar restrictions on HFCs in 2020, adopting SNAP 20 and 21.

DEC regulations prohibit the sale, installation, and use of certain HFCs in new or retrofitted food refrigeration equipment, large air conditioning equipment (such as chillers), vending machines, and consumer products that use aerosol propellants or foam-blowing agents.[205] Although these regulations do not require replacement of functioning existing equipment, Part 494 requirements apply once the equipment reaches the end of its useful life.

### *B.4.9.3 Implications for Geothermal*

As regulations evolve, developers may face increased maintenance and replacement costs for regulated refrigerants. They should consider these potential future costs when selecting technology today.

Although the EPA has already authorized several refrigerants with lower global warming potentials (GWP) for air-conditioner end-uses under the SNAP program[206] using AIM Act authority, regulations are evolving rapidly. Some states, such as California, continue to impose more stringent restrictions on GWP levels.[207]

Many next-generation refrigerants pose additional environmental and regulatory risks, such as increased flammability compared to commonly used refrigerants today.[208] Furthermore, equipment manufacturers cannot use these refrigerants as "drop-in" replacements for existing equipment until they develop systems compatible with the new substances and until state building codes specify acceptable uses.[209] Given the uncertain and rapidly evolving HFC regulations and the challenges surrounding safe and effective HFC substitutes, hydronic systems, or other systems that eliminate refrigerant use, may prove to be an economical choice today when evaluating the full lifecycle of technology options and regulatory risks.

## B.5 Summary of Recommendations

### B.5.1 Environmental Regulatory Design and Implementation

Because SCT sits near environmentally sensitive wetlands, waterways, and Jamaica Bay, the project's design and construction should minimize environmental impacts that could trigger heightened review and regulatory requirements.

- **Determine lead agency:** Due to the location of the project site, a preliminary determination should be made whether DEC or DEP will act as lead agency for the regulatory environmental review under SEQR or CEQR. Given the need for City agency permits and New York City's vested interest in protecting its coastal ecosystems, DEP likely serves as the appropriate lead agency.
- **Classify action:** The level of environmental review and regulatory requirements depends, in part, on whether the lead agency (DEP) classifies the project as Type II (excluded from review) or Type I/Unlisted. If classified as Type I or Unlisted, the applicant must submit an Environmental Assessment Statement, and the lead agency must issue a Determination of Significance. Project design and implementation should consider the following issues:
    - **Determine whether the project qualifies as a retrofit:** Assess whether the geothermal project constitutes a "retrofit" by evaluating if it introduces a "substantial change" to the existing structure. Typically, upgrades made solely to comply with fire or plumbing codes do not qualify as substantial, unless the repairs are extensive enough to trigger a Type I threshold. Evaluate whether the system replacement qualifies as a "replacement in kind."[210] Because fire and plumbing codes do not require geothermal upgrades, the proposed changes may be considered substantial.
    - **Evaluate whether the system will exceed Type 1 thresholds:** Identify whether the project will use groundwater in quantities that meet or exceed regulatory thresholds.[211] A project becomes a Type I action if it "would use ground or surface water in excess of 2,000,000 gallons per day."[212]Additionally, an action is classified as Unlisted if it exceeds 25% of the 2,000,000-gallon per day water use threshold and occurs "wholly or partially within, or substantially contiguous to any publicly owned or operated parkland, recreation area, or designated open space . . . ."[213]

## B.5.2 Preliminary Commercial Terms and Contractual Relationships

- **Tax optimization:** The geothermal system qualifies as a depreciable asset, offering opportunities for tax-advantaged financing. Ownership of the system can be structured separately from the project and its phases to maximize these benefits. A standalone geothermal financing structure may enhance the project's overall financial return; however, it also introduces additional complexity and legal risk, particularly in the event of nonperformance or legal disputes.

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[68] New York State Department of Environmental Conservation (DEC), Division of Environmental Planning and Protection. 2008. *Clean Water Act Section 401 Certification for Commercial Vessel and Large Recreation Vessel General Permit* (November 3). https://www.nwf.org/Regional-Centers/~/media/PDFs/Regional/Great-Lakes/DEC_VGP_401_Certification_final.ashx

[69] Knauf Shaw LLP. 2015. *Clean Water Regulation*, 8. Accessed September 27, 2021. https://www.nyenvlaw.com/wp-content/uploads/2015/05/Chapter-4-Clean-Water-Regulation.pdf

[70] Technology-based standards are a type of performance standards developed by the U.S. Environmental Protection Agency (EPA) for specific industrial categories. These standards establish pollutant-by-pollutant discharge limits that can be achieved using the most cost-effective combination of available pollution prevention and control technologies appropriate for those industries. All facilities within a subcategory are required to meet these end-of-pipe limits, regardless of the condition of the receiving waterbody. The specific requirements vary depending on the type of pollutant and whether the discharge is new or existing at the time the standards are established. U.S. Environmental Protection Agency (EPA). Watershed Academy Web, *Introduction to the Clean Water Act*. Accessed October 12, 2021. https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=2734&object_id=2738

[71] Meeting technology-based standards alone does not ensure that a discharge will avoid causing or contributing to a violation of the state’s ambient water quality standards for the receiving waterbody. Therefore, regulators must assess the specific impact of a discharge on water quality, even if it complies with the applicable technology-based effluent limit. If the assessment indicates that the discharge could still lead to an exceedance of water quality standards, then more stringent effluent limits (known as water quality-based effluent limits) must be included in the discharge permit. New York Water Environment Association. 2013. “Regulatory Overview and Legal Responsibilities.) *Handbook on Wastewater Management*, 4–56 (January). https://efc.syr.edu/wp-content/uploads/2015/03/Chapter4-web.pdf

[72] National Association of State Departments of Agricultural Research Foundation, National Center for Agricultural Law Research and Information. *State Environmental Laws Affecting New York Agriculture,* at 6 (explaining that New York’s SPDES program regulates point source discharges into state waters and applies water quality standards, including criteria governing thermal discharges), https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf

[73] 6 N.Y.C.R.R. § 700.1 (Definitions) (defining "thermal discharge" for purposes of New York's water quality regulations as any discharge that causes or would cause a change in the temperature of receiving waters).

[74] 6 N.Y.C.R.R. § 704.1 (Thermal Discharges) (establishing biological protection standards for thermal discharges and requiring that temperature changes not impair balanced, indigenous aquatic populations).

[75] 6 N.Y.C.R.R. Parts 649-758.Ammendments to repeal specific parts

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

[77] New York State Department of Environmental Conservation (DEC). 2020. "*Permit No. GP-0-20-001, SPDES General Permit for Stormwater Discharges from Construction Activity*" (January 28). https://www.dec.ny.gov/docs/water_pdf/constgp020001.pdf

[78] New York State Department of Environmental Conservation (DEC). N.d. "*Stormwater Permit for Construction Activity*." Accessed September 28, 2021. https://www.dec.ny.gov/chemical/43133.html

[79] National Association of State Departments of Agricultural Research Foundation, National Center for Agricultural Law Research and Information. N.d. *State Environmental Laws Affecting New York Agriculture*. https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf

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

[81] New York State Department of Environmental Conservation (DEC), Division of Environmental Planning and Protection. 2008. *Clean Water Act Section 401 Certification for Commercial Vessel and Large Recreation Vessel General Permit* (November). https://www.nwf.org/Regional-Centers/~/media/PDFs/Regional/Great-Lakes/DEC_VGP_401_Certification_final.ashx

[82] National Association of State Departments of Agricultural Research Foundation, National Center for Agricultural Law Research and Information. N.d. *State Environmental Laws Affecting New York Agriculture*, at NY-6 (describing New York water quality regulations as establishing general conditions applicable across all water classifications, including criteria governing thermal discharges and other effluent standards), https://efotg.sc.egov.usda.gov/references/public/NY/NewYork.pdf

[83] 6 N.Y.C.R.R. 700.1 (Definitions) (defining "thermal discharge" for purposes of New York's water quality regulations).

[84] 6 CRR-NY 701.13. (701.13 Class I saline surface waters.)

[85] New York City Office of Sustainability. 2018. *Geothermal Pre-Screening Tool*, 6. January. https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/RIVERWATER-ASSESSMENT-FINAL-RPT.pdf. As noted above, the Essential Fish Habitat (EFH) for the Smoothhound Shark extends from Jamaica Bay into Hendrix Creek up to Bay Parkway and into Fresh Creek beyond the Belt Parkway.

[86] Melissa Samet. 2009. *A Citizen's Guide to the Corps of Engineers*. American Rivers and National Wildlife Federation, 131. https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf

[87] Melissa Samet. 2009. *A Citizen's Guide to the Corps of Engineers*. American Rivers and National Wildlife Federation, 1. https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf

[88] Melissa Samet. 2009. *A Citizen's Guide to the Corps of Engineers* American Rivers and National Wildlife Federation, at 81 (describing the requirement that state Section 401 certification be issued or waived before a federal Section 404 permit may be granted), https://biotech.law.lsu.edu/blog/A-Citizens-Guide-to-the-Corps-of-Engineers-Permitting-D.pdf

[89] N.Y. Envtl. Conserv. Law § 15-0505; New York State Department of Environmental Conservation (DEC). N.d. Protection of Waters Program: Excavation or Placement of Fill in Navigable Waters. Accessed August 20, 2025. https://dec.ny.gov/regulatory/permits-licenses/waterways-coastlines-wetlands/protection-of-waters-program

[90] New York State Department of Environmental Conservation (DEC). N.d. *Protection of Waters: Application Procedures*. Accessed September 28, 2021. https://www.dec.ny.gov/permits/6333.html

[91] 6 N.Y.C.R.R. Part 621. New York State Department of Environmental Conservation (DEC). n.d. *Excavation or Fill in Navigable Waters*. Accessed September 28, 2021. https://www.dec.ny.gov/permits/6548.html

[92] New York State Department of Environmental Conservation (DEC). N.d. *Getting an Environmental Permit*. Accessed September 28, 2021. https://www.dec.ny.gov/permits/6230.html

[93] New York State Department of Environmental Conservation (DEC). N.d. *Getting an Environmental Permit*. Accessed September 28, 2021. https://www.dec.ny.gov/permits/6230.html

[94] Mark A Chertok et. al. 2019. “Environmental Law: Developments in the Law of SEQRA.” *Syracuse Law Review*, 69: 773, 775-76, https://lawreview.syr.edu/wp-content/uploads/2020/01/M-Environmental-Article.pdf.

[95] Mark A Chertok et. al. 2019. “Environmental Law: Developments in the Law of SEQRA.” *Syracuse Law Review*, 69: 773, 776-78, https://lawreview.syr.edu/wp-content/uploads/2020/01/M-Environmental-Article.pdf.

[96] Mark A Chertok et. al. 2019. “Environmental Law: Developments in the Law of SEQRA.” *Syracuse Law Review*, 69: 773, 777-78 (noting that a negative declaration ends SEQRA review but may be challenged in court), https://lawreview.syr.edu/wp-content/uploads/2020/01/M-Environmental-Article.pdf

[97] 6 N.Y.C.R.R. § 617.9 (b)(5)(iii)(e).

[98] 1 Environmental Impact Review in New York § 3.01 (2021).

[99] 2 Environmental Impact Review in New York § 5.12 (2019).

[100] 2 Environmental Impact Review in New York § 5.12 (2019).

[101] Mark A Chertok et. al. 2019. “Environmental Law: Developments in the Law of SEQRA.” *Syracuse Law Review,* 69: 773, 778 (explaining that issuance of a positive declaration requires preparation of a DEIS and initiates public review under SEQRA), https://lawreview.syr.edu/wp-content/uploads/2020/01/M-Environmental-Article.pdf

[102] 6 N.Y.C.R.R. § 617.9(b)(1) and (5); see also Mark A Chertok et. al. 2019. “Environmental Law: Developments in the Law of SEQRA.” Syracuse Law Review, 69: 773, 778 (explaining that where an EIS is required, the draft EIS must analyze reasonably anticipated significant adverse environmental impacts and evaluate a range of reasonable alternatives to the proposed action, consistent with SEQRA’s substantive and procedural requirements), https://lawreview.syr.edu/wp-content/uploads/2020/01/M-Environmental-Article.pdf

[103] 6 N.Y.C.R.R. § 617.9(b)(1) and (5).

[104] See New York State Department of Environmental Conservation (DEC). N.d. *DECinfo Locator Layers: Layer Descriptions*. Accessed September 2, 2022, https://www.dec.ny.gov/pubs/117231.html#Sensitive, and *DECinfo Locator GIS Tool*: *Environmentally Sensitive Areas layer.* Accessed January 5, 2026, https://gisservices.dec.ny.gov/gis/dil/index.html?cat=es (describing the Environmentally Sensitive Areas data layers used in the DECinfo Locator, including mapped CEAs, and depicting the tributaries as located entirely within the Jamaica Bay CEA).

[105] 6 N.Y.C.R.R. § 617.14(g)(1).

[106] New York State Department of Environmental Conservation (DEC). N.d. *DECinfo Locator Layers: Layer Descriptions*. Accessed September 2, 2022. https://www.dec.ny.gov/pubs/117231.html#Sensitive; New York State Department of Environmental Conservation (DEC). N.d. “Hudson River Estuary Program.” Critical Environmental Areas Fact Sheet. Accessed September 2, 2022. https://www.dec.ny.gov/docs/remediation_hudson_pdf/ceafactsheet.pdf

[107] New York State Department of Environmental Conservation (DEC). N.d. *New York’s Endangered Species Regulations*. Accessed September 28, 2021. DEC, https://www.dec.ny.gov/animals/68645.html

[108] New York State Department of Environmental Conservation (DEC). N.d. *New York’s Endangered Species Regulations*. Accessed September 28, 2021. https://www.dec.ny.gov/animals/68645.html

[109] New York State Department of Environmental Conservation (DEC). N.d. *New York’s Endangered Species Regulations*, Accessed September 28, 2021. https://www.dec.ny.gov/animals/68645.html

[110] New York State Department of Environmental Conservation (DEC). N.d. *New York’s Endangered Species Regulations*, Accessed September 28, 2021. https://www.dec.ny.gov/animals/68645.html

[111] 19 N.Y.C.R.R. § 602.5; New York State Department of State (DOS), *Geographic Information Gateway* (Contract No. C006029). Accessed September 2, 2022. https://dos.ny.gov/geographic-information-gateway-0

[112] National Oceanic and Atmospheric Administration (NOAA) and New York State Department of State (DOS). 2021. *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] New York State Department of State (DOS), Office of Planning and Development. N.d. *Local Waterfront Revitalization Program*. Accessed September 27, 2022. https://video.dos.ny.gov/opd/programs/WFRevitalization/LWRP.html

[114] Patricia E. Salkin. 2021. “Integrating Local Waterfront Revitalization Planning into Local Comprehensive Planning and Zoning,” *Pace Environmental Law Review* 22: 207, 216 (September) (describing the purpose and scope of LWRPs as locally driven waterfront planning tools), https://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1141&context=pelr

[115] Patricia E. Salkin. 2021. "Integrating Local Waterfront Revitalization Planning into Local Comprehensive Planning and Zoning," Pace Environmental Law Review 22: 216 (September). https://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1141&context=pelr

[116] New York State Department of State (DOS), Office of Planning and Development. N.d. *Local Waterfront Revitalization Program*. Accessed September 27, 2022. https://video.dos.ny.gov/opd/programs/WFRevitalization/LWRP.html

[117] New York State Department of State (DOS). N.d. *New York City Local Waterfront Revitalization Program*. Accessed September 27, 2022. https://dos.ny.gov/location/new-york-city-local-waterfront-revitalization-program

[118] New York State Department of State (DOS). 2016. *New York City Waterfront Revitalization Program, Part 1: Program Description*. Accessed September 27, 2022. https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf

[119] New York State Department of State (DOS). 2016. *New York City Waterfront Revitalization Program, Part 1: Program Description*. Accessed September 27, 2022. https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf

[120] New York State Department of State (DOS). 2016. *New York City Waterfront Revitalization Program, Part 1: Program Description*. Accessed September 27, 2022. https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf

[121] New York State Department of State (DOS). 2016. New York City Waterfront Revitalization Program, Part 1: Program Description. Accessed September 27, 2022. https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf

[122] New York State Department of State (DOS). 2019. *The NYC Waterfront Revitalization Program Coastal Zone Boundary Maps*. Accessed September 2, 2022. https://dos.ny.gov/system/files/documents/2019/05/coastal-boundary-maps.pdf; New York State Department of State (DOS), New York City Department of City Planning. N.d. *The New York City Waterfront Revitalization Program* (2016 Amendment). https://docs.dos.ny.gov/opd-lwrp/LWRP/New%20York%20City/Amendment2/Final/NYC%20WRP%202015.pdf; New York City Department of City Planning. 2020. *Vision 2020: New York City Comprehensive Waterfront Plan*. Accessed September 2, 2022. https://www1.nyc.gov/site/planning/plans/vision-2020-cwp/vision-2020-cwp.page; New York City Department of City Planning. 2020. *Vision 2020: New York City Comprehensive Waterfront Plan—Neighborhood Strategies, Reach 17—Jamaica Bay/Rockaway*. https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/vision-2020-cwp/reach_maps/reach17.pdf

[123] New York State Department of State (DOS). 2020. "*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

[124] National Park Service. N.d. *Gateway National Recreation Area Map*. Accessed September 2, 2022. https://www.nps.gov/gate/planyourvisit/map_jbu.htm

[125] New York City Department of City Planning. 2020. *Vision 2020: New York City Comprehensive Waterfront Plan—Neighborhood Strategies, Reach 17—Jamaica Bay/Rockaway*. https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/vision-2020-cwp/reach_maps/reach17.pdf.

[126] New York City Department of City Planning. 2015. *New York City Waterfront Revitalization Program, Part 1: Program Description*. Accessed September 2, 2022. https://dos.ny.gov/system/files/documents/2019/05/nyc-wrp-2015parti.pdf

[127] Pursuant to the Accelerated Renewable Energy Growth and Community Benefit Act, S. 7508-B, A. 9508, 2020–21 Reg. Sess. (N.Y. 2020), the Office of Renewable Energy Siting (ORES) is responsible for siting and permitting new major renewable energy facilities in New York State. These facilities are defined as "any renewable energy system, as such term is defined in Section 66-p of the public service law . . . with a nameplate generating capacity of 25,000 kilowatts or more." Section 66-p of the Public Service Law defines renewable energy systems as "systems that generate electricity or thermal energy through use of the following technologies: solar thermal, photovoltaics, on land and offshore wind, hydroelectric, geothermal electric, geothermal ground-source heat, tidal energy, wave energy, ocean thermal, and fuel cells which do not utilize a fossil fuel resource in the process of generating electricity."

[128] A 25 $MW_{th}$ system, assuming a conversion rate of 2.93 $kW_{th}$ per heating ton (based on the ratio 3.517 ÷ (12,000 BTU ÷ 10,000 BTU), could support approximately 1,700 homes using 5-ton systems or 2,130 homes using 4-ton systems. See RapidTables. N.d. *Kilowatts to Refrigeration Tons Conversion.* Accessed April 14, 2021 (providing standard conversion factors between kilowatts and refrigeration tons used to estimate residential thermal capacity equivalents), https://www.rapidtables.com/convert/power/kw-to-ton.html

[129] N.Y. Exec. Law § 94-C(5)(c)(ii).

[130] New York State Department of Environmental Conservation (DEC). N.d. *Geothermal Wells*. Accessed March 10, 2021. https://www.dec.ny.gov/lands/61176.html

[131] New York State Department of Environmental Conservation (DEC). N.d. *Geothermal Wells*. Accessed March 10, 2021. https://www.dec.ny.gov/lands/61176.html

[132] N.Y. Envtl. Conserv. Law § 23-0305(14).

[133] New York State Department of Environmental Conservation (DEC), New York City Office of Sustainability. 2015. *Geothermal Systems and Their Application in New York City*, 36 (February), http://www.nyc.gov/html/planyc/downloads/pdf/publications/2015_Geothermal.pdf; New York State Department of Environmental Conservation (DEC), *Well Permitting Requirements*. Accessed March 10, 2021. https://www.dec.ny.gov/energy/1783.html

[134] New York State Department of Environmental Conservation (DEC). *Well Permitting Requirements.* Accessed March 10, 2021 (outlining DEC reporting requirements and the need for a separate permit to plug and abandon a well), https://www.dec.ny.gov/energy/1783.html

[135] 6 NYCRR § 554.1(c).

[136] New York State Department of Environmental Conservation (DEC). N.d. *Well Design And Construction.* Accessed March 10, 2021 (describing casing and cementing standards designed to protect groundwater and prevent fluid migration), https://www.dec.ny.gov/energy/1628.html

[137] New York State Department of Environmental Conservation (DEC). N.d. *Well Design And Construction*. Accessed March 10, 2021. https://www.dec.ny.gov/energy/1628.html

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

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

[140] New York State Department of Environmental Conservation (DEC). N.d. *Well Permit Fee Calculator*. Accessed March 10, 2021. https://www.dec.ny.gov/energy/1779.html

[141] DEC 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. New York City Department of Design and Construction, Office of Sustainable Design. 2012. *Geothermal Heat Pump Systems Manual: A Design and Installation Guide for New York City Projects*, 127.

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

[143] Council on Environmental Quality, Executive Office of the President. 2015. "*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

[144] Council on Environmental Quality, Executive Office of the President. 2015. "*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

[145] Council on Environmental Quality, Executive Office of the President. 2015. "*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

[146] Council on Environmental Quality, Executive Office of the President. 2015. "*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

[147] *See* New York City Mayor's Office of Environmental Coordination. N.d. *CEQR Forms & Templates.* Accessed September 1, 2022, https://www1.nyc.gov/site/oec/environmental-quality-review/ceqr-forms-templates.page; New York City Mayor's Office of Environmental Coordination. N.d. *CEQR FAQs—General.* Accessed September 1, 2022, https://www1.nyc.gov/site/oec/environmental-quality-review/ceqr-faqs-general.page; and New York City Mayor's Office of Environmental Coordination, *CEQR FAQs—Procedures.* Accessed September 1, 2022, https://www1.nyc.gov/site/oec/environmental-quality-review/ceqr-faqs-procedures.page (explaining CEQR's lead-agency framework for City actions, including coordination among involved agencies and the consolidation of environmental review responsibilities when a City agency is designated as lead agency).

[148] 15 R.C.N.Y. § 57-03 (Standards for Drilling and Excavation) (requiring a DEP permit for drilling or excavation beyond specified depth limits or near water tunnel infrastructure, and prohibiting activity outside the scope of an issued permit).

[149] 15 R.C.N.Y. § 57-04(a) (Application for Drilling and Excavation Permit) (requiring submission of a pre-application assessment to DEP for proposed drilling or excavation exceeding specified depth thresholds, prior to determination of whether a permit is required).

[150] 15 R.C.N.Y. § 57-04(a)(2) (requiring DEP, within ten business days of receipt of a pre-application assessment, to notify the applicant whether the proposed activity is prohibited, exempt, or requires submission of a permit application).

[151] 15 R.C.N.Y. § 57-04(a)(2)(iv) (mandating DEP permitting for drilling or excavation within a designated corridor).

[152] 15 R.C.N.Y. § 57-04(b) (authorizing DEP permit issuance within thirty days following corridor review).

[153] 15 R.C.N.Y. § 57-04 (a)(2)(ii)–(iii) (clarifying circumstances under which drilling or excavation outside a corridor does not require a permit).

[154] 15 R.C.N.Y. § 57-03.

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

[156] New York City Department of Parks and Recreation. N.d. *Construction Permits*. Accessed September 30, 2022. https://www.nycgovparks.org/permits/construction

[157] New York City Department of Parks and Recreation. N.d. *Construction Permits*. Accessed September 30, 2022. https://www.nycgovparks.org/permits/construction

[158] New York City Department of Parks and Recreation. N.d. *Construction Permits.* Accessed September 30, 2022. https://www.nycgovparks.org/permits/construction

[159] New York City Department of Parks and Recreation. N.d. *Construction Permits*. Accessed September 30, 2022. https://www.nycgovparks.org/permits/construction

[160] New York City Department of Parks and Recreation. N.d. *Construction Permits*. Accessed September 30, 2022. https://www.nycgovparks.org/permits/construction

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

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

[163] MTA Buildings Near Transit. N.d. Accessed September 30, 2022. https://new.mta.info/agency/construction-and-development/building-near-transit

[164] New York City Department of Environmental Protection (DEP). N.d. *Noise Rules Regulations*. Accessed October 4, 2021. https://www1.nyc.gov/site/dep/environment/construction-noise-rules-regulations.page

[165] New York City Department of Design and Construction, Office of Sustainable Design. 2012. *Geothermal Heat Pump Systems Manual: A Design and Installation Guide for New York City Projects*. https://a860-gpp.nyc.gov/concern/nyc_government_publications/qz20ss97p?locale=en

[166] New York City Department of Environmental Protection (DEP). N.d. *Water & Sewer Forms: Dewatering, Pretreatment, & Scavenger Waste*. Accessed September 30, 2022. https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page

[167] New York City Department of Environmental Protection (DEP). N.d. *Water & Sewer Forms: Dewatering, Pretreatment, & Scavenger Waste*. Accessed September 30, 2022. https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page

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

[169] New York City Department of Environmental Protection (DEP). N.d. *Water & Sewer Forms: Dewatering, Pretreatment, & Scavenger Waste*. Accessed September 30, 2022. https://www1.nyc.gov/site/dep/about/dewatering-pretreatment-scavenger.page

[170] New York State Department of Environmental Conservation (DEC). N.d. *Floodplain Construction Requirements.* Accessed September 28, 2022. https://www.dec.ny.gov/lands/40576.html

[171] New York State Department of Environmental Conservation (DEC). N.d. *Floodplain Construction Requirements.* Accessed September 30, 2022 (describing state floodplain construction standards applicable to development within FEMA-designated SFHAs that are generally implemented through local floodplain development permits consistent with NFIP requirements), https://www.dec.ny.gov/lands/40576.html

[172] New York City Department City Planning. N.d. NYC Flood Hazar Mapper. Accessed September 1, 2022. https://dcp.maps.arcgis.com/apps/webappviewer/index.html?id=1c37d271fba14163bbb520517153d6d5

[173] New York City Department City Planning. N.d. *NYC Flood Hazar Mapper*. Accessed September 1, 2022. https://dcp.maps.arcgis.com/apps/webappviewer/index.html?id=1c37d271fba14163bbb520517153d6d5

[174] New York State Department of Environmental Conservation (DEC). N.d. *Floodplain Construction Requirements in NYS*. Accessed September 1, 2022. https://www.dec.ny.gov/lands/40576.html

[175] New York State Department of Environmental Conservation (DEC). N.d. *SPDES Permit No. NY0287890*, 47. Accessed August 1, 2022. https://www.dec.ny.gov/docs/water_pdf/nycms4permit.pdf

[176] Wastewater treatment plants (WWTPs) are equipped to process industrial and domestic contaminants because combined systems convey rainwater runoff, domestic sewage, and industrial wastewater in one pipe. Alternatively, publicly owned treatment works (POTWs) are equipped to treat domestic sanitary wastes but not industrial wastes and are used for separate systems.

[177] U.S. Environmental Protection Agency (EPA). N.d. *NPDEA—Combined Sewer Overflows (CSOs)*. Accessed September 1, 2022. https://www.epa.gov/npdes/combined-sewer-overflows-csos

[178] U.S. Environmental Protection Agency (EPA). N.d. *NPDEA—Combined Sewer Overflows (CSOs)*. Accessed September 1, 2022. https://www.epa.gov/npdes/combined-sewer-overflows-csos

[179] DEC, *Fact Sheet for SPDES General Permit for Stormwater Discharges from MS4s* (GP-0-15-003)(April 15, 2015), https://www.dec.ny.gov/docs/water_pdf/ms4factsheet.pdf (replaced prior GP-0-10-002).

[180] U.S. Environmental Protection Agency (EPA). 2006. *Stormwater Permit Manual*, § 890 State Stormwater Programs. 2006 WL 3423188 (Dec. 2011 Supplement).

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[206] 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. U.S. Environmental Protection Agency (EPA). N.d. *SNAP Regulations*. Accessed December 15, 2021. https://www.epa.gov/snap/snap-regulations https://www.northamerica-daikin.com/assets/resources/r-32/Driving-the-Next-Generation-of-Refrigerants.pdf

[207] For instance, the California Air Resources Board (CARB) has established a global warming potential (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 North America. 2021. *Driving the Next Generation of Refrigerants* (April). https://www.northamerica-daikin.com/assets/resources/r-32/Driving-the-Next-Generation-of-Refrigerants.pdf

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[210] 6 N.Y.C.R.R. § 617.5(c)(3) (Type I Actions) (distinguishing routine maintenance and in-kind replacements from substantial changes that may trigger Type I review).

[211] 6 N.Y.C.R.R. § 617.4(b)(6)(ii) (identifying groundwater withdrawals above specified thresholds as Type I actions under SEQRA).

[212] 6 N.Y.C.R.R. § 617.4(b)(6)(ii).

[213] 6 N.Y.C.R.R. § 617.2(ak).

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