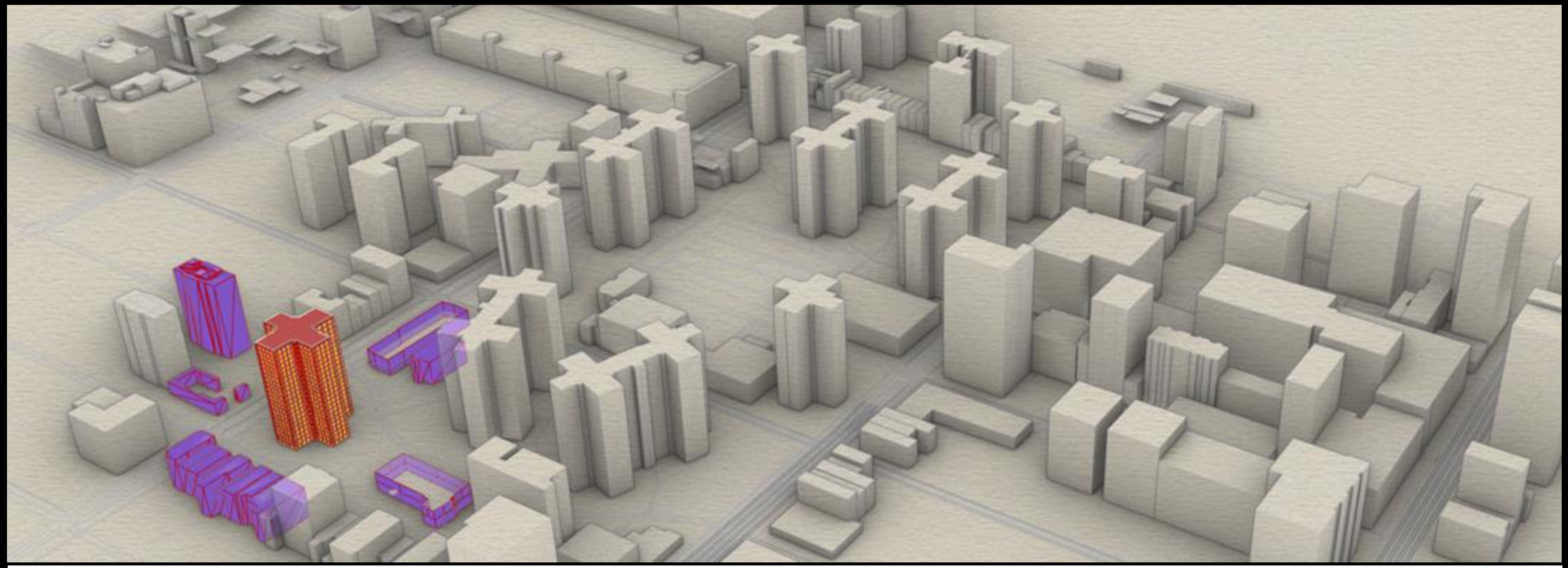
Thermal Energy Network Evolution of the Penn South Community in Manhattan

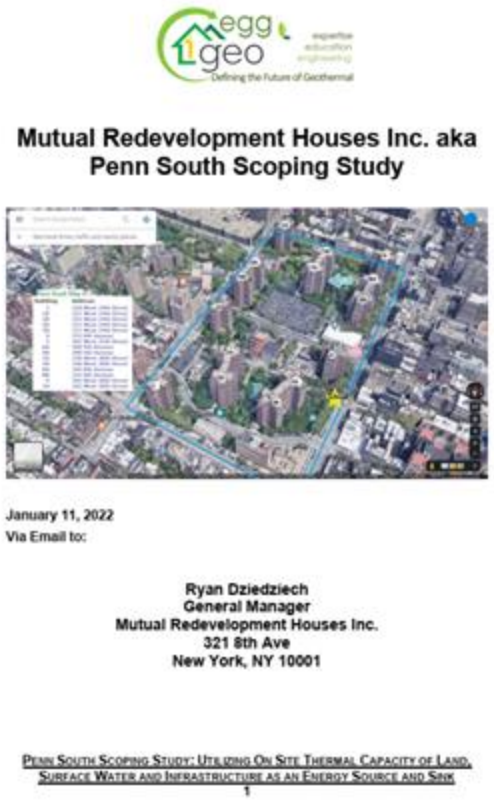
NYSERDA PON 4614: Community Heat Pump Systems



District Scale Building Energy Simulation Started, February 2021

Geothermal Query:

How To Decarbonize (15) 22 Story Residential Buildings?



Mutual Redevelopment Houses Inc. aka Penn South Scoping Study

January 11, 2022
Via Email to:

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General Manager
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321 8th Ave
New York, NY 10001

PENN SOUTH SCOPING STUDY: UTILIZING ON SITE THERMAL CAPACITY OF LAND, SURFACE WATER AND INFRASTRUCTURE AS AN ENERGY SOURCE AND SINK
1

During the 2021 scoping study, A (5) MW heating load was identified; The complex is home to 2500 families living in downtown Manhattan. The 5 MW boiler and 1800 central chiller plant located in the middle of the complex.

GENERAL OBSERVATIONS; LOCAL LEGISLATION
LL38, LL97, IMMINENT THREATS OF FINES

- The heat gain and loss loads of the Penn South site have the potential capacity of thermal exchange within the site boundaries, providing ample reason to move to the funding, feasibility and engineering stages.
- Ample decarbonization funding mechanisms exist to move from researching the energy transition at Penn South, through full feasibility, and onto the front-end engineering stages.
- Proceeding now with decarbonization opportunities at Penn South will further mitigate the facilities inherent exposure to LL38, LL97, and unforeseen future legislative action.
- There are other commercial buildings onsite & offsite in the area that may be able to tie into a geothermal energy network with Penn South. These should be further vetted, and letters of intent should be drafted during the feasibility stage, or for any application to NYSERDA PON 4614.

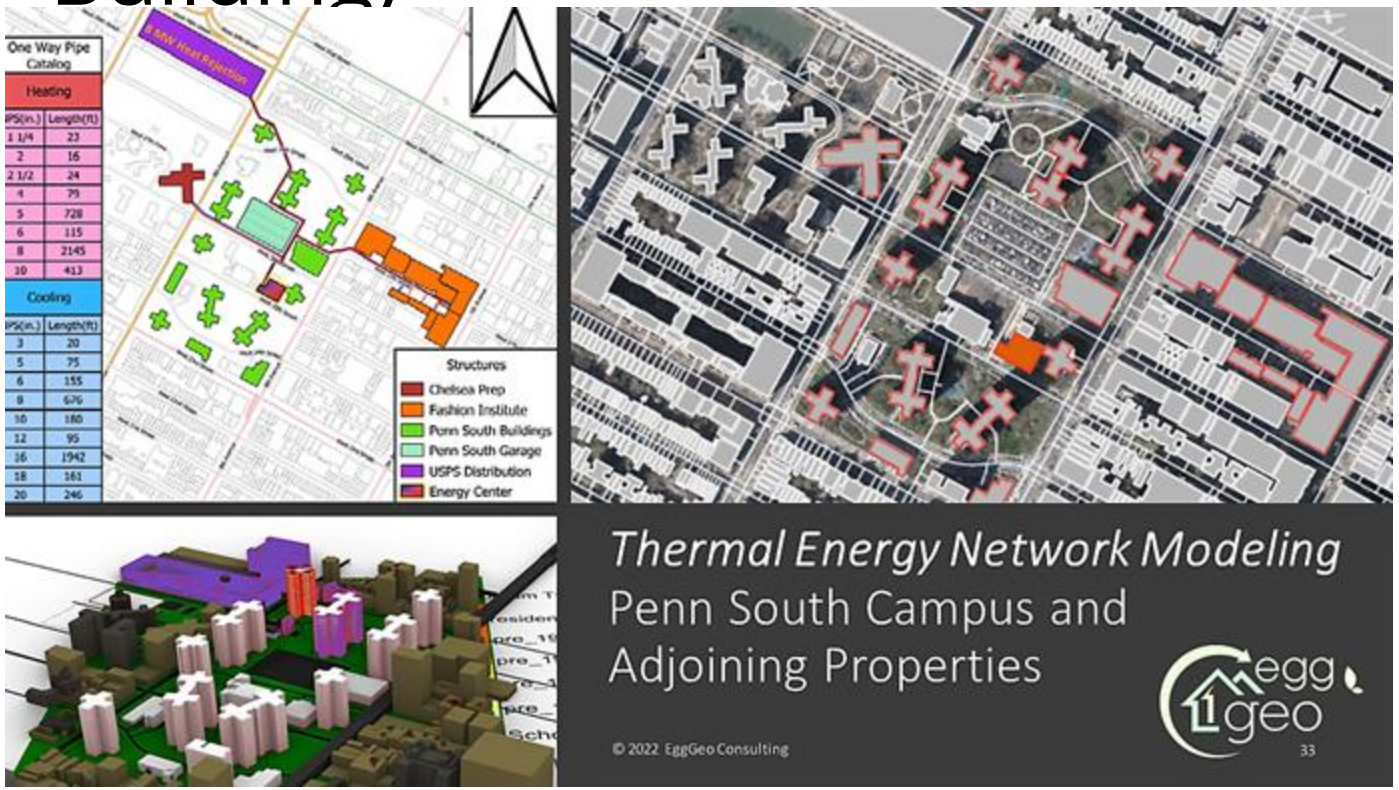
Decision To Move Forward With An Application For Public Opportunity Notice 4614

- NYSERDA PON 4614 is a “Community Heat Pump Systems” funding opportunity
- Building owners and participants do not need to be system benefits charge payers to join
- Anchor loads, like those from government buildings and offices, are important for gaining NYSERDA PON 4614 support
- NYC buildings qualify for PON 4614 – direct from NYSERDA
- Higher performance, lower energy consumption, given larger load diversity between residential and commercial buildings

311 W 24 ST

212 9 AVE

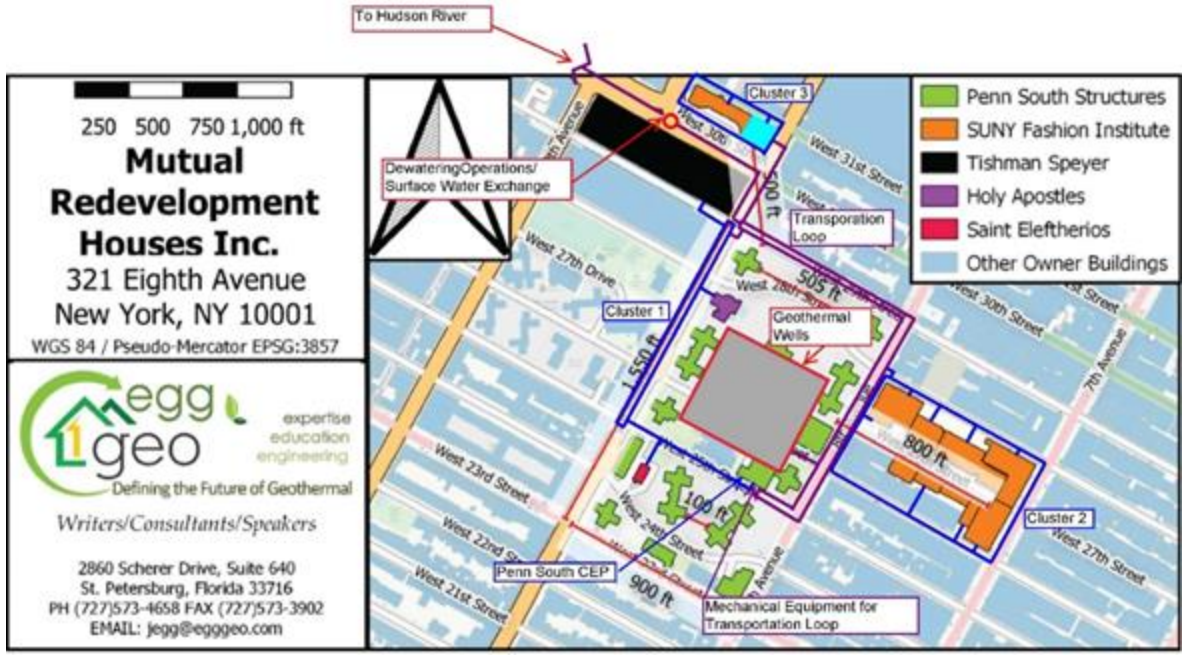
Load Diversity (Pumping Heat From Building To Building)

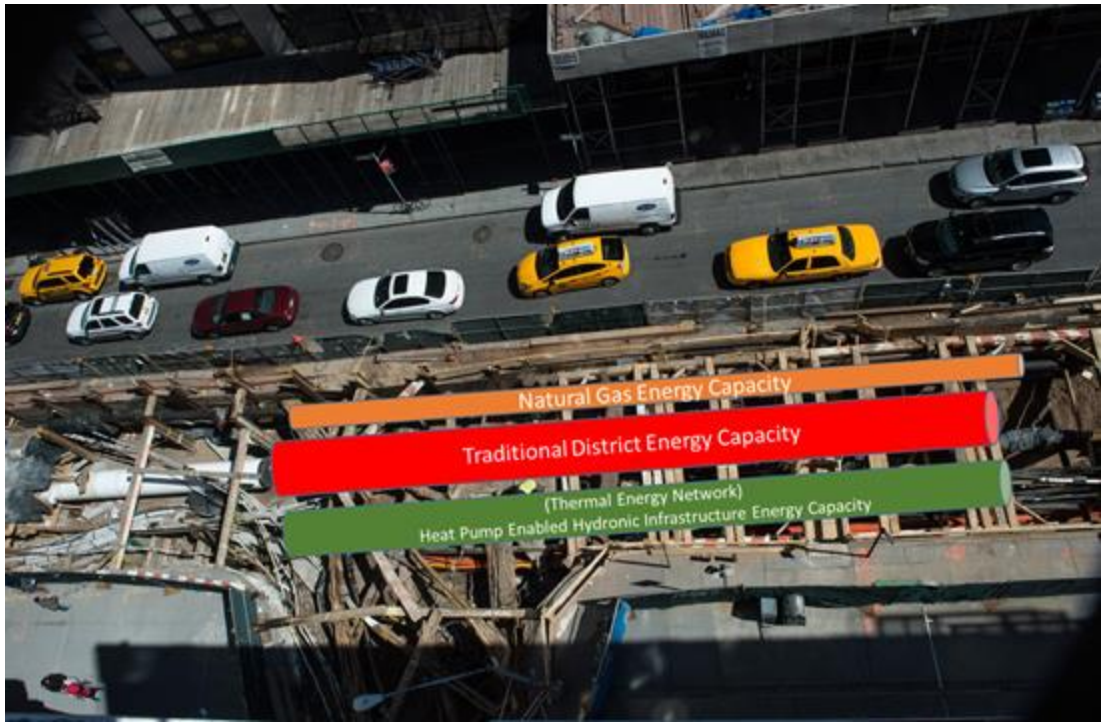


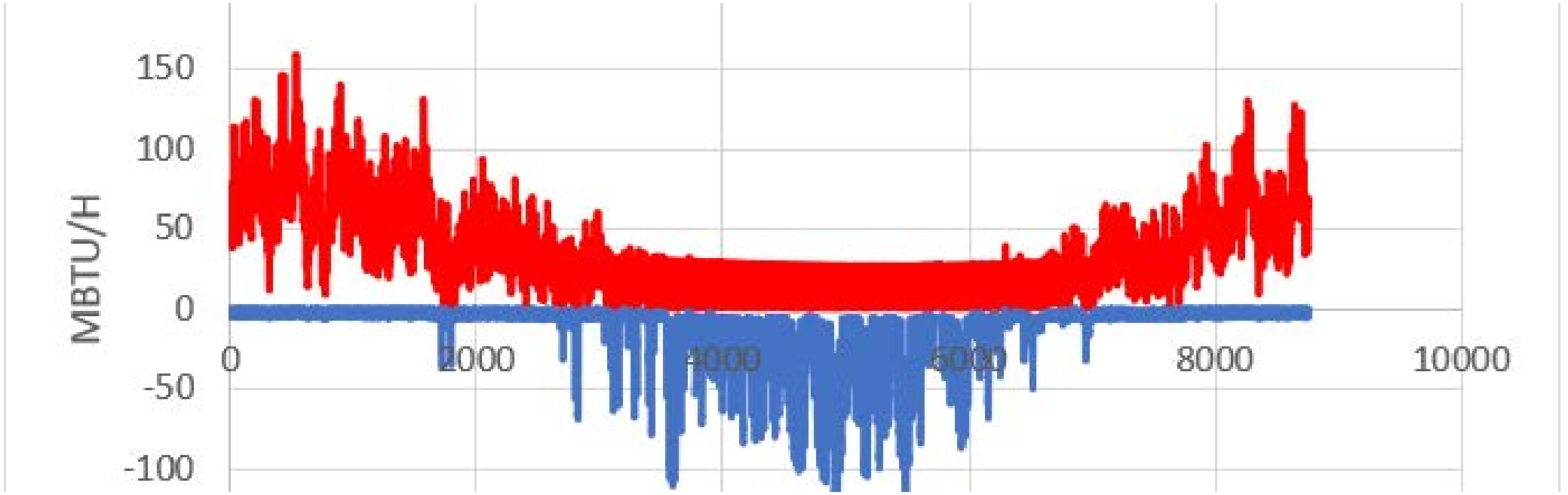
The US Postal Service to the northwest has up to 8 megawatts of thermal rejection through its cooling towers.

Much of that energy can be tapped to assist in the heating loads for proposed heat pump chillers at the central energy plant for Penn South play

Working Within The City's Existing Infrastructure Is Expensive And Complicated



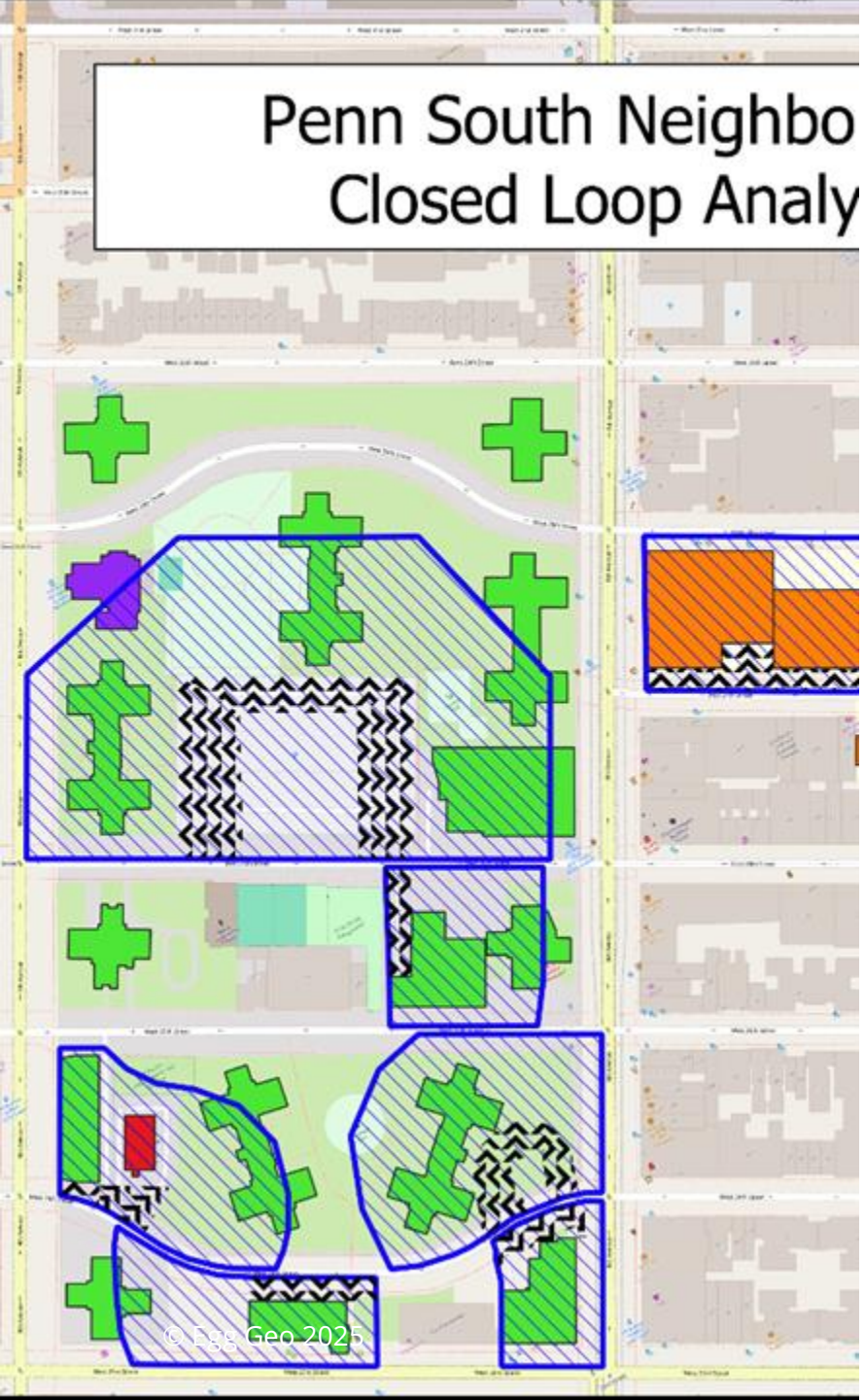




JANUARY 16, 2025, UPDATE

Current Objective

After identifying ground source heat exchange and wastewater energy recovery as potential sources and sinks for the Penn South site in previous work, this report aims to determine optimal energy source combinations and develop a conceptual design. Technical and economic feasibility of the conceptual design is explored through the lens of each resource. Site layout, sub grade infrastructure, and ability of the design to meet consumption are outlined along with an assessment of design alternatives and a sensitivity analysis.



POTENTIAL DRILLING SPACE
(CLOSED LOOP OPTION)

•Drilling contractors recommend drilling no deeper than 850 vertical feet. Additionally, the maximum angle they are capable of drilling is 15 degrees. A simple equation was used to calculate the lateral length (b) based on the depth of the borehole (a)=850ft, and angle (ß)=15 degrees. b, or the lateral distance we are able to access with the use of inclined drilling is 228 feet (Figure & Figure). This was applied as a buffer to selected sides of potential drilling spaces to determine how far under partner-owned buildings we are able to drill for additional heat exchange area. Care was taken to avoid drilling under streets and buildings not owned by project partners. This area (open drilling space + lateral accessible subsurface) was used in GLHEPro as part of the closed loop analysis to reflect the additional load able to be met due to the use of inclined drilling. This software does not have options to consider the use of inclined boreholes, so the additional space described above and displayed in Figure was used to reflect this technique.

Angled Drilling In Order To Maximize Footprint To Heat Exchange Capacity Ratio

Figure 4 Left: Inclined drilling rig (about 10 degrees) in Paris, France. Right: Simplified illustration of inclined borehole cluster and an accompanying heat exchanger (Celsius Energy).

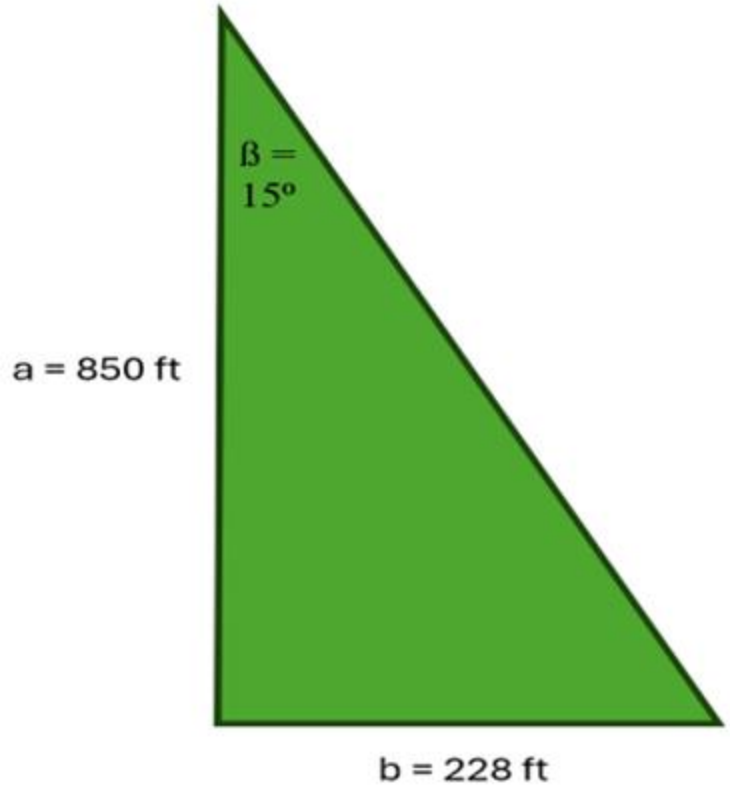
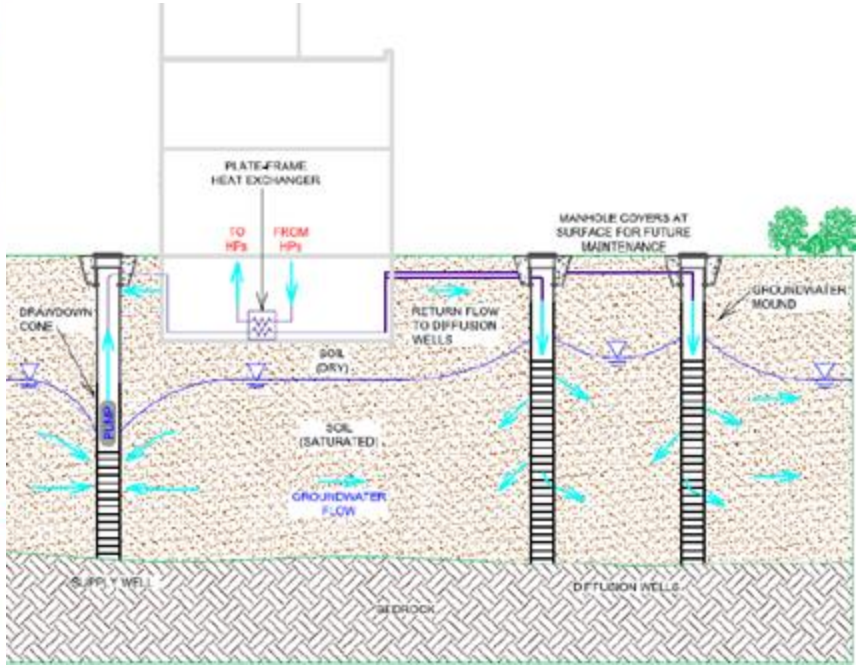


Figure 3

Aquifer Coupled Opportunities Identified at the Chelsea Location (Penn South) due to the presence of glacial till



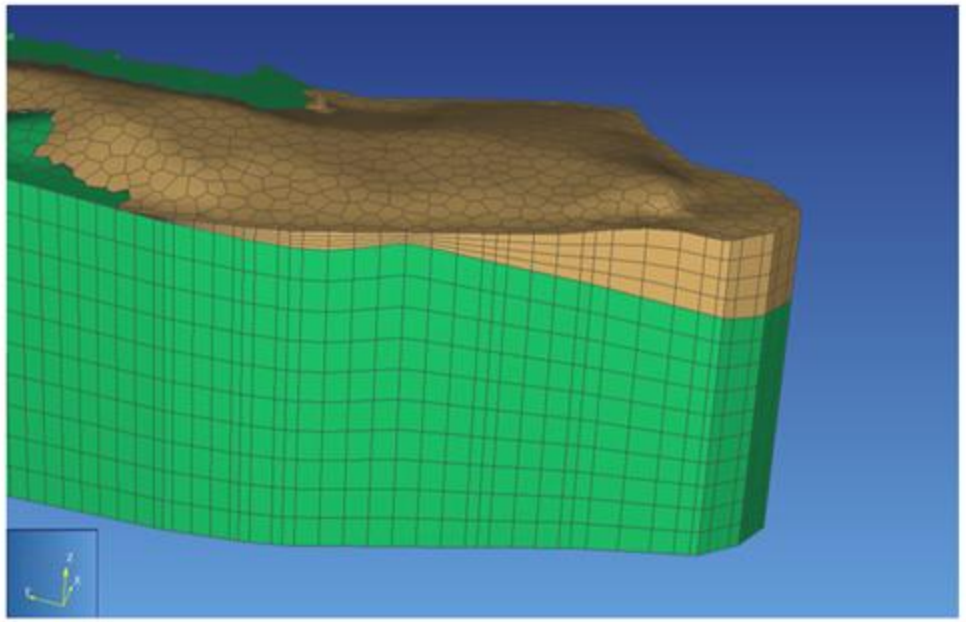
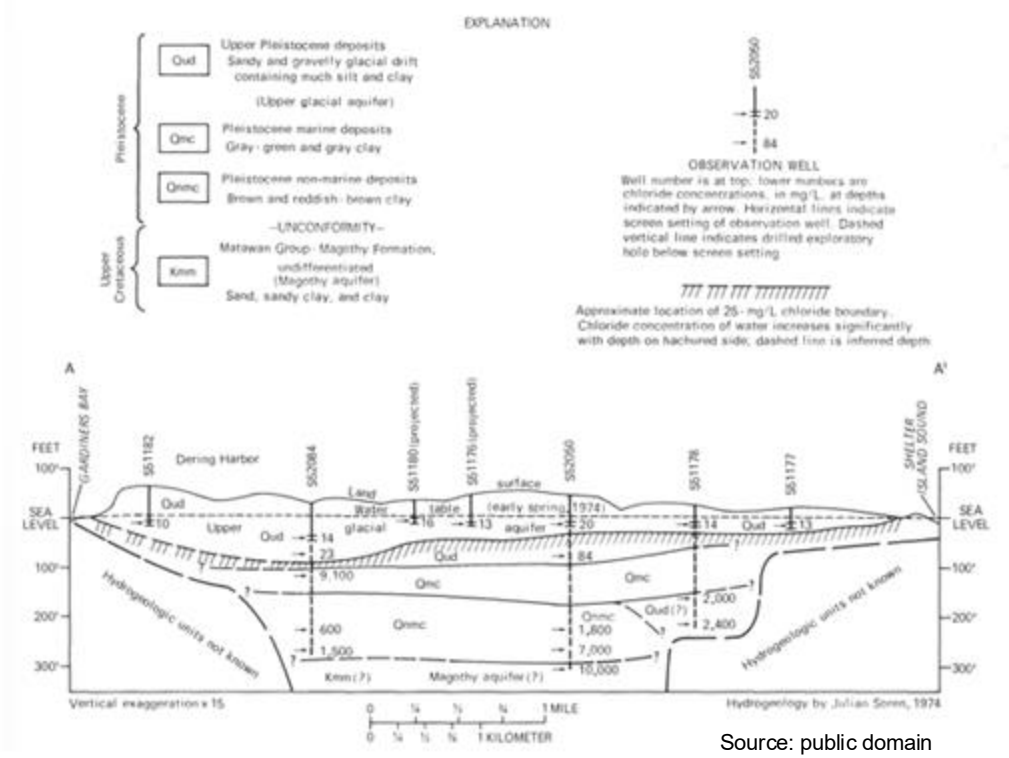


Figure 7 The well data (red dots) displayed were imported into PetraSim and used to create a geologic model of the entire Manhattan Island

Figure 8 A sideview of the completed geologic model. Glacial till is represented by the tan cells and bedrock is represented by the green. Vertical distance (Z axis) has been exaggerated by 8x

Hydrogeologists Studied Subterranean Water Flow To Analyze Thermal Communication And Saturation



Source: public domain

Figure 10 Geologic vertical slice of Shelter Island in Suffolk County (pubs.usgs.gov/wri/1977/0077/report.pdf).

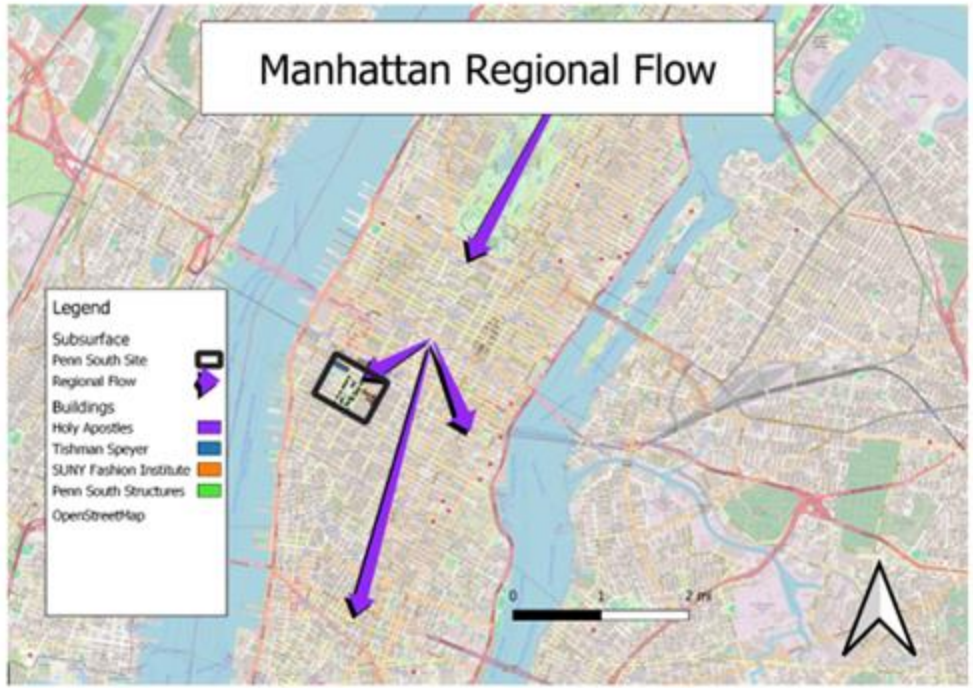


Figure 11 General regional flow of groundwater on Manhattan Island and across the site

Flow & Thermal Effect Over 25 Years Is Computed And Digitized

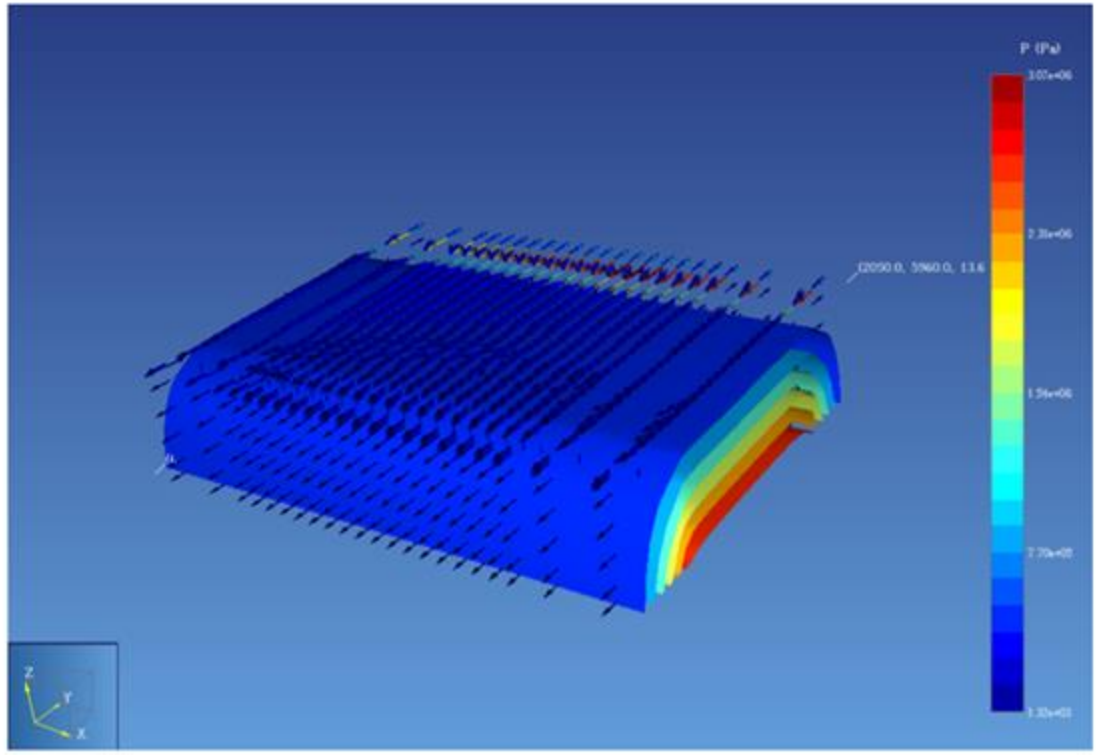
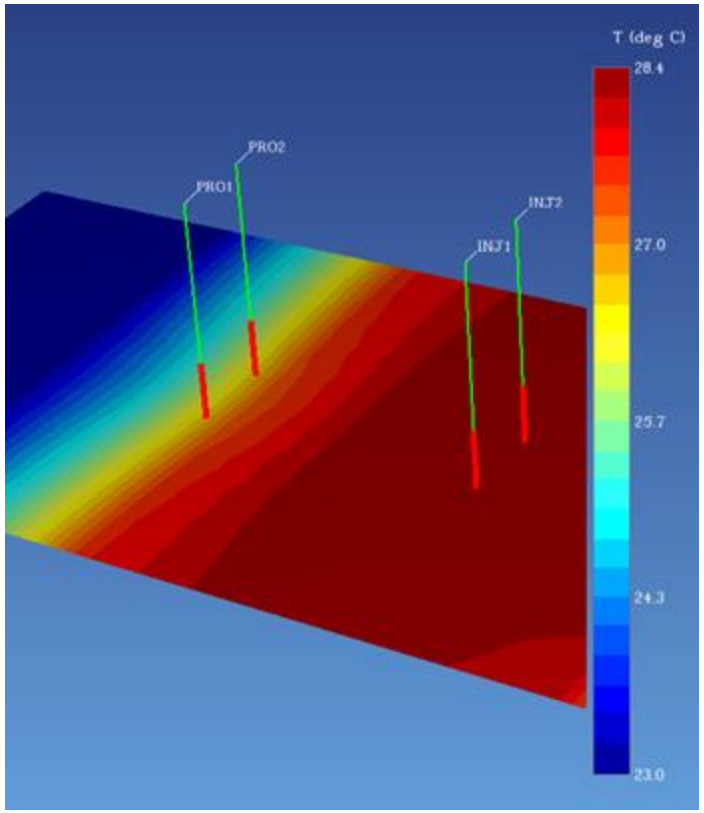


Figure 15 Pressure (Pa) displayed across the site model and vectors indicating the groundwater flow across the site



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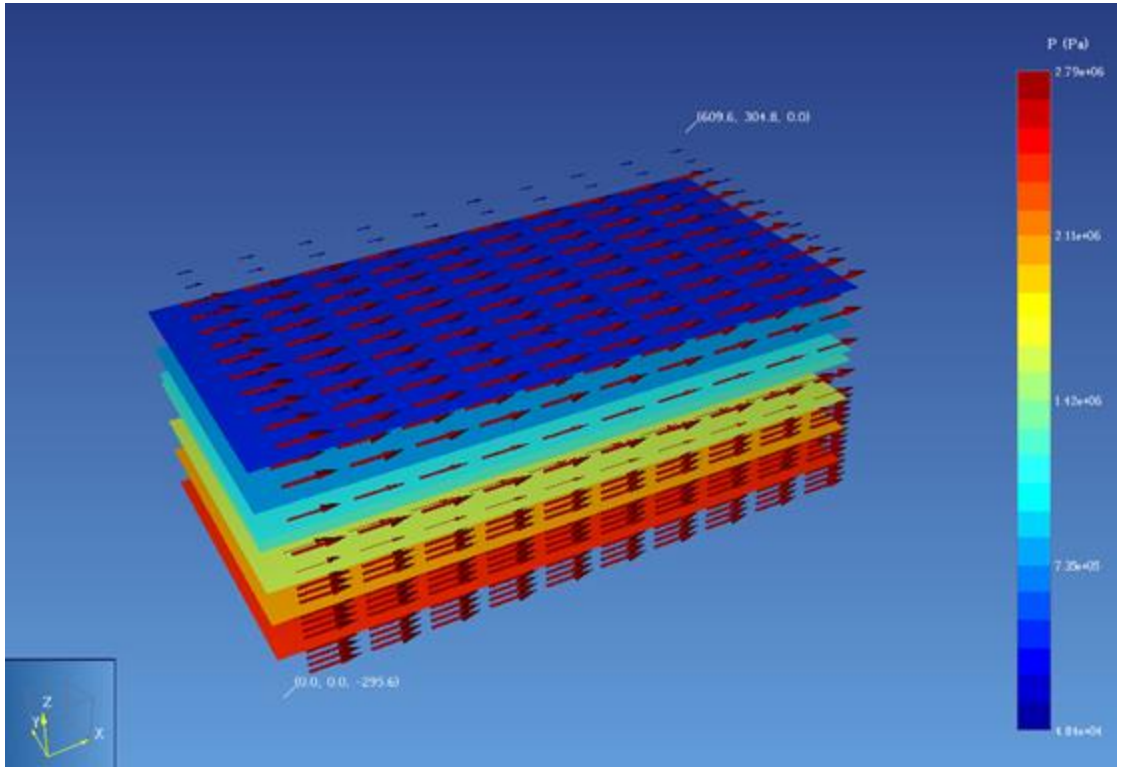


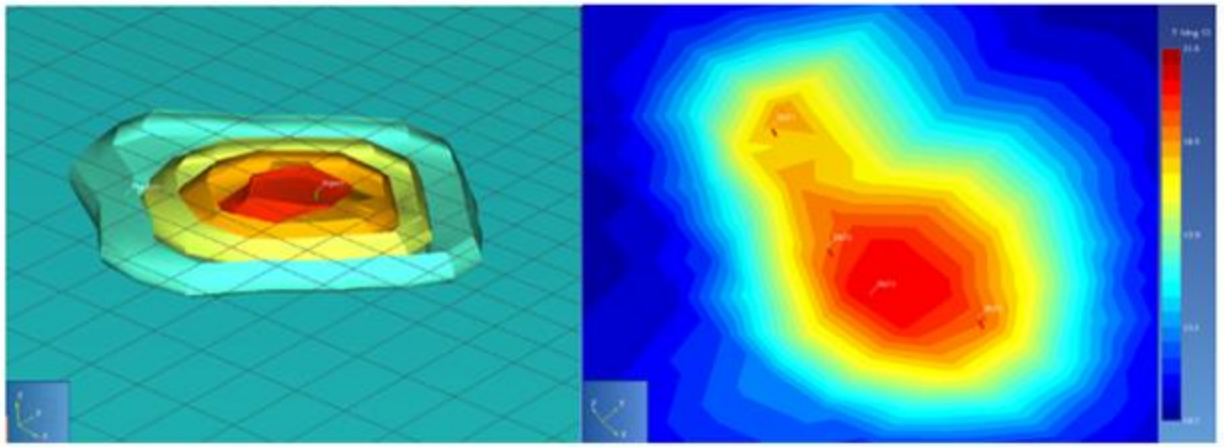


Figure 17 Example results displaying the temperature isosurfaces in the narrative to visualize the most important output from an otherwise large and complex 3-dimensional model (Left).). An example result of a horizontal slice is also included (Right) Temperature in Fahrenheit across 25 years is also computed at the production wells and plotted below (not pictured here).

The Result Of Thermal Influence After 25 Years Of Pumping At 600 GPM. Also Modeled With Four Doublets Over Five Years

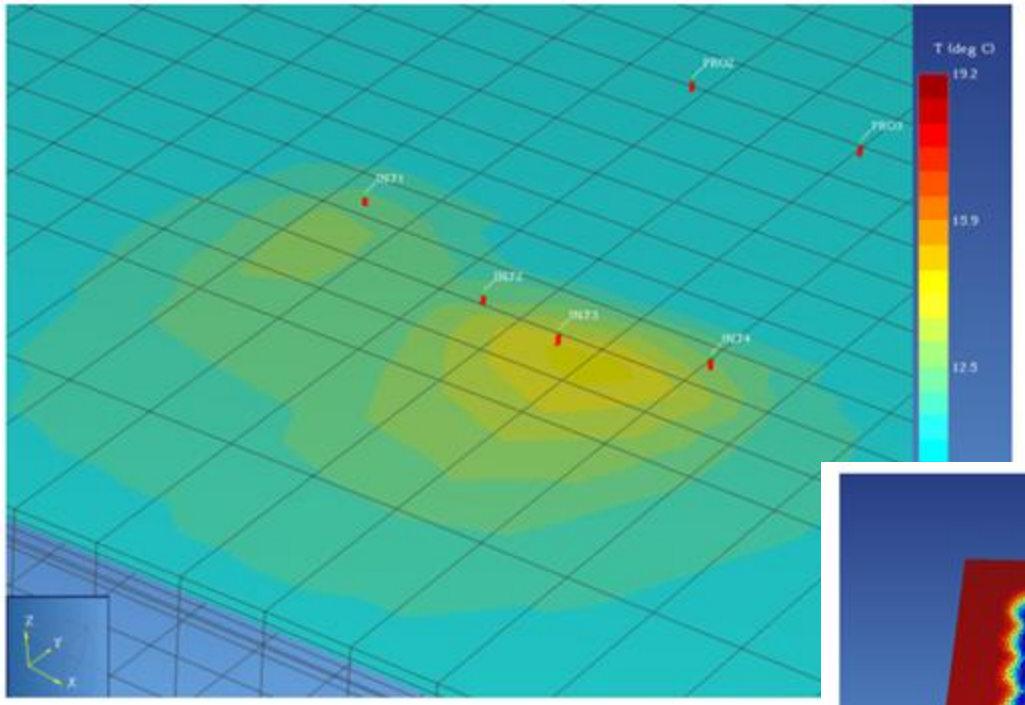
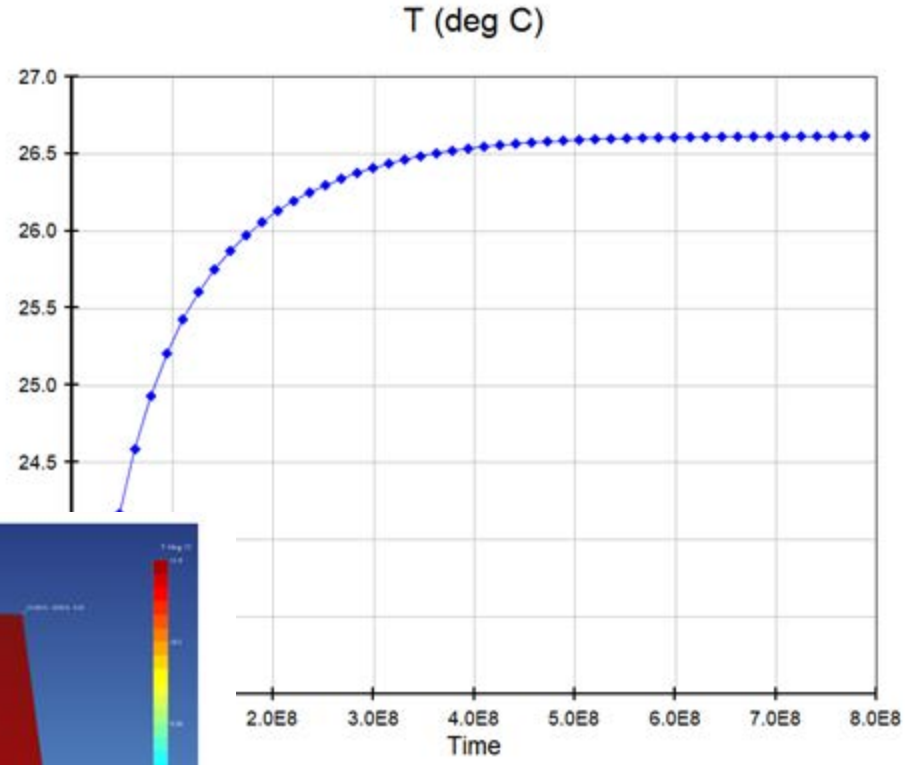


Figure 23 Scenario 2 - Horizontal temperature slice at 45' below surface after 25 years of pumping at 60



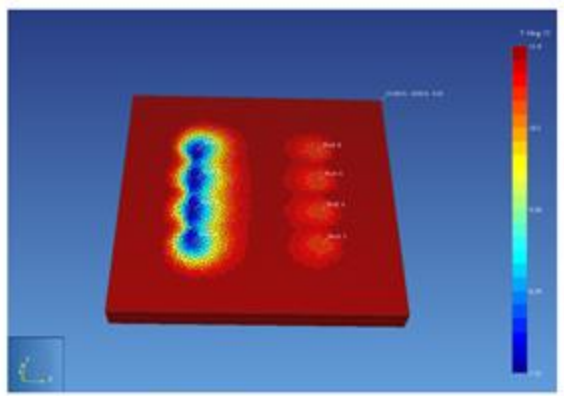


Figure 30 Scenario Two, or the 'four doublets' arrangement required less total area and less well separation than the first. Results after five years of thermal energy storage.

The Thermal Energy Neighborhood Is Identified And Piping Arrangements Are Proposed

Site Layout

The conceptual transport loop configuration and potential drilling space for open and closed loop implementation, and other site details are displayed in Figure 34 and Figure 35. The details of the optimal spacing, depth, and type of borehole are discussed in the sensitivity analysis.

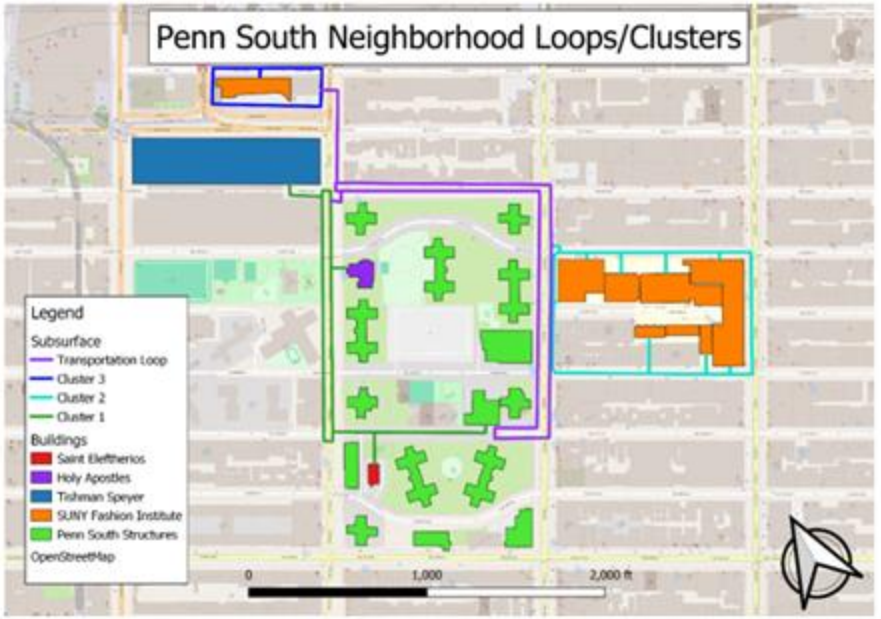
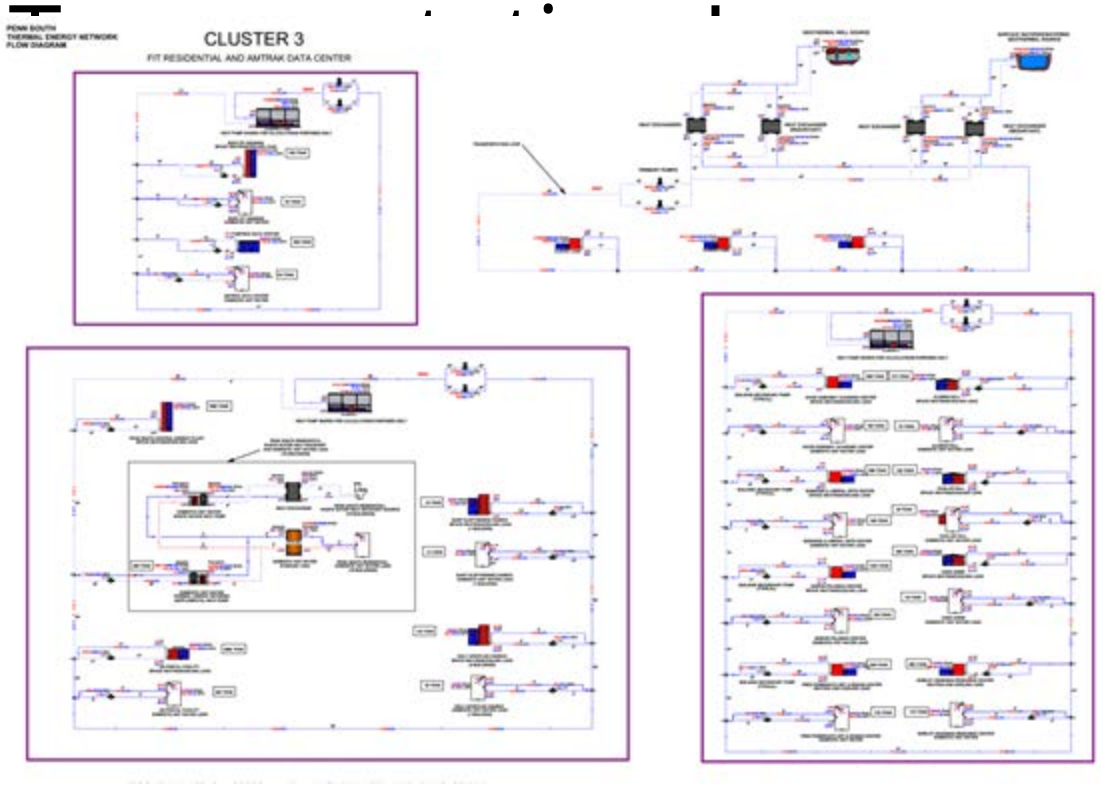
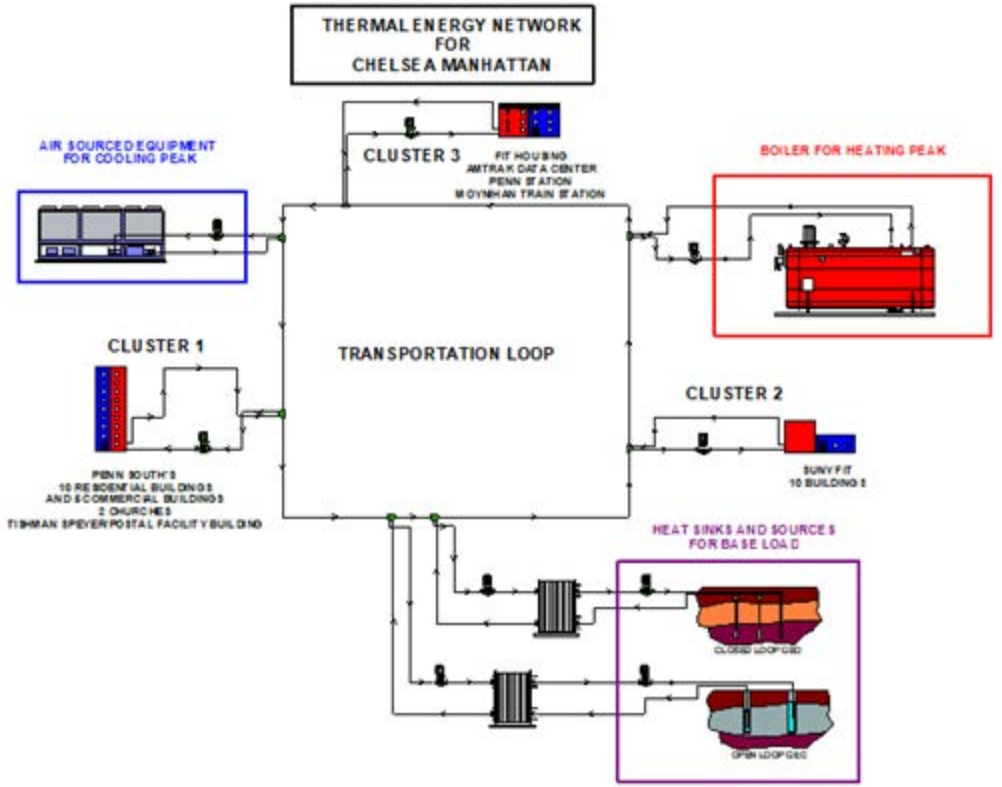


Figure 33 Site plan with the visualized transportation loop and all three conceptual clusters

Hydronic Arrangement Of Three Clusters Decoupled To A Central Thermal Energy





Components of a Geo-Thermal Energy Network (TEN)

1. Thermal Energy Networks are utility-scale infrastructure projects that connect multiple buildings into a shared network with sources of thermal energy like geothermal boreholes, surface water, and wastewater.

2. Wastewater Energy Transfer (WET) systems extract and reject heat from the sewers.

3. Heat (Thermal Energy) is conducted in/out of the mechanical system of buildings.

4. Various geothermal exchange resources absorb or reject thermal energy.

5. Power generation facilities of all types can provide waste heat to a "TEN"

6. Recreational facilities such as ice rinks and waterparks may be connected.

7. Geothermal exchangers under buildings (Piles)…

8. Surface Water Exchange (Rivers, Lakes, Etc.)

9. Office buildings and data centers are cooling dominant, meaning, they reject heat all year long.

10. Thermal Storage & Energy Exchange facilities

egg geo
expertise
education
engineering
Defining the Future of Geothermal

Eligible for IRA Incentives up to…

…40% (or more)

RES.ENV 007 Geothermal Energy Networks (GENs): Transforming our Thermal Energy System

IAP 2025