

# Earth Source Heat & Cornell University Borehole Observatory

(ESH & CUBO)  
Ithaca, NY

*What? Why? How?*

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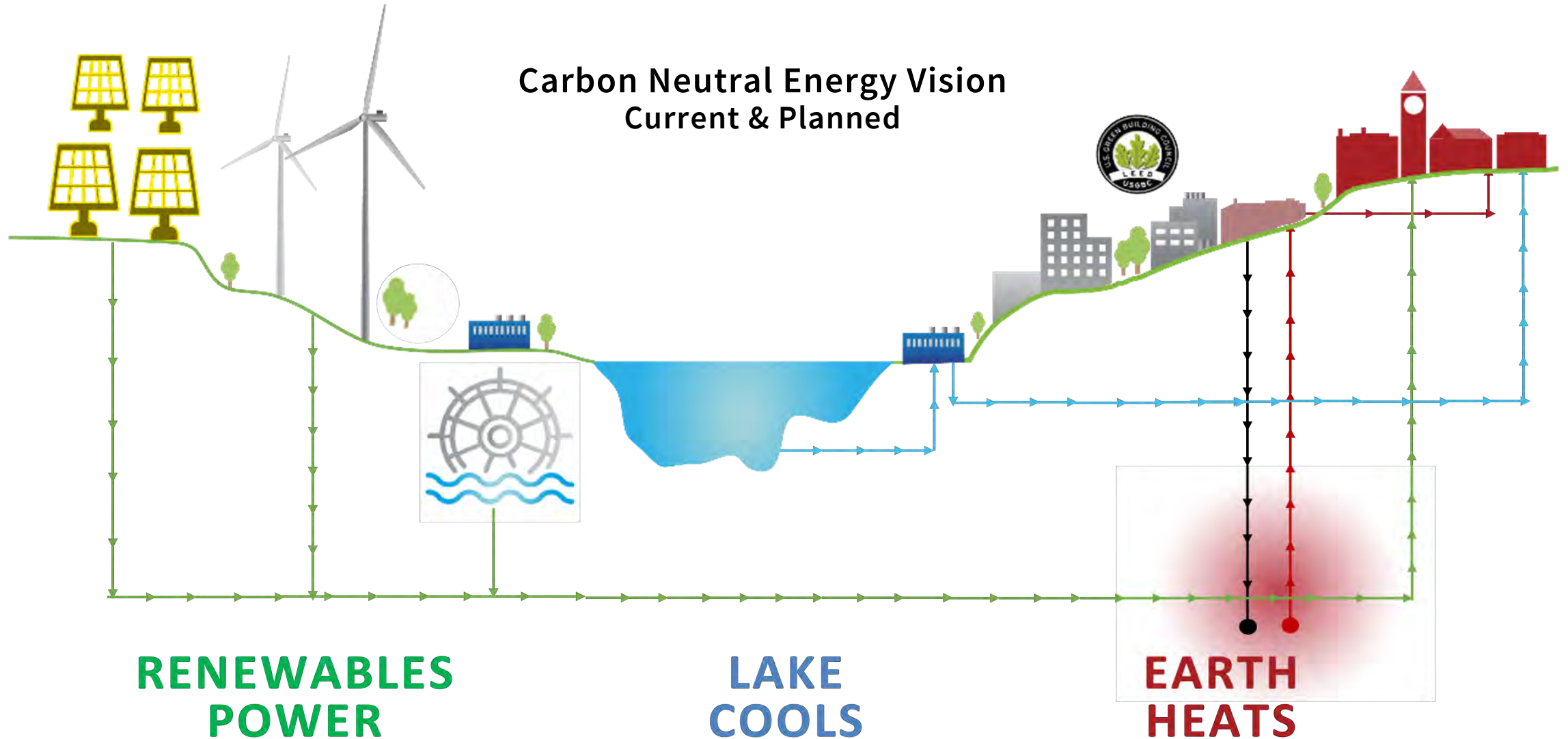
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Atmospheric Sciences



# Energy & Carbon Neutrality

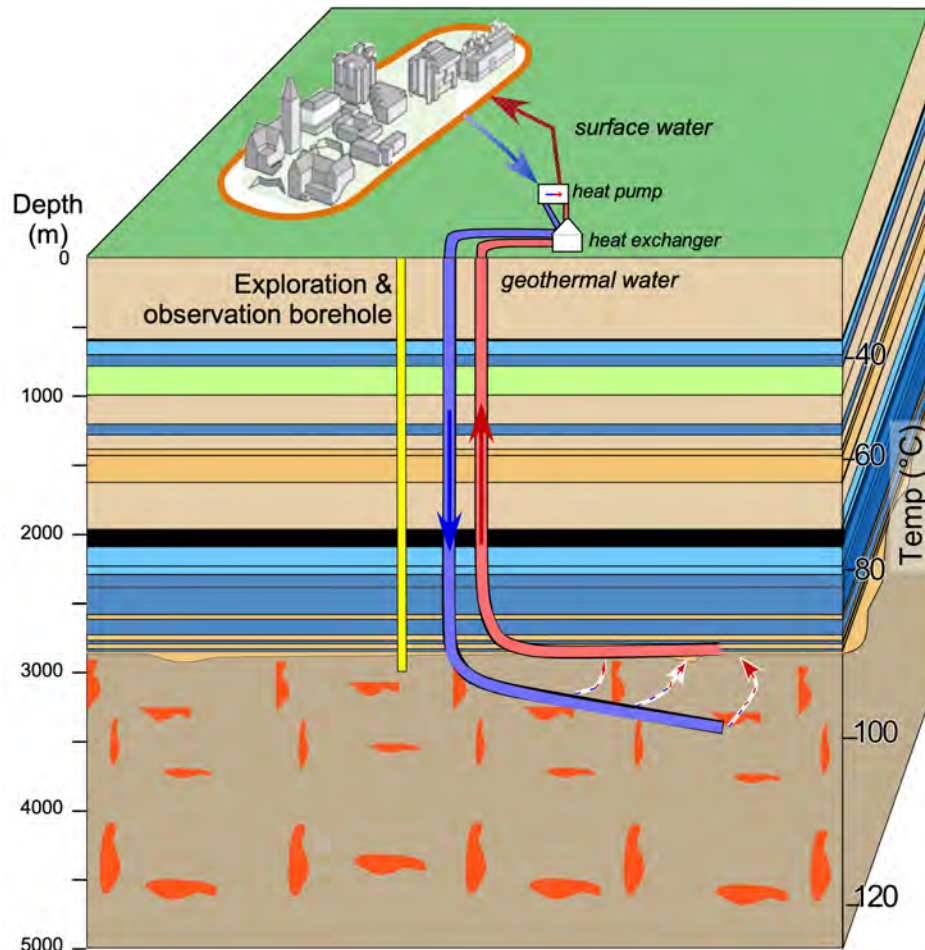
Earth Source Heat can provide renewable heat to our campus district heating system without the use of fossil fuels, helping us achieve campus and community carbon neutrality.



# What is Earth Source Heat?

Earth Source Heat is Cornell's vision for a campus-wide geothermal heating system. If successful, it will replace fossil fuels with renewable heat for our Ithaca campus.

## How Does it Work?



- Uses campus **district energy system** with hot water
- **Two (or more) deep wells** are drilled to where rocks are hot
- **Hot water is pumped from one**, and cooled water is returned to the rocks in the other
- **Heat is extracted** from the geothermal water and transferred to surface water via the heat exchanger
- **The heated surface water circulates** through the pipes of the campus heating system



# Why develop Earth Source Heat at Cornell?

Earth Source Heat is a transformative solution for renewable heating in even the coldest climates. We can advance a stable, sustainable technology to share with the world.

## Research



Earth Source Heat requires us to combine existing knowledge with new research. Researchers from many disciplines are partnering with facilities staff to use our campus as a living laboratory to research, test, and deploy a game-changing solution.

**We have a unique ability to bring a great contribution to the fight against climate change by testing and demonstrating a scalable new technology.**

## Climate



Cornell is committed to reaching carbon neutrality by 2035. We must advance renewable energy solutions that help our campus, community, county and New York State meet our climate targets and move beyond fossil fuels.

**Earth Source Heat will enable our campus to reach carbon neutrality, and reduce 7% of Tompkins County greenhouse gas emissions.**

## Solutions

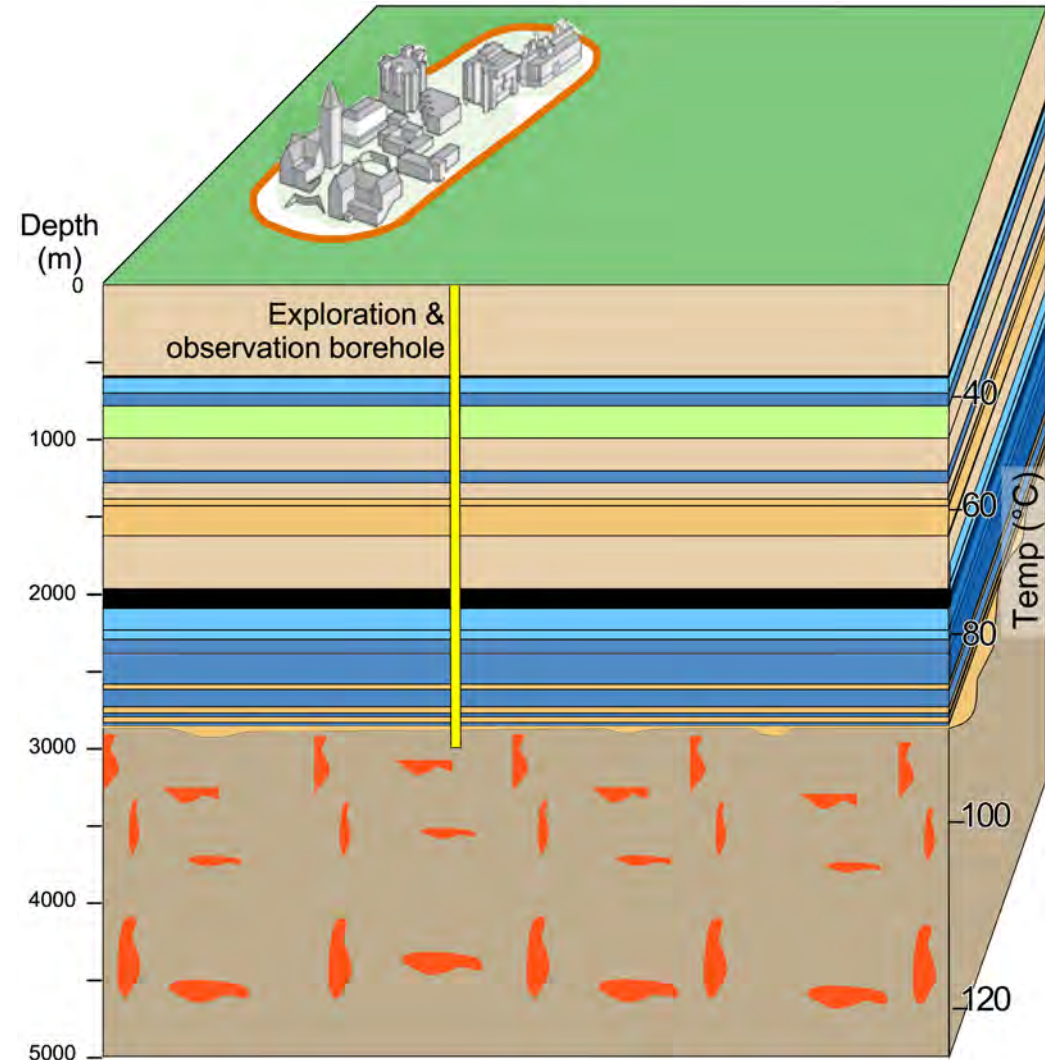


We can advance a safe, constant and reliable heating technology - using minimal electricity or refrigerants. Most existing solutions for a climate-smart future rely on electricity, significantly increasing the challenge of greening the grid.

**Earth Source Heat frees up electric capacity for other residential, commercial, and transportation needs where district energy solutions are not possible.**

# Questions Needing Answers

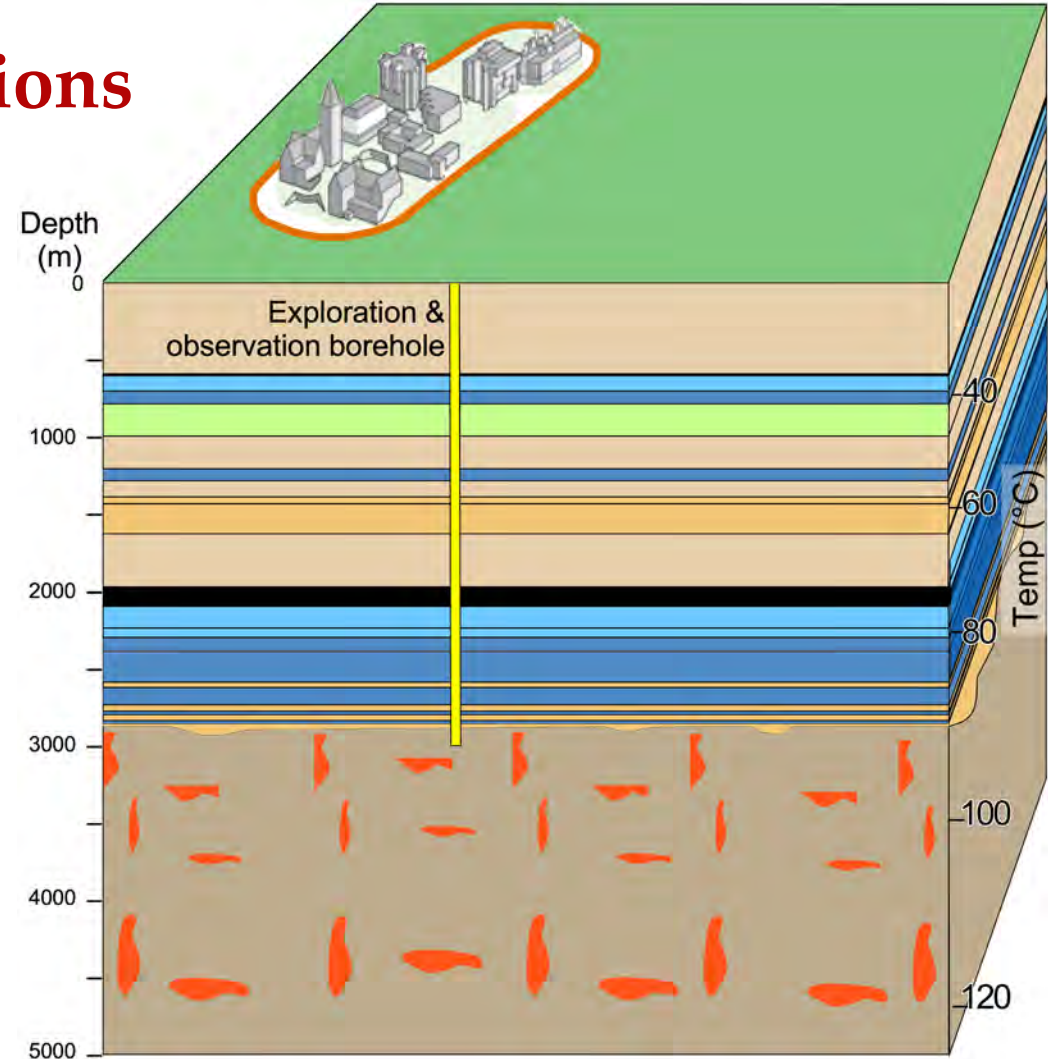
- Can sufficient heat be produced to meet Cornell's Climate Action Plan goal at an acceptable cost?
- Can heat production be sustained over many years to justify investment?
- What is the level of risk of unintended consequences, can they be mitigated, and how (e.g. felt earthquakes, water pollution)?



# Questions Needing Answers

## CUBO's Goal: To Answer Questions

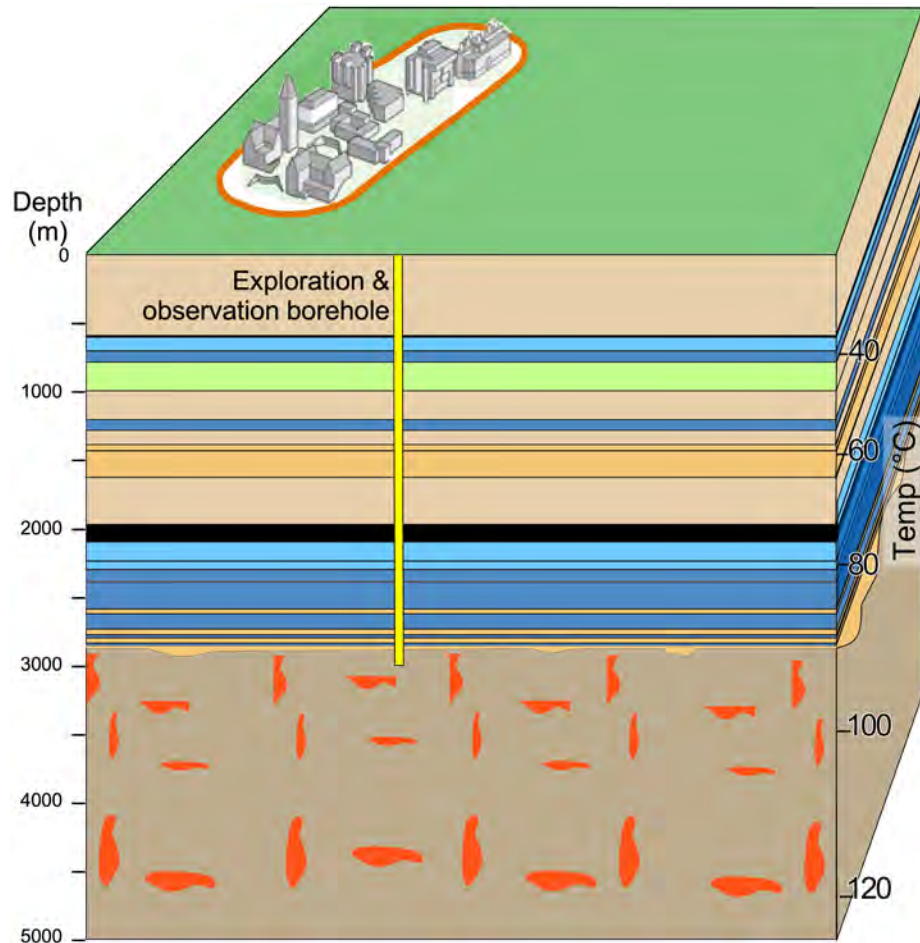
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# CUBO Goals

Designed to gather data in order to analyze risks.

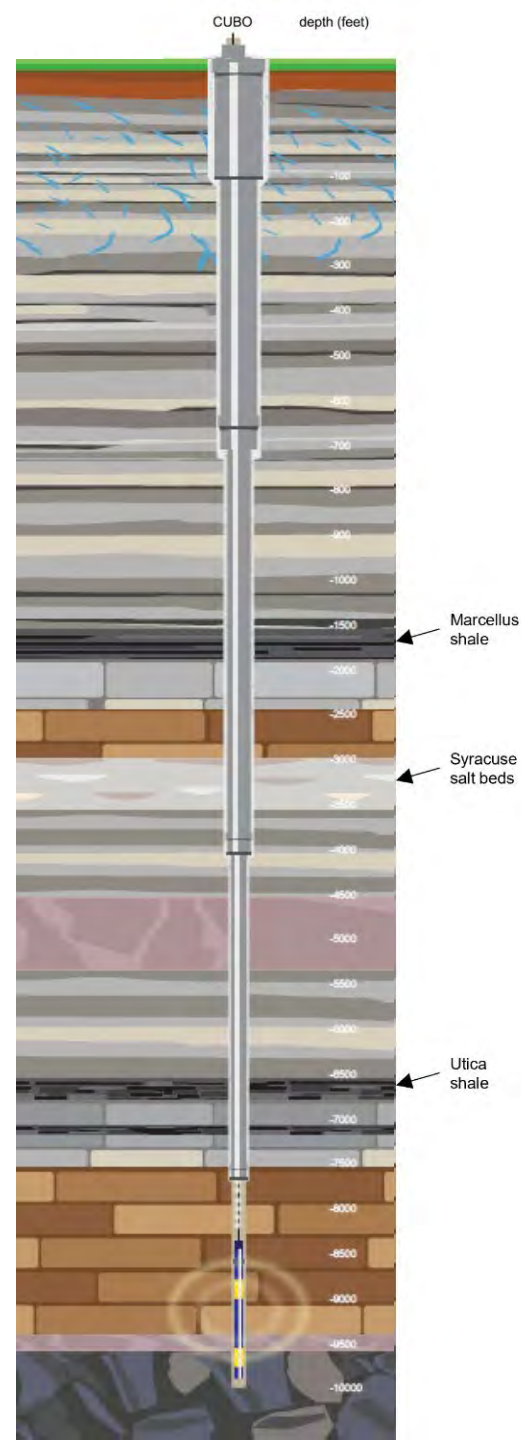
Planned to monitor subsurface conditions later, if ESH moves forward to demonstration.



- Geophysical rock properties
- Fracture characteristics
- Rock samples
- Fluid samples
- Hydrogeologic tests
- Stress tests
- Fiber optic temperature profiler
- Borehole seismometer



- Borehole plan to  
10,000 ft depth:
- Geological units
  - Casing cemented  
into borehole  
down to interval  
of interest
  - Open hole at  
bottom for testing



*See animation of drilling, installation  
of casing, and cementing at:  
<https://earthsourceheat.cornell.edu>*





# Cornell University Borehole Observatory

*Located* for minimal environmental impact, with a small footprint and ongoing monitoring in mind



Main campus

Nearest academic buildings = 2100 feet

Adjacent spaces are used for warehousing, storage, maintenance, grounds, workshops

Drilling site

**Project Site**

Nearest residences = 2000 feet

Nearest water wells = 4800 feet

# Cornell University Borehole Observatory

*Designed* for minimal environmental impact, with a small footprint and ongoing monitoring in mind

## Environmental Impact

- Repurposing existing developed site
- Work expected on site for ~8 weeks
- Electric drill rig will reduce noise and use of fossil fuels
- Moderate truck traffic during construction
- Can use campus water (no trucked water); total is less than 1 day of typical campus use
- Site lighting will use shields to direct the light down and reduce light pollution
- After drilling is completed, well site will consist of a small fenced area around the well head, along with a small testing trailer for a few months



# Geological Column & Proposed Well Diagram



**Fluids (in Tompkins and adjacent counties)**

- \* gas } noted in completion reports
- \* water } (only produced as noted below)

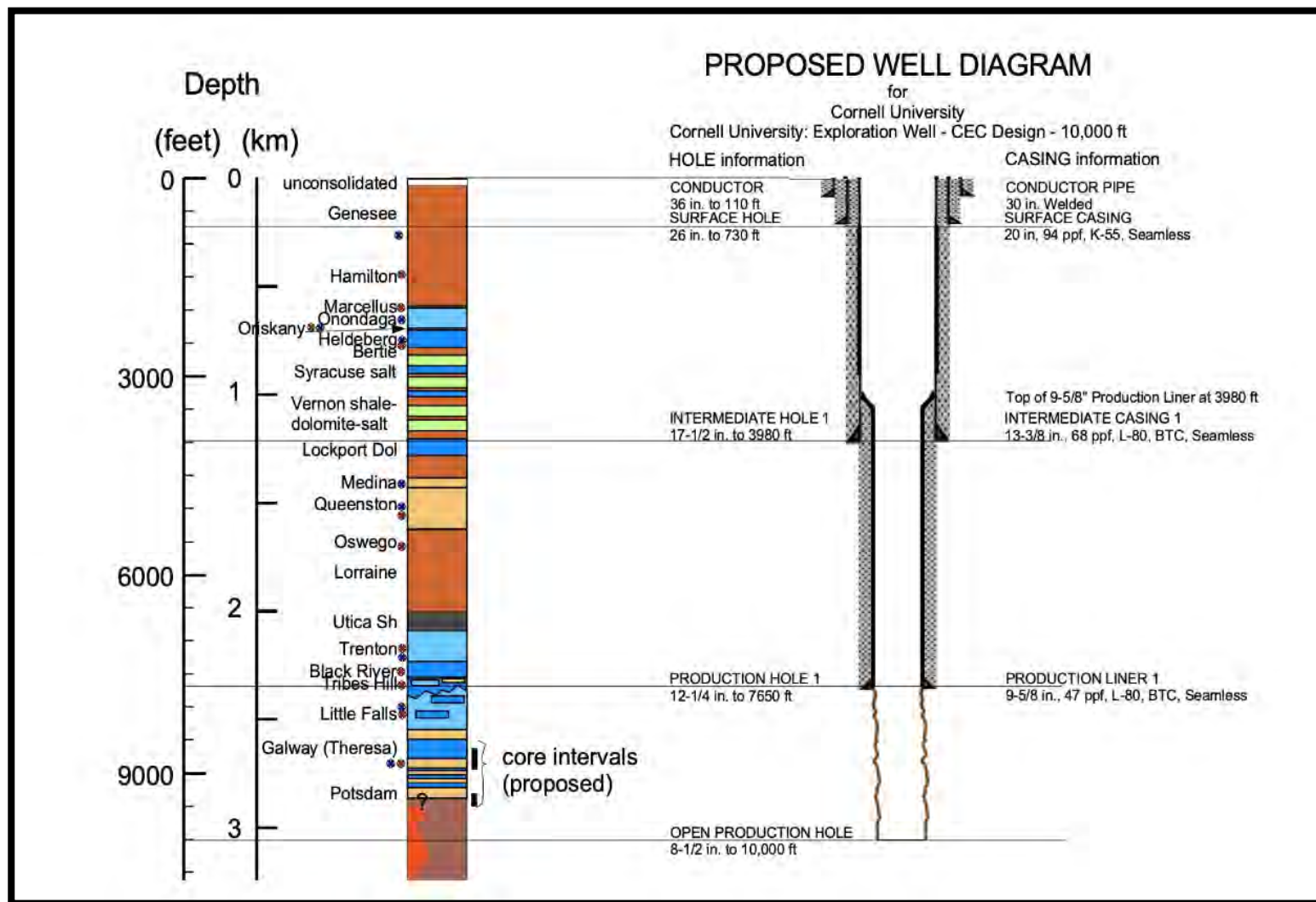
Marcellus and Utica: produce gas only as unconventional plays in PA

Trenton: gas shows not common but high pressures a concern to NY DEC

Black River: gas fields where there are structural controls in counties to west; high pressures a concern to NY DEC

**Borehole stability**

If Oriskany is water-bearing and fills borehole while drilling Vernon shale, Vernon becomes very weak. Completion and mud/air selections need to prevent this.

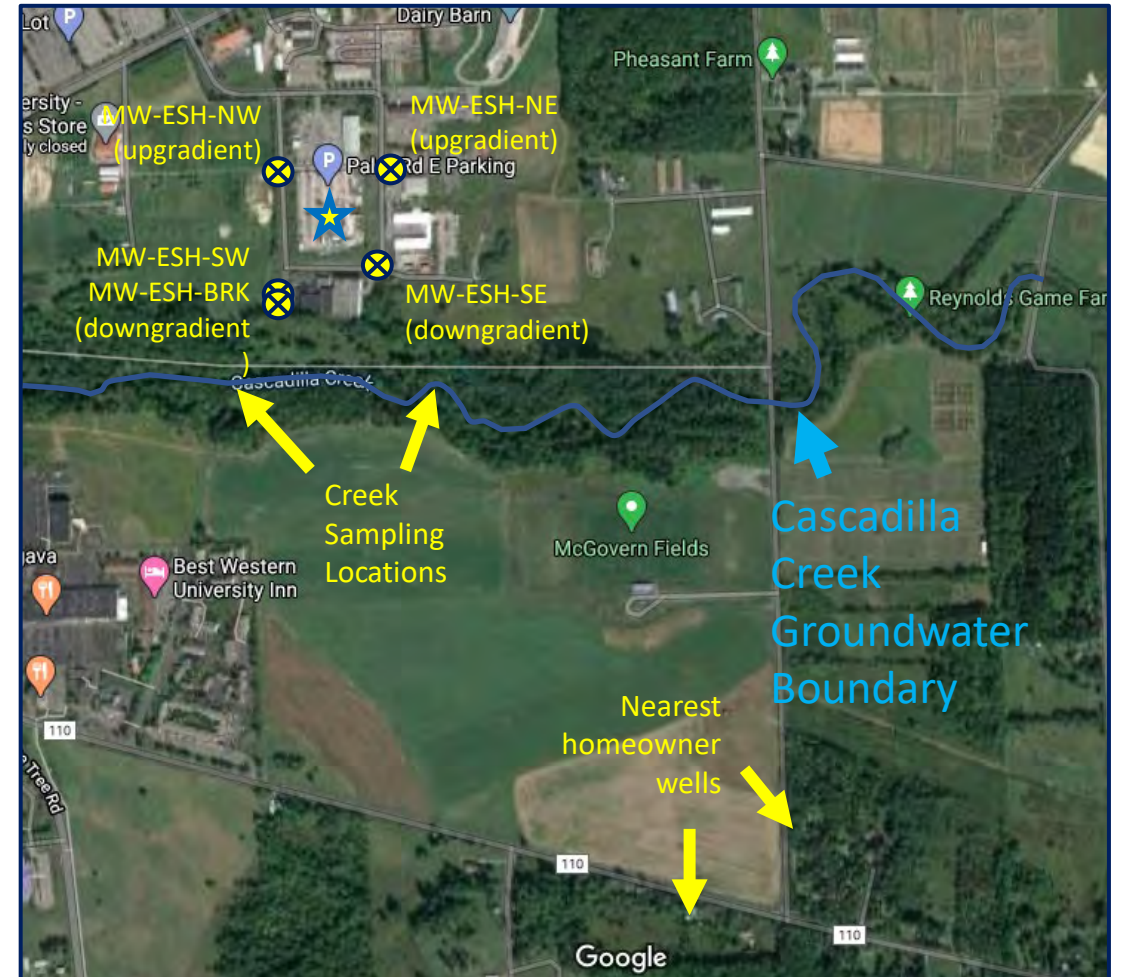


# Cornell University Borehole Observatory

*Monitored* to ensure adverse impacts are avoided

## Environmental Monitoring

- Groundwater monitoring wells
- Surface water sampling
- Noise monitoring
- Seismic monitoring

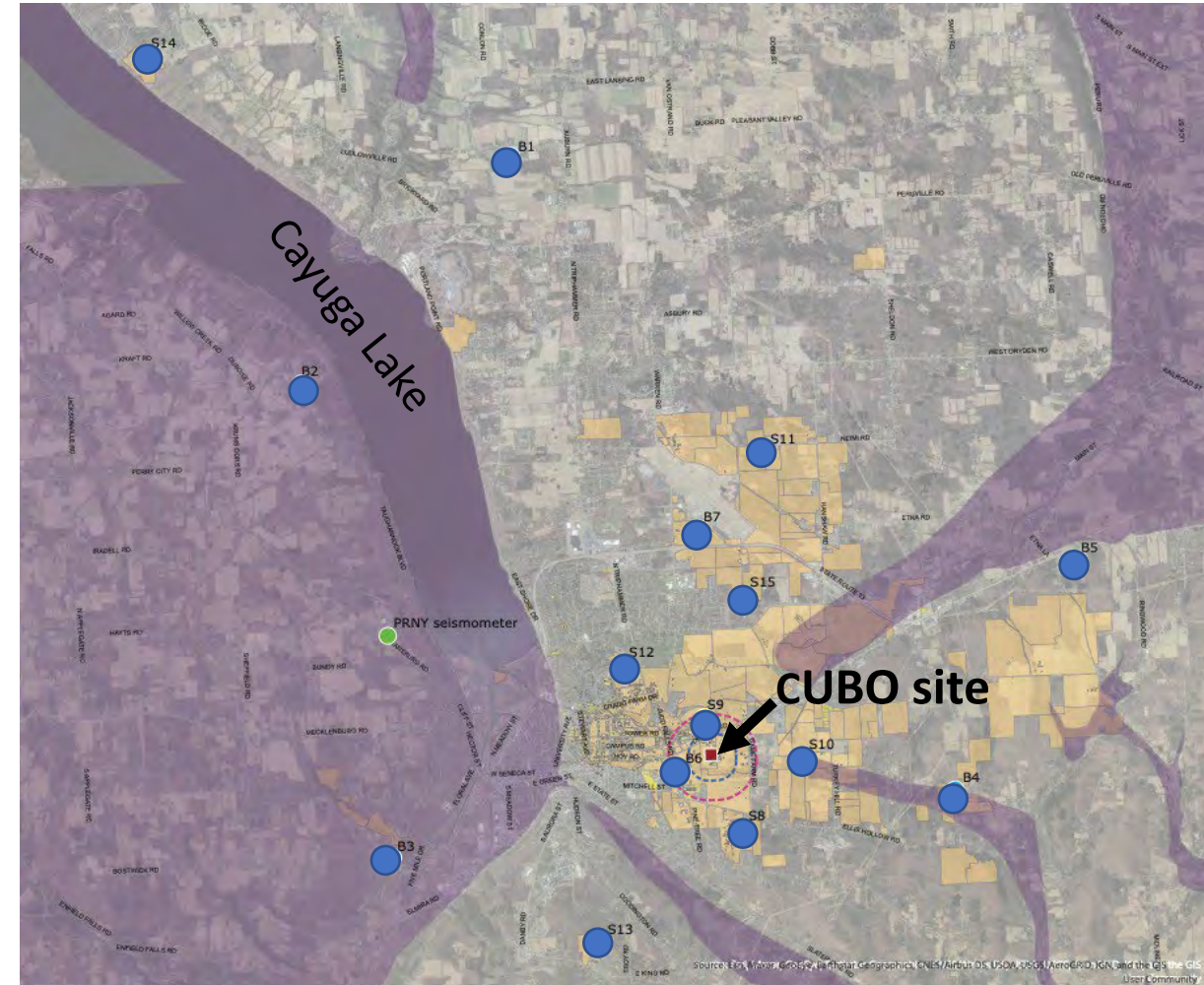


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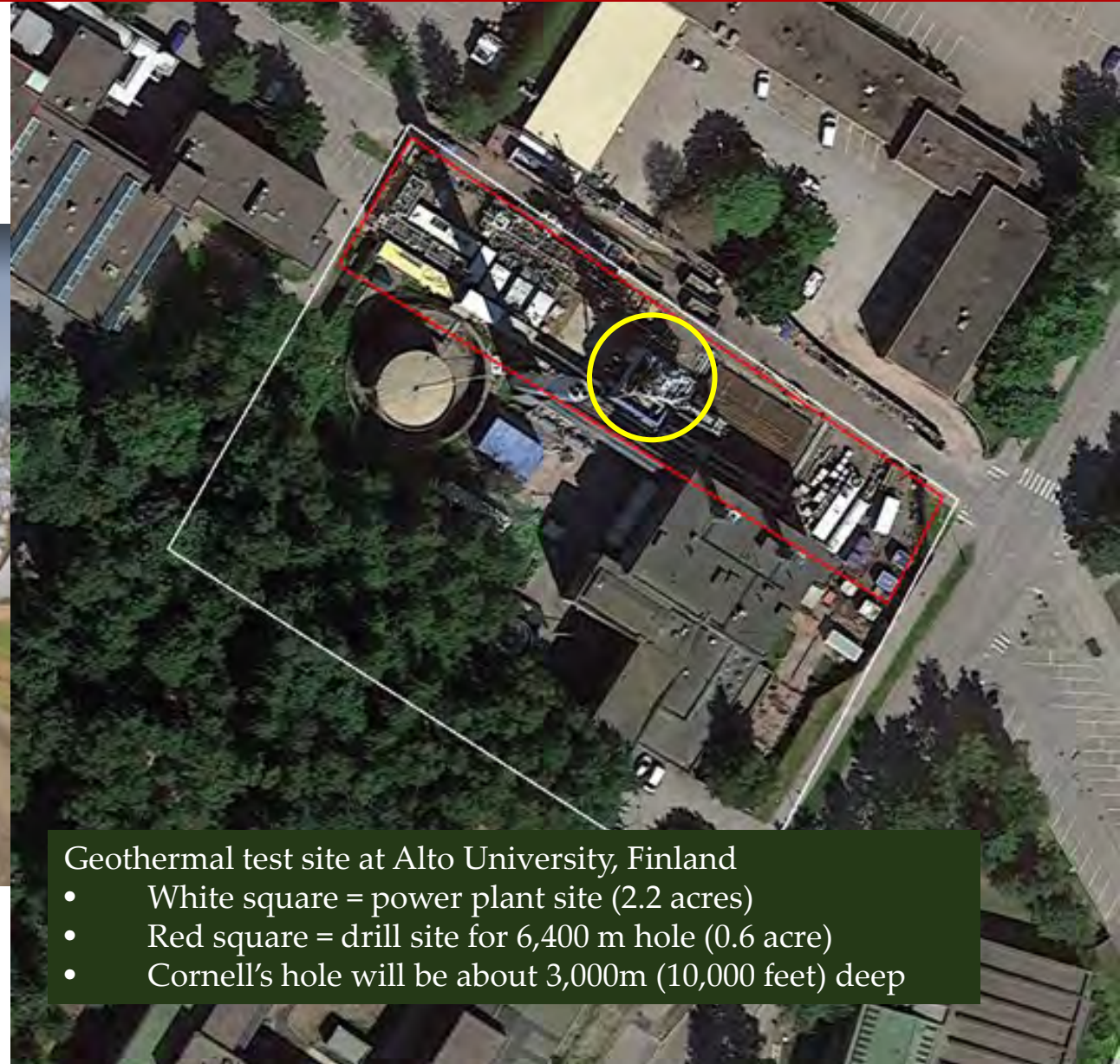
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# Example Site Views

Google Street view during drilling at Rittershofen, Germany geothermal facility



Geothermal test site at Alto University, Finland

- White square = power plant site (2.2 acres)
- Red square = drill site for 6,400 m hole (0.6 acre)
- Cornell's hole will be about 3,000m (10,000 feet) deep



# Earth Source Heat Quick Facts

Earth Source Heat would eliminate 66,000 metric tons of CO<sub>2</sub> each year.

That weight is equivalent to

**8,000**

American homes' energy use for a year



The top of the borehole will be no larger than a hula hoop (36").

The rock temperature at the bottom of the well is anticipated to be 75-100 C or 167-212 F.



The boiling point of water is 100 C/212 F.

The bottom of the borehole will be roughly the size of a frying pan (8").



CUBO will be drilled to a depth of 2 miles. That's about the same as stacking 7 1/4 Empire State Buildings end to end.

**x7.25**

