

Earth Source Heat Community Forum

Virtual Meeting

January 19, 2021



Welcome and Introductions

Joel Malina

Vice President, University Relations

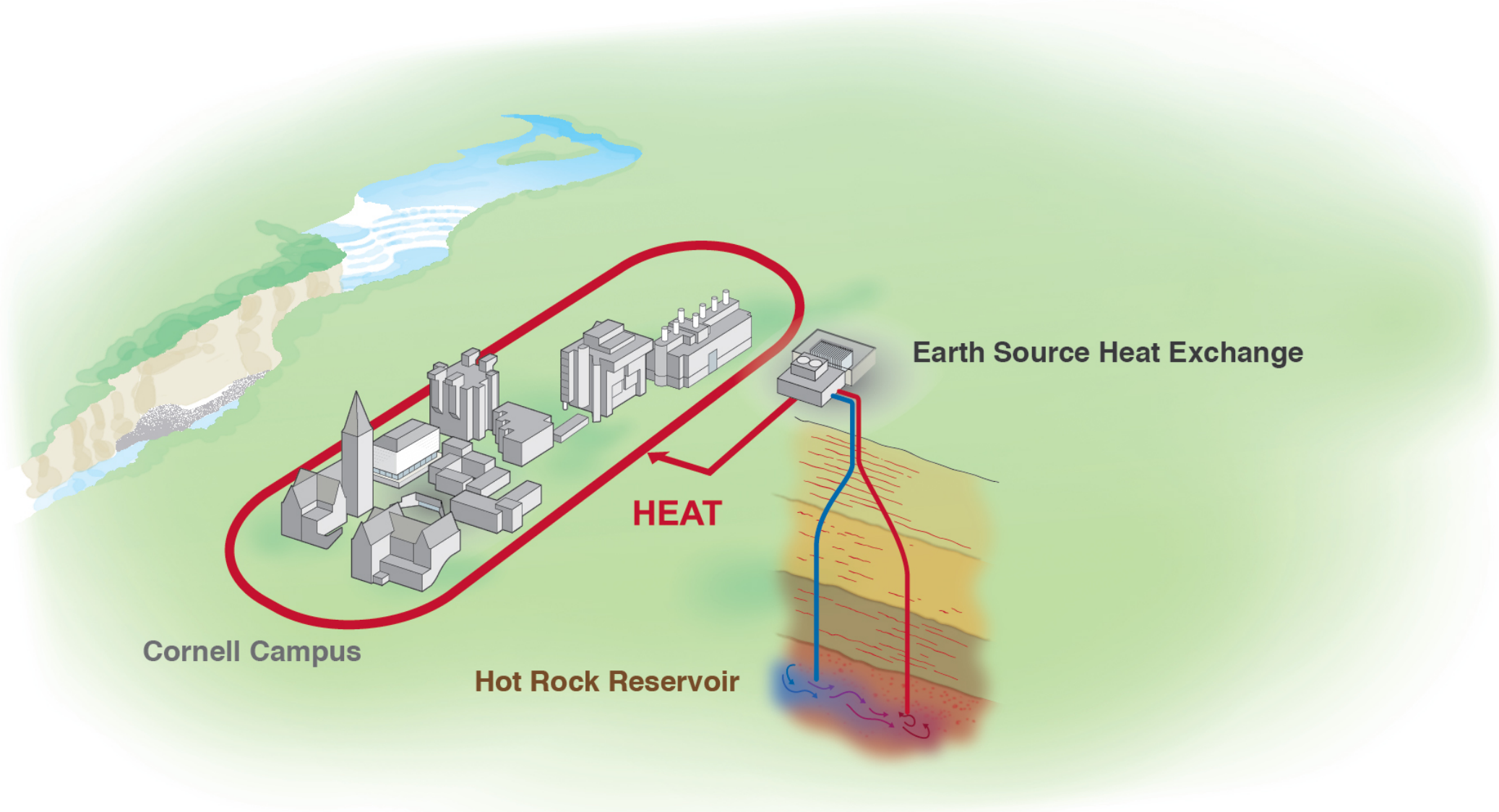
Cornell Panelists

- **Rick Burgess**, Vice President, Facilities and Campus Services
- **Teresa Jordan**, The J. Preston Levis Professor of Engineering, Earth and Atmospheric Sciences
- **Steve Beyers**, Environmental Engineer, Facilities and Campus Services
- **Tony Ingraffea**, The Dwight C. Baum Professor of Engineering Emeritus, Civil and Environmental Engineering

Cornell's Earth Source Heat Project

Rick Burgess

Vice President, Facilities and Campus Services



Designed in Stages to Mitigate Risks



DISCOVERY & DESIGN

- Data collection, including subsurface imaging, background seismic, and water monitoring
- Single borehole and subsurface analysis (DOE)
- System design



DEMONSTRATE

- Create functioning well-pair
- Continued risk analysis
- Connect to district heating system



DEPLOY

- Technology de-risked, new industries created
- Private-sector deploy across the state at sites with existing district heating systems and appropriate geological subsurface

- 2016 – present
- Exploration & observation borehole – coming in 2021

- Subject to funding, 2-3 years
- Rigorous risk analysis to determine system efficacy

- Subject to funding, 3-5 years, after successful demonstration full deployment to campus and beyond

Undertaking Rigorous Risk Analysis to Determine System Efficacy

- What is the level of risk of unintended consequences, can they be mitigated, and how? For example:
 - Induced felt earthquakes
 - Water pollution
- 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?
- Can an ESH project succeed through the stages of regulatory permits and community acceptance?

Academic Studies of the Subsurface-Borehole Observatory

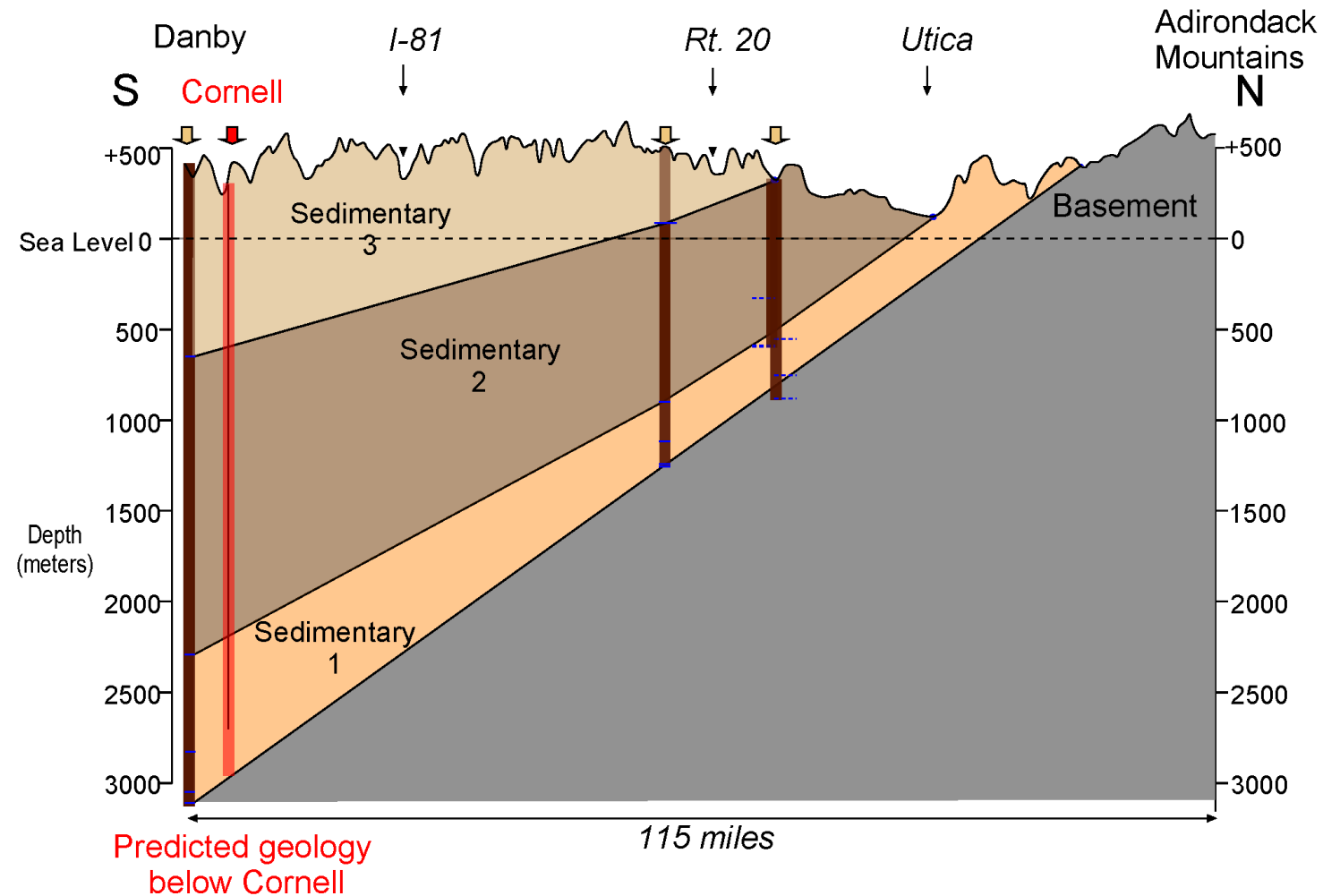
Teresa Jordan

J. Preston Levis Professor of Engineering,
Earth and Atmospheric Sciences

De-risking Earth Source Heat Requires Obtaining Information about the Subsurface, Now and Into the Future

- Risks of unintended consequences and mitigation planning?
 - Mechanical conditions and fluid conditions
- Can sufficient heat be produced?
 - Natural fluids flow, fracture pathways, and temperature
- Can heat production be sustained over many years?
 - Volume of rock in which fluid might circulate
- Can an ESH project achieve permits and public acceptance?
 - Changing conditions and mitigate possibilities

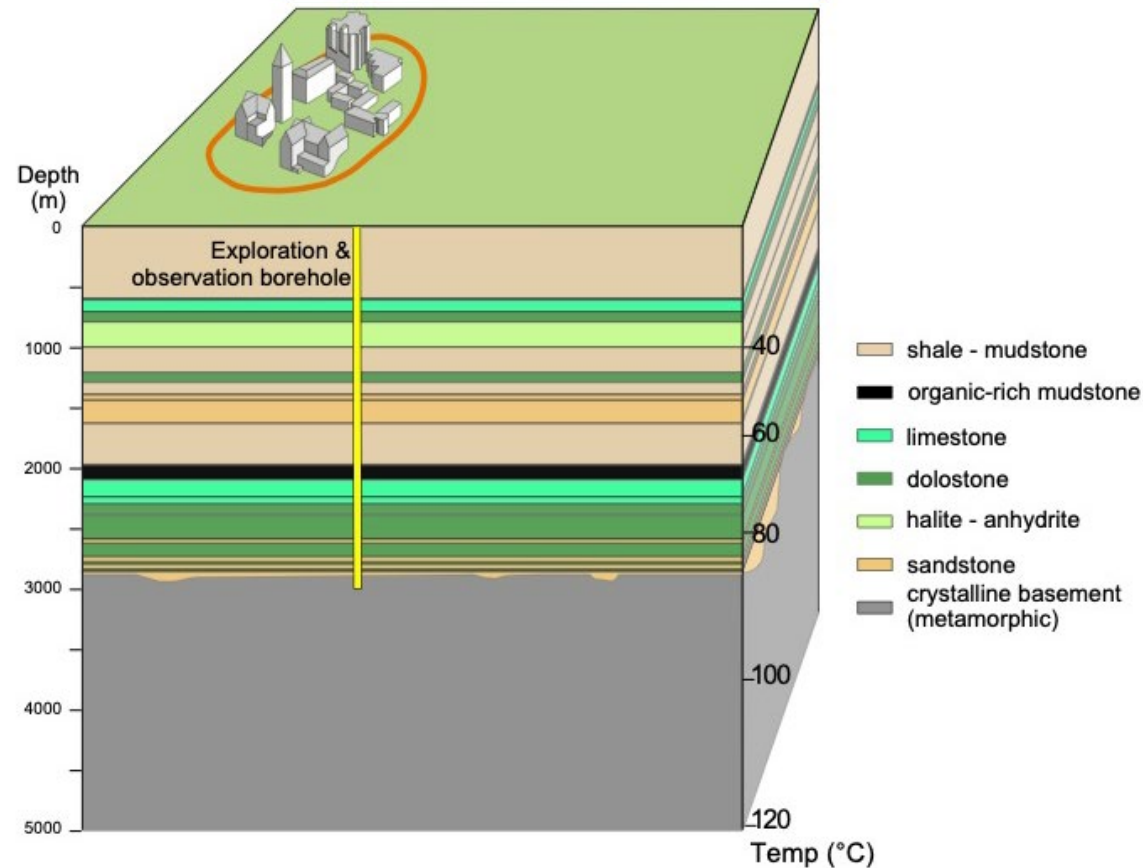
Solid Rock Compositions and Temperatures have been Deduced Based on Surface Geology and Old Boreholes



De-risking ESH: Subsurface information

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

CUBO: Designed to gather data in order to analyze risks



CUBO will Provide Data about Fluids, Stress, Mechanical Conditions, and Temperature

- Can sufficient heat be produced and for how long?
 - Depths with natural capacity for water flow through rocks
 - Fluid compositions
 - Natural stress magnitudes, orientations, and variations
 - Natural fractures patterns
 - Temperatures at increasing depths
- Risks of unintended consequences and mitigation planning?
 - Natural stress magnitudes, orientations, and variations
 - Natural fractures patterns
 - Fluid compositions

CUBO Monitoring will Enhance Safety

Cornell plans to use CUBO to monitor the subsurface now and into the future. CUBO monitoring tools include:

- Temperatures along length of borehole (fiber optic cable)
- Strain along length of borehole (fiber optic cable)
- Time-series sampling of fluids
- Borehole seismometer at bottom

Cornell Project to Explore Earth Source Heat

Steve Beyers

Environmental Engineer, Facilities and Campus Services

How Did We Get Here?

- **2017-2019: U.S. DOE funds Cornell feasibility study.** Site-specific study advances ESH design to incorporate high-performance district heat pumps (heat recovery chillers).
- **Jan. 2020: International Continental Drilling Science Program (ICDP) funds workshop to refine ESH scientific objectives; Cornell University Borehole Observatory (CUBO) concept is recommended.**
- **2020: Cornell notified of DOE award for the Cornell University Borehole Observatory—National test case for deep-enhanced geothermal heating.**

Undertaking Rigorous Risk Analysis to Determine System Efficacy

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Cornell University Borehole Observatory (CUBO): Technical and Program Goals

- Safety considerations
- Ground truthing: Predict specific site performance vs. “range of possible performances”
- Geothermal systems approach (based on CUBO results)
- Other technical information for planning and design

Cornell University Borehole Observatory (CUBO) Proposed Schedule (per DOE Scope)

Task	Year 1 (from DOE Start)				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1 - Planning and Design												
1.1 - Borehole and Science Plan												
1.2 - Borehole Design for Bidding												
1.3 - Competitive Procurement												
1.4 - Permitting												
1.5 - Set up Observatory Trailer												
Task 2 - Drilling and Logging												
2.1 - Mobilize Drill Rig and Set Up Site												
2.2 - Drilling and Logging												
2.3 - De-Mobilize and Clear up Site (Monitoring Tests Continue)												
Task 3 - Data Collection												
Task 4 - Computer Modeling												
Task 5: Options Analysis and Documentation												
Task 6: Final System Modeling & Analysis												
Task 7: DOE Required Final Report and Recommendations												

Proposed Borehole Observatory

- Proposed Borehole Site
- Surface Seismometers
- Borehole Seismometers
- Cornell Land
- Aquifer
- ½ mile radius
- ¼ mile radius



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA/USGS, AeroGRID, IGN, and the GIS User Community

Borehole Observatory: Seismic and Water Monitoring, Well Design

Tony Ingraffea

Dwight C. Baum Professor of Engineering Emeritus,
Civil and Environmental Engineering

Proposed Borehole Observatory

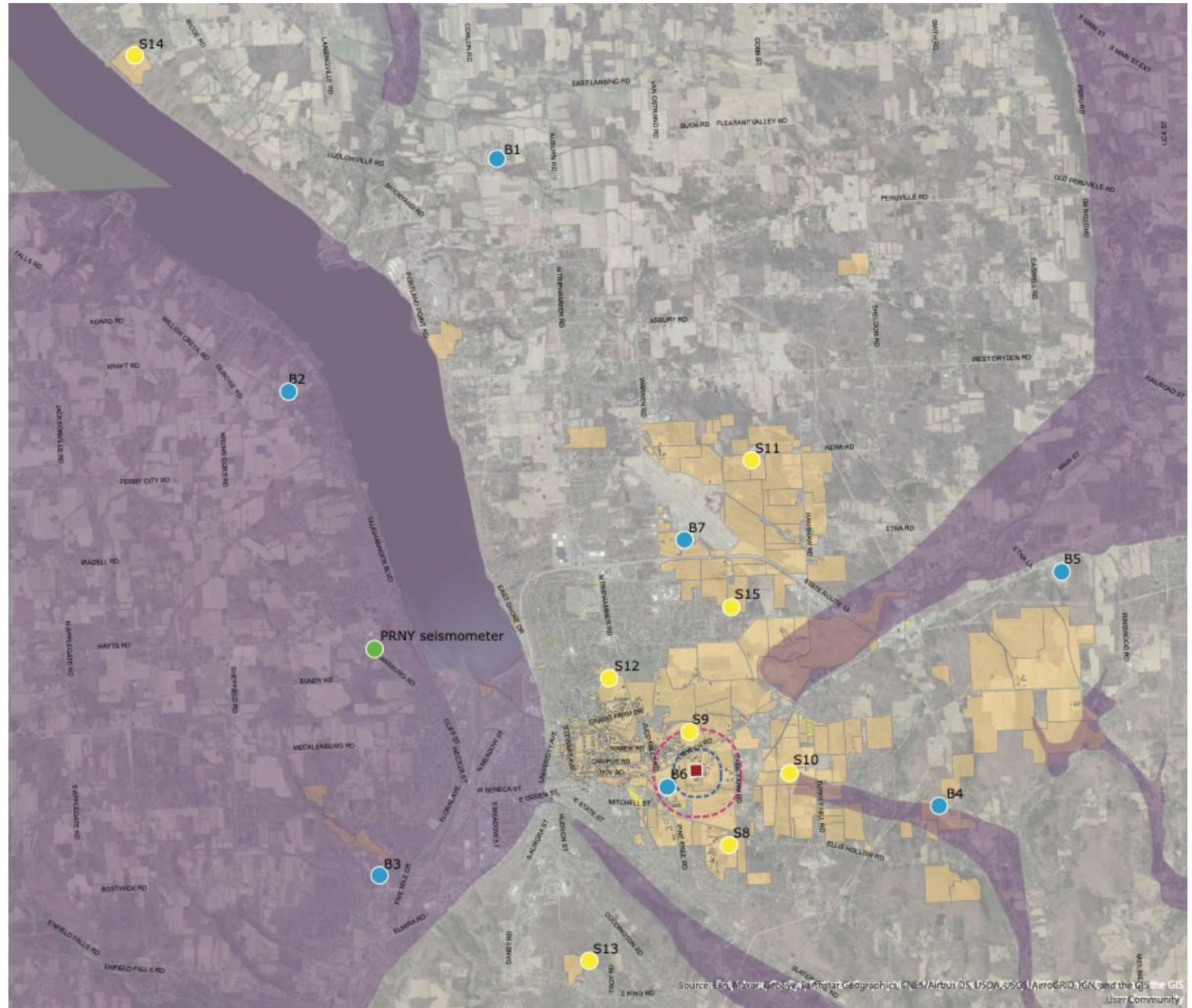
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Seismic Monitoring

- Proposed Borehole Site
- Surface Seismometers
- Borehole Seismometers
- Cornell Land
- Aquifer
- - - ½ mile radius
- - - ¼ mile radius

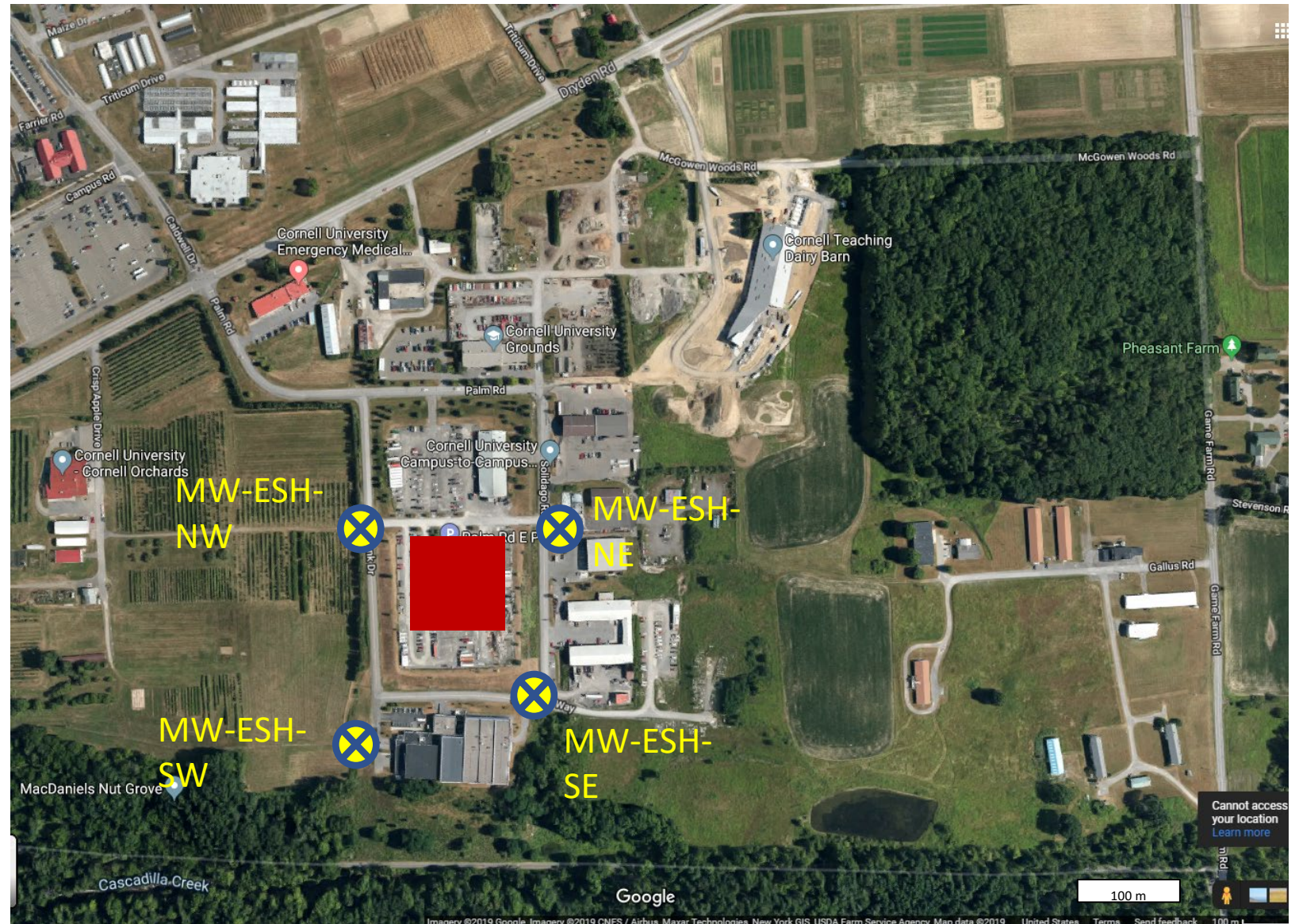


Source: Esri, Mapbox, Google, Garmin, Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location of New Water Monitoring Wells Near Drill Site

 Monitoring well location

 Borehole site



Cornell Borehole Observatory Well Design

HOLE information

CONDUCTOR
36 in wide and
50 ft deep

SURFACE HOLE
26 in wide and
250 ft deep

INTERMEDIATE HOLE 1
17-1/2 in wide and
2000 ft deep

INTERMEDIATE HOLE 2
17-1/2 in wide and
6500 ft deep

Stage 1:
OPEN PRODUCTION HOLE
8-1/2 in wide and
10000 ft deep

CASING information

CONDUCTOR PIPE
30 in

SURFACE CASING
20 in

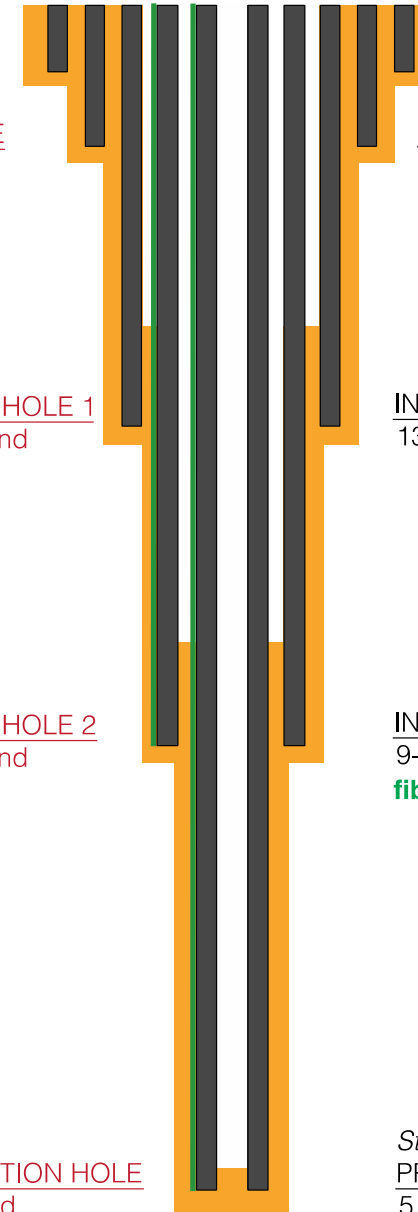
INTERMEDIATE CASING 1
13-3/8 in

INTERMEDIATE CASING 2
9-5/8 in
fiber-optic cable to 6500 ft

Stage 2:
PRODUCTION LINER 1
5 in
fiber-optic cable to 10000 ft

ORANGE = Cement
GREY = Steel
GREEN = Fiber optic cable

NOT TO SCALE



Open Q&A

Thank You

For More Information, Please Visit:

earthsourceheat.cornell.edu