



# Large Campus Geothermal



ENGINEERING FUTURE FOCUSED SOLUTIONS.

## Repurposing Energy

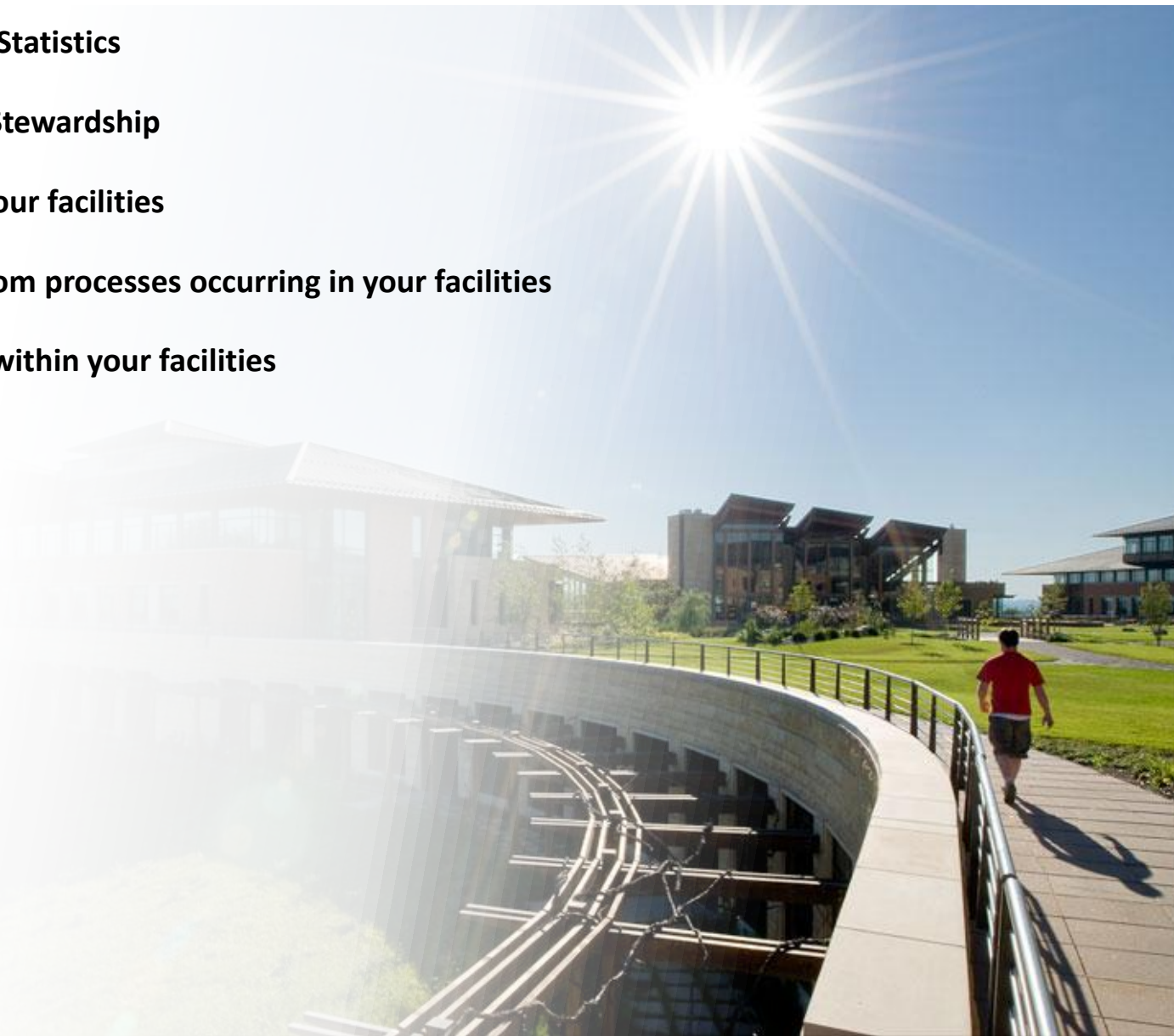
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# Agenda



- **Campus Overview & Statistics**
- **Approach to Energy Stewardship**
- **Reducing Energy in your facilities**
- **Recovering Energy from processes occurring in your facilities**
- **Repurposing Energy within your facilities**
- **Benefits**

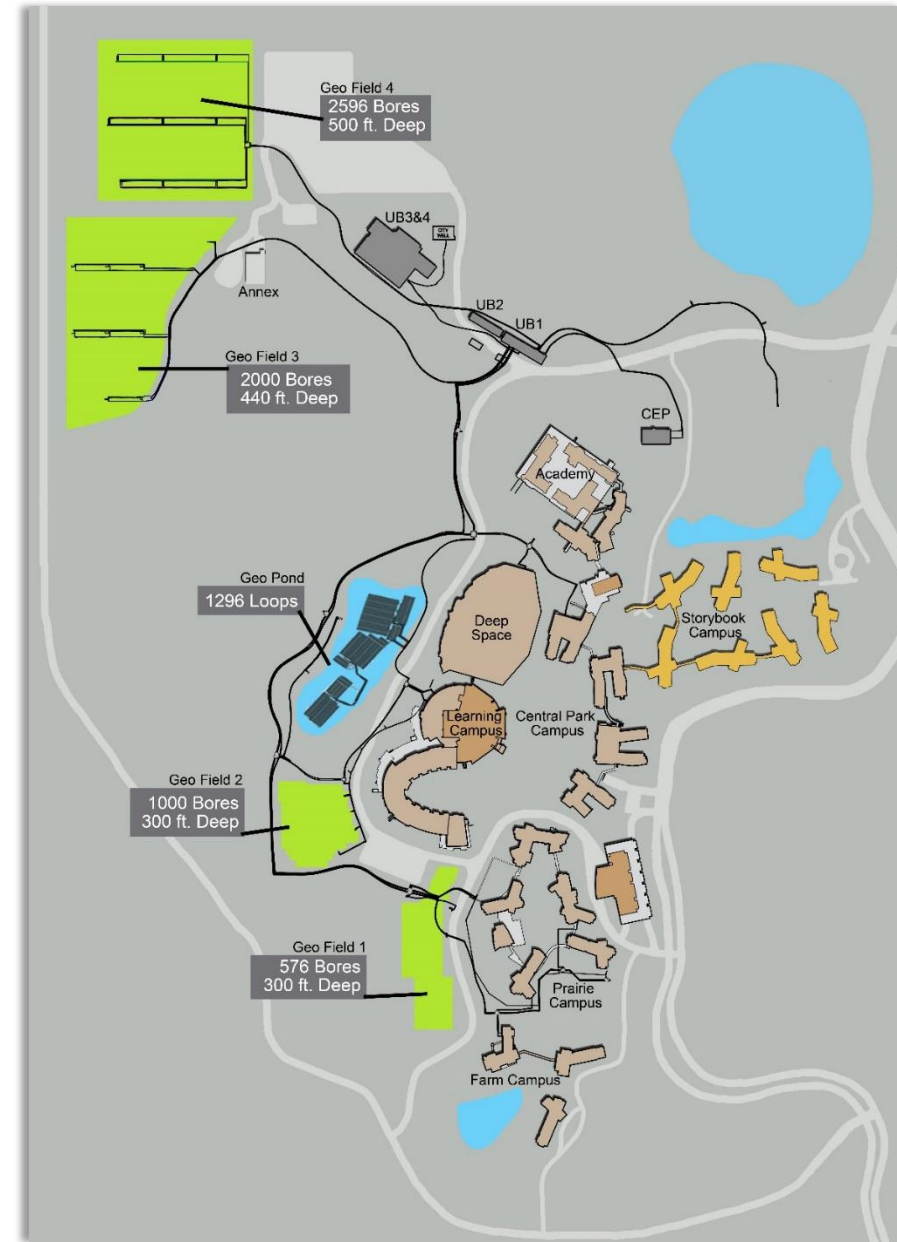


# Campus Overview



## Statistics

- Approximately 1051 Acres
- Over 7.0 Million SF occupied space
- Over 9,000 employees to keep happy and productive
- 27 Existing Buildings
- 12 Buildings under construction
- 7,338 Underground parking stalls (4 multi-level garages)
- 1.5 MW Solar PV
- 10 MW Wind Generation





# Campus Overview



## Various Systems

- Water-to-air source heat pumps with dedicated outside air system equipped with total energy recovery
- VAV air-distribution systems with dedicated total energy recovery units
- Distributed Central Energy Plants (CEP)
- Water-to-water heat pumps chiller/heaters
- VAV air-distribution systems with integral total energy recovery wheels
- Central pumping station
- Geothermal bore fields
- Geothermal pond
- Variable primary-secondary pumping
- Variable primary-secondary-tertiary pumping
- Variable-primary pumping
- Domestic water heating system that utilizes geothermal water
- Snow/ice melt systems
- Exhaust fan arrays for parking structures
- Commercial kitchen exhaust systems
- Onsite photovoltaic solar panels
- Off-site wind farm





# Campus Overview



## Geothermal System (15,000 ton Cap.)

### •Bore Fields (vertical bore shafts)

- Bore Field 1: 576 bores @ 300 feet
- Bore Field 2: 1,000 bores @ 300 feet
- Bore Field 3: 2,000 bores @ 420-480 feet
- Bore Field 4: 2,596 Bores @ 500 feet

### •Storm Water / Geo Pond

- 1,296 slinky loops @ 600 feet each
- Pond Depth: 10-15 feet





# Campus Overview



## Energy Conserving Building Design

- Geothermal Heating & Cooling
- Heat Recovery systems
- Variable flow ventilation & pumping systems
- Daylight Harvesting / automatic dimming
- Occupancy control of lighting and HVAC
- Motion activated parking lot lighting
- Operable windows for natural ventilation
- Green Roofs (22 Acres)



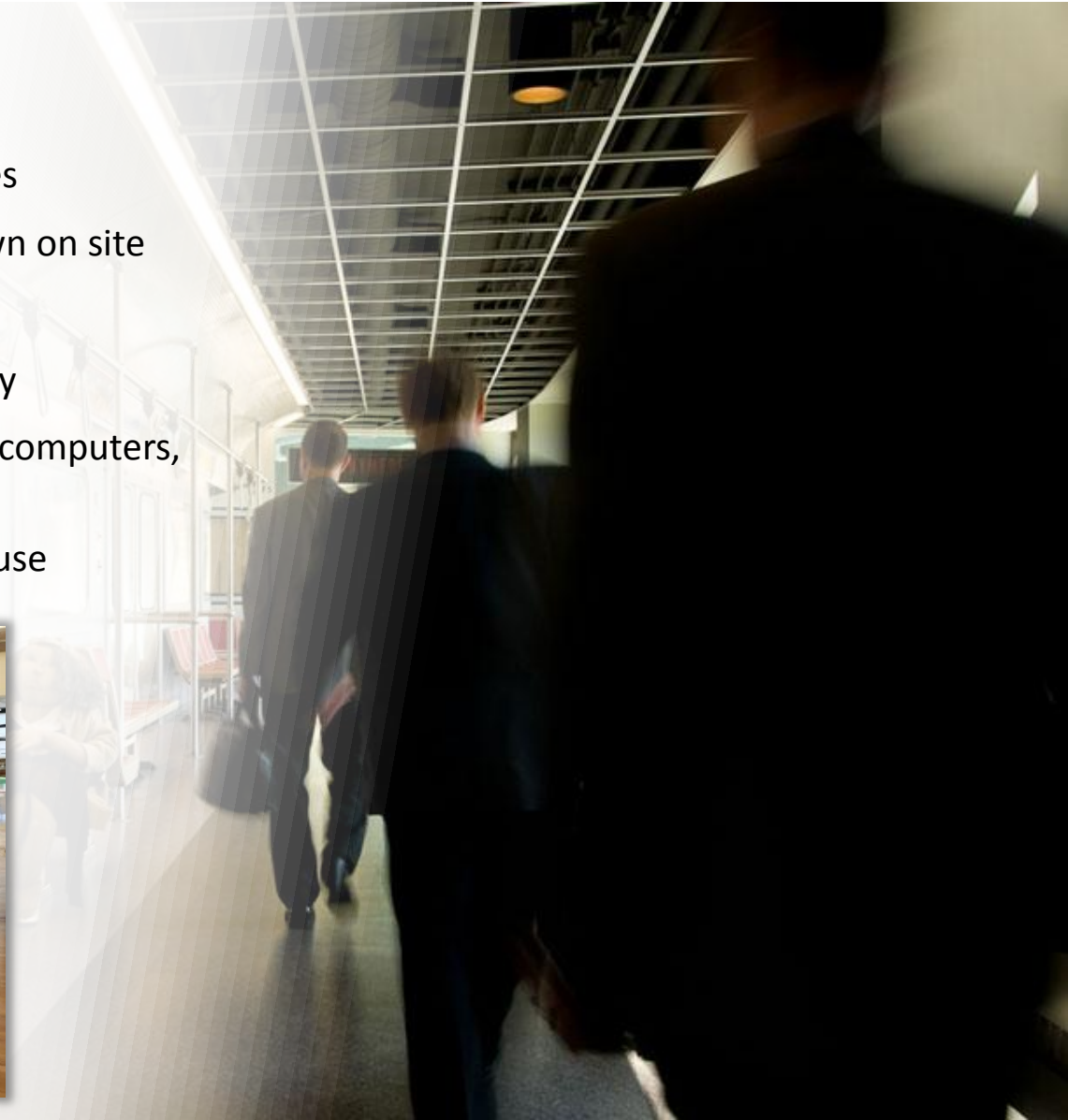


# Campus Overview



## Day-to-Day Operations

- Composting of food service waste
- Surplus Food to local food banks
- Community Gardens for employees
- Herbs/spices for food service grown on site
- Leaf Mulch produced on site
- Madison Metro bus service subsidy
- Recycle paper, cardboard, metals, computers, fluorescent lamps
- Continuous monitoring of energy use



# Energy Stewardship



**Energy Stewardship** is maximized by engineering solutions that **Reduce**, **Repurpose** and **Recover** energy.

## REDUCE

**Reduce** the initial required thermal energy to serve the building's needs.

- Minimize Outdoor Air
- Cascaded Air Systems
- Thermal Decoupling
- Process Ventilation Controls

## REPURPOSE

**Repurpose** thermal energy to be used again in lieu of discarding it.

- Simultaneous Heating and Cooling Loads

## RECOVER

**Recover** thermal energy from waste streams to be reused in the facility.

- Energy Recovery



# Reduce Demand Side



## Reducing Energy in your Facilities

- High Performance Building Envelope
- Design systems to match loads
  - Part-Load vs. Peak
- Minimize Over Pumping
- Design systems within equipment limitations to optimize performance
- Optimize Controls
  - Reset Differential Pressure in Hydraulic System
  - Incorporate interlock for operable windows
  - Incorporate Occupancy Sensing Control



# Recover



## Recovering energy from processes occurring in your facilities

- Energy Recovery Wheel

- Reduces plant sizing (chiller, pumps, geo fields)
- Efficiencies

- *Winter – 79%*

- *Summer – 79%*





# Repurpose



## Simultaneous Heating & Cooling

- Office Buildings Cooling Dominant
- VAV Reheat
- Domestic Water Heating
- Snow Melt

**Utilize building relief air from adjacent buildings as make-up air for kitchen exhaust or parking garage ventilation.**





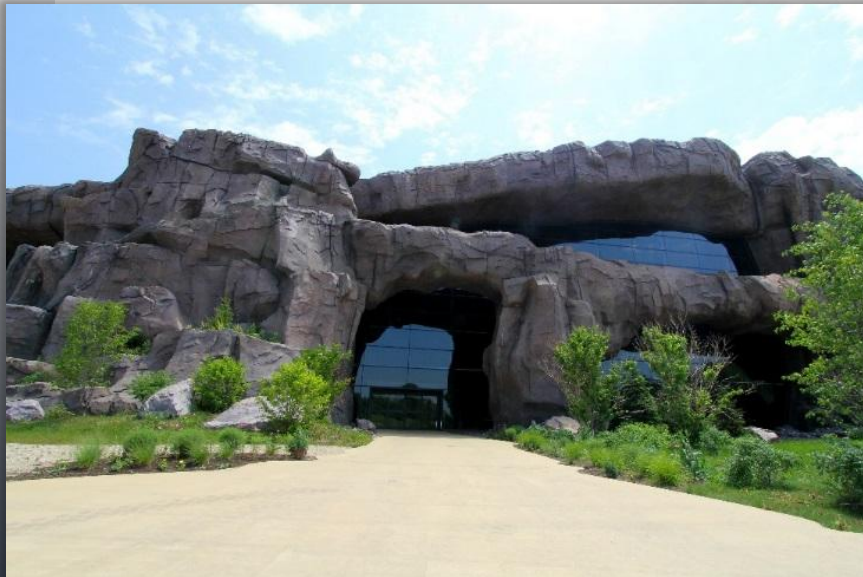
# Benefits



## Snow Melt

### •Serves Multiple Purposes

- Melts snow and ice
- Reduces load on geothermal bore field
- Reduce maintenance staffing
- Minimize failure from freeze / thaw cycles
- Use of less salt





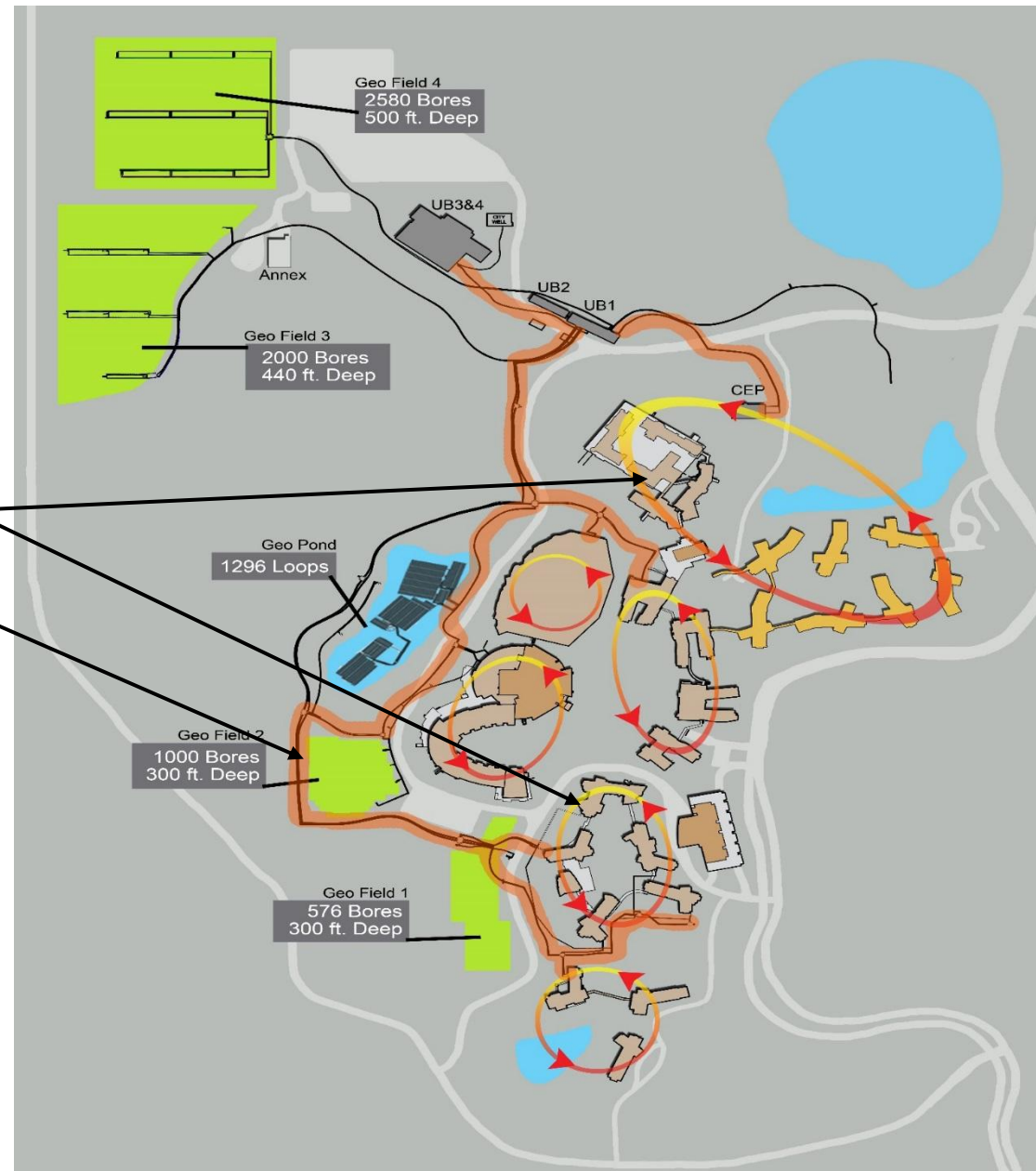
# Repurpose

Repurposing Energy  
throughout your campus



Energy Usage Loops

Energy Exchange Loop



# Production of Energy



## 4 Central Energy Plants

- Farm Campus
- Campus 2
- New CEP
- Epicenter / Pluto





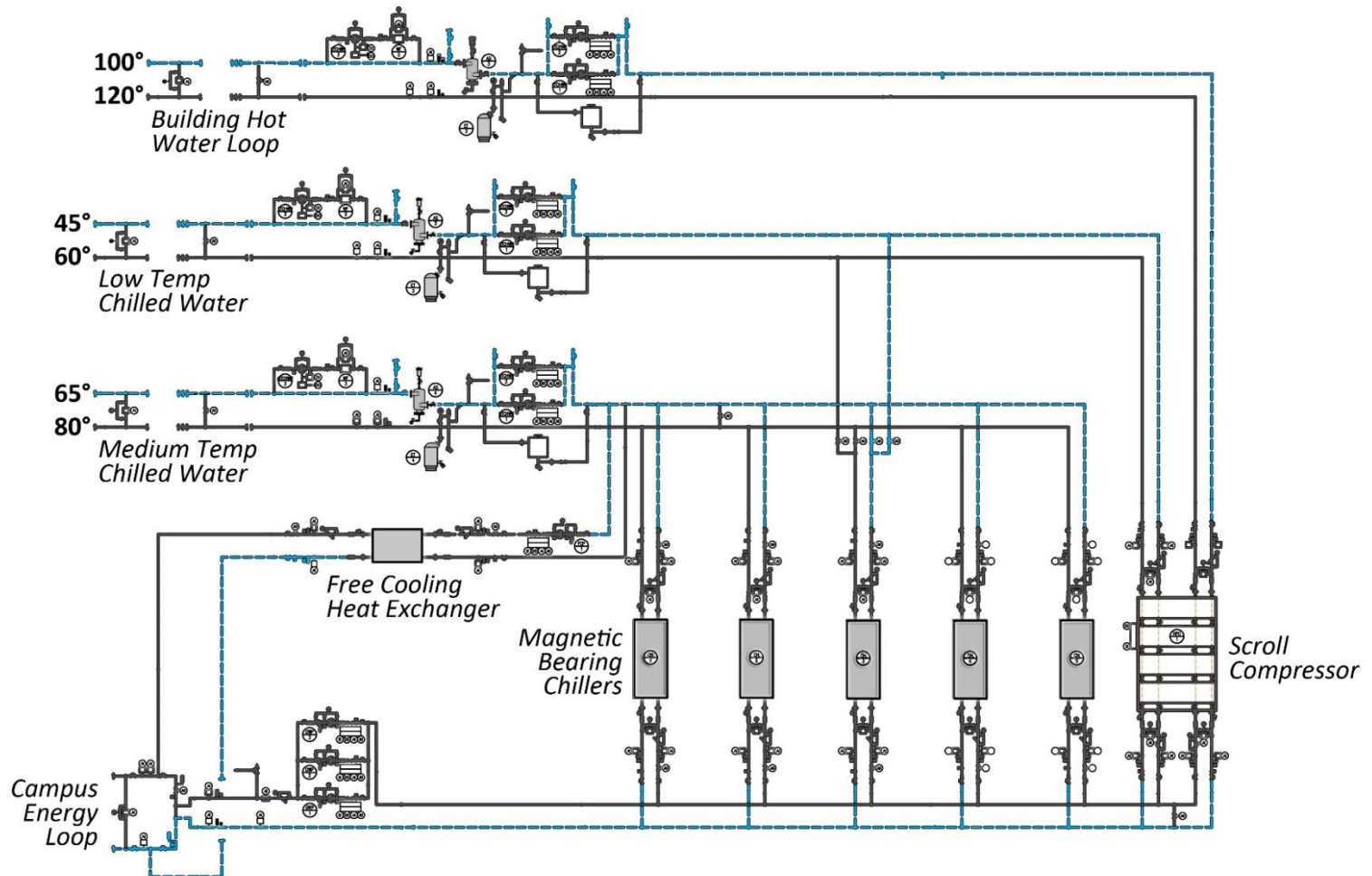
# Chiller Comparison



Condenser	%	Scroll Chiller	Centrifugal Chiller
EWT (°F)	Load	kW/Ton	kW/Ton
66	100	0.565	0.355
66	75	0.541	0.303
66	50	0.535	0.271
66	25	0.548	0.323
70	100	0.595	0.389
70	75	0.568	0.342
70	50	0.563	0.321
70	25	0.564	0.404
75	100	0.638	0.436
75	75	0.607	0.393
75	50	0.6	0.387
75	25	0.6	0.533
80	100	0.685	0.486
80	75	0.651	0.448
80	50	0.643	0.476
80	25	0.64	0.6

# Utility Building Flow Diagram

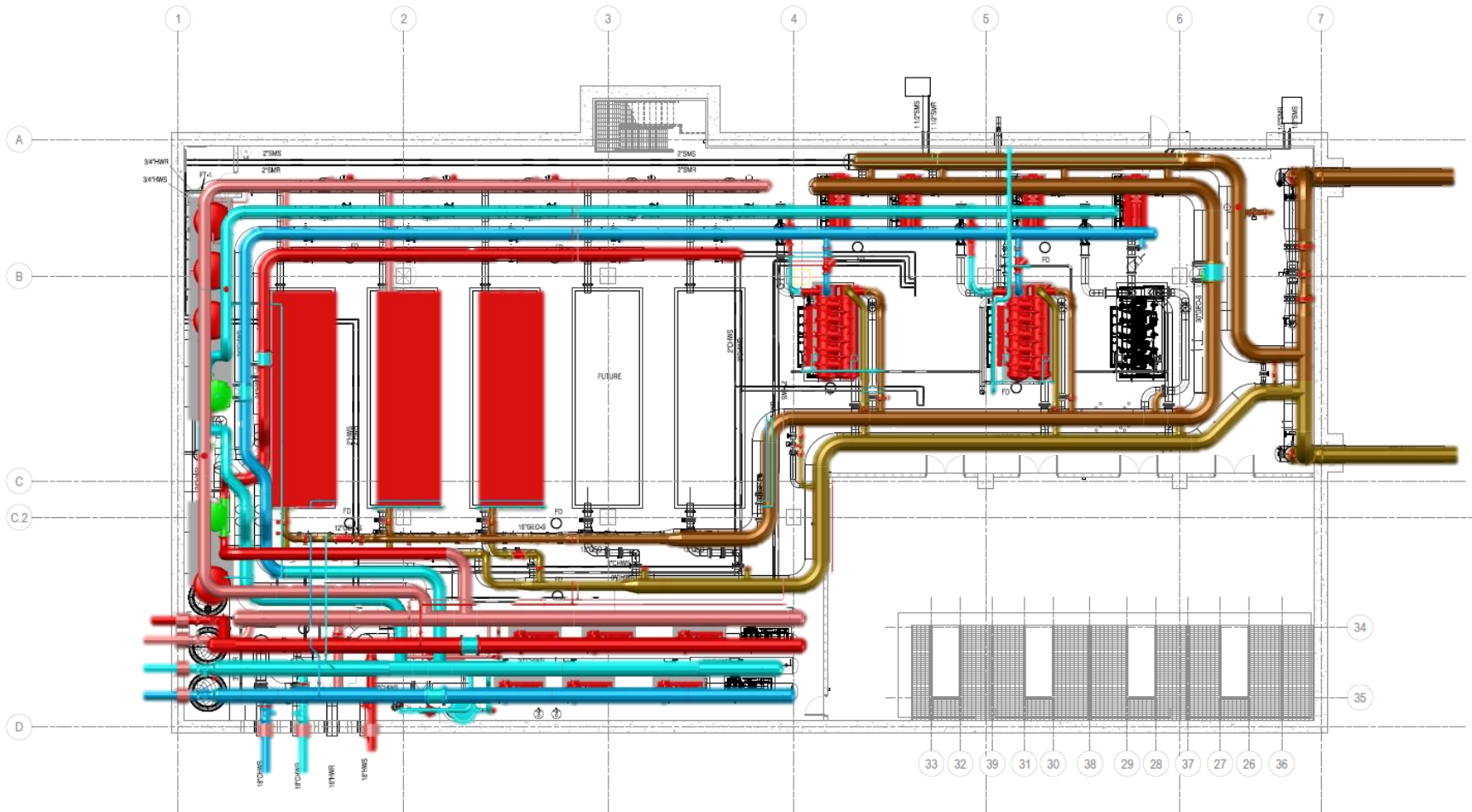
- Heat rejection used for building heat
- Excess heat is transferred through Campus Geo Loop and can be used by other campus buildings.





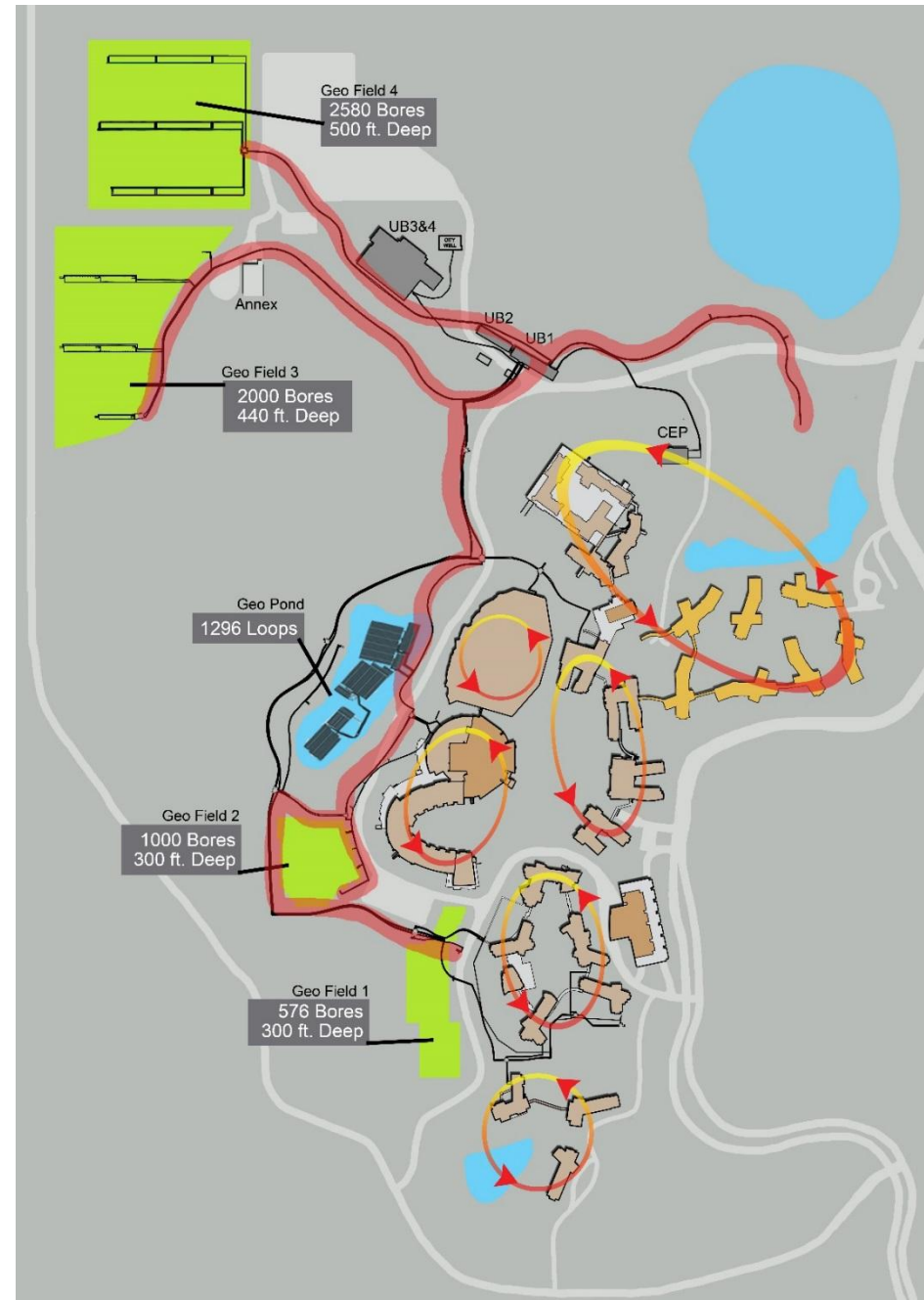
# Central Energy Plant

- Energy transfer between campus buildings
- Excess energy transferred to other campus Central Energy Plants



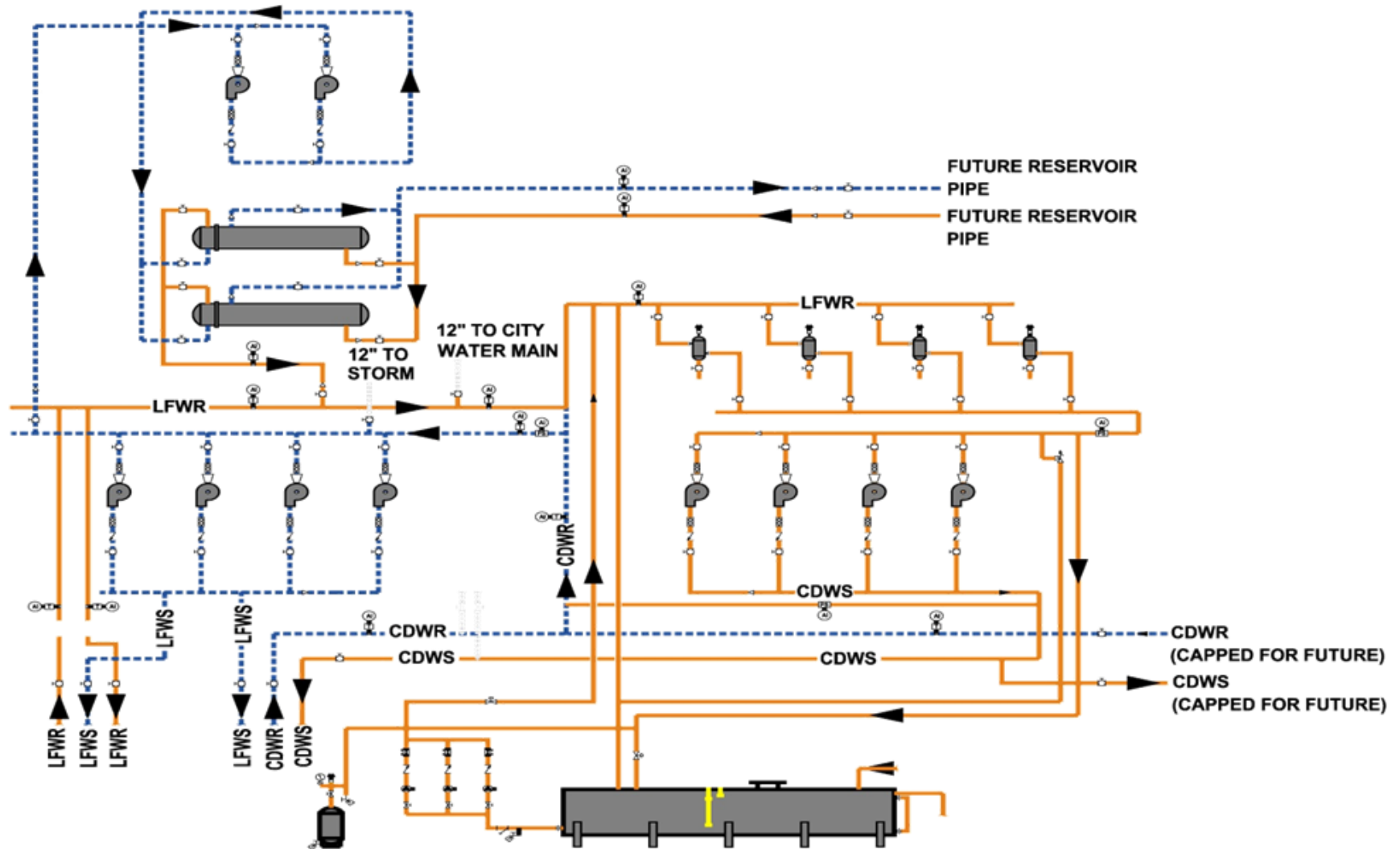
# Energy Source

- Utilized when the campus energy loop is out of balance
- Stand-alone Pump House
  - 6 Pumps designed to pump 60,000 gpm through 6,127 vertical bores and 1296 pond loops (*designed for 8 Pumps*)
  - 6 Pumps designed to pump 60,000 gpm of loop water around the campus to serve stand-alone heat pump chiller plants





# Stand-Alone Pump House



# Geothermal Loops



## Bore Field Loop

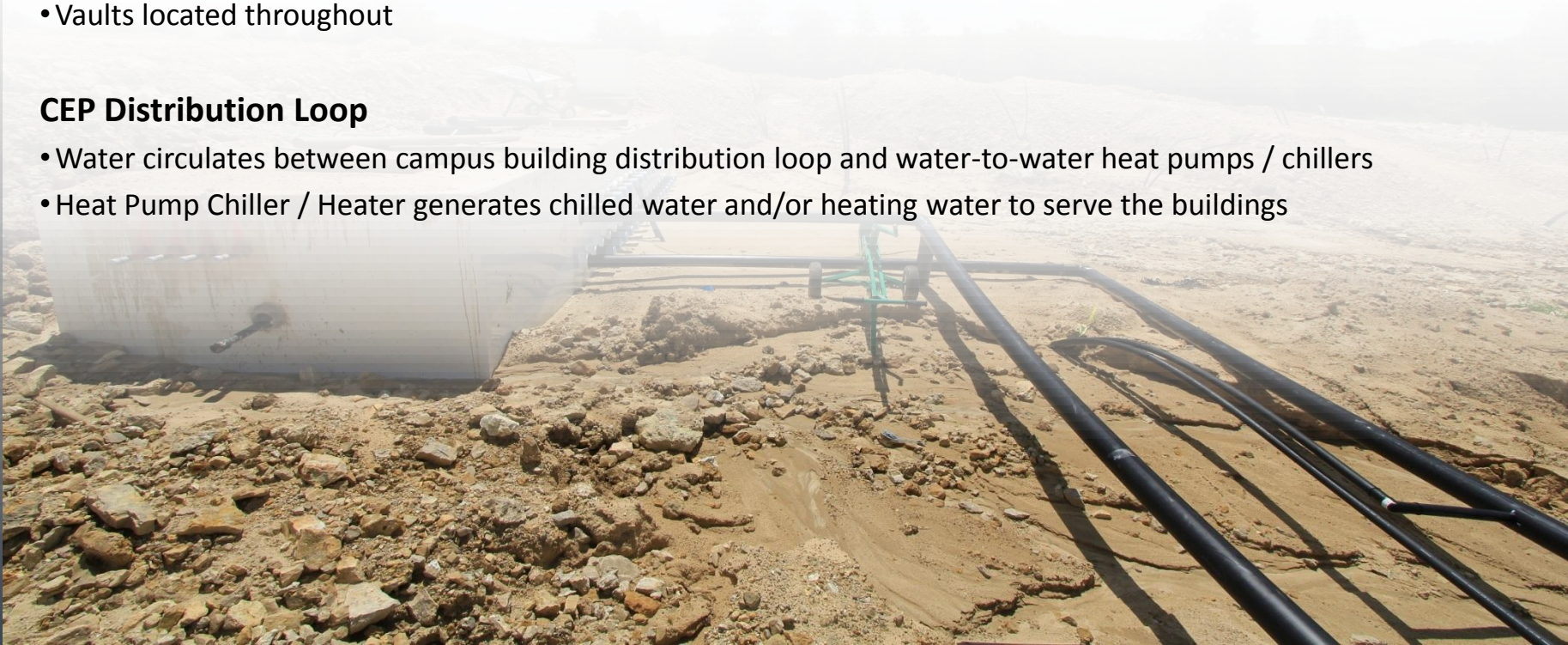
- Water circulates between bore fields and central pump station
- All borefields (1, 2, 3 & 4) and the Geo Pond are interconnected
- 36" HDPE piping mains and many geo vaults

## Building Distribution Loop

- Water circulates between central pump station and campus buildings
- Piping connects all the CEPs
- 36" HDPE piping mains
- Vaults located throughout

## CEP Distribution Loop

- Water circulates between campus building distribution loop and water-to-water heat pumps / chillers
- Heat Pump Chiller / Heater generates chilled water and/or heating water to serve the buildings





# Geothermal Statistics



- 502 miles of vertical piping in geothermal wells
- 16 miles of horizontal underground piping (6" – 36" diameter)
- 300 miles of piping resting at bottom of Geo Pond
- 1100 miles total pipe length
- 4 million gallons of water to fill system (No glycol)
- 6,172 Vertical Bores 300 ft. to 500 ft. in depth
- 15,000 tons cooling capacity
- Maximum design flow is 80,000 gallons per minute





# Utilizing a Geothermal System



## Benefits

- Reduced Maintenance
  - 0.3 FTE
  - Snowmelt System reduces cost of snow removal / salt use
  - Closed loop System – Water Only (no glycol)
  - No Boilers or Cooling Towers to Maintain
  - Oil-Free Centrifugal Chillers
- Energy Footprint Reduction
- Carbon Reduction







Thank You!

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Questions?

