A BOLD CHOICE

Geothermal Energy Plant at Wake Tech

John Majernik
Owner

LeAnn White
MEP Designer

Jeff Urlaub
MEP Designer

Andy LaFerriere
MEP Designer

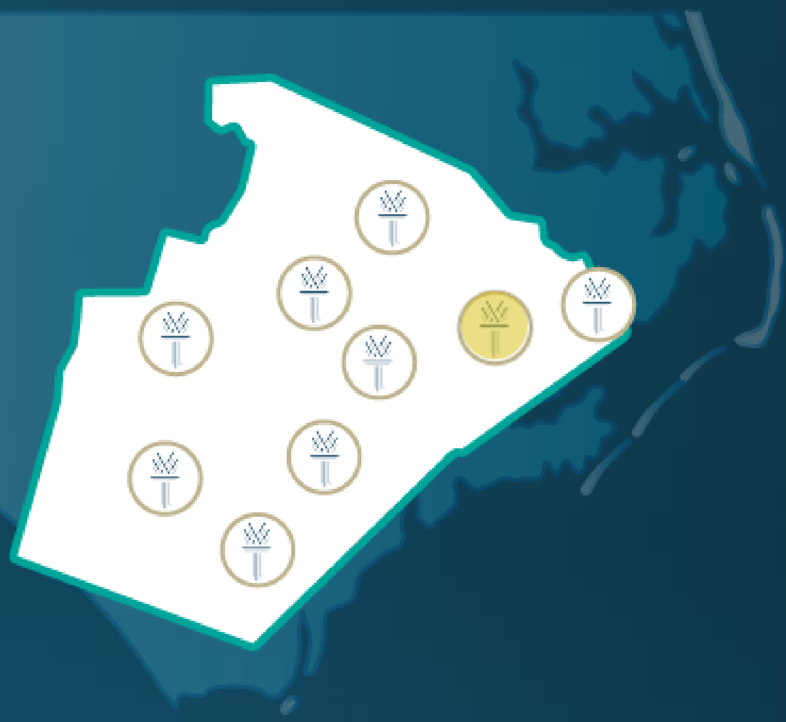
Jason Tobias
Builder

9 locations

250+
Degrees, Diplomas, and Certificates

100+
Online Programs

LARGEST
Community College in NC



Nearly 70,000 students served annually

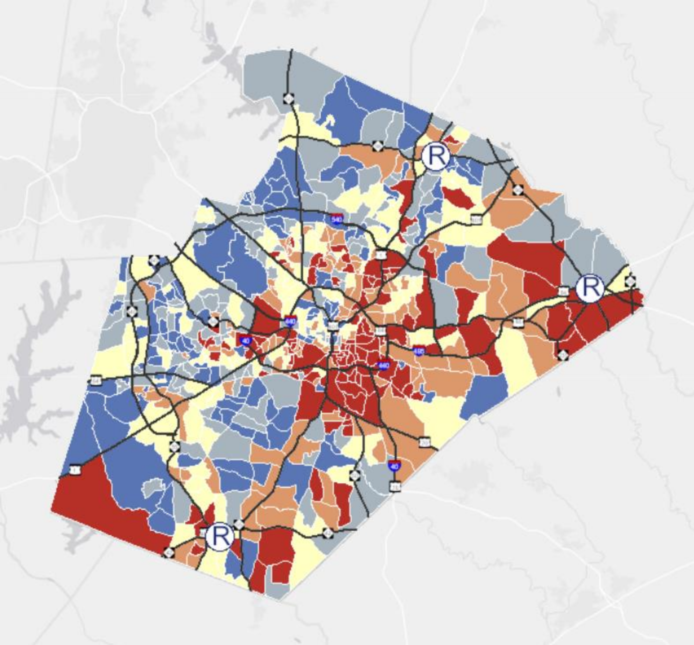
43 Buildings • 3 Parking Decks • 4 in Design/Construction ≈ 3 MSF

Wake Tech Fun Facts

Why Eastern Wake County?

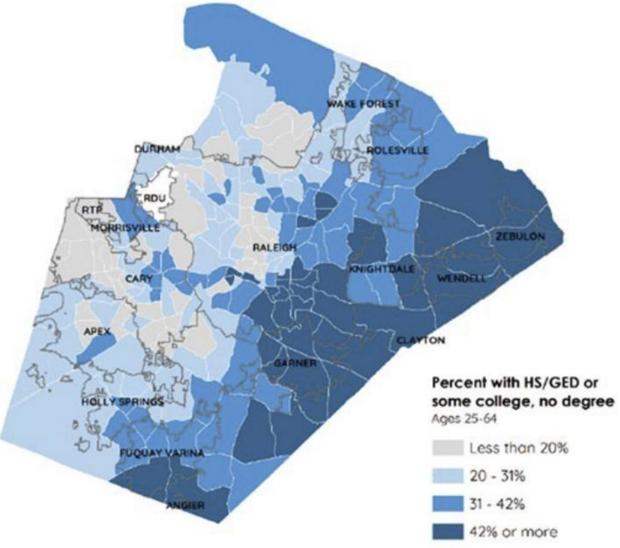
Economic Health Index
of Residents

(Red = less healthy)



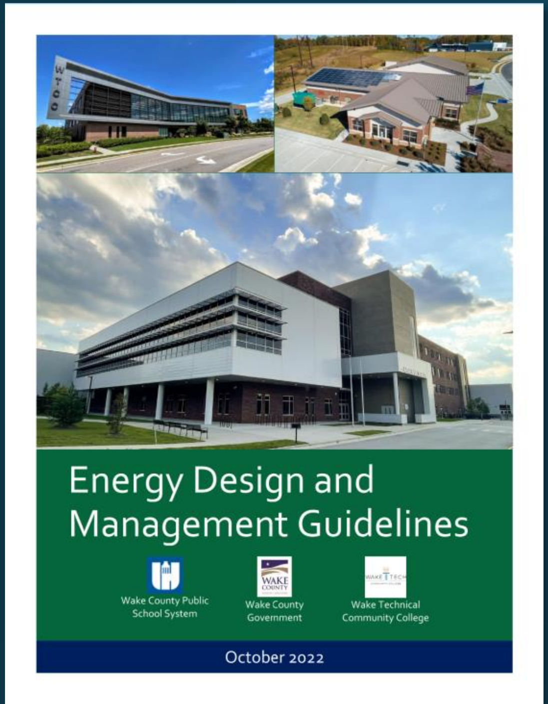
Percent of Residents Ages 25-64 with HSD/GED, but **no College Degree**

(Dark Blue ≥ 42%)



Source: Carolina Demography (2018; internal report)

Energy & Sustainability Guidelines

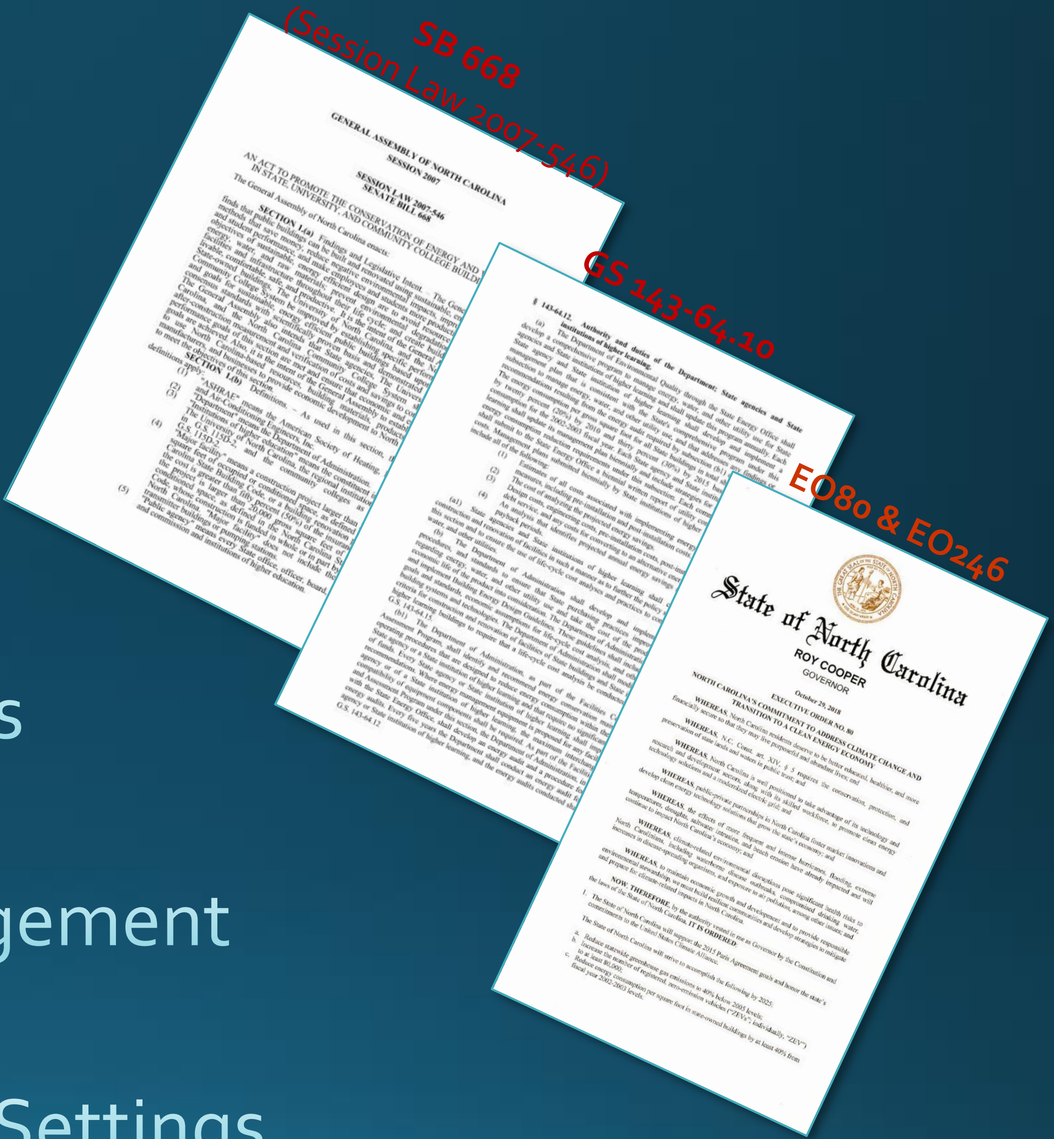


External

- State Requirements
- Wake³ Partnership

Internal

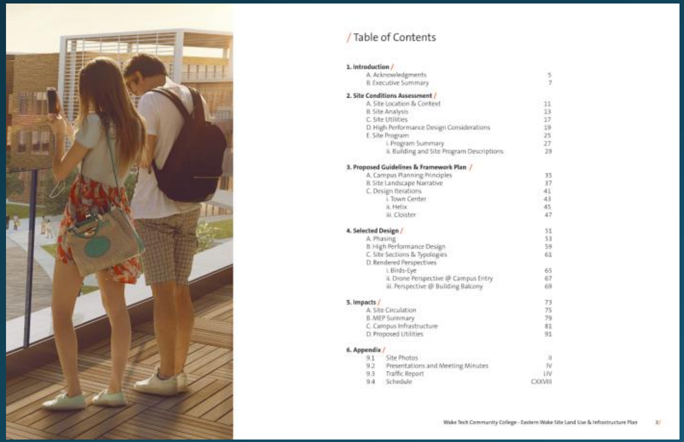
- D&C Guidelines + BAS
- Energy Star Appliances
- Green Cleaning
- Integrated Pest Management
- No Irrigation Standard
- Building Temperature Settings



Owner's Design & Construction Considerations

- **Localized Systems**
  - RTUs/Heat pumps
  - Air Cooled Chillers
  - Natural Gas Boilers
- **Regional Plants**
  - Water Cooled Chillers/Cooling Towers
  - Natural Gas Boilers (condensing)
- **Central Plant**
  - Cogeneration
  - Thermal Energy Storage
  - Geothermal System

Thermal Energy Systems



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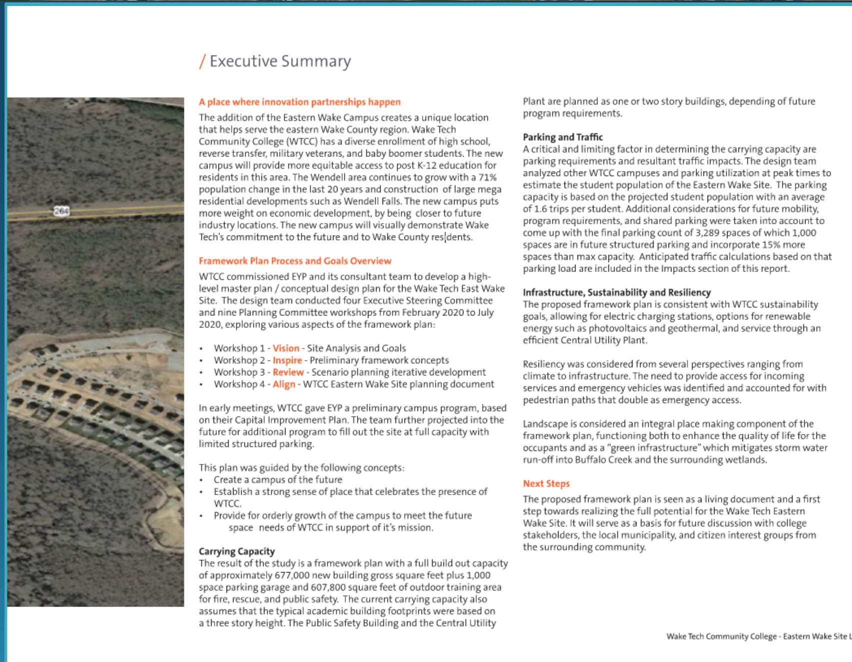
Eastern Wake 4.0

Campus Master Plan



/ Executive Summary

A place where innovation partnerships happen

The addition of the Eastern Wake Campus creates a unique location that helps serve the eastern Wake County region. Wake Tech Community College (WTCC) has a diverse enrollment of high school, reverse transfer, military veterans, and baby boomer students. The new campus will provide more equitable access to post K-12 education for residents in this area. The Wendell area continues to grow with a 71% population change in the last 20 years and construction of large mega residential developments such as Wendell Falls. The new campus puts more weight on economic development, by being closer to future industry locations. The new campus will visually demonstrate Wake Tech's commitment to the future and to Wake County residents.

Framework Plan Process and Goals Overview

WTCC commissioned EYP and its consultant team to develop a high-level master plan / conceptual design plan for the Wake Tech East Wake Site. The design team conducted four Executive Steering Committee and nine Planning Committee workshops from February 2020 to July 2020, exploring various aspects of the framework plan:

- Workshop 1 - **Vision** - Site Analysis and Goals
- Workshop 2 - **Inspire** - Preliminary framework concepts
- Workshop 3 - **Review** - Scenario planning iterative development
- Workshop 4 - **Align** - WTCC Eastern Wake Site planning document

In early meetings, WTCC gave EYP a preliminary campus program, based on their Capital Improvement Plan. The team further projected into the future for additional program to fill out the site at full capacity with limited structured parking.

This plan was guided by the following concepts:
- Create a campus of the future
- Establish a strong sense of place that celebrates the presence of WTCC.
- Provide for orderly growth of the campus to meet the future space needs of WTCC in support of it's mission.

Carrying Capacity

The result of the study is a framework plan with a full build out capacity of approximately 677,000 new building gross square feet plus 1,000 space parking garage and 607,800 square feet of outdoor training area for fire, rescue, and public safety. The current carrying capacity also assumes that the typical academic building footprints were based on a three story height. The Public Safety Building and the Central Utility Plant are planned as one or two story buildings, depending of future program requirements.

Parking and Traffic

A critical and limiting factor in determining the carrying capacity are parking requirements and resultant traffic impacts. The design team analyzed other WTCC campuses and parking utilization at peak times to estimate the student population of the Eastern Wake Site. The parking capacity is based on the projected student population with an average of 1.6 trips per student. Additional considerations for future mobility, program requirements, and shared parking were taken into account to come up with the final parking count of 3,289 spaces of which 1,000 spaces are in future structured parking and incorporate 15% more spaces than max capacity. Anticipated traffic calculations based on that parking load are included in the Impacts section of this report.

Infrastructure, Sustainability and Resiliency

The proposed framework plan is consistent with WTCC sustainability goals, allowing for electric charging stations, options for renewable energy such as photovoltaics and geothermal, and service through an efficient Central Utility Plant.

Resiliency was considered from several perspectives ranging from climate to infrastructure. The need to provide access for incoming services and emergency vehicles was identified and accounted for with pedestrian paths that double as emergency access.

Landscape is considered an integral place making component of the framework plan, functioning both to enhance the quality of life for the occupants and as a "green infrastructure" which mitigates storm water run-off into Buffalo Creek and the surrounding wetlands.

Next Steps

The proposed framework plan is seen as a living document and a first step towards realizing the full potential for the Wake Tech Eastern Wake Site. It will serve as a basis for future discussion with college stakeholders, the local municipality, and citizen interest groups from the surrounding community.

Geothermal Field Reports & Data

Eastern Wake 4.0

CEP - Central Energy Plant

GSHX – Geothermal (Ground Source Heat Exchange)

PSSC - Public Safety Simulation Complex

GEB1 - General Education Building 1

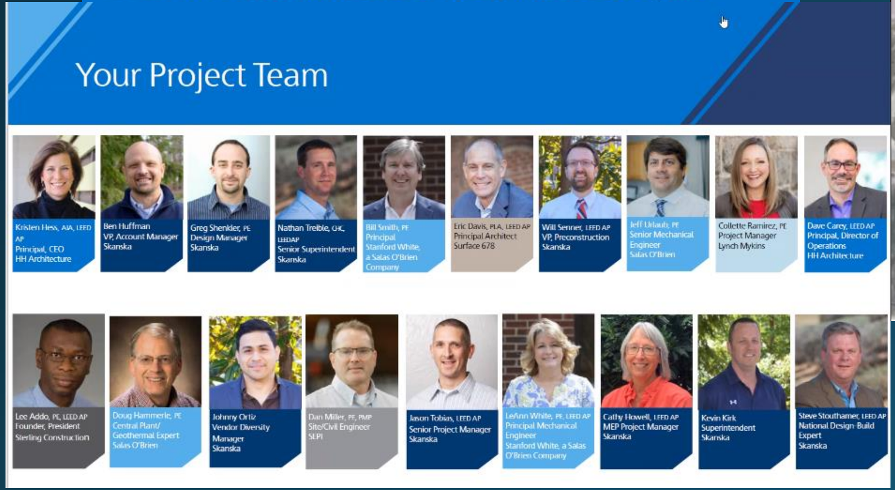
T4.0 - Technology 4.0 Building

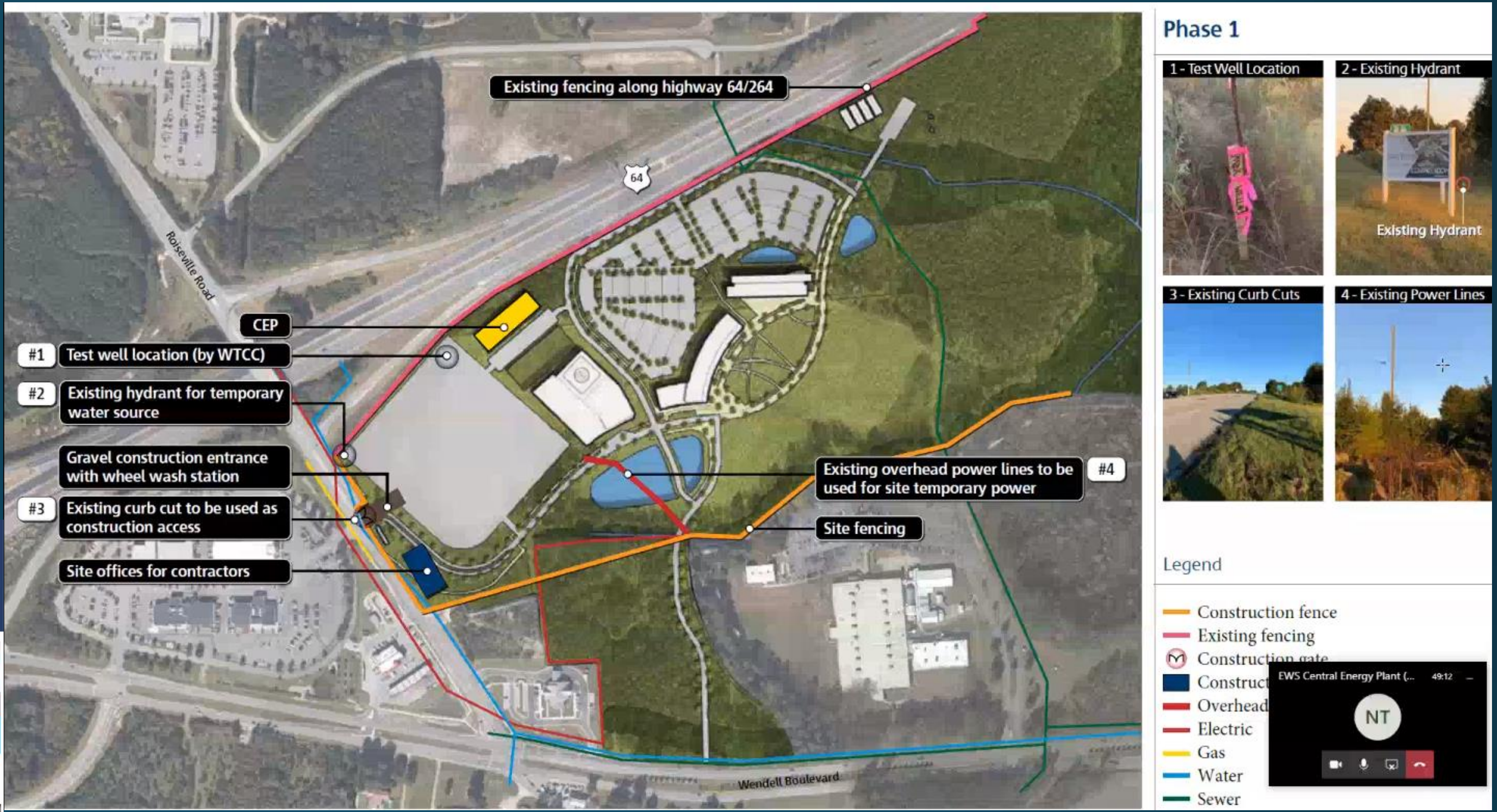
FTC - Fire & Rescue Training Center

Geothermal Experience

Stanford White | Salas O'Brien

- Miami University
- Epic Corporation
- Ford Motor Company
- Ball State University
- Carleton College
- Cornell College
- Minot State University
- Chippewa Valley Technical College
- Iowa National Guard Readiness Complex





"Geothermal project will have impacts with infrastructure & roadways."

Project Delivery Methods

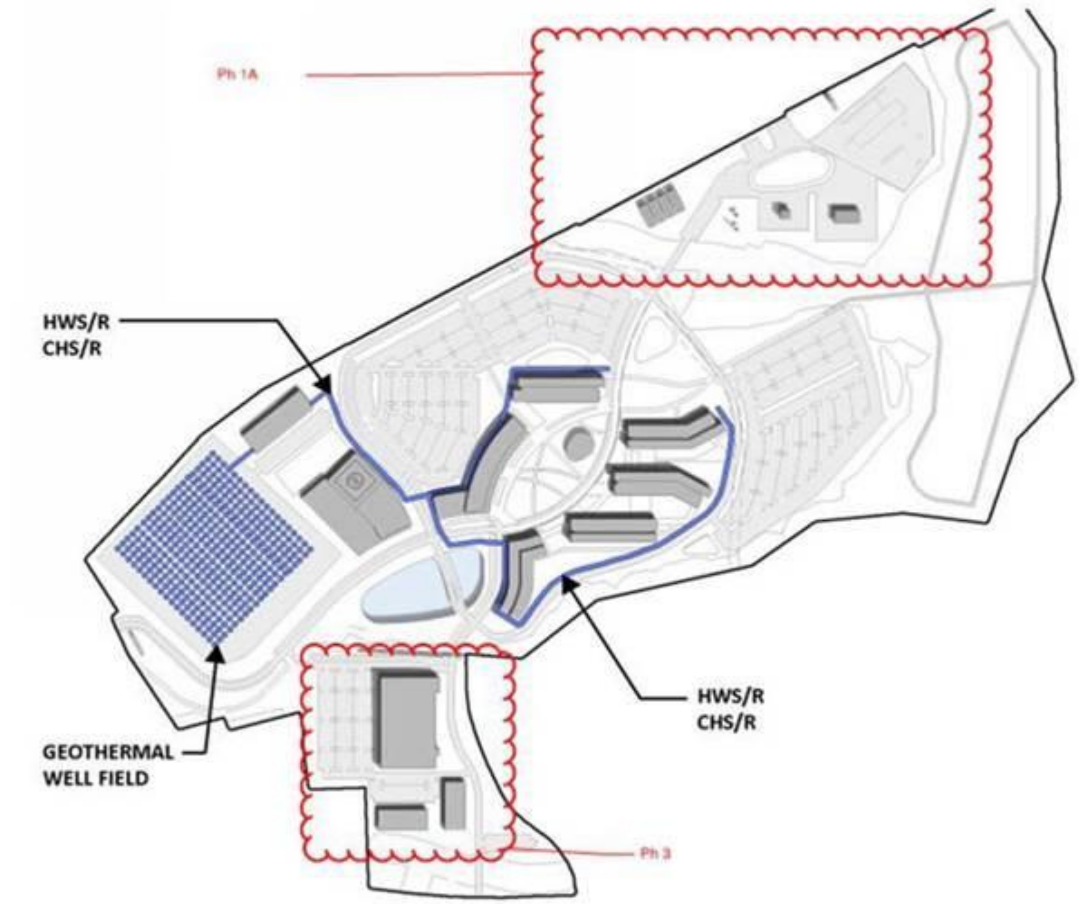
Eastern Wake 4.0 Site - Central Energy Plant

Net Zero Approach

Buildings Served by Central Energy Plant

The clouded areas are assumed to not be connected to the central energy plant. Connected buildings and assumed SF shown with phasing:

Phase	Building	SF
1	CEP	20,000
	Public safety	70,000
	Technology 4.0	80,000
	General education w/ student services	110,000
2	General classroom	80,000
	General classroom	80,000
3	Academic building 4	80,000
	Academic building 5	80,000
	Total	600,000



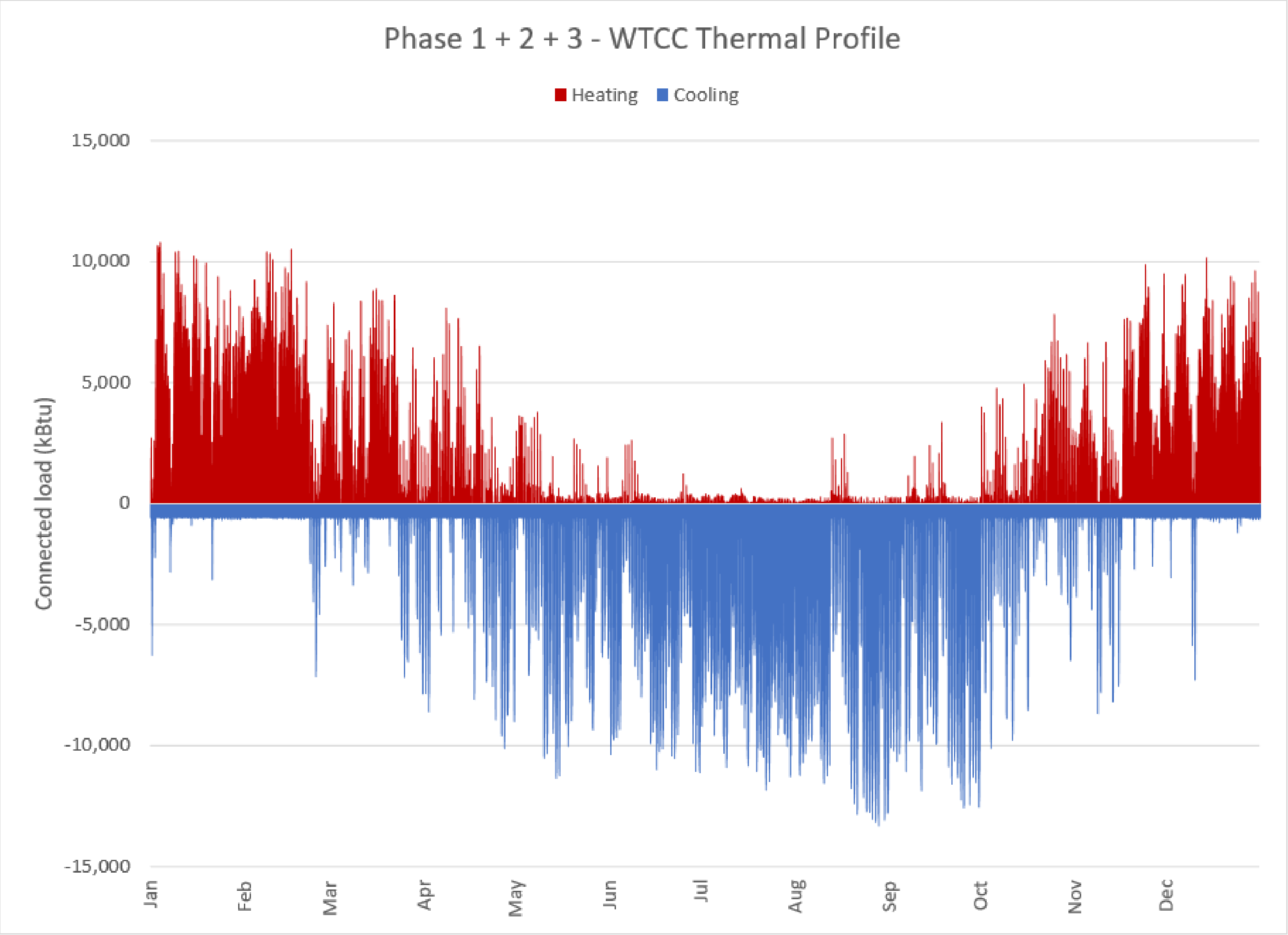
Section SC.1: Geothermal Utility Diagram

Thermal Profile

- Total build out thermal profile

	Annual load (kBtu)	Peak load (kBtu)	Peak load (tons)
Heating	11,088,387	10,825	902
Cooling	22,306,951	13,341	1,112

- Energy recovery in cooling mode
- No energy recovery in heating mode
  - Hours where you can use the enthalpy wheel in the winter are very few
    - In the winter, the supply air temperature > 55°F while using the enthalpy wheel, requiring the cooling coil to turn on to meet 55°F supply air into VAV boxes



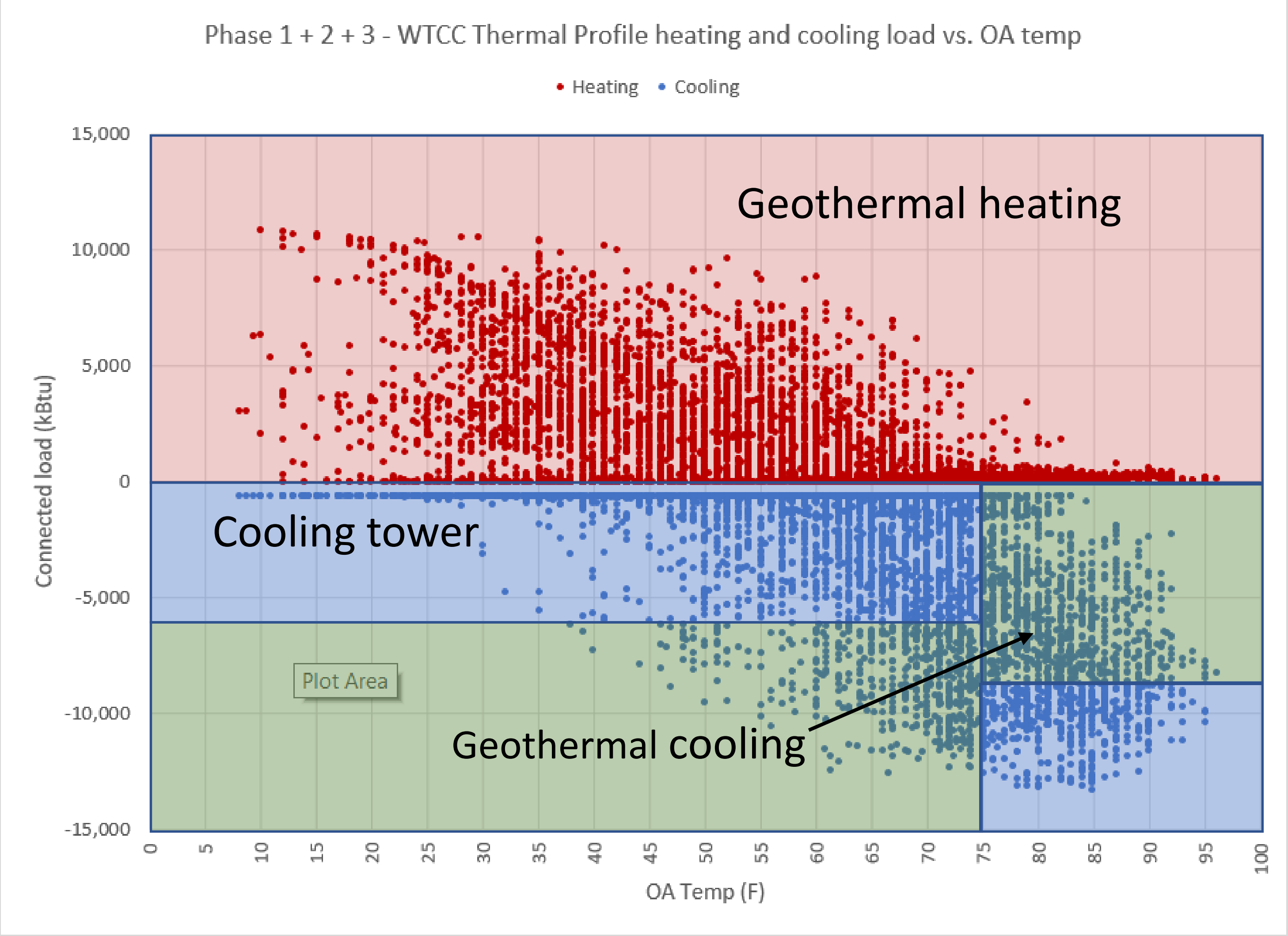
Plant Design Options

	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A	Option # 5
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*	*CHW thermal storage (with option #4A parameters)*
Description:	Traditional gas fired boiler, conventional chiller with cooling tower	Full geothermal (sized for 100% of the heating and cooling loads)	Geothermal with ASHP (sized for 100% of the heating, use ASHP for favorable conditions and maintain a balanced borefield) 130ºF HHW supply temperature	Geothermal with ASHP (sized for 100% of the heating, use ASHP for favorable conditions and maintain a balanced borefield) 105ºF HHW supply temperature	Geothermal with cooling tower (sized for 100% of the heating, balanced borefield) 130ºF HHW supply temperature	Geothermal with cooling tower (sized for 100% of the heating, balanced borefield) 105ºF HHW supply temperature	Chilled water thermal energy storage (with option #4A parameters)

Cooling Tower & Geothermal

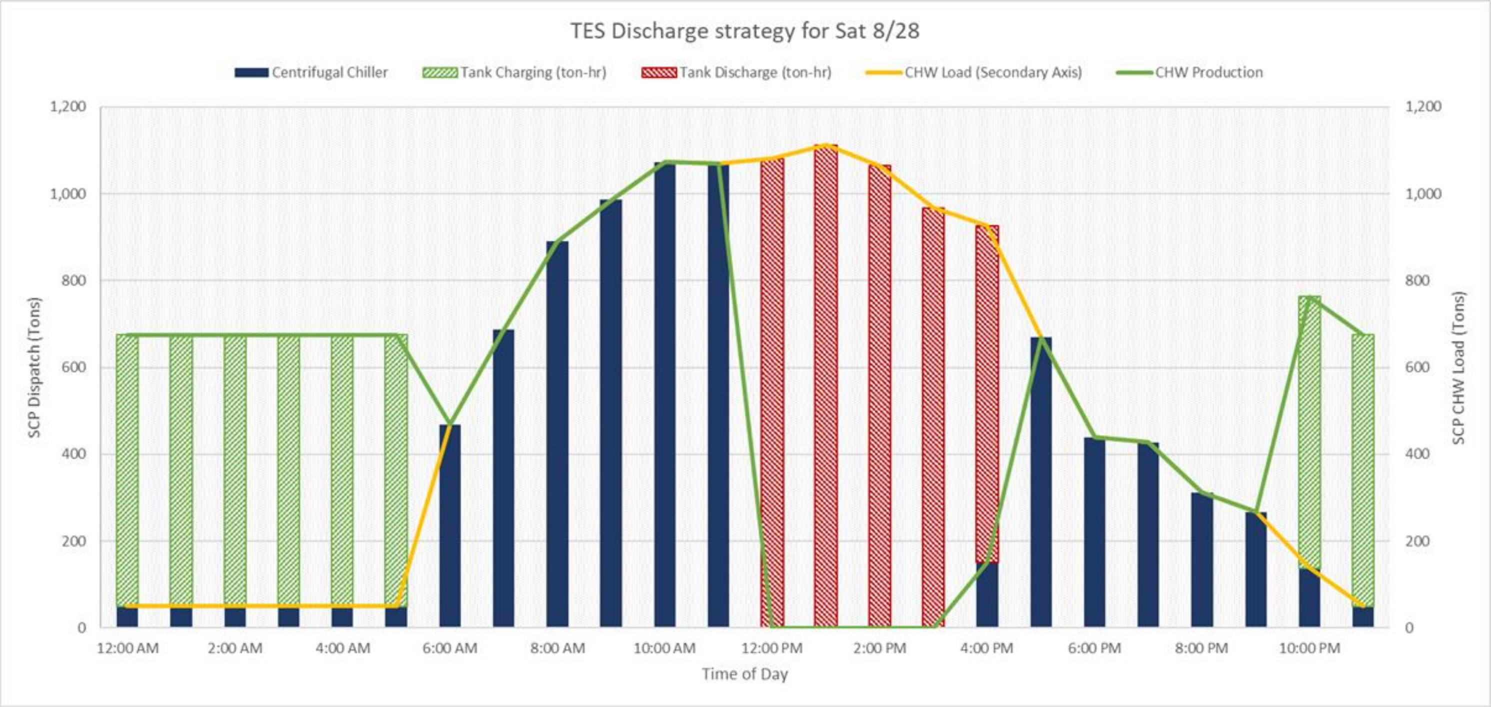
- Combination of cooling tower and geothermal cooling and heating
- Utilized cooling tower in cooler ambient conditions for all cooling load that is less than 75°F OA temperature up to 500 tons capacity
- Utilize cooling tower in high OA ambient temperatures over 650 tons to minimize GLHE size
  - Unbalanced heating peak ~650 tons (what GLHE is sized for)
- Balanced GLHE
  - Minimizes GLHE size
  - No temperature creep of GLHE
  - Maximizes GLHE performance

	Annual load	Heat rejected/extracted from borefield
Geothermal cooling	4,937,580	6,418,854
Geothermal heating	8,313,573	6,395,056



Technology Considerations

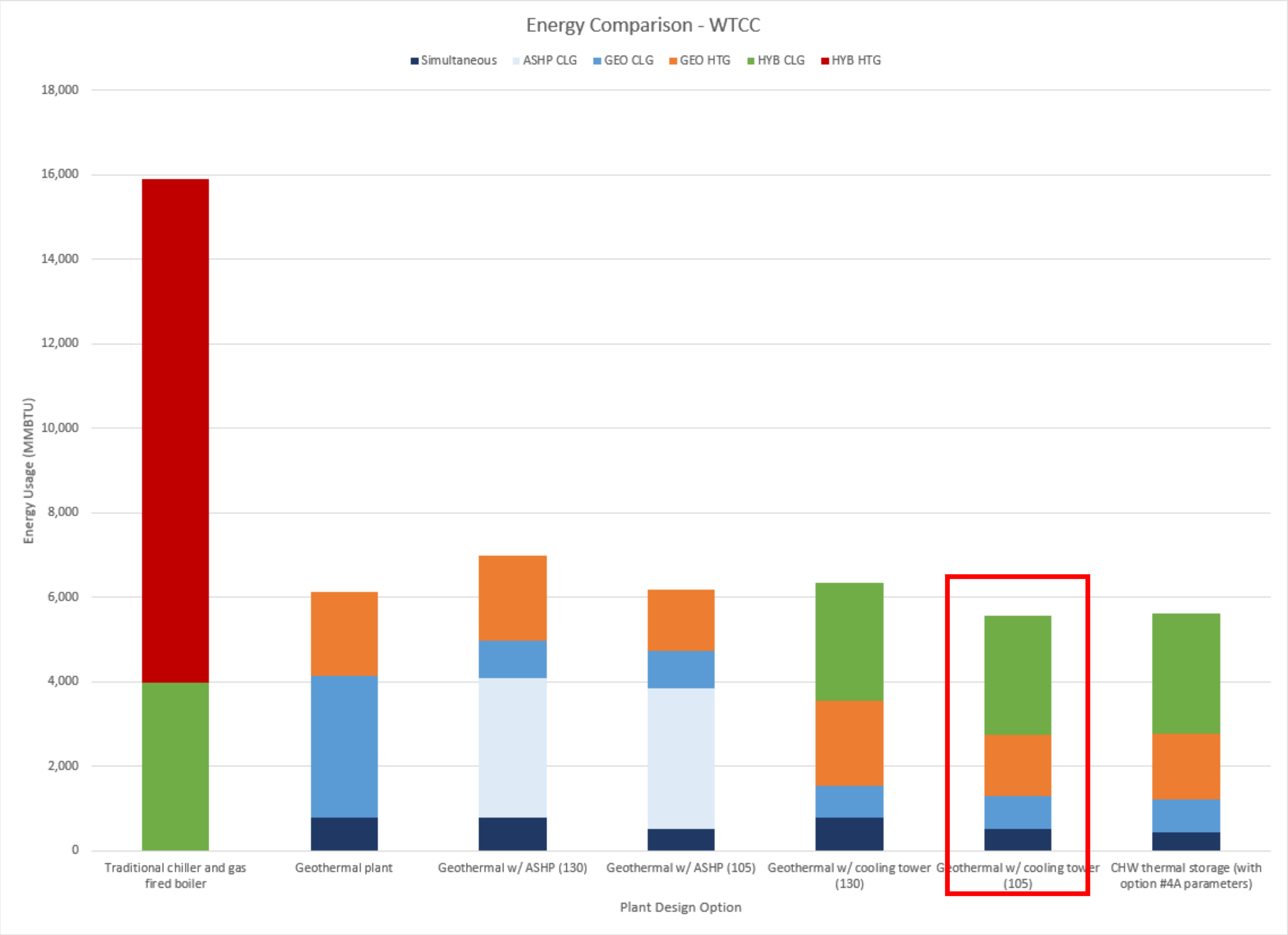
Thermal Energy Storage



Equipment Capacity

	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A	Option # 5
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*	*CHW thermal storage (with option #4A parameters)*
Natural gas fired boilers	(4) 4,000 MBH	(2) 3,000 MBH	(2) 3,000 MBH	(2) 3,000 MBH	(2) 3,000 MBH	(2) 3,000 MBH	(2) 3,000 MBH
Chillers / heat pumps	(4) 500-ton	(4) 500-ton	(3) 500-ton	(3) 500-ton	(4) 500-ton	(4) 500-ton	(4) 500-ton
Closed circuit evaporative cooling tower	(4) 500-ton	-	-	-	(1) 500-ton	(1) 500-ton	(1) 500-ton
Simultaneous heat pump	-	(1) 80-ton	(1) 80-ton	(1) 80-ton	(1) 80-ton	(1) 80-ton	(1) 80-ton
Modular ASHP	-	-	(9) 60-ton	(9) 60-ton	-	-	-
Geothermal borefield (at depth of 400')	-	810	390	390	390	390	390
TES tank	-	-	-	-	-	-	5,000 ton-hr

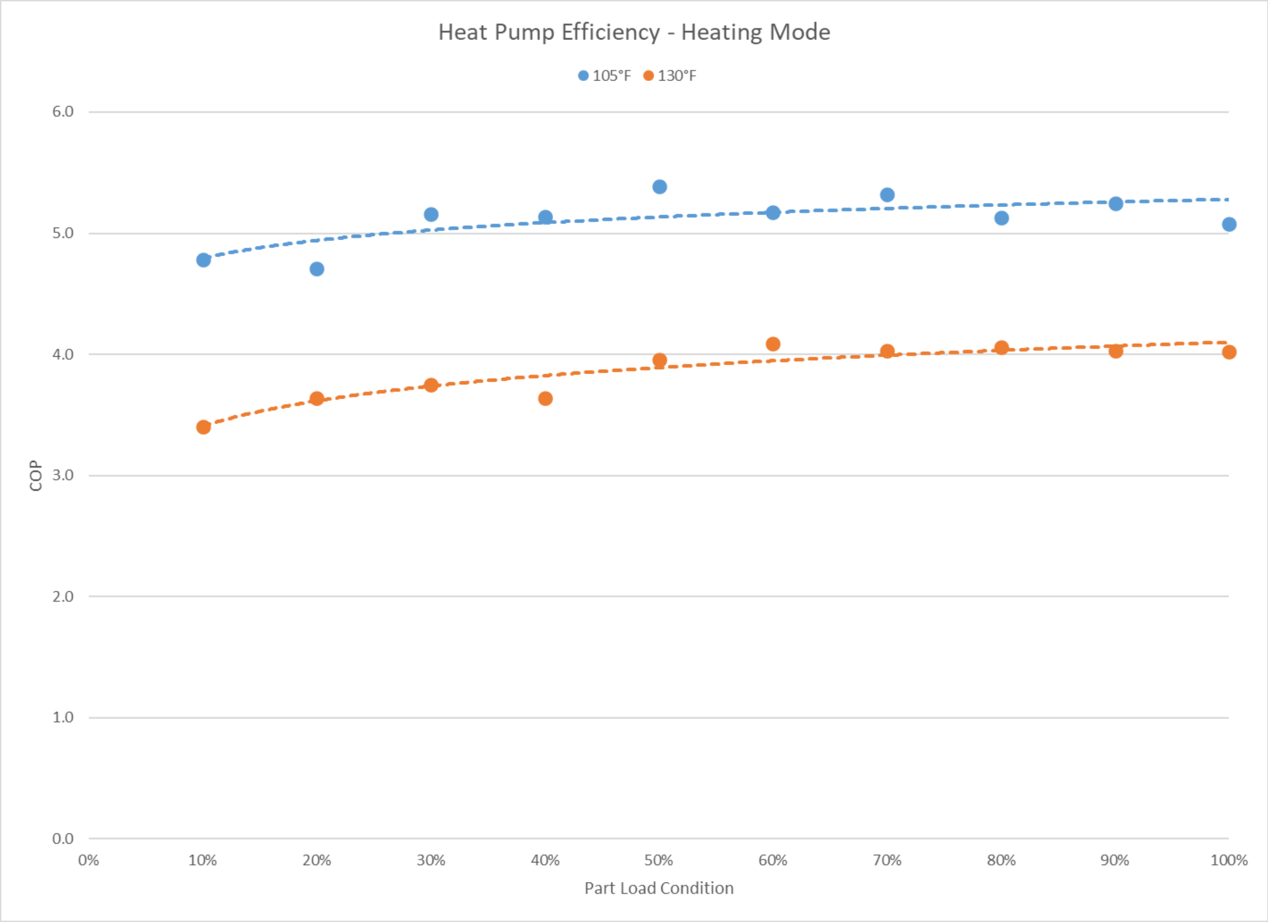
Plant Energy Consumption

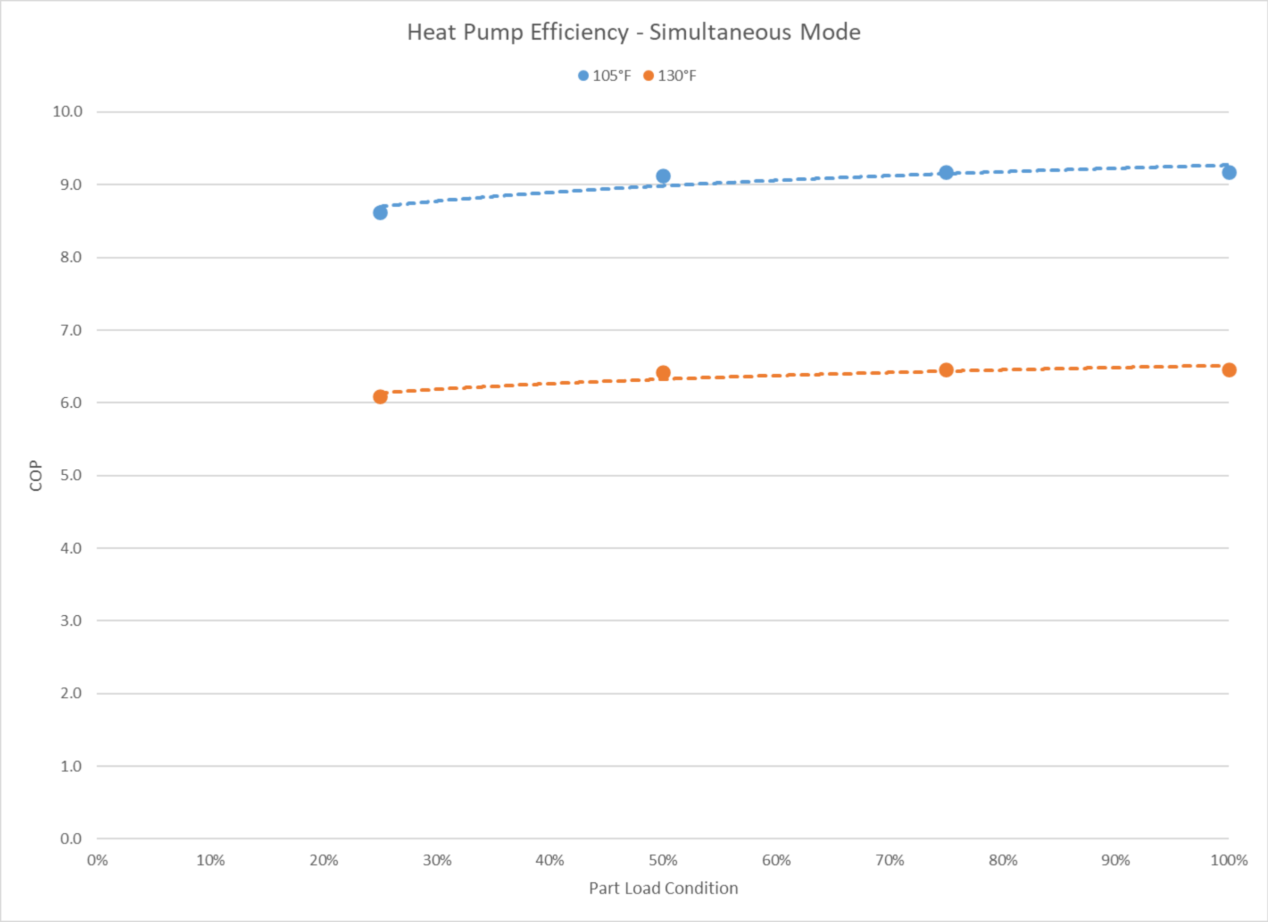


Plant Energy Consumption (MMBTU)

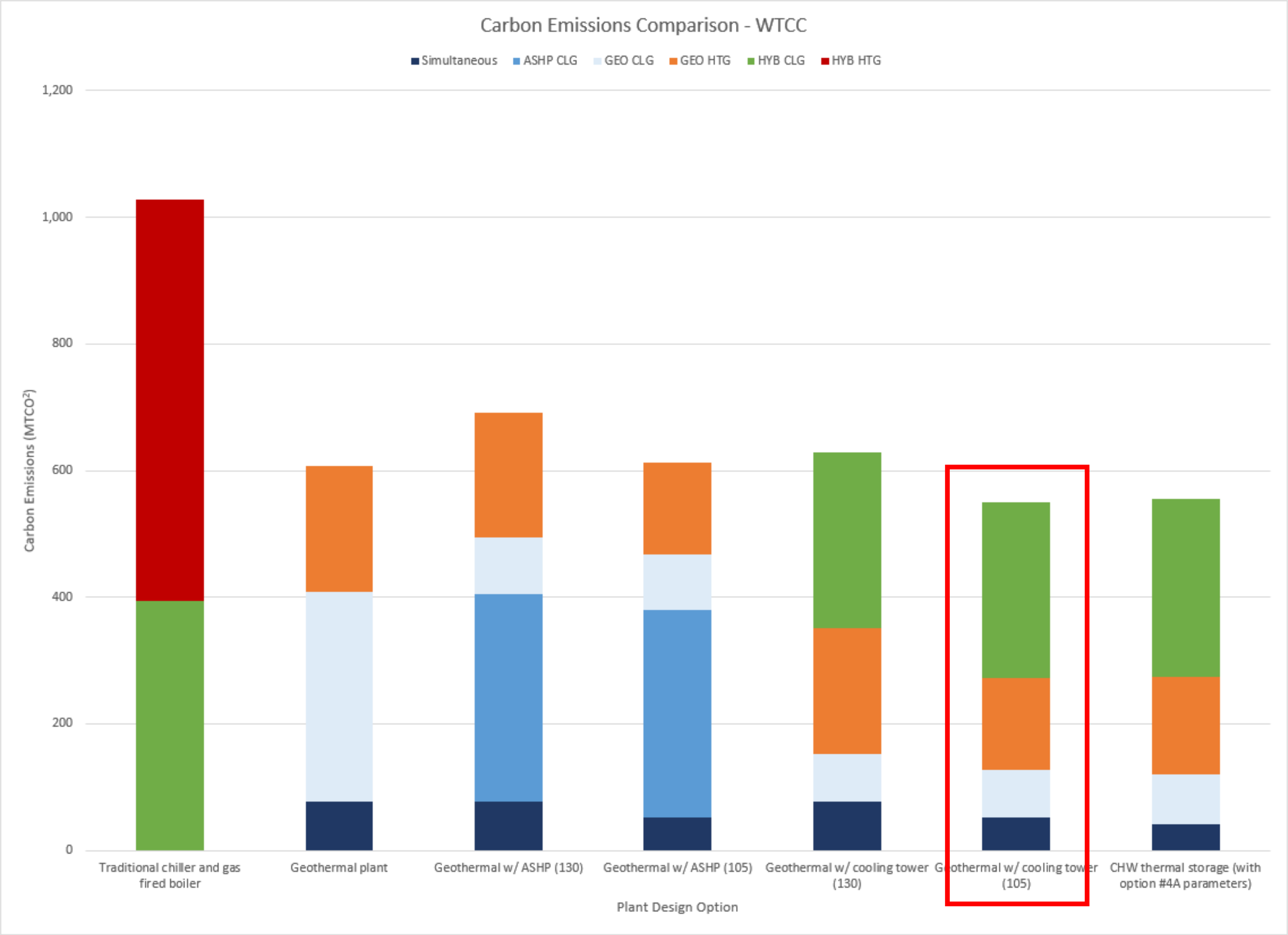
	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A	Option # 5
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*	*CHW thermal storage (with option #4A parameters)*
Simultaneous	0	783	783	522	783	522	426
ASHP CLG	0	0	3,313	3,313	0	0	0
ASHP HTG	0	0	0	0	0	0	0
GEO CLG	0	3,351	890	890	765	765	792
GEO HTG	0	1,995	1,995	1,465	1,995	1,465	1,554
HYB CLG	3,977	0	0	0	2,803	2,803	2,836
HYB HTG	11,923	0	0	0	0	0	0
Total	**15,900**	**6,130**	**6,981**	**6,190**	**6,346**	**5,555**	**5,609**
Savings over baseline		9,770	8,918	9,709	9,553	10,344	10,291
% savings		61%	56%	61%	60%	65%	65%

Heat Pump Chiller Performance

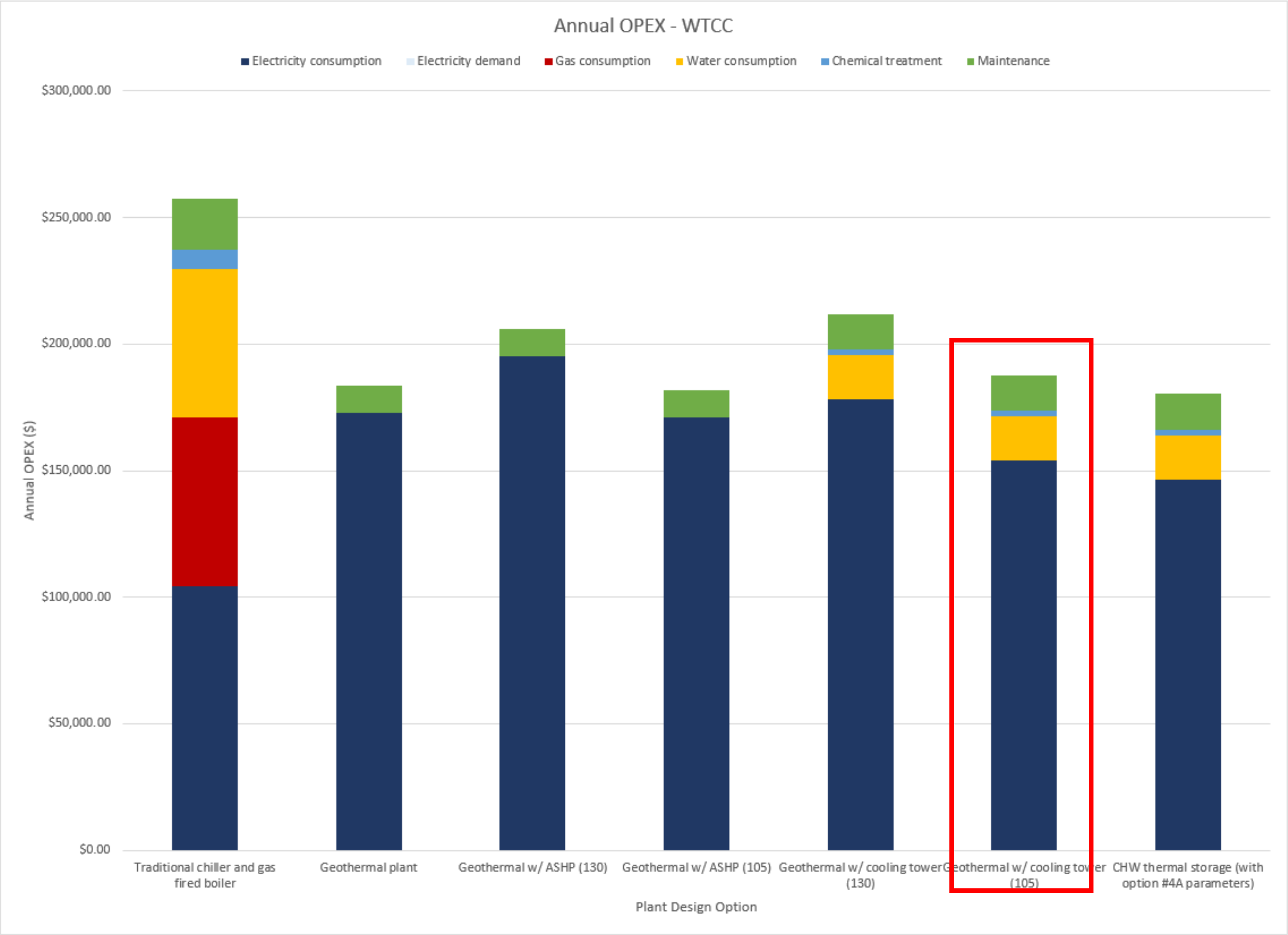




Plant $C0_2$ Emissions



Plant OPEX (SGS Rate)



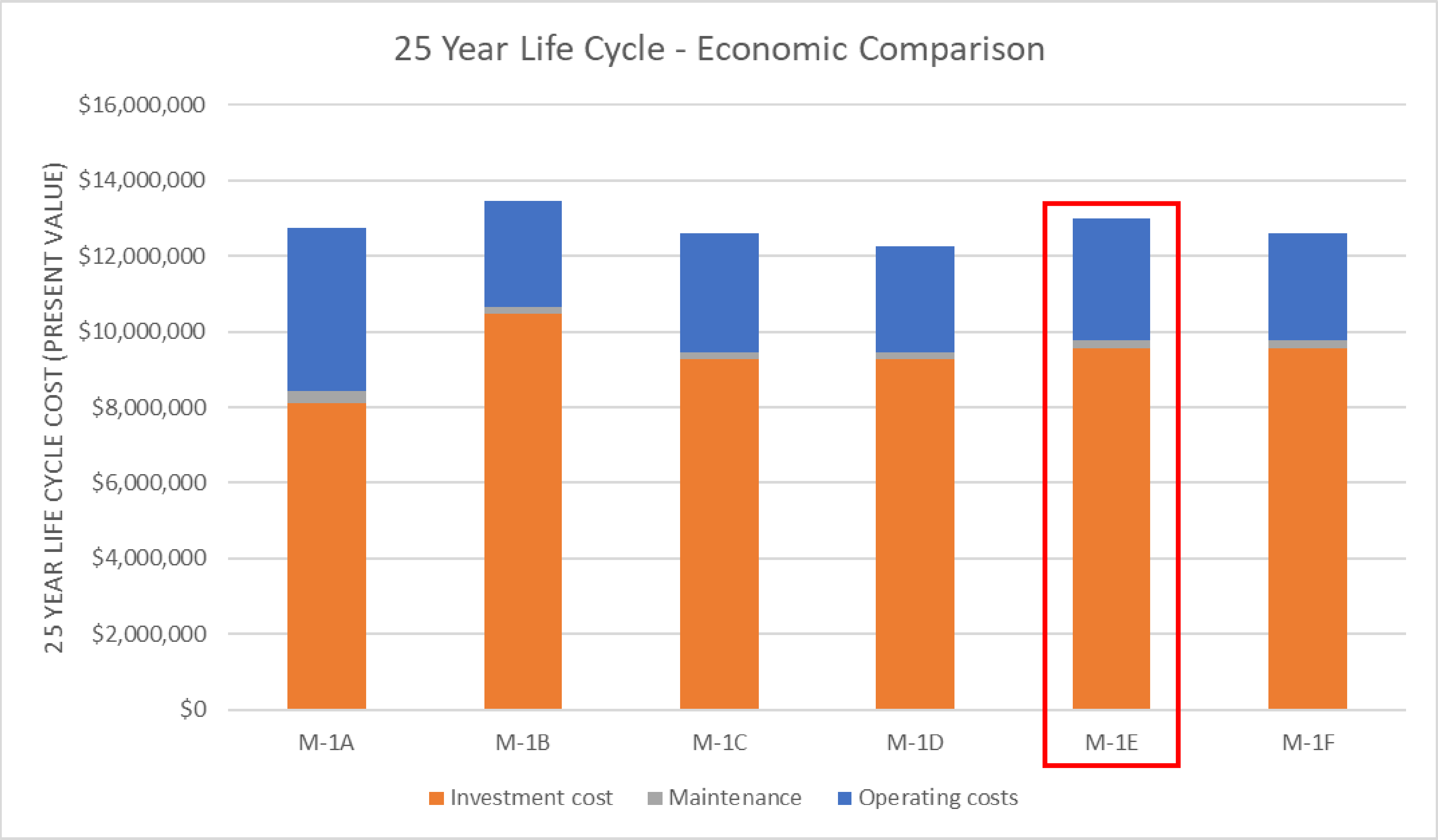
Plant OPEX (SGS Rate)

	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A	Option # 5
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*	*CHW thermal storage (with option #4A parameters)*
Electricity consumption	$104,195.47	$172,986.33	$195,392.76	$171,015.93	$178,440.66	$154,063.82	$146,500.64
Electricity demand	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gas consumption	$66,768.78	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Water consumption	$58,582.75	$0.00	$0.00	$0.00	$17,337.69	$17,337.69	$17,518.02
Chemical treatment	$7,773.82	$0.00	$0.00	$0.00	$2,300.68	$2,300.68	$2,324.61
Maintenance	$20,163.35	$10,686.51	$10,686.51	$10,686.51	$13,936.51	$13,936.51	$13,936.51
Total	**$257,484.16**	**$183,672.84**	**$206,079.27**	**$181,702.44**	**$212,015.53**	**$187,638.70**	**$180,279.77**
Savings over baseline	$0.00	$73,811.33	$51,404.89	$75,781.73	$45,468.63	$69,845.47	$77,204.39
Savings over baseline including social cost of carbon	$0.00	$115,887.98	$85,048.40	$117,258.62	$85,400.57	$117,610.79	$124,441.84

Capital Expenditures

	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A	Option # 5
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*	*CHW thermal storage (with option #4A parameters)*
Natural gas fired boilers	$1,725,061	$780,455	$780,455	$780,455	$780,455	$780,455	$780,455
Chillers / heat pumps	$2,891,138	$6,875,559	$4,874,026	$4,874,026	$6,875,559	$6,875,559	$6,875,559
Closed circuit evaporative cooling tower	$3,025,107	$0	$0	$0	$748,684	$748,684	$748,684
Modular ASHP	$0	$0	$2,349,870	$2,349,870	$0	$0	$0
Glycol & HX	$0	$0	$197,378	$197,378	$0	$0	$0
Geothermal borefield (at depth of 400’)	$0	$5,433,333	$2,600,000	$2,600,000	$2,600,000	$2,600,000	$2,600,000
TES tank	$0	$0	$0	$0	$0	$0	$963,515
Total	**$7,641,306**	**$13,089,347**	**$10,801,729**	**$10,801,729**	**$11,004,698**	**$11,004,698**	**$11,968,213**
Incremental over baseline	$0	$5,448,041	$3,160,423	$3,160,423	$3,363,392	$3,363,392	$4,326,907

Life Cycle Cost Assessment



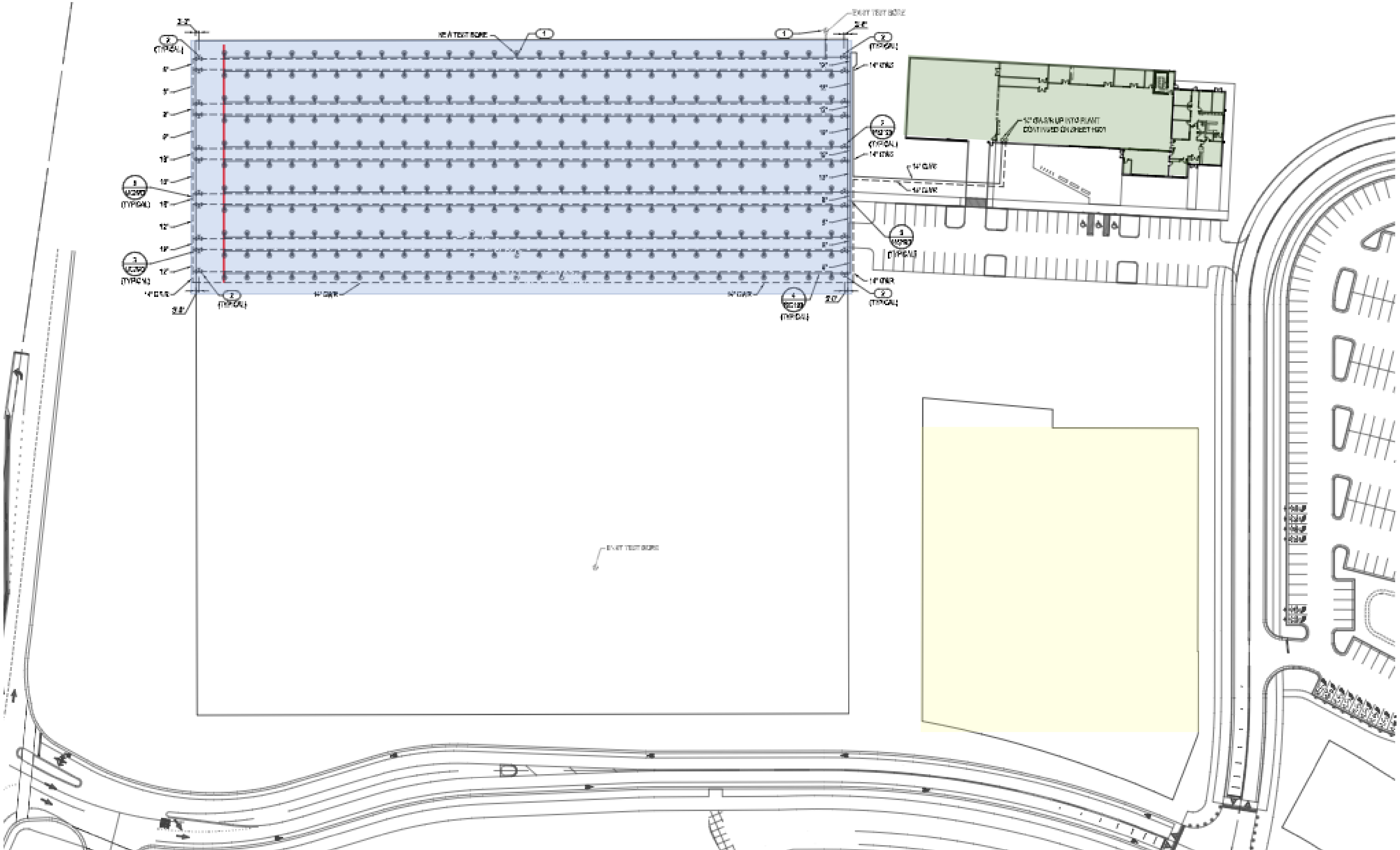
Life Cycle Cost Assessment

	Option # 1	Option # 2	Option # 3	Option # 3A	Option # 4	Option # 4A
	M – 1A	*M – 1B*	*M – 1C*	*M – 1D*	*M – 1E*	*M – 1F*
	Traditional chiller and gas fired boiler	*Geothermal plant*	*Geothermal w/ ASHP (130)*	*Geothermal w/ ASHP (105)*	*Geothermal w/ cooling tower (130)*	*Geothermal w/ cooling tower (105)*
Electric utility cost	$1,899,713	$2,787,878	$3,142,349	$2,777,254	$2,874,207	$2,498,636
Gas utility cost	$1,289,871	$0	$0	$0	$0	$0
Water & chemical treatment	$1,125,106	$0	$0	$0	$332,986	$332,986
Total operating costs	$4,314,690	$2,787,878	$3,142,349	$2,777,254	$3,207,193	$2,831,622
Maintenance	$341,888	$181,202	$181,202	$181,202	$236,307	$236,307
Investment cost	$7,159,637	$12,233,029	$10,120,843	$10,120,843	$10,311,018	$10,311,018
Replacement costs	$2,530,879	$0	$0	$0	$377,086	$377,086
Residual value	-$1,593,725	-$1,745,439	-$840,396	-$840,396	-$1,142,299	-$1,142,299
Net Investment cost*	$8,096,791	$10,487,591	$9,280,446	$9,280,446	$9,545,805	$9,545,805
Total 25-year cost	**$12,753,369**	**$13,456,671**	**$12,603,998**	**$12,238,902**	**$12,989,305**	**$12,613,734**
25-year savings	$0	-$703,302	$149,371	$514,466	-$235,936	$139,634

Design Conclusions / Recommendations

- **105°F HHW supply temperature**
  - Benefit in heating efficiency will lead to savings annually for the CEP
  - More competitive bid offers on equipment manufacturers
  - Allows for flexibility at building level to select standard or new coil technologies
  - No difference in leaving air temperature on air handlers or VAV boxes (95F)
- **Cooling tower**
  - Smaller footprint than ASHP
  - Greater flexibility in maintaining healthy geothermal borefield temperature
    - Can pre-cool geothermal borefield and lead to lower operating temps in the summer → (additional savings)
- **No CHW TES tank**
  - Not viable financially, 25-years worth of operating costs savings won't pay for the tank
- **Geothermal w/ cooling tower (105°F HHWS) is preferred solution**
  - Lower 25-year cost to baseline
  - Lowest EUI & greatest carbon emissions savings compared to all plant options
  - Environmental stewardship
    - 11,950 $MTCO_2$ savings over 25-year period compared to traditional plant options

Geothermal Well Field



Plant Dispatch Strategy

Heat Pump Technology

ClimaCool Modular Scroll

Waterfurnace Screw

Water furnace Modular Scroll

Trane RTWD Screw

Multistack Modular Scroll

Heat Pump Technology

York YK

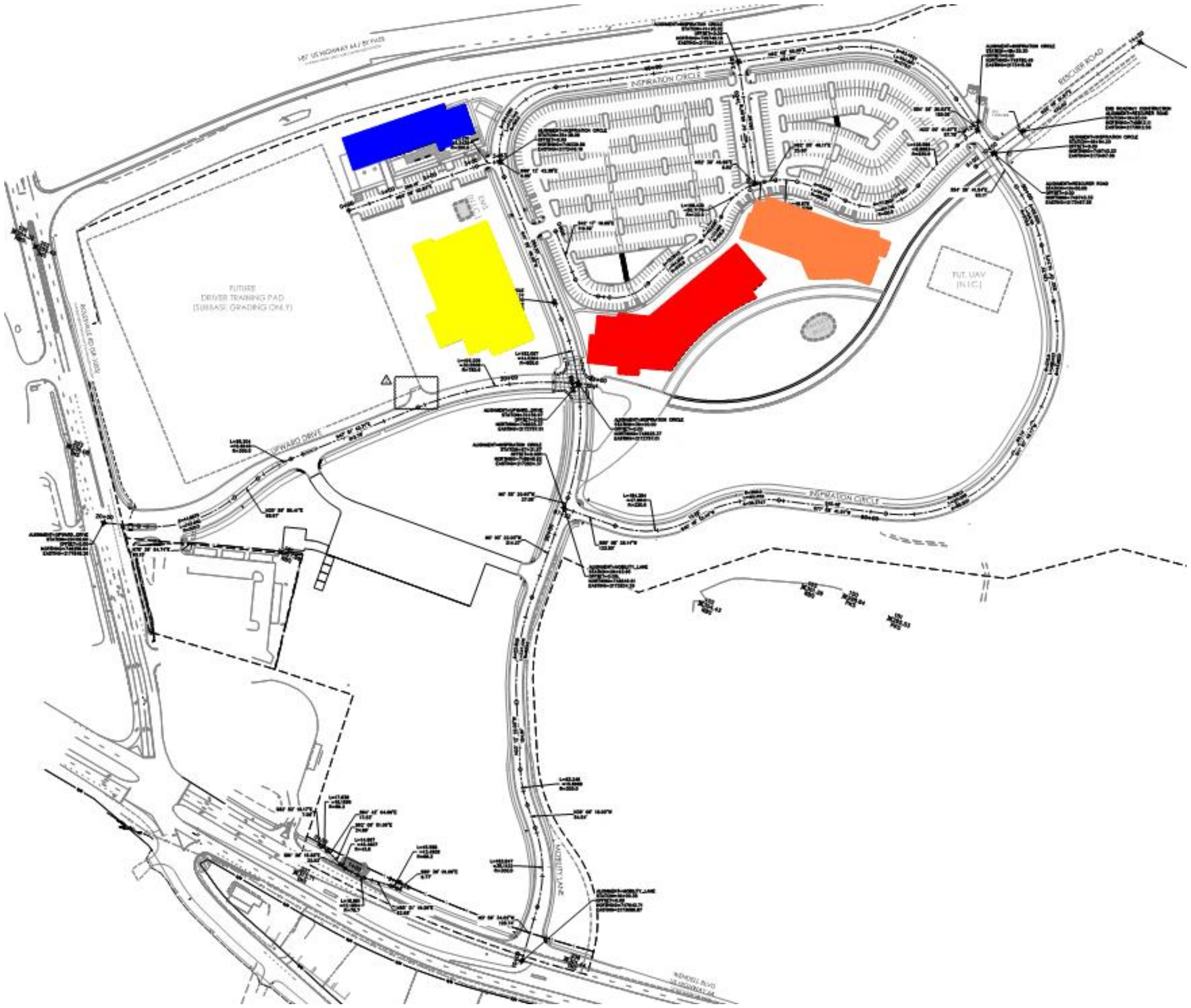
York CYK

Carrier 19DV

Multistack Centrifugal

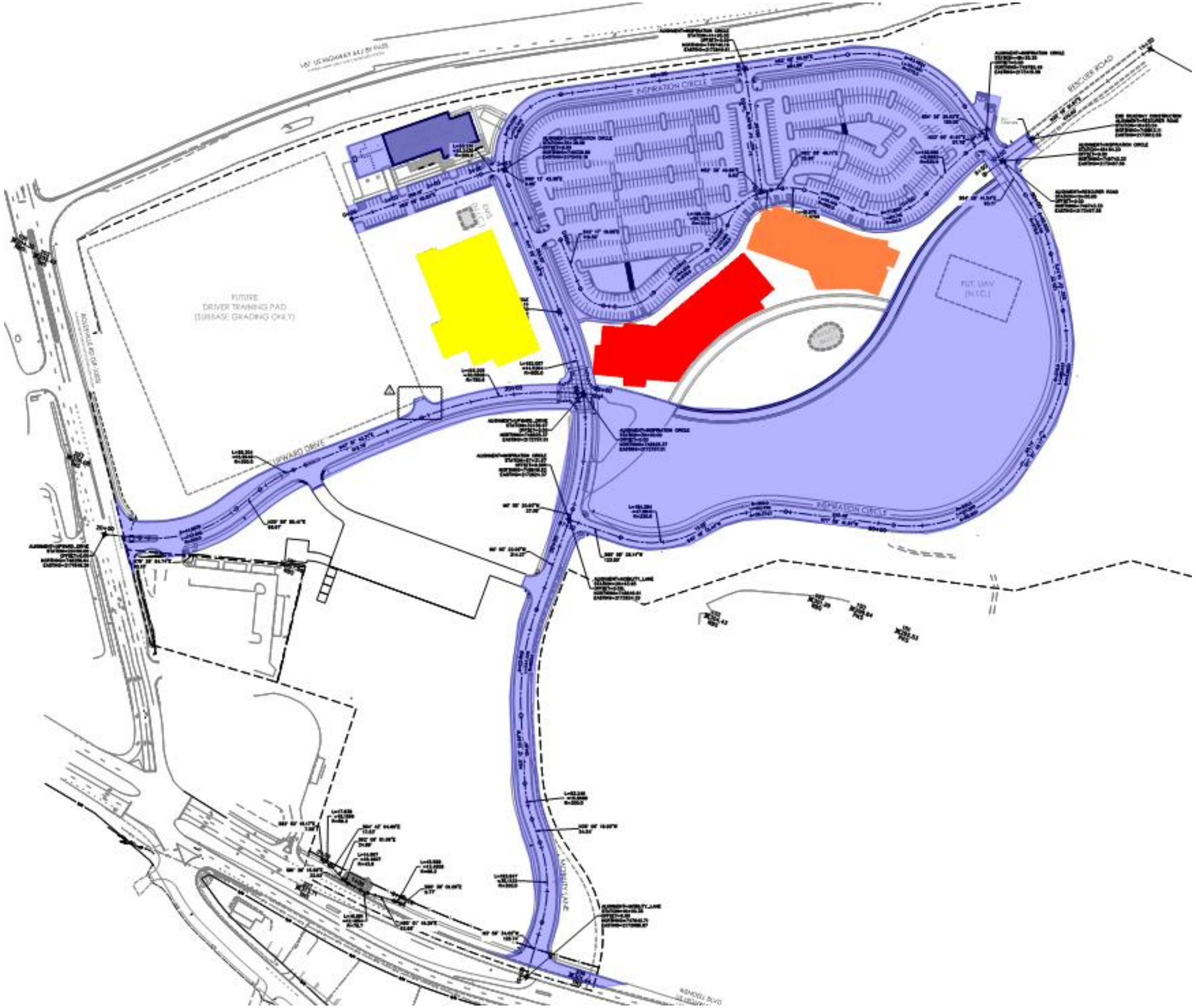
Trane Centravac Centrifugal

Construction on a New Campus with Multiple General Contractors



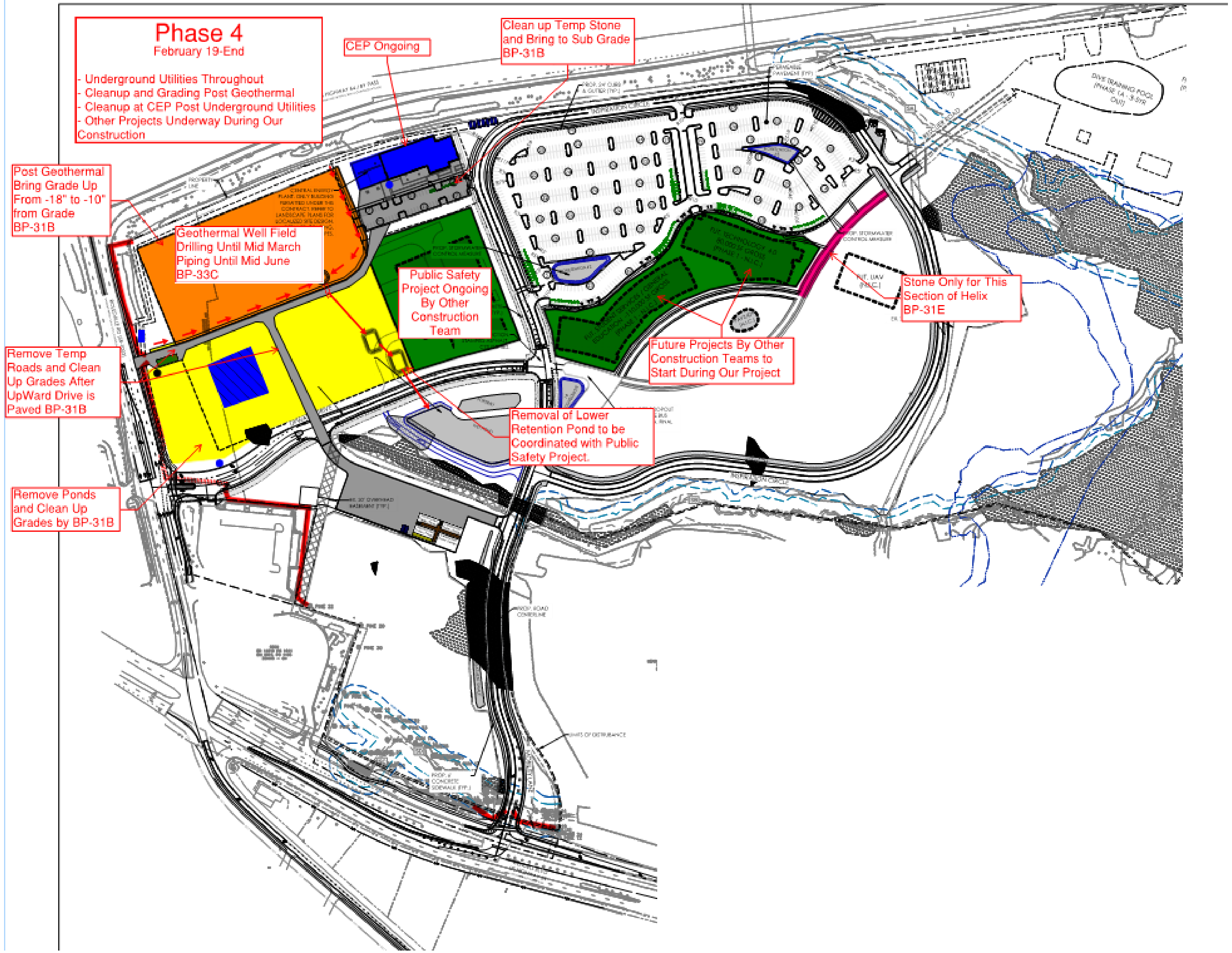
- 4 Separate General Contractors
- Logistical Considerations for Each Project
- Staggered Design and Construction Start Dates
- Interim Milestones to Support Each Project Required Throughout
- Key to Success…Continuous Communication and Collaboration with all Stakeholders!!!

Scope of Work Area by General Contractor



- Skanska
- Balfour Beatty
- Monteith
- Metcon

Logistics Plan…One of Many



SKANSKA

SKANSKA

Geothermal Installation

Key Components:
Test Wells During Design

Subcontractor Bidding and Capacity

Installation Considerations
- Ground Water
- Soil Composition
- Logistics and Temporary Sediment Basins
- Significant QA/QC Items

Geothermal Well Field

Geothermal Well Drilling Operation

SKANSKA

Geothermal Temporary Sediment Pond

Alternate Method for Capturing Water – Frac Tanks

SKANSKA

Geothermal Well Field – 3 Drill Rigs

SKANSKA

Geothermal Vertical Tubing

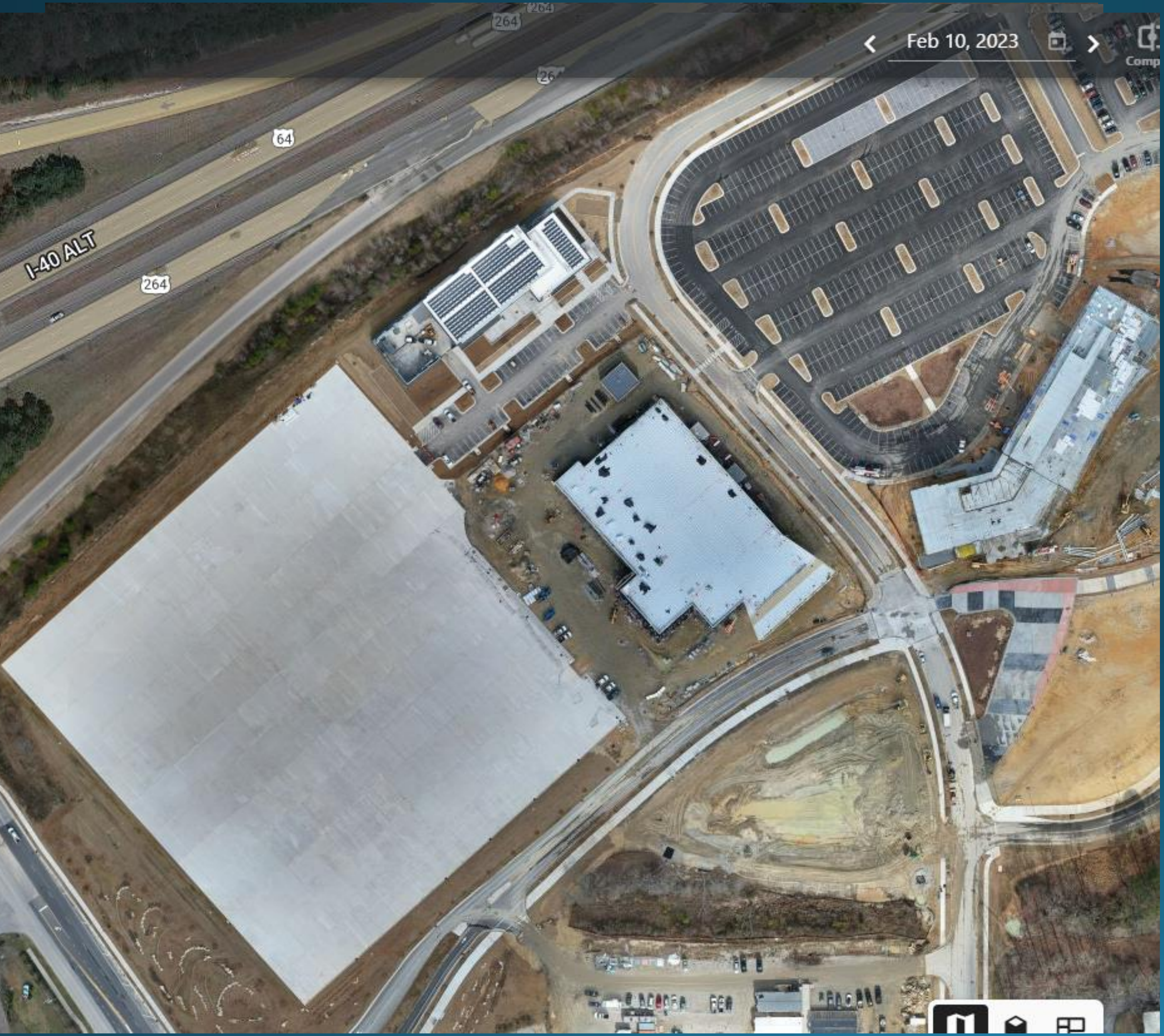
Geothermal Vertical Tubing Installation and Pressure Testing

Geothermal Grout Batching and Installation

SKANSKA

Geothermal Horizontal Piping and Connection to Vertical Tubing

SKANSKA



Geothermal Wellfield

Time-lapse progress

Long Lead Items and Procurement Methods

Central Energy Plant

Central Energy Plant

Campus Energy Loop


WAKE TECH
COMMUNITY COLLEGE
THREE GREEN GLOBES CERTIFIED
46% ANNUAL ENERGY SAVINGS
75% WASTE DIVERSION
CENTRAL ENERGY PLANT
SUSTAINABLE MATERIALS
30% OF BUILDING MATERIALS INLCUDE RECYCLED CONTENT
GEOTHERMAL ENERGY
100% OF BUILDING ENERGY NEEDS SERVED BY GEOTHERMAL
SOLAR OUTPUT
ARRAY PRODUCES 17.5W PER SQUARE FOOT
HIGH SOLAR REFLECTANCE
SITE AND BUILDING DESIGN ACHIEVES SRI OF 78
INDOOR AIR QUALITY
100% OF INTERIOR MATERIALS WITH LOW OR NO V.O.C.'S
GREENGUARD
VISUAL CONNECTION
OCCUPANTS HAVE CONNECTION BETWEEN SPACES AND THE EXTERIOR
DISTRICT HEATING
SKANSKA
HH ARCHITECTURE

WAKE TECH
COMMUNITY COLLEGE
PUBLIC SAFETY SIMULATION COMPLEX
Daylight & Visual Connection to Nature
Efficient LED Lighting Fixtures Throughout
Deep Shade Overhang @ South Elevation
CANOPY SECTION
Canopy Design Shaped by Solar Analysis
High SRI Membrane Roofing System
Rooftop Solar PV System
Vertical Solar Shading; East Elevation
20 kBTU/sf
(w/ PV system)
49 kBTU/sf
(w/o PV system)
(estimated Energy Use Intensity)
GREEN GLOBES
(TWO GLOBES)
PV Summary
417.96kW (DC input)
360kW (AC output)
DC/AC Ratio = 1.161
972-430W PV modules
6-60 kW inverters
Native & Drought Tolerant Vegetation
Reestablishing Natural Landscape & Bioswales
High SRI Hard-scape & Roadway Paving
GREENGUARD
floor score
Low VOC & Environmentally Mindful Material Selections
ENERGY STAR
Energy Efficient Appliances & Equipment
Building Provides Power to Electric Vehicle Charging Stations
Heating & Cooling Water from Central Energy Plant (Geothermal)
LEO A DALY
boomerang DESIGN

WAKE TECH GENERAL EDUCATION BUILDING #1 & STUDENT SERVICES

THREE GREEN GLOBES

26% WATER USE REDUCTION

48% ANNUAL ENERGY SAVINGS

35 kBtu/sf EUI

BSA


TWO GREEN GLOBES
DAYLIGHT & CONNECTION TO NATURE
GREEN ROOF
EXTERIOR SUNSHADES
PV PANELS
ENERGY EFFICIENT GLAZING
COLLABORATION SPACES
D
1160
NATIVE & ADAPTIVE VEGETATION
BIKE RACKS
DISTRICT HEATING AND HOT WATER PROVIDED BY CEP (GEOTHERMAL)
RAINWATER HARVESTING
PRIORITIZE LOCAL LOW-VOC HEALTHY MATERIALS
LIGHT COLORED PAVING
EV CHARGING STATIONS

Eastern Wake 4.0 - Sustainability Highlights

- Hybrid Geothermal Central Energy Plant
  - 105°F HHW supply temperature
  - 44°F CHW supply temperature
  - 1580 Tons (Phase 1, 2, 3)
  - 297 Wells at 500 ft, 650 Tons: Phase 1
- Rooftop Solar PV Systems [net meter]
  - CEP: **110kW**, 283 Modules/Panels
  - PSSC: **418kW**, 972 Modules/Panels
  - GEB & SS: **228kW**, 576 Modules/Panels
- Solar PV Parking Lot/Roadway Lighting
  - No wired fixtures
- EV Charging Stations
  - 20 Ports campus wide (Phase 1)
- Operational Transparency
  - Energy/Sustainability Dashboard in Buildings
- Connection with Nature
  - Daylight & Views (HP windows/glazing)
  - Drought Tolerant/Native Plant Species
  - Green Roof/Outdoor Spaces
- Stormwater Mitigation
  - Rainwater Harvesting
  - Pervious Hardscape
  - Bioswales
  - Bio-R Ponds/UG Storm Chamber System
- Solar Reflectance
  - Light Colored Hardscapes & Paving
  - Cool-rated Roofing Membranes
  - Canopies/Vertical shading
- Community Connectivity
  - Multimodal Pathways (bike lanes)
  - Public Bus Access/Bike Racks
  - Nature/Walking Trail

Green Globes Building Certifications

Thank You