Gas Fired Chiller Replacements at UConn

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OVERVIEW | STORRS

Campus History

- Founded in 1881 as the Storrs Agricultural School
- Land, Sea & Space Grants
- Became the University of Connecticut in 1939
- Under UConn 2000, $3.7 billion in construction
- With Next Generation CT, $1.5 billion in infrastructure

OVERVIEW | STORRS

Campus Overview Today

- National leader among public research universities
- More than 19,000 undergraduate students at Storrs Campus
- Over 100 undergraduate majors
- Ranked among the top 25 public universities in the nation by U.S. News & World Report in 2014
- Storrs Campus ≈ 443 acres

OVERVIEW | STORRS

Master Plan & Goals

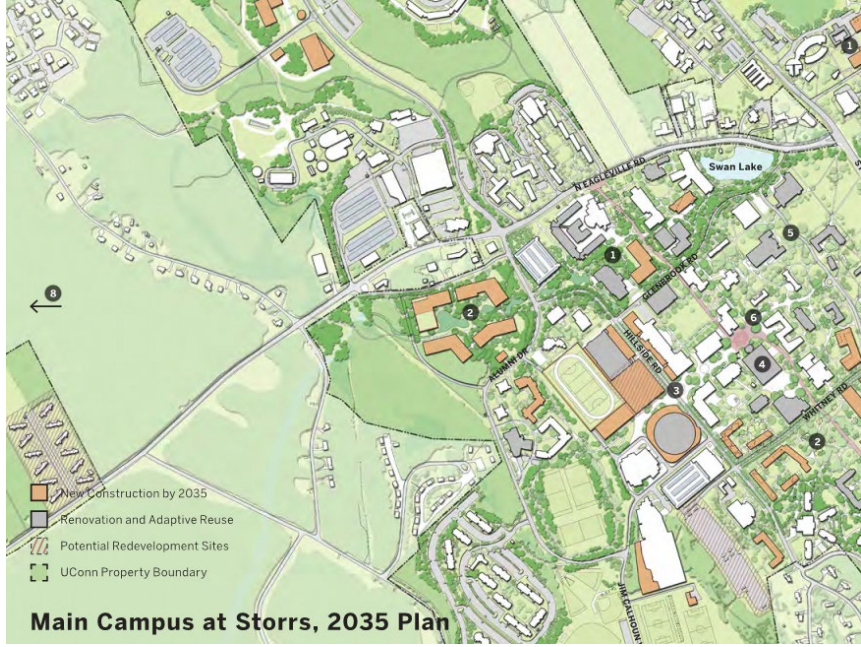
- Significant new building to meet rising student enrollment & increased research footprint
- Development capacity in conjunction with sustainability goals
- Prioritize increases in efficiency
- District, connected & looped SUPs

Chilled Water Load Projections

		Present	Near Term	Mid Term	Long Term
Business As Usual Approach	Demand	8,300	14,691	16,301	22,171
	New Capacity	(1,700)	2,691	4,301	10,171
10% Energy Reduction	Demand		13,222	14,671	19,954
	New Capacity		1,222	2,671	7,954
20% Energy Reduction	Demand		11,753	13,041	17,737
	New Capacity		(247)	1,041	5,737
30% Energy Reduction	Demand		10,284	11,411	15,520
	New Capacity		(1,716)	(589)	3,520

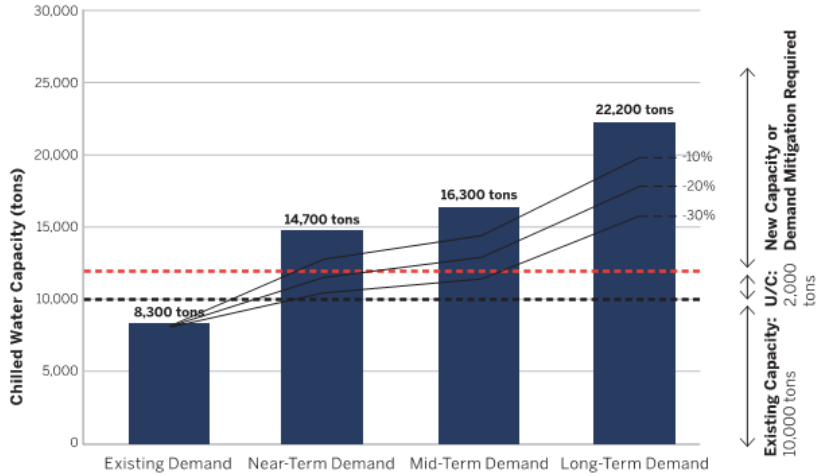
Assumptions: (SF/TON)	New Buildings	Demolition	Renovation
Academic / Teaching	200	154	-667
Administration	200	154	-667
Arts / Culture	225	173	-750
Athletics + Recreation	375	288	-1,250
Misc	400	308	-1,333
Parking	0	0	0
Residence / Dining	200	154	-667
Science	175	135	-583
Student Services	200	154	-667
Support / Utility	400	308	-1,333

*Renovated buildings are assumed to be approximatley 30% more efficent following the renovation. Indicated value is relative energy savings.
** Load projections based on new, removed, and renovated space by phase and use type, as outlined in the Campus Master Plan and the Load Calculations at the end of this report.



Main Campus at Storrs, 2035 Plan

Impact on Utility Systems



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OVERVIEW | STORRS

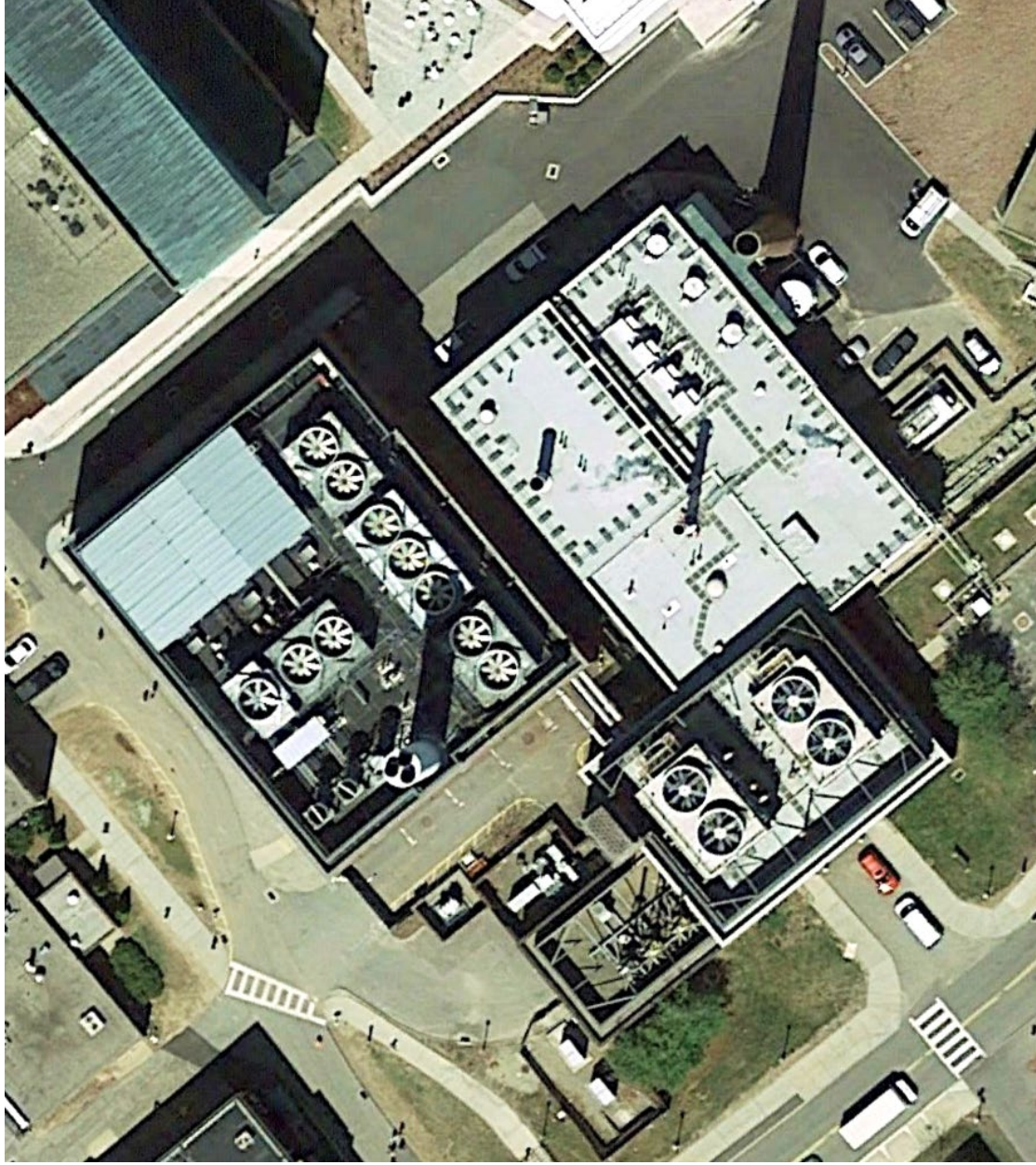
From MicroGrids & CHP Report – Sept 8, 2016

Category			
Peak Demands	Steam = 250 KPPH	CHW= 9,000 Tons	Elec = 27.0 MW
Steam Generation Capacity Criteria: **Fuel Types**	5 Stationary Boilers 1963 - 1998 3 Heat Recovery Steam Generators 2006 Capacity: 530k pounds/hour Fuel = Natural Gas & No. 2 Oil (Ultra Low Sulfur Diesel in six 50k gallon tanks)		
Steam Generation Reliability Criteria: **Primary Driver Types**	Generation Pressure: Inside CUP 600/125 PSI, 1 Backpressure Steam Turbine Generator Distribution Pressure: 65 PSI Feed Water Makeup Supplied by Reclaim Water backed up by Potable Water Vulnerability = Loss of Natural Gas		
CHP Description & Performance	CUP Supplies CHW to 3M+ SF Building Space via North & South Utility Tunnels - Capacity 12k tons, 4 Steam Chillers, 2 Electric Chillers, 4 Gas Chillers, Free Cooling Heat Exchanger South Chilled Water 1993 - Capacity 1k tons, 500 ton electric driven, 500 ton gas driven 97 Building Stand Alone Systems		

OVERVIEW | STORRS

Critically Important Factors

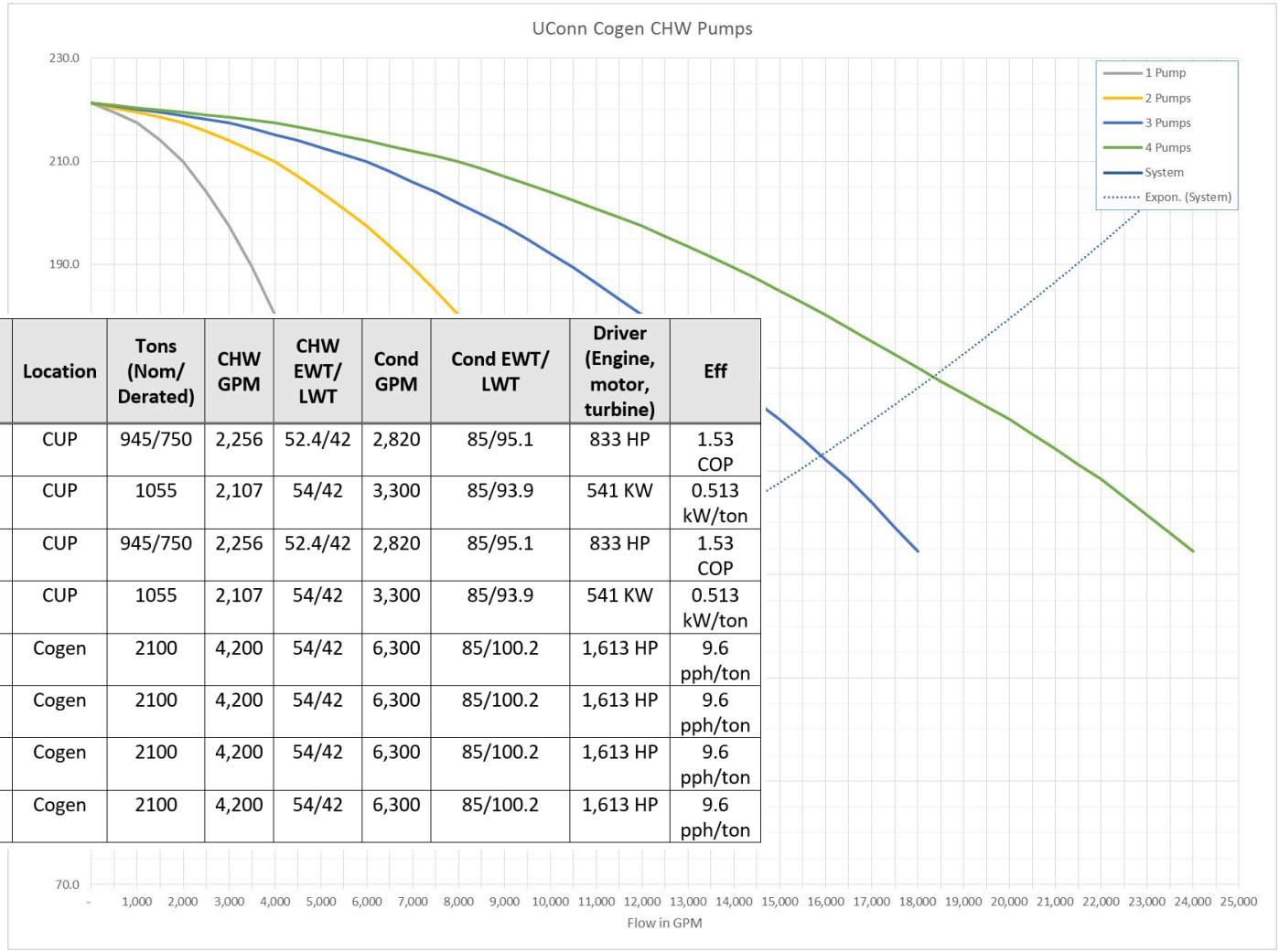
- **Plant was a primary/secondary chilled water pumping system on one side, primary variable on the other.** The project reconfigured the header system and is now all variable primary, greatly improving operational DP control.
- **The 3 gas turbine inlets were originally designed with a chilled water loop for summer use only.** A glycol loop was installed for preheating turbine inlet air in the winter, which also improves NOx control during extreme cold conditions.



ENGINEERING | DESIGN **CHALLENGE**

Problem Statement

- Verify size/age/capacity of system vs updated need projections
- Capacity shortfall assessment for redundancy & resiliency
- Coordination with Master Plan
- Critical timeline & scheduling

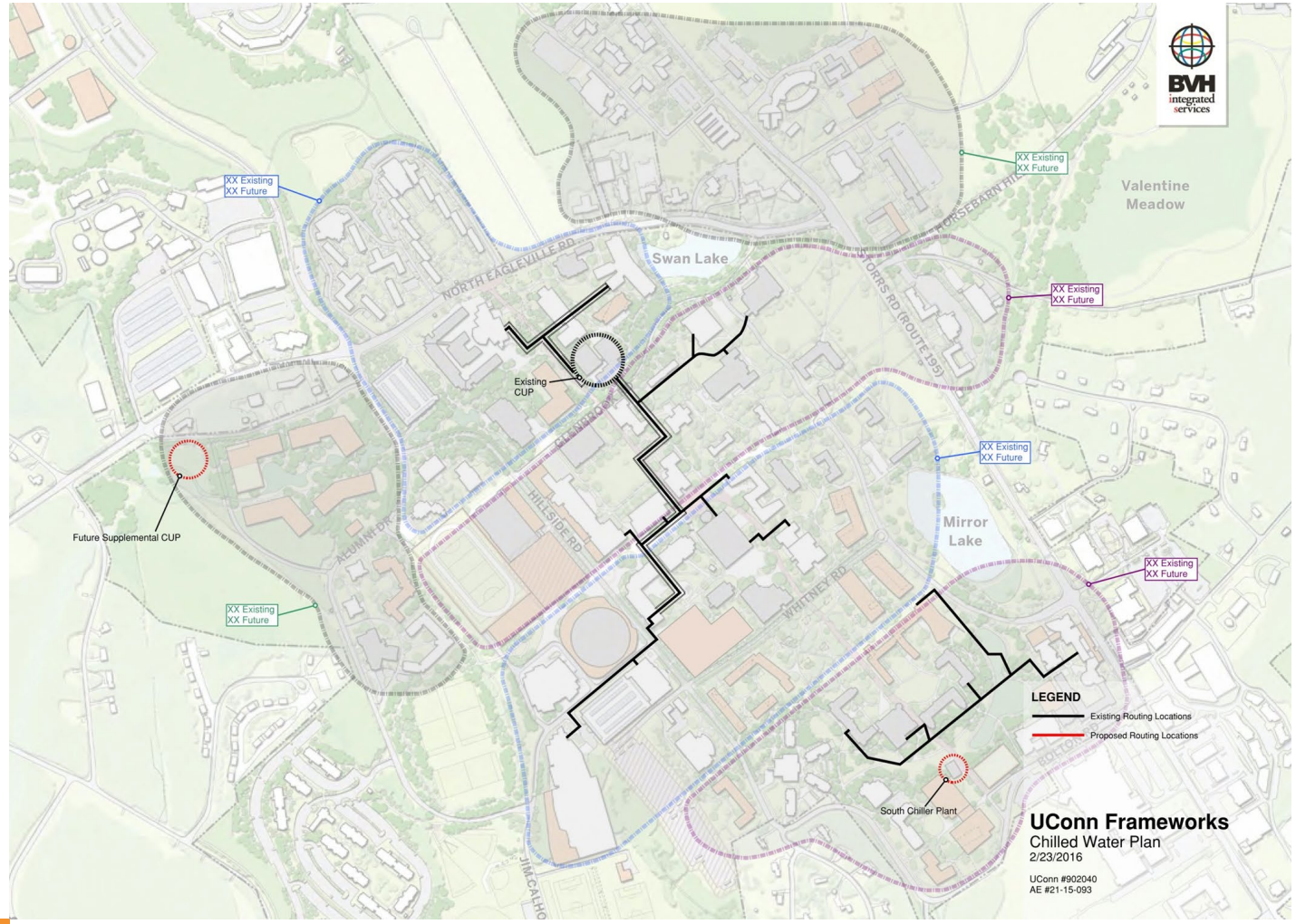


Tag	Type	Location	Tons (Nom/ Derated)	CHW GPM	CHW EWT/ LWT	Cond GPM	Cond EWT/ LWT	Driver (Engine, motor, turbine)	Eff
CH-1	Gas-engine	CUP	945/750	2,256	52.4/42	2,820	85/95.1	833 HP	1.53 COP
CH-2	Electric	CUP	1055	2,107	54/42	3,300	85/93.9	541 KW	0.513 kW/ton
CH-3	Gas-engine	CUP	945/750	2,256	52.4/42	2,820	85/95.1	833 HP	1.53 COP
CH-4	Electric	CUP	1055	2,107	54/42	3,300	85/93.9	541 KW	0.513 kW/ton
CH-5	Steam turbine	Cogen	2100	4,200	54/42	6,300	85/100.2	1,613 HP	9.6 pph/ton
CH-6	Steam turbine	Cogen	2100	4,200	54/42	6,300	85/100.2	1,613 HP	9.6 pph/ton
CH-7	Steam turbine	Cogen	2100	4,200	54/42	6,300	85/100.2	1,613 HP	9.6 pph/ton
CH-8	Steam turbine	Cogen	2100	4,200	54/42	6,300	85/100.2	1,613 HP	9.6 pph/ton

ENGINEERING | DESIGN **CHALLENGE**

Chiller Plant & Pumping Station

- Existing physical & operational conditions
- Mapping sub-zone capacity/distribution
- Evaluation of reuse, rerouting, replacement & new infrastructure
- Proposed plant & location factors



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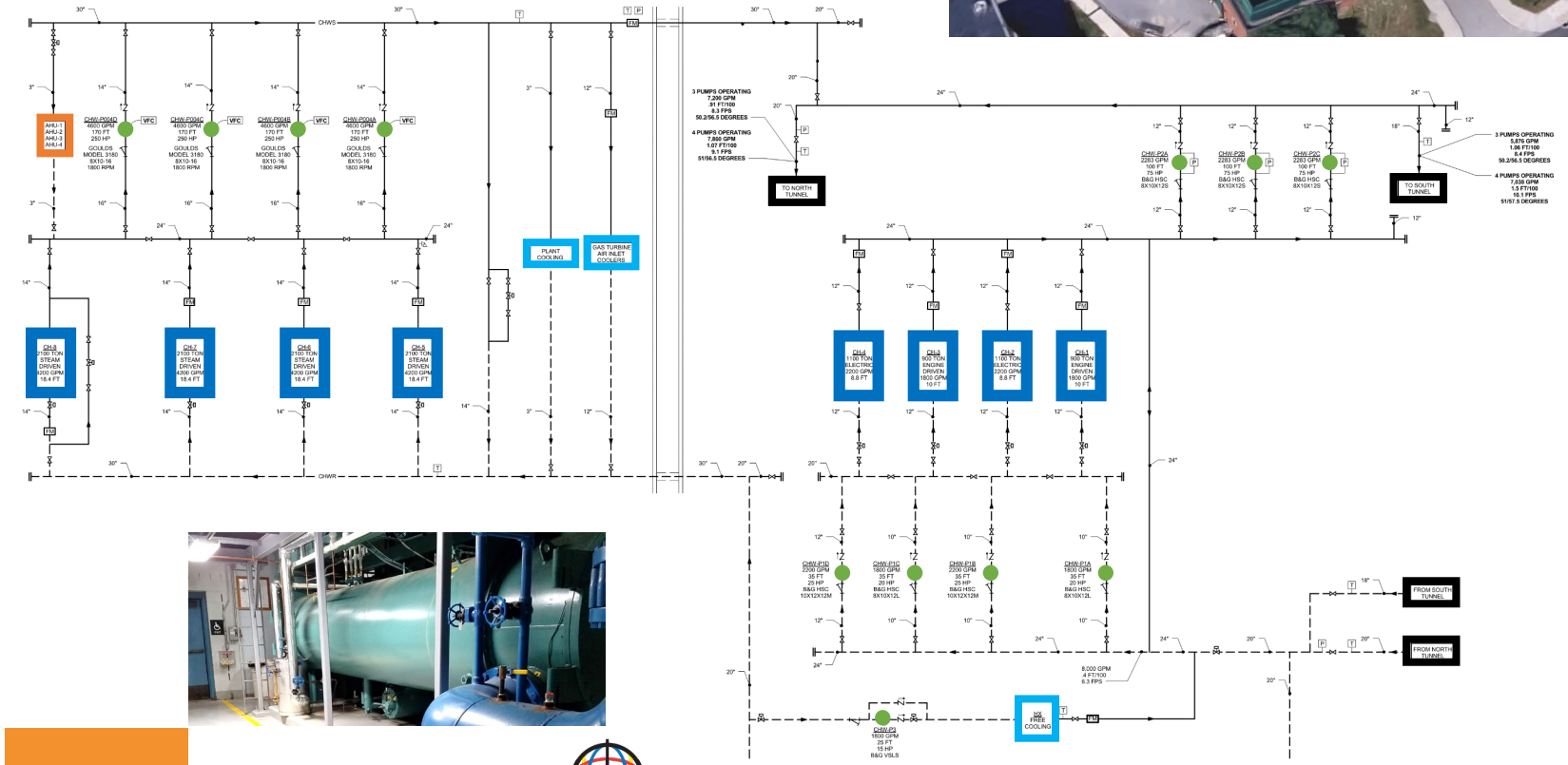
ENGINEERING | DESIGN **CHALLENGE**

Key Design Challenges

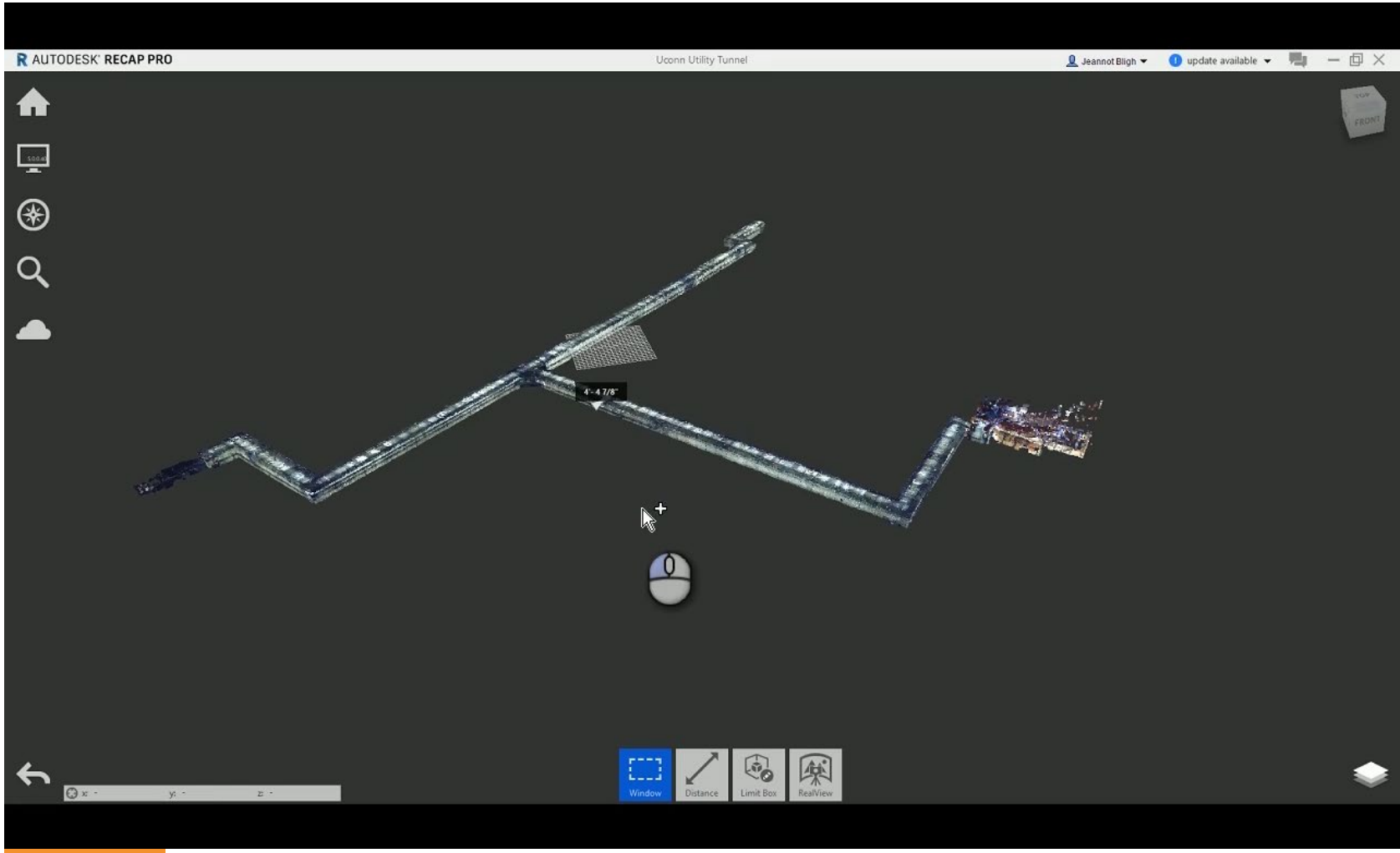
- Flexibility / diversity / resiliency
- Maintaining occupied, active campus
- Diversity through multiple fuel sources
- Electrically constrained
- Logistical considerations



ENGINEERING | DESIGN **SOLUTION**

Design Approach

- System evaluation & assessment process
- Laser scanning & point clouds of building & tunnels
- Detailed infrastructure routing options
- Modeling scenarios



ENGINEERING | DESIGN **SOLUTION**

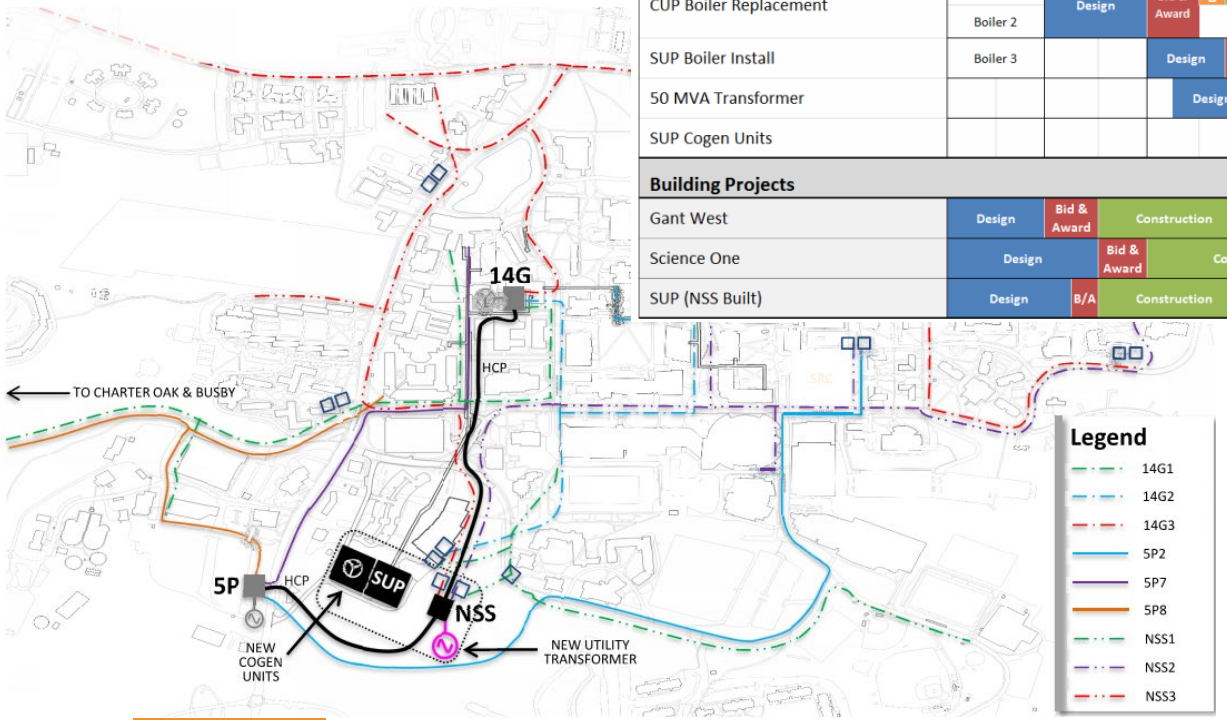
Approach

- Conceptual timelines
- Design options & alternatives
- Enabling projects
- Estimating & budgeting priorities
- Identify & order long lead items

Conceptual Timeline

UConn Storrs Campus – Utility Framework

Infrastructure Projects	2018	2019	2020	2021	2022	2023	2024	2025
NER - Underground Base - NSS3 (Discovery to Churches)			Design	Bid & Award	Construction			
NER - NSS Extension - NSS3 Alt #3			Design	Bid & Award	Construction			
NSS2			Design	Bid & Award	Construction			
NWSQPH3 East Tunnel		Design	Bid & Award	Construction				
CUP Boiler Replacement	Boiler 1	Design	Bid & Award	Demo / Construction	Cx			
	Boiler 2			Demo / Construction	Cx			
SUP Boiler Install	Boiler 3		Design	Bid & Award	Construction	Cx		
50 MVA Transformer			Design	Bid & Award	Construction	Cx		
SUP Cogen Units					Design	Bid & Award	Construction	Cx
Building Projects								
Gant West	Design	Bid & Award	Construction					
Science One	Design	Bid & Award	Construction					
SUP (NSS Built)	Design	B/A	Construction	Cx				



Power Infrastructure Enabling Upgrades

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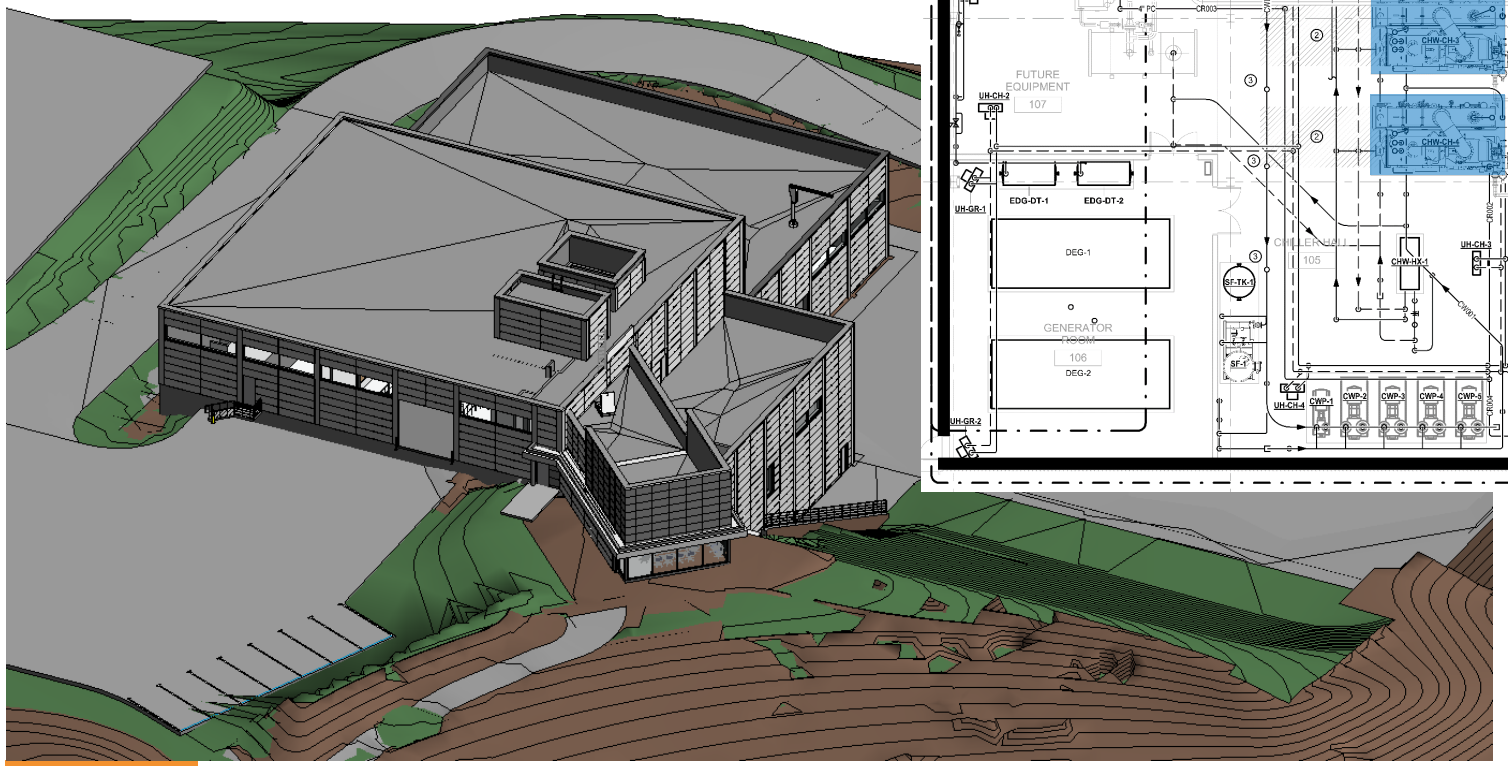
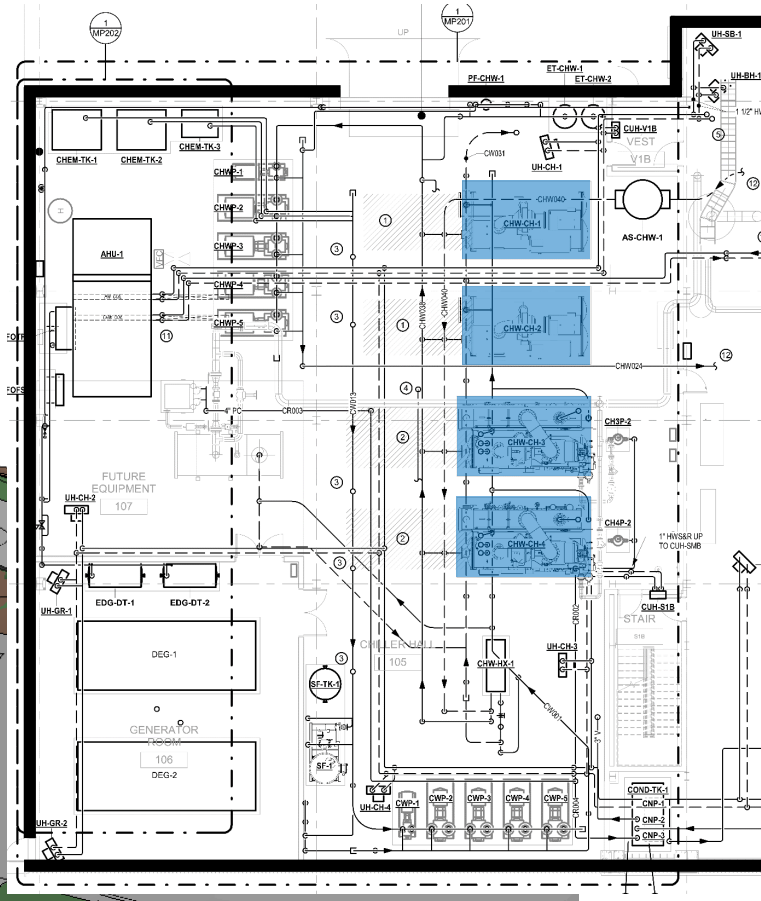
ENGINEERING | DESIGN **SOLUTION**

Final Design Solution

- After enabling projects, new sUP chiller plant at periphery of campus
- 4 x ton chillers
- Looped back to existing chiller CUP plant at center of campus
- Upgrades to pumping stations





ENGINEERING | DESIGN **RESULT**

Equipment in Place

UConn Chiller Plant:
4 new 400 ton gas-engine chillers were up and running this past summer. They were temporarily shut down as the new cooling towers were being replaced this fall/winter and will be back in operation this spring.

ENGINEERING | DESIGN **RESULT**

Impact on Capacity / Performance

- **Ongoing projects kept on-track**
- Provided the Storrs Campus with excess capacity during this past cooling season for first the time in years
- Resiliency enabling upgrades to proceed without service losses

NW Science Complex in Design

Gant Science Complex Under Renovation

Student Recreation Center Recently Completed

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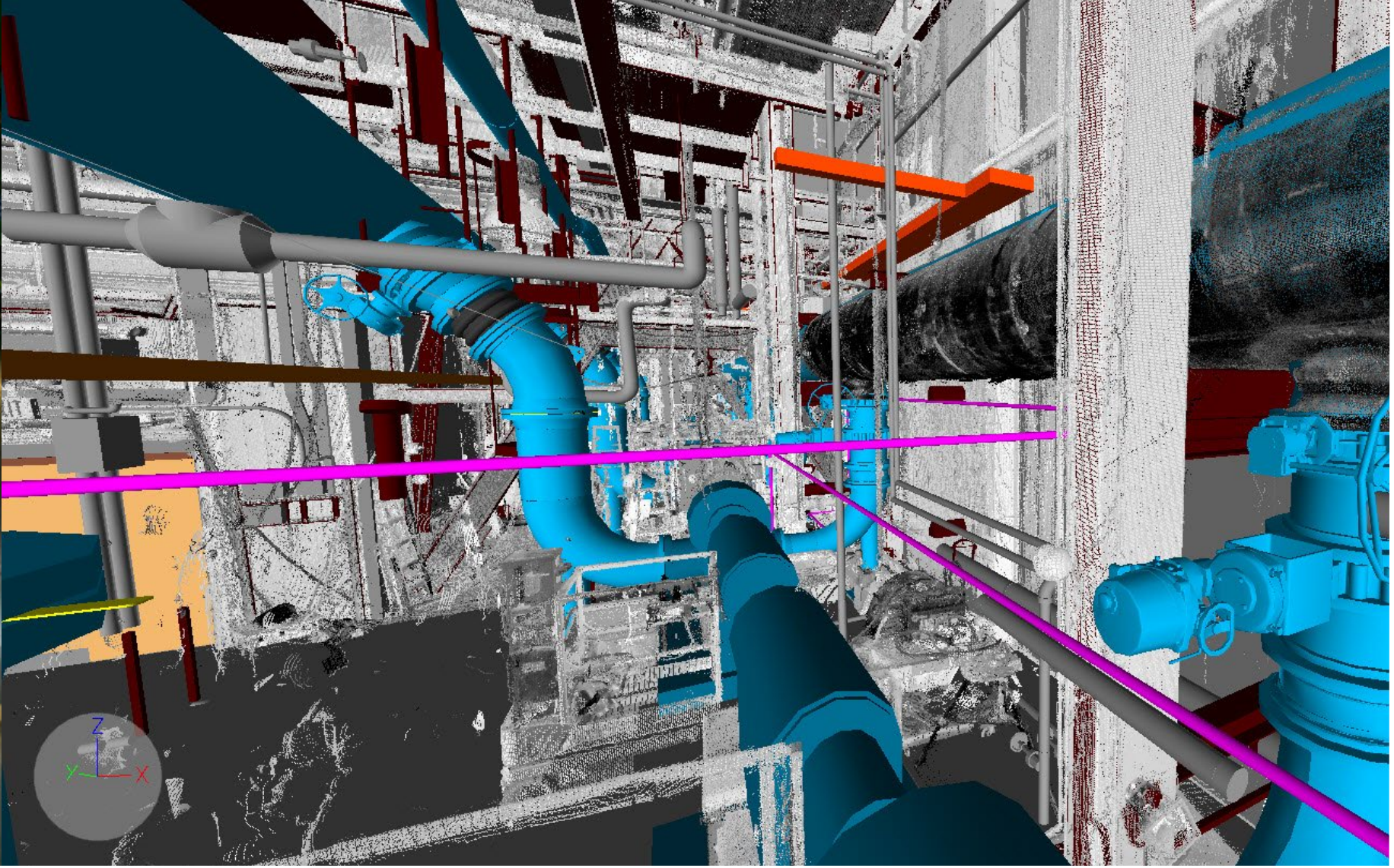
ENGINEERING | DESIGN **RESULT**

Design Lessons Learned

- New drive technology surpassed
- Gas driven chiller public bidding
- Pre-qualifications
- Planning interim steps



CONSTRUCTION

CONSTRAINTS

CHALLENGES

Mission Critical Plant with unique equipment requirements

- Lack of space
- Complex sequencing
- Public procurement
- Multiple campus jobsites
- No laydown space
- Critical milestones

SEQUENCING

CHALLENGES

22 Month Project

Phase A: Pre-shutdown over summer/fall 2018 (@ 6 months)

- Initial demolition and prep
- Add temporary chiller capacity

Phase B; Entire chilled water system shutdown over Jan & Feb 2019 (@ 2 months)

- Reconfigure headers, new connections & valves
- New electrical gear

Phase C; CUP chiller plant shutdown early spring 2019 (@ 2 months)

- New gas engine driven chillers 3A & B

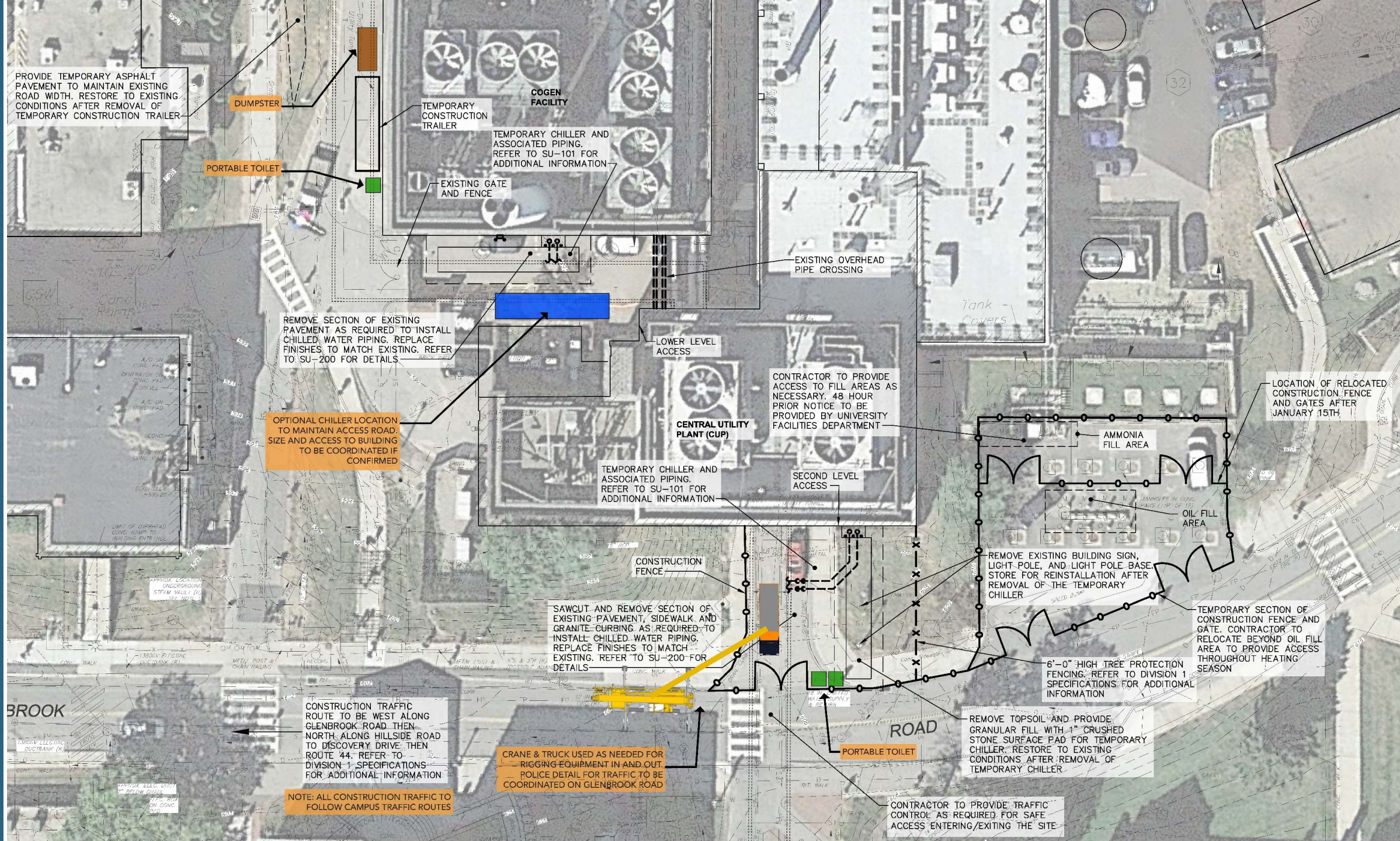
Phase D; CUP must be operational over summer 2019 (@ 5 months)

- New gas engine chillers 1A & B
- Clean up work and prep for upcoming outage

Phase E; CUP chiller plant shutdown over fall/winter 2019/2020 (@ 7 months)

- Replace all condenser water and towers
- Project close-out

LOGISTICS


PROVIDE TEMPORARY ASPHALT PAVEMENT TO MAINTAIN EXISTING ROAD WIDTH. RESTORE TO EXISTING CONDITIONS AFTER REMOVAL OF TEMPORARY CONSTRUCTION TRAILER
DUMPSTER
TEMPORARY CONSTRUCTION TRAILER
COGEN FACILITY
TEMPORARY CHILLER AND ASSOCIATED PIPING. REFER TO SU-101 FOR ADDITIONAL INFORMATION
PORTABLE TOILET
EXISTING GATE AND FENCE
EXISTING OVERHEAD PIPE CROSSING
REMOVE SECTION OF EXISTING PAVEMENT AS REQUIRED TO INSTALL CHILLED WATER PIPING. REPLACE FINISHES TO MATCH EXISTING. REFER TO SU-200 FOR DETAILS
LOWER LEVEL ACCESS
OPTIONAL CHILLER LOCATION TO MAINTAIN ACCESS ROAD. SIZE AND ACCESS TO BUILDING TO BE COORDINATED IF CONFIRMED
CENTRAL UTILITY PLANT (CUP)
CONTRACTOR TO PROVIDE ACCESS TO FILL AREAS AS NECESSARY. 48 HOUR PRIOR NOTICE TO BE PROVIDED BY UNIVERSITY FACILITIES DEPARTMENT
AMMONIA FILL AREA
LOCATION OF RELOCATED CONSTRUCTION FENCE AND GATES AFTER JANUARY 15TH
TEMPORARY CHILLER AND ASSOCIATED PIPING. REFER TO SU-101 FOR ADDITIONAL INFORMATION
SECOND LEVEL ACCESS
OIL FILL AREA
CONSTRUCTION FENCE
REMOVE EXISTING BUILDING SIGN, LIGHT POLE, AND LIGHT POLE BASE. STORE FOR REINSTALLATION AFTER REMOVAL OF THE TEMPORARY CHILLER
SAWCUT AND REMOVE SECTION OF EXISTING PAVEMENT, SIDEWALK AND GRANITE CURBING AS REQUIRED TO INSTALL CHILLED WATER PIPING. REPLACE FINISHES TO MATCH EXISTING. REFER TO SU-200 FOR DETAILS
TEMPORARY SECTION OF CONSTRUCTION FENCE AND GATE. CONTRACTOR TO RELOCATE BEYOND OIL FILL AREA TO PROVIDE ACCESS THROUGHOUT HEATING SEASON
6'-0" HIGH TREE PROTECTION FENCING. REFER TO DIVISION 1 SPECIFICATIONS FOR ADDITIONAL INFORMATION
CONSTRUCTION TRAFFIC ROUTE TO BE WEST ALONG GLENBROOK ROAD THEN NORTH ALONG HILLSIDE ROAD TO DISCOVERY DRIVE THEN ROUTE 44. REFER TO DIVISION 1 SPECIFICATIONS FOR ADDITIONAL INFORMATION
CRANE & TRUCK USED AS NEEDED FOR RIGGING EQUIPMENT IN AND OUT. POLICE DETAIL FOR TRAFFIC TO BE COORDINATED ON GLENBROOK ROAD
REMOVE TOPSOIL AND PROVIDE GRANULAR FILL WITH 1" CRUSHED STONE SURFACE PAD FOR TEMPORARY CHILLER. RESTORE TO EXISTING CONDITIONS AFTER REMOVAL OF TEMPORARY CHILLER
PORTABLE TOILET
CONTRACTOR TO PROVIDE TRAFFIC CONTROL AS REQUIRED FOR SAFE ACCESS ENTERING/EXITING THE SITE
NOTE: ALL CONSTRUCTION TRAFFIC TO FOLLOW CAMPUS TRAFFIC ROUTES
ROAD

SOLUTIONS

START WITH THE END IN MIND

QA/QC Requirements

- Provides Database of Checklists for Team's Use
- Full Project Team has 24/7 Access to Live Project Data

Safety Management

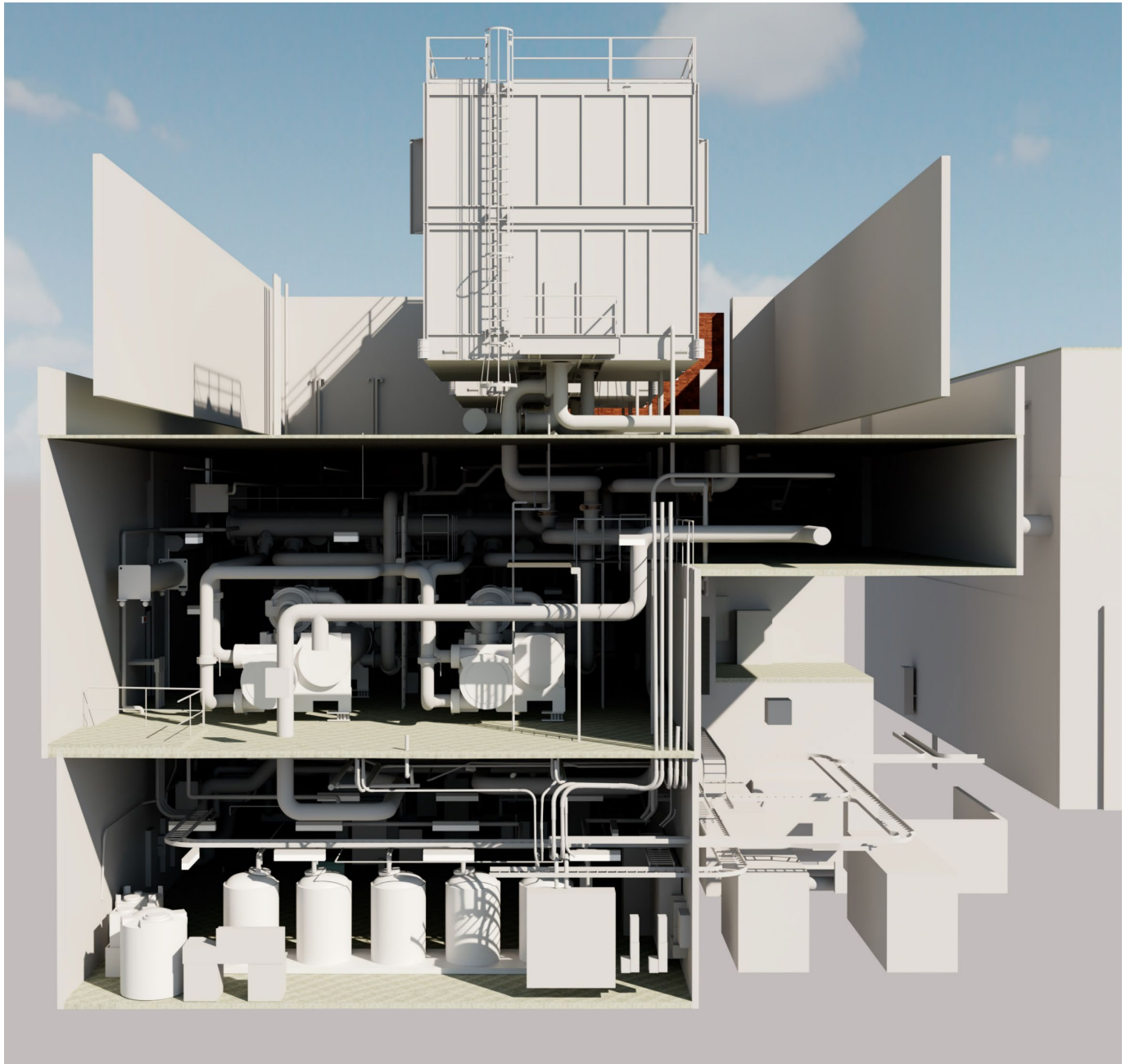
- A major issue will ruin the most well executed project

Application of Technology

- Superintendent and Field Staff Inspect Installation in Progress / Take Photos / Document in BIM 360
- Subcontractors Use BIM 360 to Document Corrective Work

SOLUTIONS

LASER SCANNING & MODELING



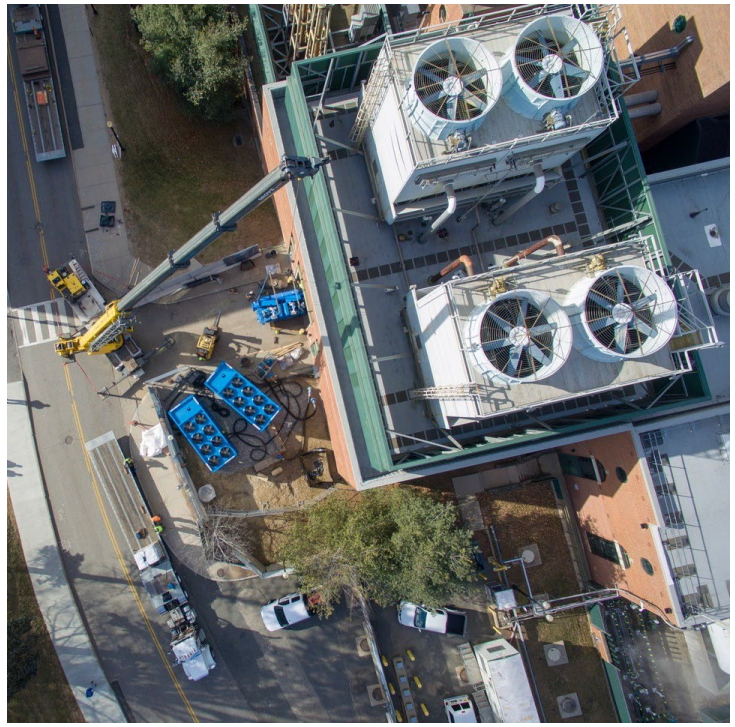
- Enhanced project planning
- Offsite prefabrication of piping sections
- Rig path analysis to avoid conflicts
- Clash detection on the desktop
- Review valve orientations with operations
- Accurate as-built conditions

SOLUTIONS

A LEAN APPROACH – REDUCE WASTE, ADD VALUE

1. Identify Value
2. Organize Work Through A Value Stream
3. Create a Smooth and Continuous Work Flow
4. Pull Planning Sessions
5. Continuous Improvement

LEAN STRATEGY



SOLUTIONS

OPERATIONAL COORDINATION

- Shutdown planning
- Temporary chillers
- Work around academic calendar
- Daily plant staff coordination
- Safety inspections and JHA’s
- Deliveries logistics
- Neighboring projects

SOLUTIONS

EQUIPMENT PROCUREMENT

RISK MANAGEMENT

- Costs
- Delivery
- FAT
- Start-up and Cx
- Warranty

CONSTRUCTION

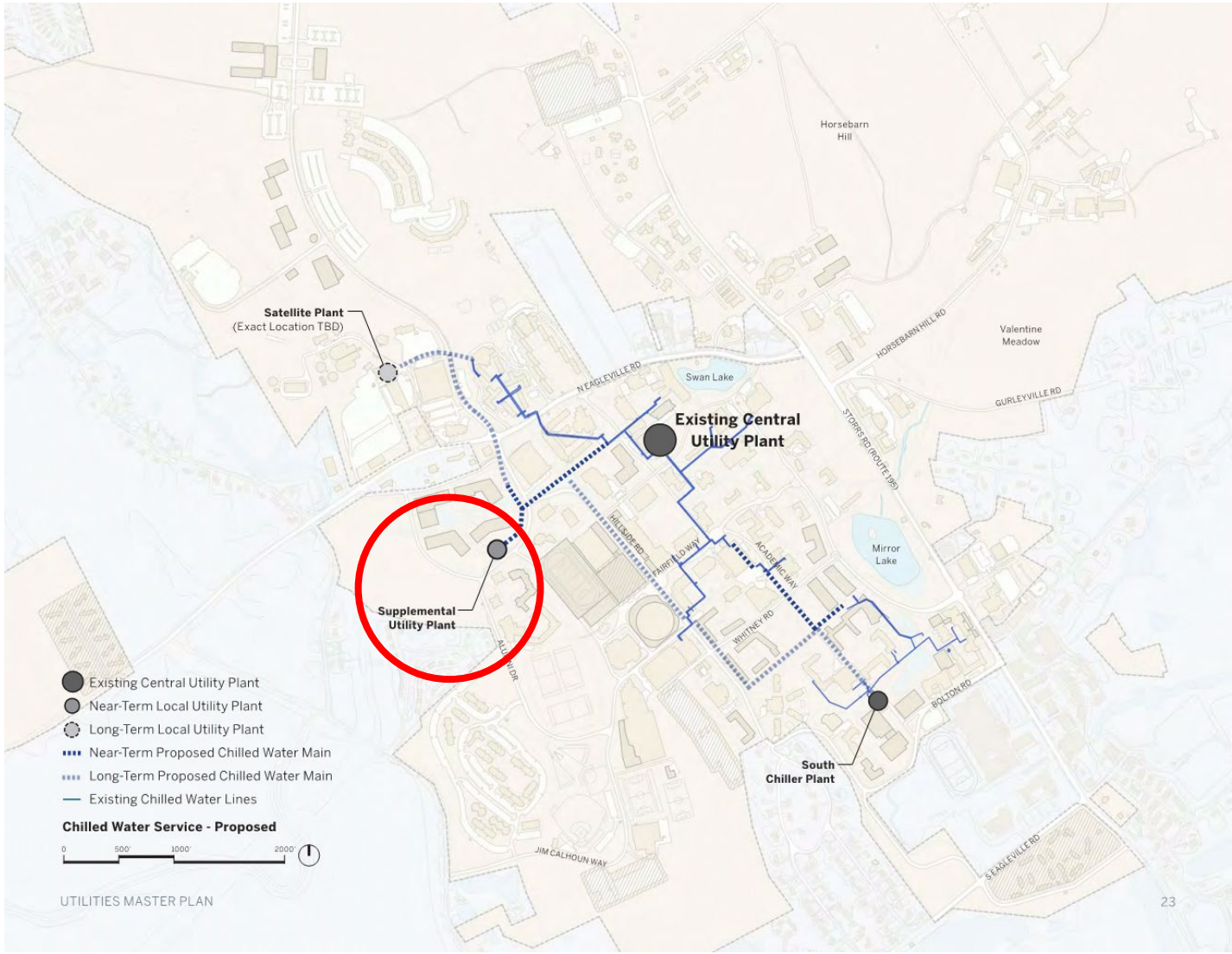
LESSONS LEARNED

- Adaptive planning, we had a contingency scenario for every major phase
- Utility grade rental equipment is a good investment
- Public procurement and set-asides requires that we understand the system and players and how to best utilize them.
- “Incremental” commissioning requires a special approach

OWNER | RESULT

Proposed Chiller Plant Under Construction

- New campus construction will increase peak demand above 10,000 tons, exceeding existing distribution capacity
- New CHW source in North District will be cross connected & provide capacity for new NW Science Quad loads
- New SUP to augment capacity utilizing steam & electric chillers



Gas Fired Chiller Replacements at UConn

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