

A photograph of a street scene at the University of Pennsylvania. In the foreground, there is a brick building with many windows and a black wrought-iron gate. To the right, a street with cars and a traffic light is visible. In the background, more university buildings and a large clock tower are visible under a clear sky.

# University of Pennsylvania Utility Master Plan

PRESENTED BY

Ben Suplick, University of Pennsylvania

Michael Walton, PE, Burns Engineering

Jason Trefz, PE, Trefz Engineering

# Agenda/Speakers

- Ben Suplick, University of Pennsylvania
  - University Background & Master Plan
  - Utility Master Plan scope
- Michael Walton, Burns Engineering
  - Overall Master Plan
  - Electric & Steam systems
- Jason Trefz, Trefz Engineering
  - Chilled Water system

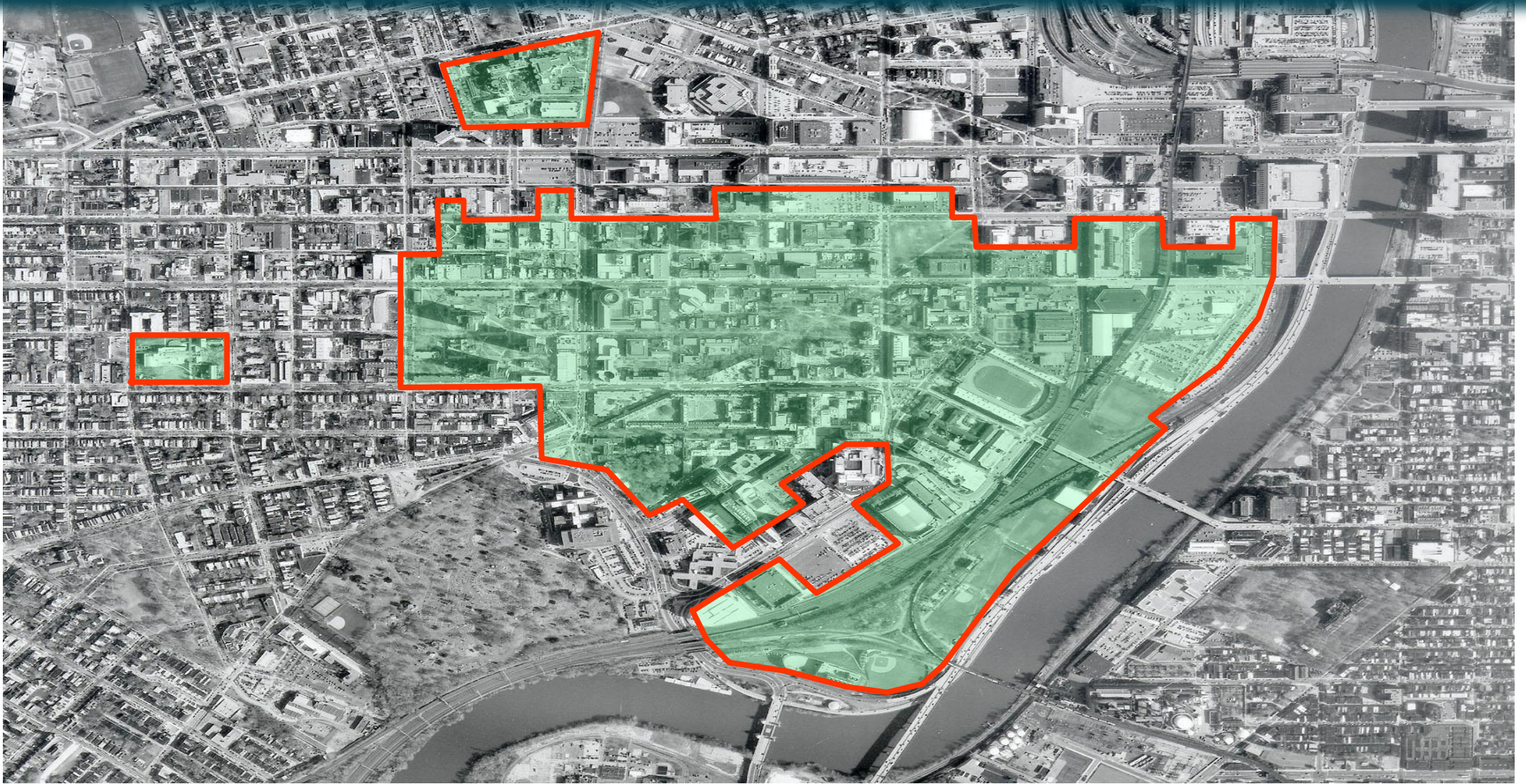


## PENN TODAY

- 290 acre West Philadelphia campus
- 14 million square feet in 180 buildings
- 20,000 students / 20,000 faculty and staff
- 12 Undergraduate, Graduate & Professional Schools
- Penn Health System, Morris Arboretum, New Bolton Center, & real estate holdings



# University of Pennsylvania







# PENN CONNECTS 2.0: VISION 2011-2030



## New Construction

- |  |  |
|--|--|
| 1. PENN PRESBYTERIAN HOSPITAL EXPANSION              | 35. VAN PELT LIBRARY SPECIAL COLLECTIONS CENTER    |
| 2. RESIDENTIAL DEVELOPMENT AT 3939 AND 4001 CHESTNUT | 36. MEYERSON HALL RENOVATIONS AND ADDITION         |
| 3. 34TH AND CHESTNUT MIXED USE                       | 37. DAVID RITTENHOUSE LABORATORIES                 |
| 4. GOLKIN HALL                                       | 38. EVANS BUILDING CLINICS                         |
| 5. NEW COLLEGE HOUSE AT HILL SQUARE                  | 39. 1920 COMMONS                                   |
| 6. CIRA SOUTH CHESTNUT MIXED USE                     | 40. STEINBERG CONFERENCE CENTER                    |
| 7. FRANKLIN BUILDING REDEVELOPMENT                   | 41. VANCE HALL                                     |
| 8. KRISHNA P. SINGH CENTER FOR NANOTECHNOLOGY        | 42. COLLEGE HALL WEST WING                         |
| 9. CIRA SOUTH WALNUT MIXED USE                       | 43. EDUCATION COMMONS                              |
| 10. HAMILTON VILLAGE INFILL COLLEGE HOUSES           | 44. HUTCHINSON GYMNASIUM INFILL AND RENOVATION     |
| 11. LOT 2 REDEVELOPMENT                              | 45. LEVY TENNIS PAVILION                           |
| 12. ICE RINK REDEVELOPMENT                           | 46. RYAN HOSPITAL                                  |
| 13. WALNUT SOUTH MIXED USE                           | 47. RICHARDS MEDICAL LABS                          |
| 14. GARAGE 14 REDEVELOPMENT                          | 48. FAGIN HALL                                     |
| 15. STEINBERG HALL - DIETRICH HALL WEST ADDITION     | 49. PERELMAN SCHOOL OF MEDECINE EDUCATION FACILITY |
| 16. BARKER TRANSPLANT HOUSE                          | 50. STEMMER HALL                                   |
| 17. 40TH AND PINE RESIDENTIAL DEVELOPMENT            | 51. MUSEUM WEST WING                               |
|  | 52. 3803 LOCUST                                    |



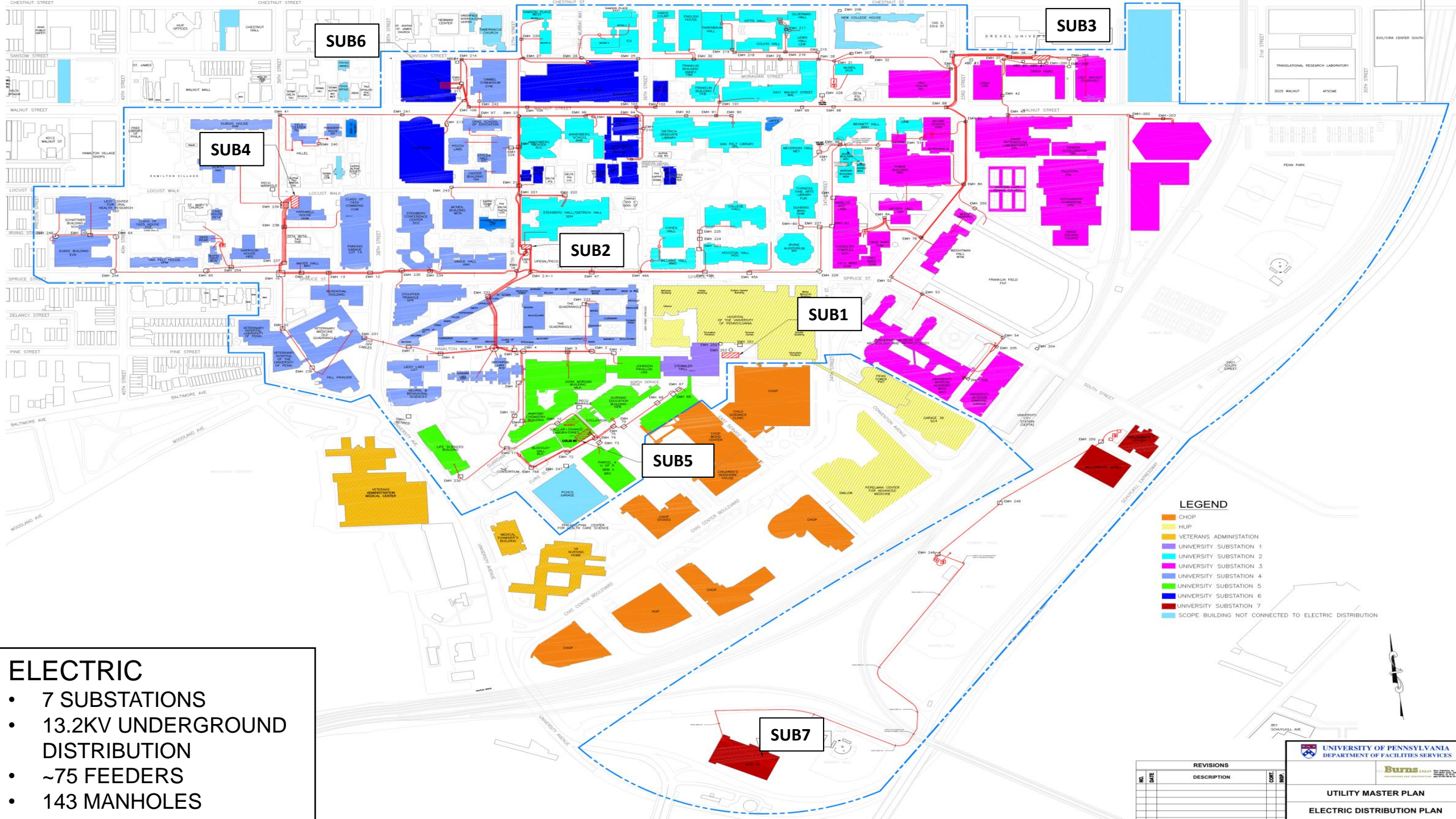
# Penn Central Utilities

- Own, Operate, Maintain Steam, Electric, & Chilled Water Distribution Systems. Generate Chilled Water.
- 20 Year Energy & Maintenance Agreement with Veolia Energy for the steam system
- HUP relies on UPENN for Steam & Back-up Chilled Water
- Dense Urban Environment with Underground Distribution
- Aging Infrastructure
- Building Energy Reductions
  - Century Bond Program
  - Energy Reduction Funds
  - Sustainability Plan

# Penn Utility Master Plan Scope

Includes University Steam, Chilled Water, and Electric Systems

- Phase A: Document Existing Systems
- Phase B: Develop Plan for Future Growth & Renewal
- Phase C: Analyze and Evaluate Current Chilled Water System
- Phase D: Develop Long Term Objectives and Strategy
- Phase E: Assessment and Preventative Maintenance Plan



ELECTRIC

- 7 SUBSTATIONS
- 13.2KV UNDERGROUND DISTRIBUTION
- ~75 FEEDERS
- 143 MANHOLES

LEGEND

- CHOP
- HUP
- VETERANS ADMINISTRATION
- UNIVERSITY SUBSTATION 1
- UNIVERSITY SUBSTATION 2
- UNIVERSITY SUBSTATION 3
- UNIVERSITY SUBSTATION 4
- UNIVERSITY SUBSTATION 5
- UNIVERSITY SUBSTATION 6
- UNIVERSITY SUBSTATION 7
- SCOPE BUILDING NOT CONNECTED TO ELECTRIC DISTRIBUTION

REVISIONS			
NO.	DATE	DESCRIPTION	DATE

UNIVERSITY OF PENNSYLVANIA  
DEPARTMENT OF FACILITIES SERVICES

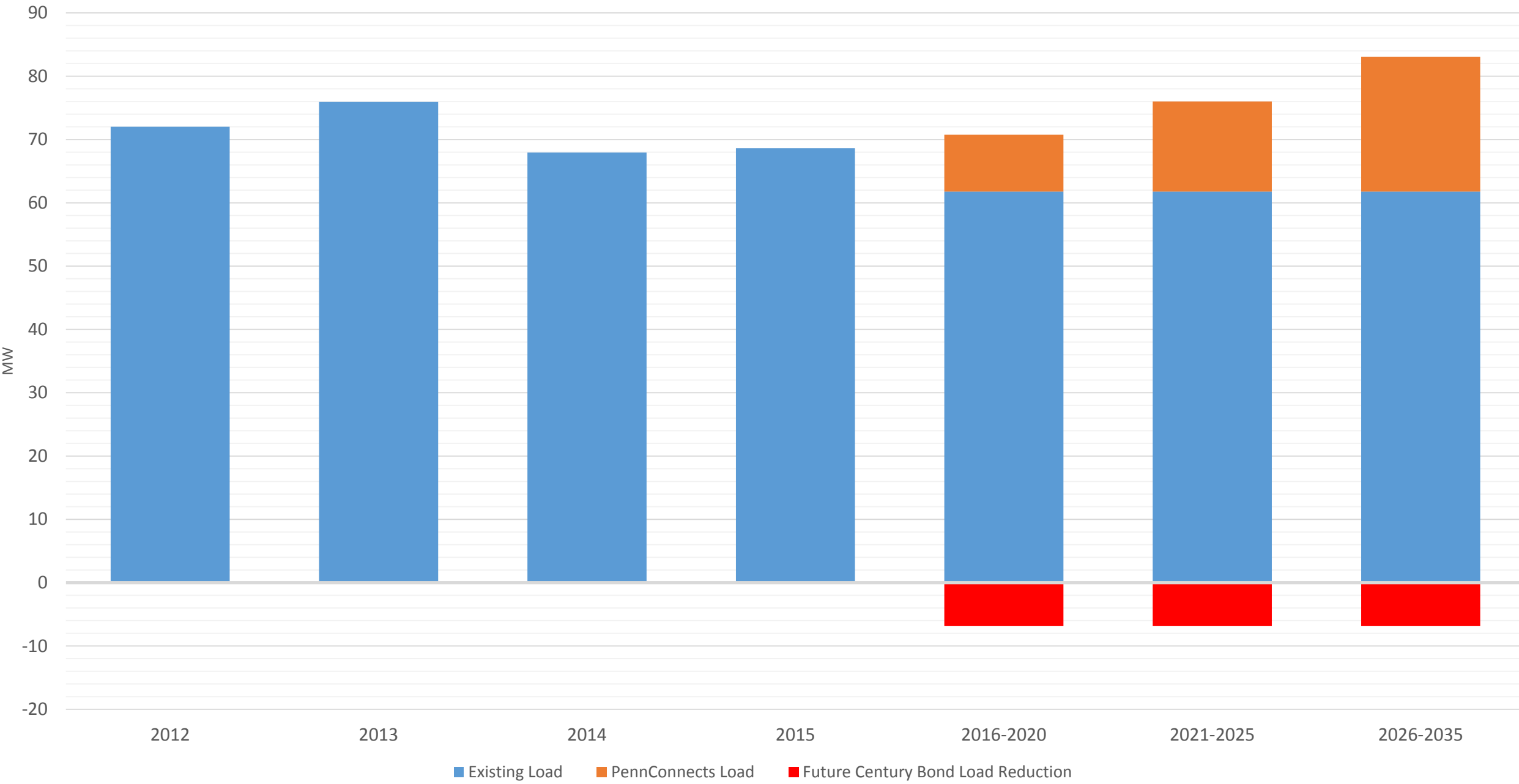
Burns

ENGINEERING AND CONSTRUCTION

UTILITY MASTER PLAN  
ELECTRIC DISTRIBUTION PLAN



# Projected Campus Electric Demand





# Electrical Recommendations

- Replace Substation 2 & 4
  - Resilience & Renewal
- Replace 11 building unit substations in 1-5 yrs
- Replace 18 building unit substations in 6-10 yrs
- Continue Feeder replacement Program
- Performed arc flash hazard analysis

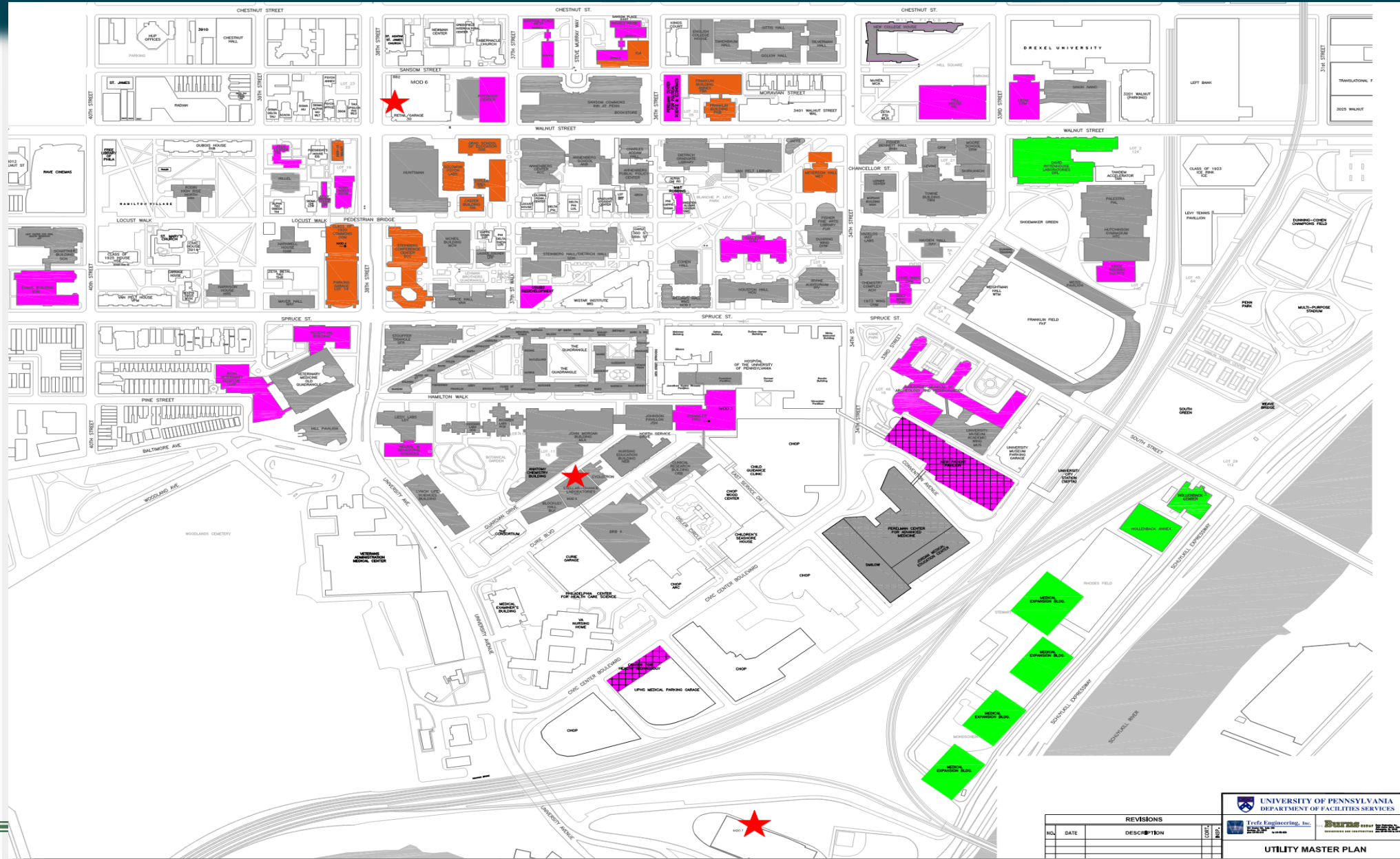


# BUILDING MASTER PLAN

DRAWING LEGEND	
BUILDINGS	
	EXISTING CHW BUILDINGS
	NOT OWNED BY PENN
	PHASE 1 (2016-2020)
	PHASE 2 (2021-2025)
	PHASE 3 (2026-2035)

## CHILLED WATER

- 3 CHILLER PLANTS
- 54,000 TONS CAPACITY
- 22,000 TON HRS THERMAL STORAGE
- 16.5 MILES OF UNDERGROUND DUCTILE IRON CEMENT LINED PIPE





# CHW PRODUCTION CAPACITY ASSESSMENT

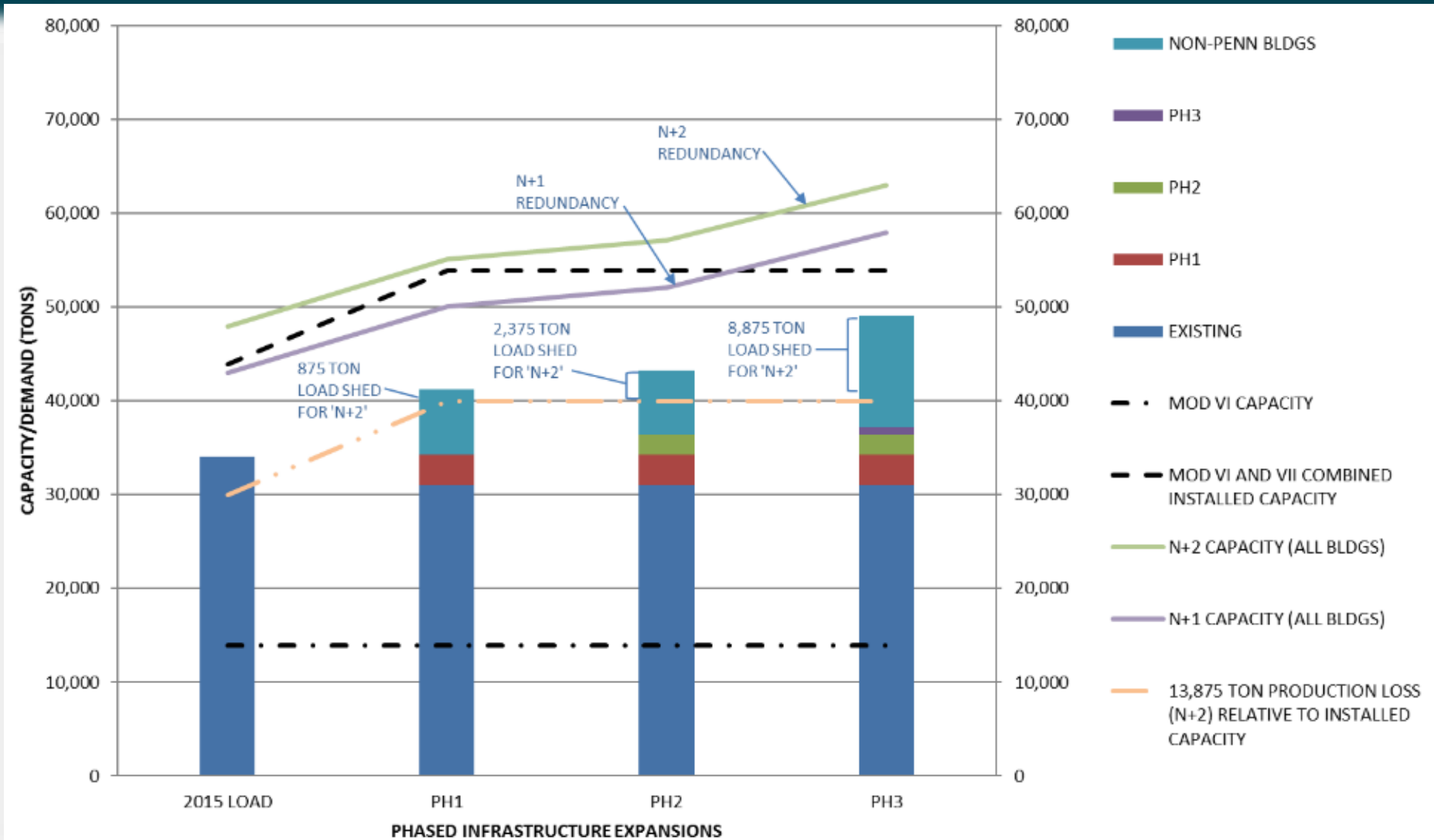
CHW PRODUCTION CAPACITY ASSESSMENT (TONS)				
CONDITION	CURRENT	PH 1	PH 2	PH 3
2016 INSTALLED CAPACITY	54,000	54,000	54,000	54,000
DEMAND FORECAST	34,000	41,000	42,500	49,000
NET	20,000	13,000	11,500	5,000
REDUNDANCY	N+3	N+1	N+1	0
N+1 LOAD SHED	0	0	0	3,875
N+2 LOAD SHED	0	875	2,375	8,875

REDUNDANCY FACTORS	
N+1	8,875
N+2	13,875
N+3	18,875

- N+1 WITH LOAD SHED OPERATIONS
  - ADD 5,000 TONS FOR PHASE 3
- N+2 WITH NO LOAD SHED OPERATIONS
  - ADD 5,000 TONS FOR PHASE 2 AND PHASE 3



# PRODUCTION CAPACITY ASSESSMENT

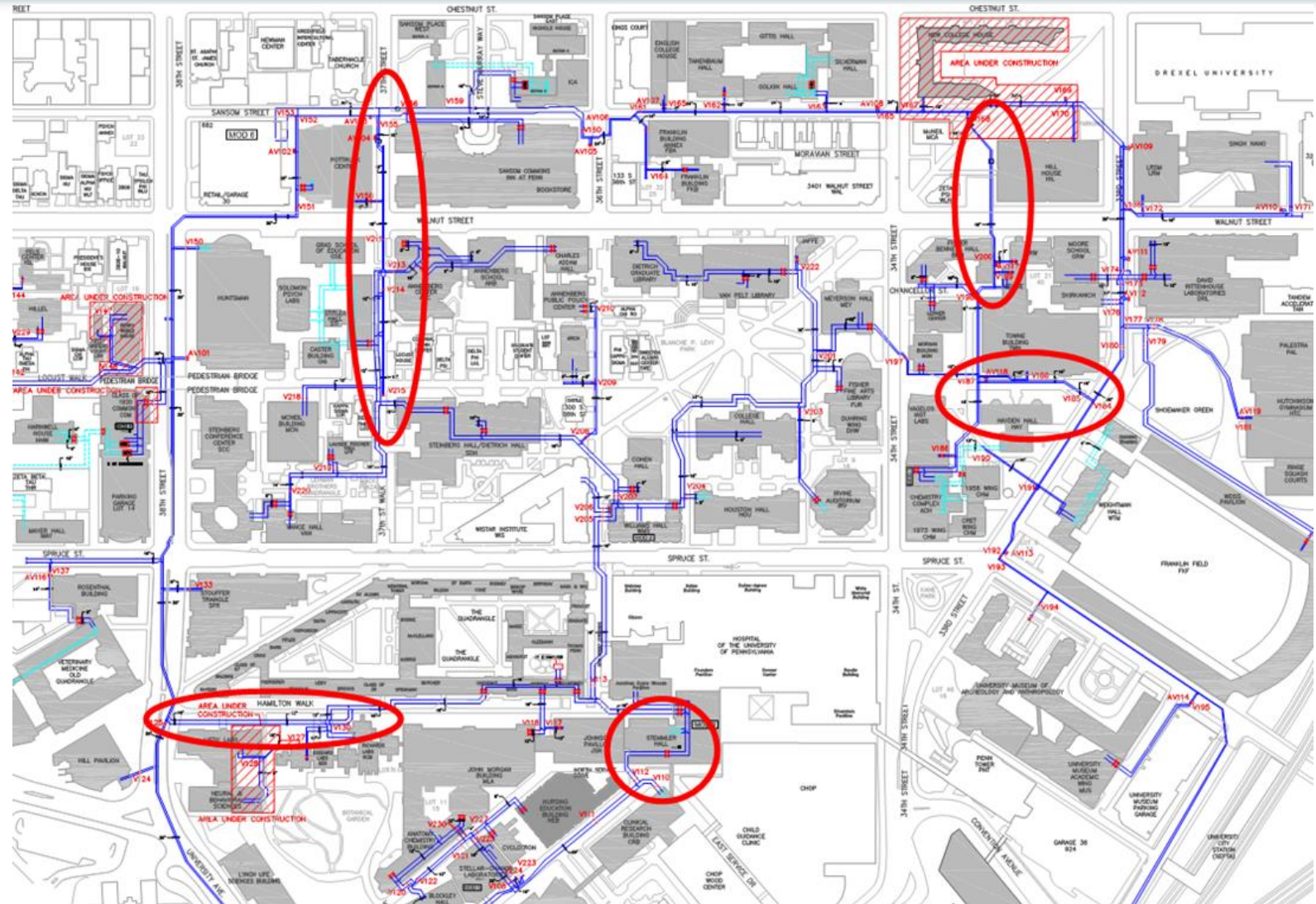




# CHW DISTRIBUTION CAPACITY ASSESSMENT

## DISTRIBUTION RESTRICTIONS

- 37<sup>TH</sup> ST
- HILL HOUSE
- TOWNE BLDG
- STEMMLER BLDG
- HAMILTON WALK



TREFZ ENGINEERING, INC.

**Burns**

# Chilled Water Piping Recommendations

## DISTRIBUTION EXPANSION

- 24" MAINS IN 34<sup>TH</sup> ST FOR PHASE 1
- 24" MAINS THROUGH 37<sup>TH</sup> AND SPRUCE ST FOR PHASE 1
  - TRIGGER: 4,500 TONS



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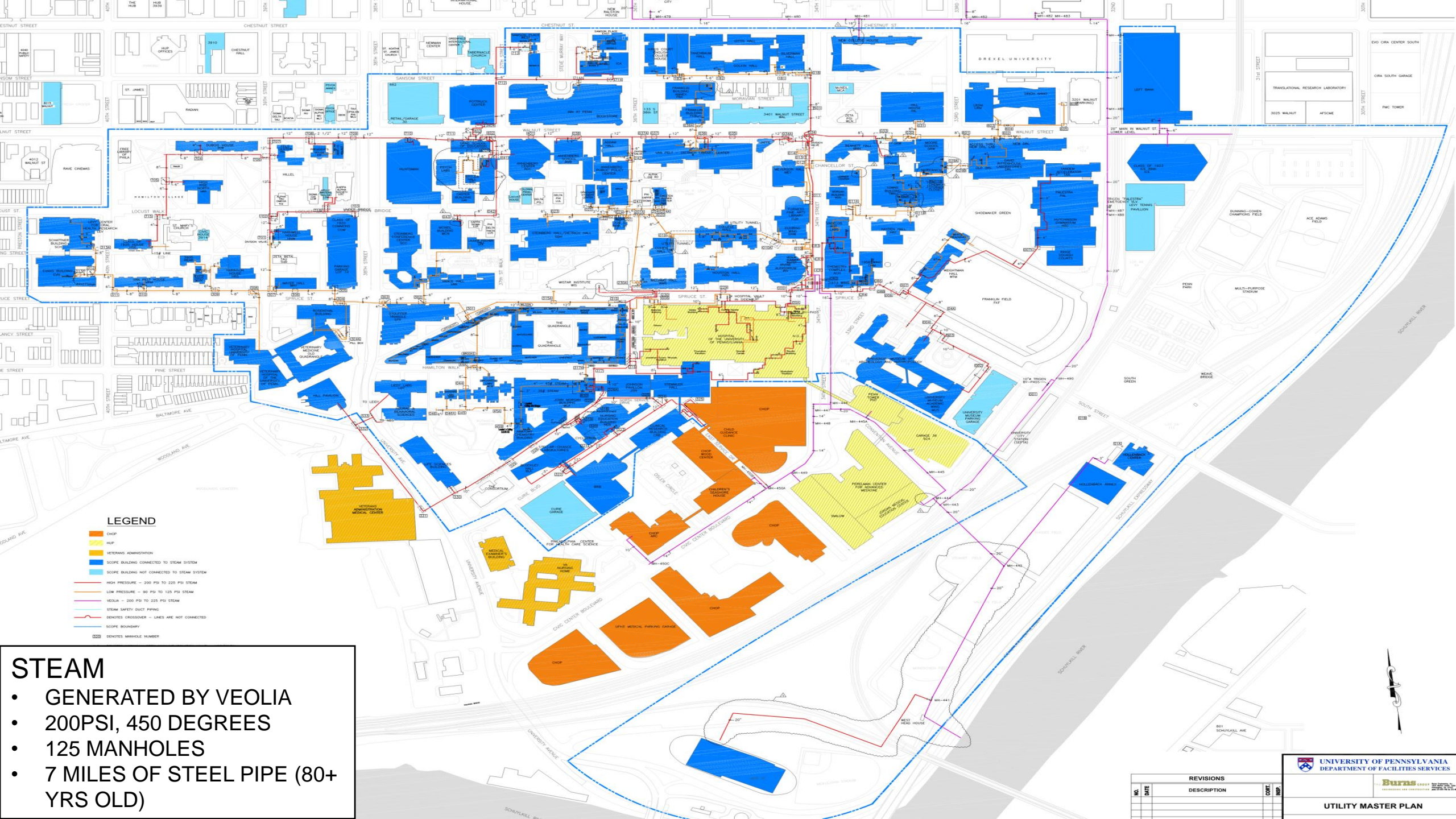


# Other Chilled Water Recommendations

- Building Primary/Secondary Interface
  - Update early generation interfaces to current standard
    - Add Instrumentation (DPT, TT, etc)
    - Add Pri/Sec Bridge
    - Add Flow Meters
  - Recommission control interface sequences
  - Calibrate instrumentation
- Plant Upgrades
  - Mod VI Controls



TREFZ ENGINEERING, INC.



LEGEND

- CHOP
- HUP
- VETERANS ADMINISTRATION
- SCOPE BUILDING CONNECTED TO STEAM SYSTEM
- SCOPE BUILDING NOT CONNECTED TO STEAM SYSTEM
- HIGH PRESSURE - 200 PS TO 225 PS STEAM
- LOW PRESSURE - 90 PS TO 125 PS STEAM
- VACUUM - 200 PS TO 225 PS STEAM
- STEAM SAFETY DUCT PIPING
- DENOTES CROSSOVER - LINES ARE NOT CONNECTED
- SCOPE BOUNDARY
- DENOTES MANHOLE NUMBER

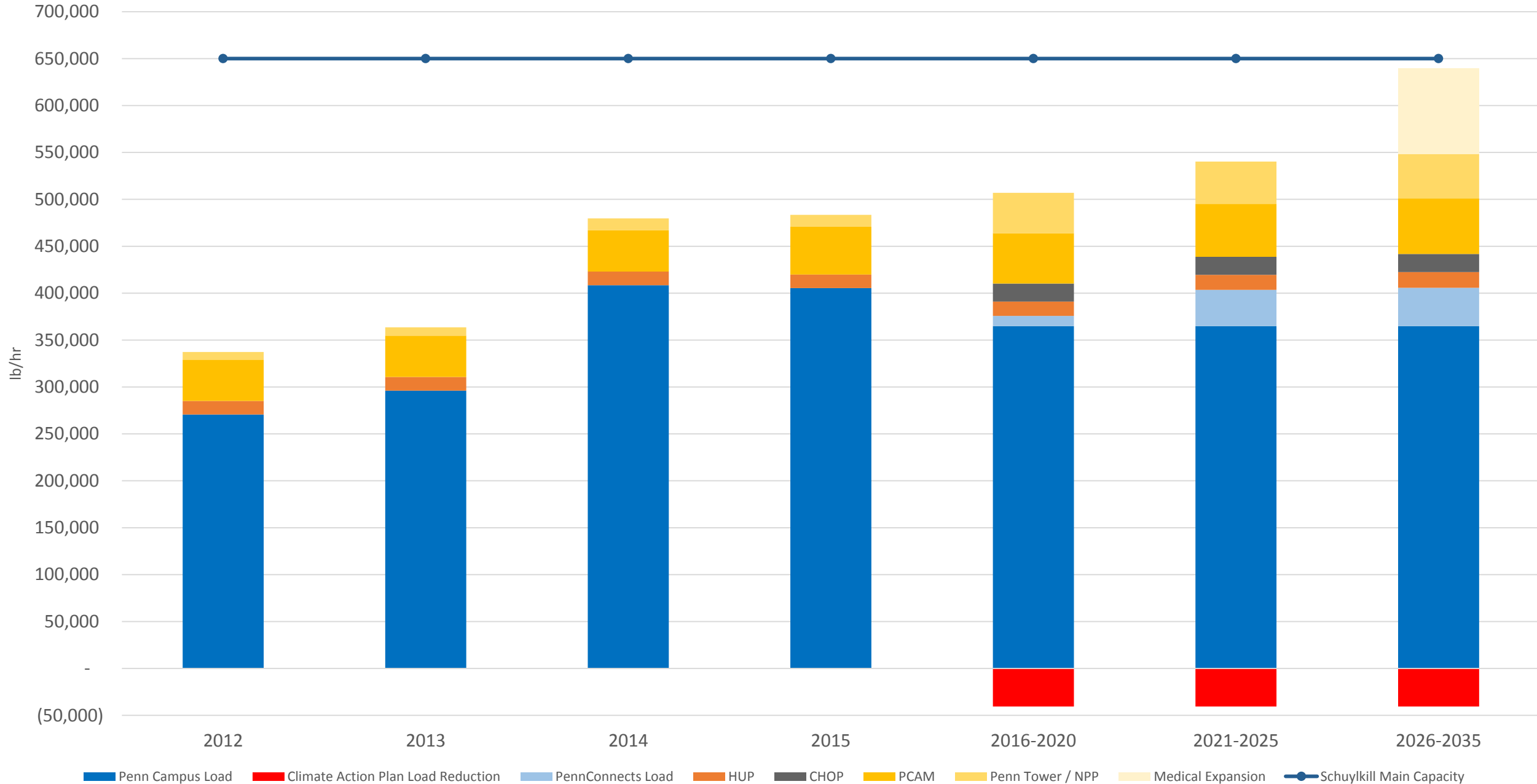
STEAM

- GENERATED BY VEOLIA
- 200PSI, 450 DEGREES
- 125 MANHOLES
- 7 MILES OF STEEL PIPE (80+ YRS OLD)

REVISIONS			
NO.	DATE	DESCRIPTION	BY



# Projected Campus Steam Demand



# Steam System Recommendations

- Additional Supply Line from Veolia
- Continue Piping Distribution renewal each summer
- Address some steam distribution bottlenecks when new loads come online



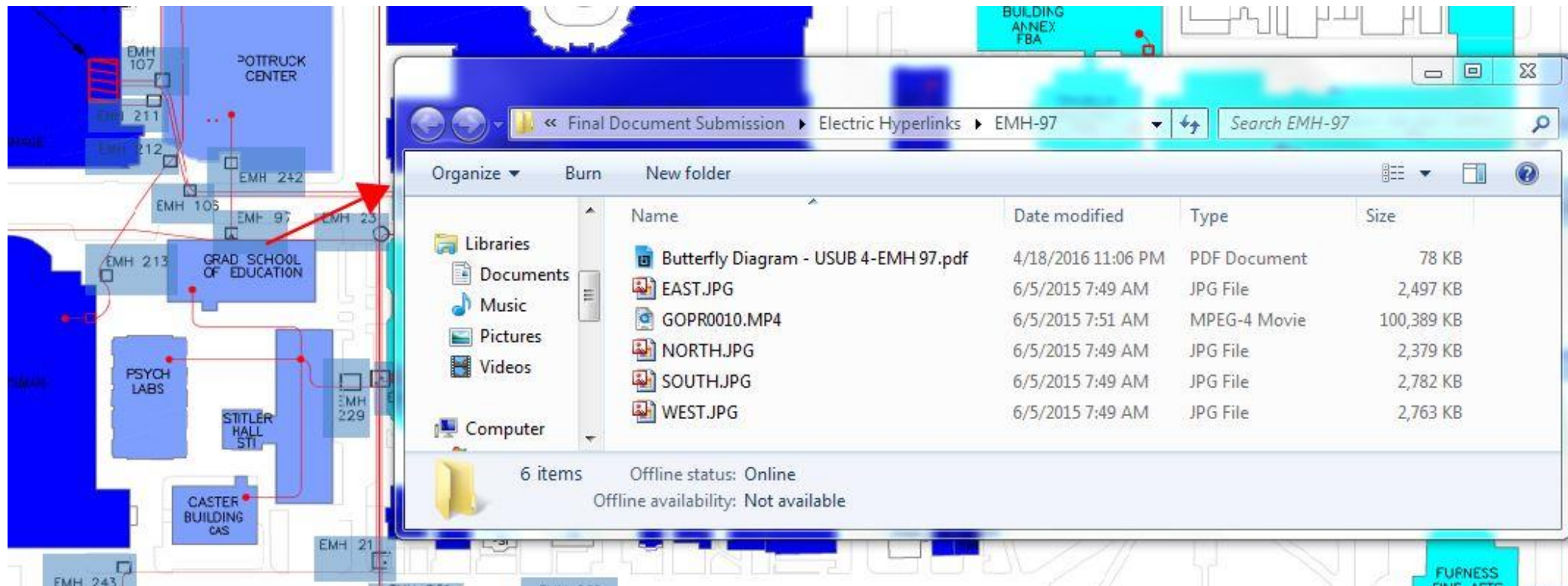


# Utility Master Plan Capital Plan

- Implementation of Recommendations
  - Projects are placed on the 5-year capital plans
  - Campus infrastructure projects funded through utility charges to schools and centers
  - Building specific utility renewals (e.g. switchgear) funded by building owner or through facility renewal funding
  - New buildings' fund extending or connecting utility distribution as part of project budget

# Consolidated Utility Records

- Makes information available in one location
- Access for Design & Construction, Engineering, & Operations





# Questions