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SHIVEHATTERY
ARCHITECTURE + ENGINEERING

50 Years of Chilled Water Distribution

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Iowa State University

- Land grant school founded in 1858
- 410 acres (Central Campus only)
- Cogeneration began in 1891
- Chilled water distribution planning began in 1968

Year	Campus Buildings Using Chilled Water	Chilled Water Distribution Cooling Load
1965	19	0 tons
1972	35	2,000 tons
2000	82	12,900 tons
2019	108	18,200 tons

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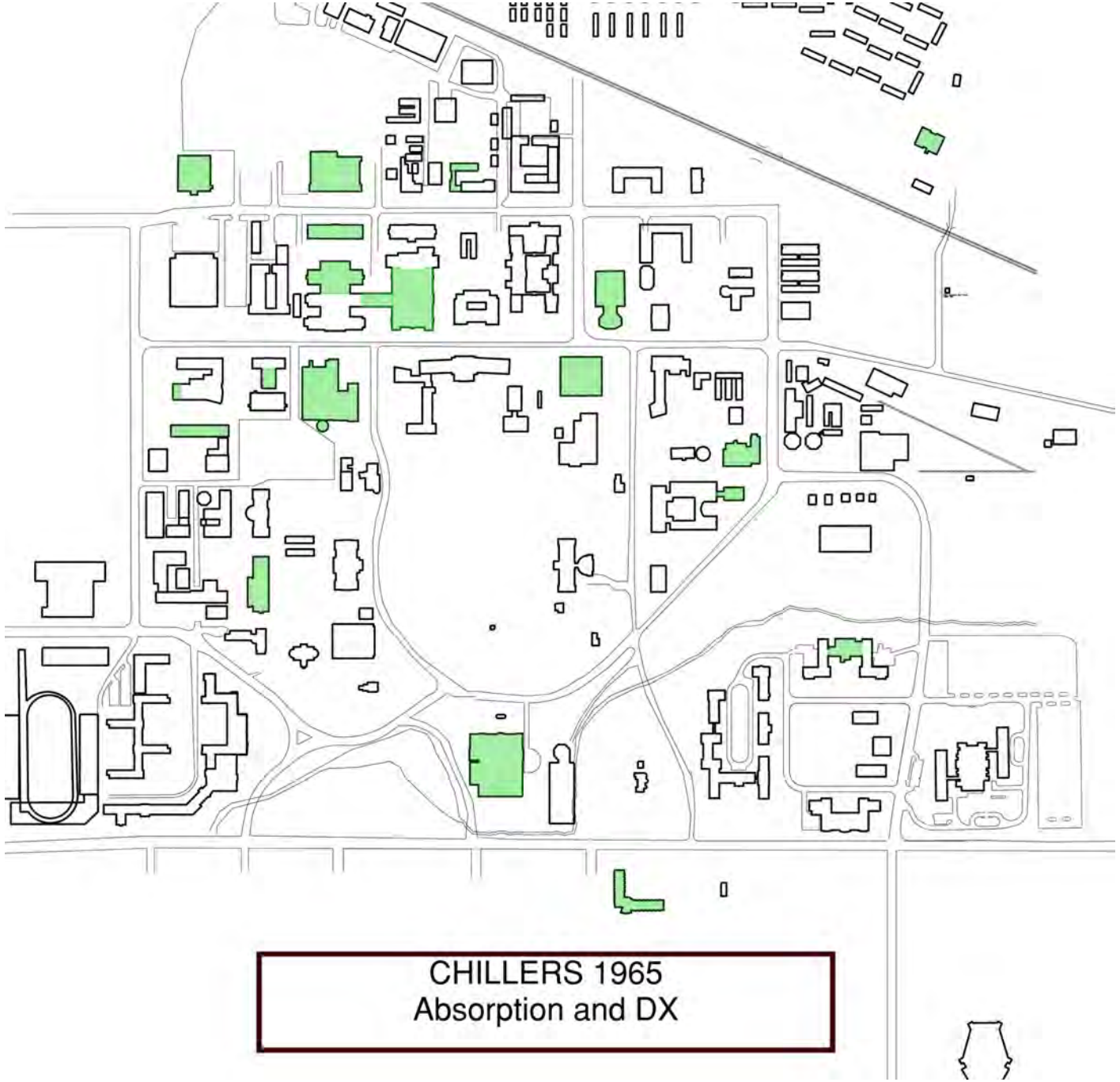
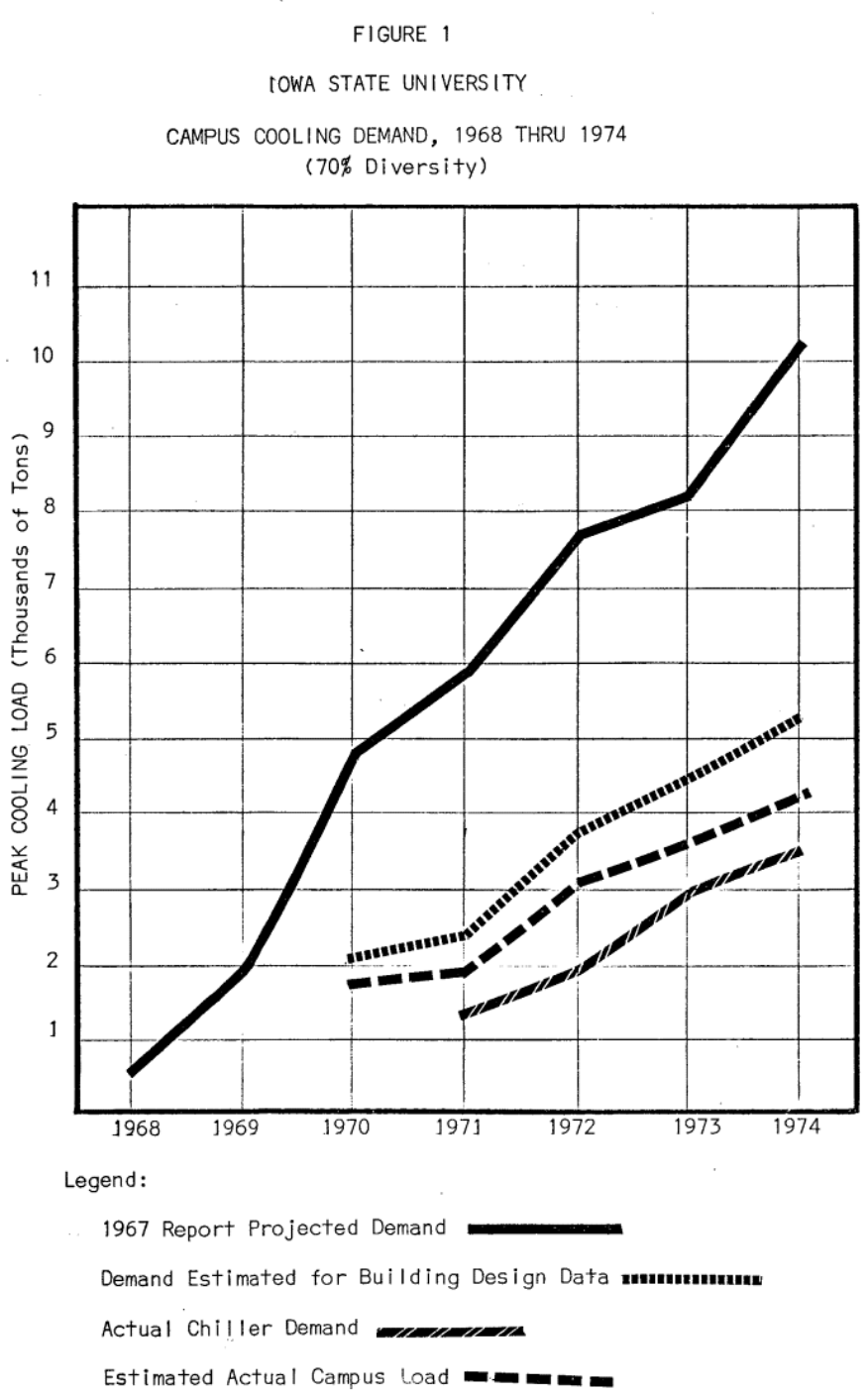
Chilled Water: **1965**





Central System: **Phase 1** *(1968 to 1972)*

- Foresighted program to provide central chilled water to campus
- Installed 5,000 tons of chiller capacity at the Power Plant
- First chillers were steam driven
- 31,000 ft of pipe over four years through the heart of campus (diameters up to 30”)
- Hybrid Primary/Secondary
  - Initially setup for 18°F ΔT at the Plant

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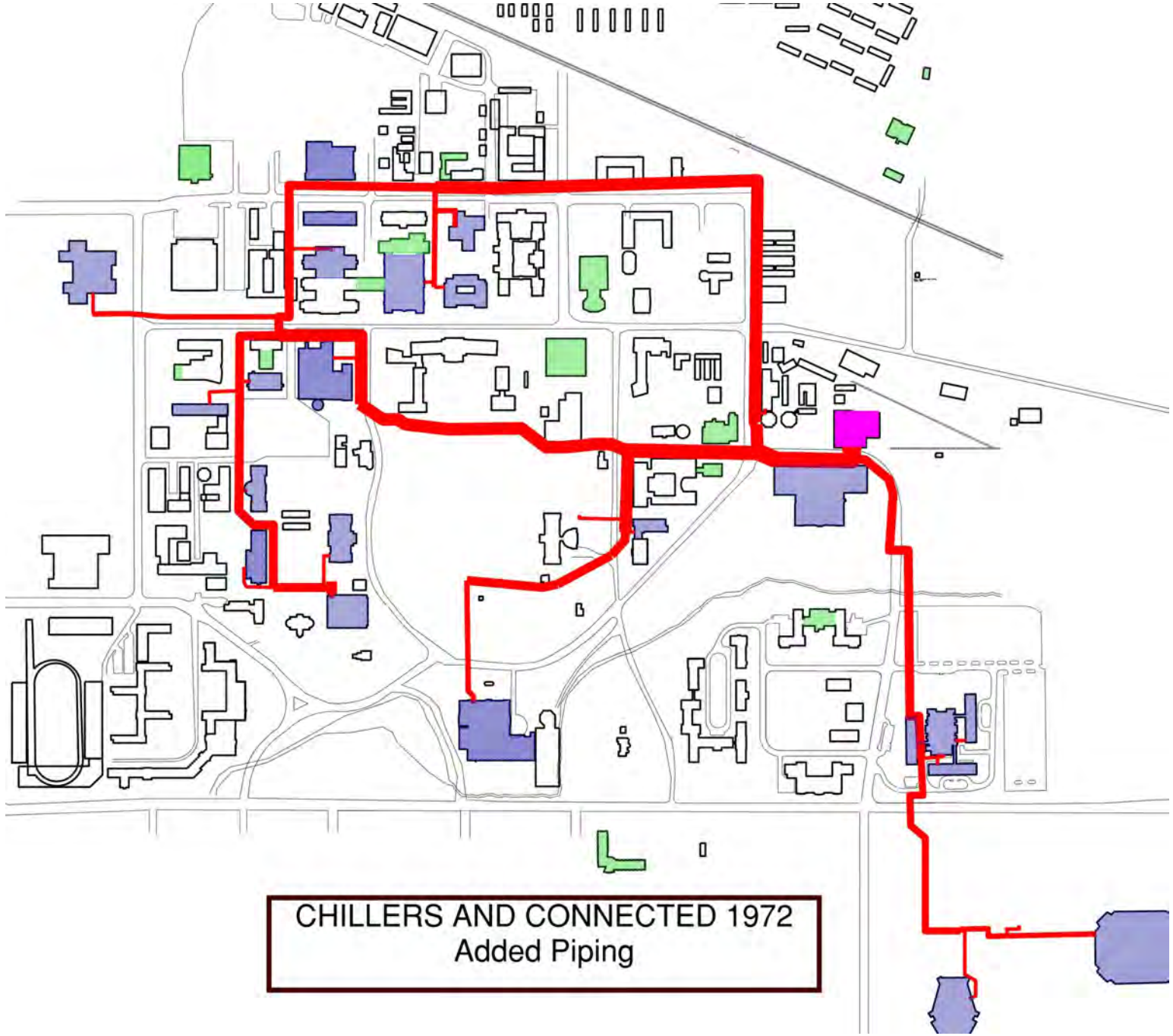
Chilled Water: 1972



Central System: **Phase 1**

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- Problems from the start
  - Difficulty with existing pumps and neutral bridges
    - Caused some buildings to “starve”
  - Building coils not designed for 18°F ΔT
  - System ΔT operated near 5°F
  - Chillers overflowed
  - Buildings not able to meet cooling demands

Central System: **Phase 2** ***(1972-2000)***

- Filled in the gaps in distribution mains
- Connected more buildings
- 3,000 ft of main line piping installed
- In 1993, the system was converted to variable/primary
  - Coils around campus replaced to achieve 20° ΔT
  - Conversion successful! Results increased capacity
- System was advertised as providing 16 psi Δ P at each building
  - Central Plant maintained 20 psi Δ P

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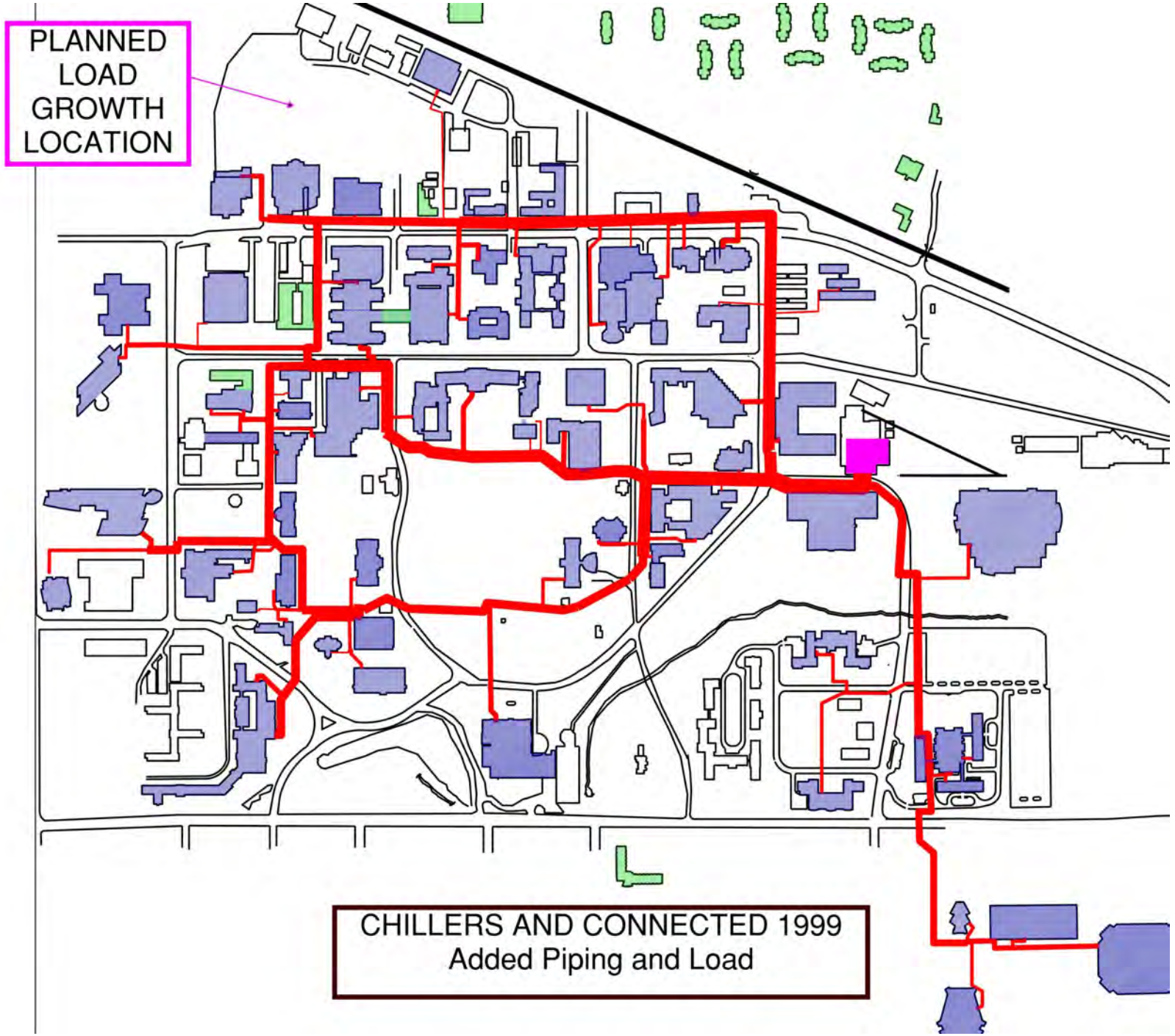
Planned Location of Future Load



Central System: **Phase 3** ***(2000-2019)***

- Load predictions revealed need for more chiller capacity
- 30-year-old backbone piping no longer sufficient
- North Chilled Water Plant added in 2004
- Site for the plant was based on:
  - Steam availability for 4,000 ton chiller
  - Future (large) building site planned adjacent to the plant
  - Politics
- System modeling updated
  - What piping sections to replace in order to make largest impact?

Central System: **Phase 3 Revised**

- Targets of opportunity:
  - **2004:** 30″ connection of new chiller to existing loop (740′).
  - **2007:** 24″ pipe with Coover Hall remodel (720′)
  - **2010:** 36″ connector section with Hach Hall utility corridor (740′)
  - **2017:** 30″ second connection to North Chiller Plant with the north chiller expansion (1,900′)

- Each pipe installation integral to nearby campus projects

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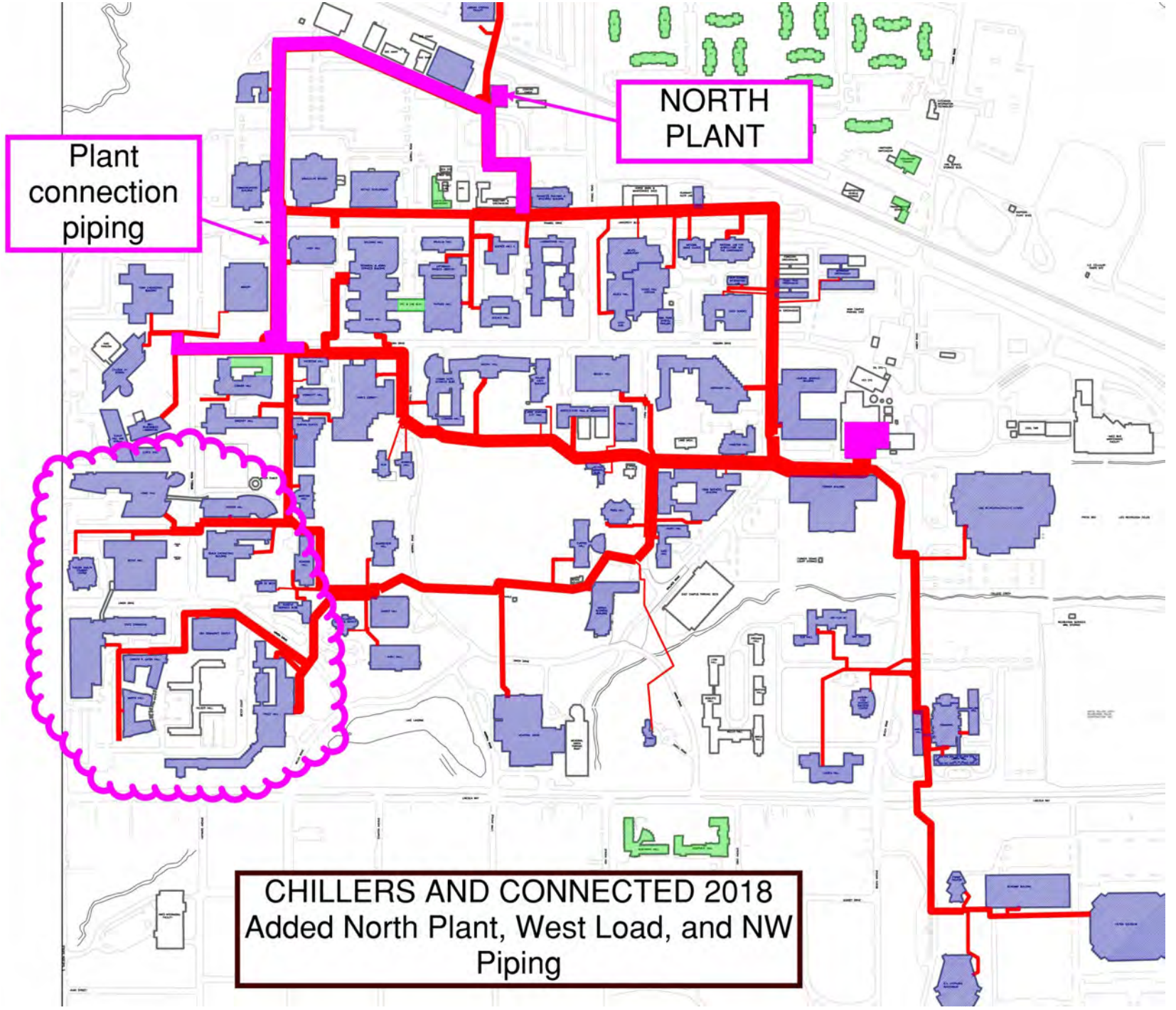
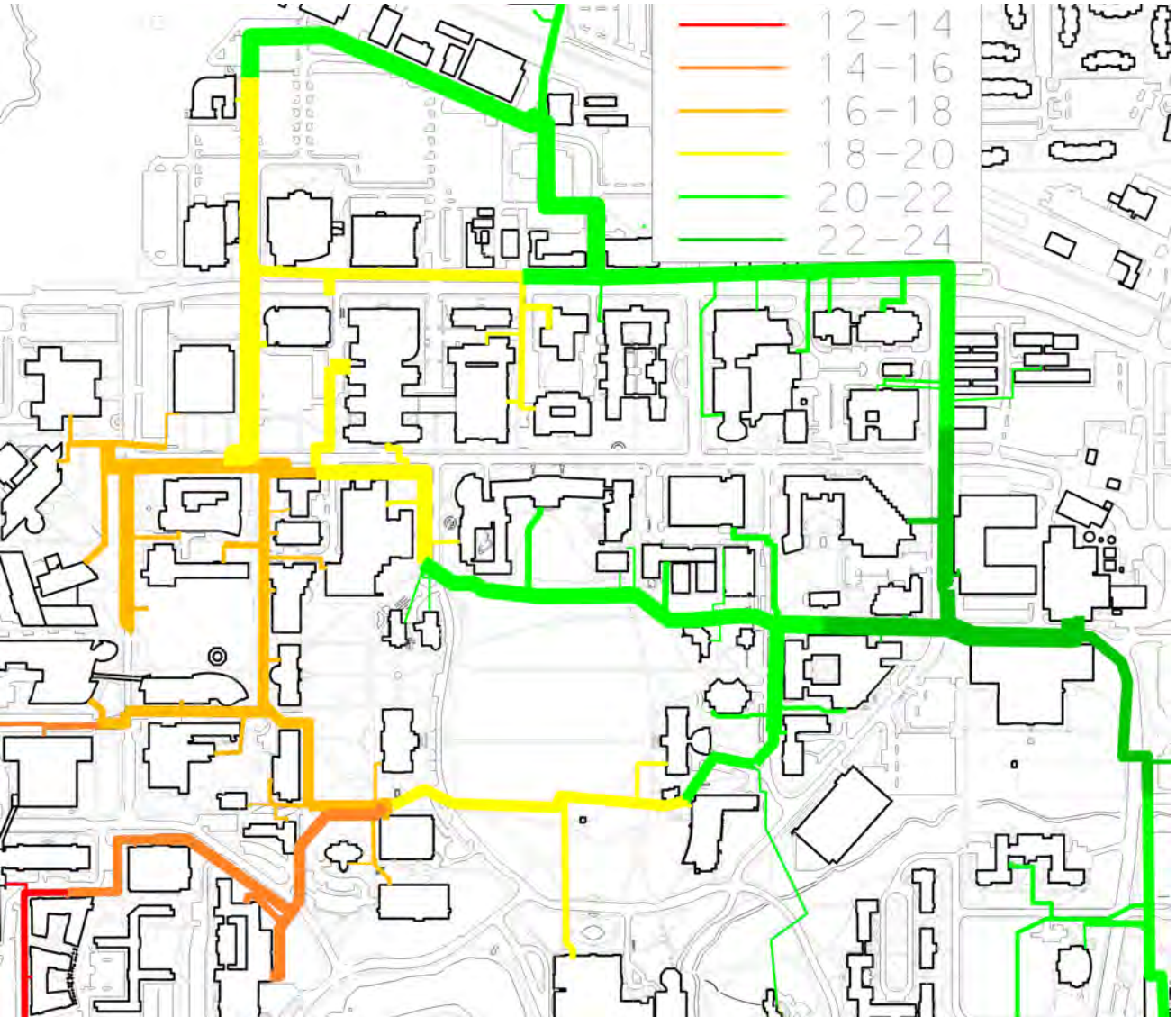
System as of **Spring 2018**



Central System: **Phase 3 Revised**



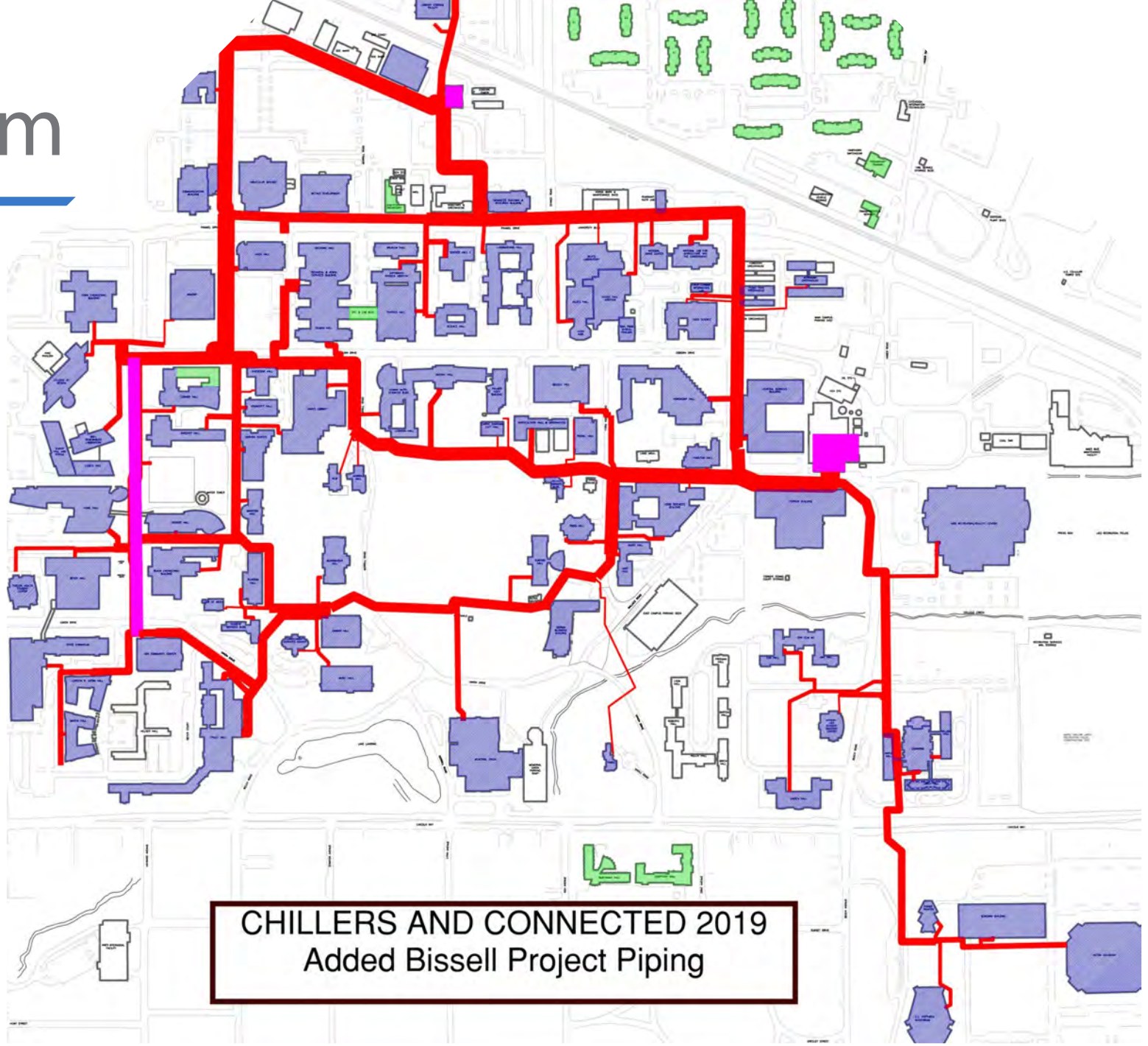
- Increased load was causing ΔP to drop on west campus
- Rarely able to maintain the advertised 16 ΔP
  - Plant responded by changing pressure control
  - The increased pressure had the effect of increasing load
- The SW section of campus was still seeing ΔP drop off

Central System: **Phase 3 Completion**

- As of 2017, system operation proved model predictions
  - Low ΔP on SW corner of campus
- This required upgrade to the distribution system under Bissel Road
- Bissel Road a major arterial through heart of campus
- Disruption to vehicular/pedestrian traffic was imminent

Central System

- The final leg of Phase 3 piping
  - 24” Diameter
- Shive-Hattery hired to design and coordinate the project



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Project **Aerial**

Bissel Road: Utility Upgrade

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- Storm water study incorporated into design
- Roadway master plan incorporated into design
- Coordination with adjacent project sites
  - Student Innovation Center Construction
  - Union Drive Re-construction Project

Bissel Road: Utility Upgrade

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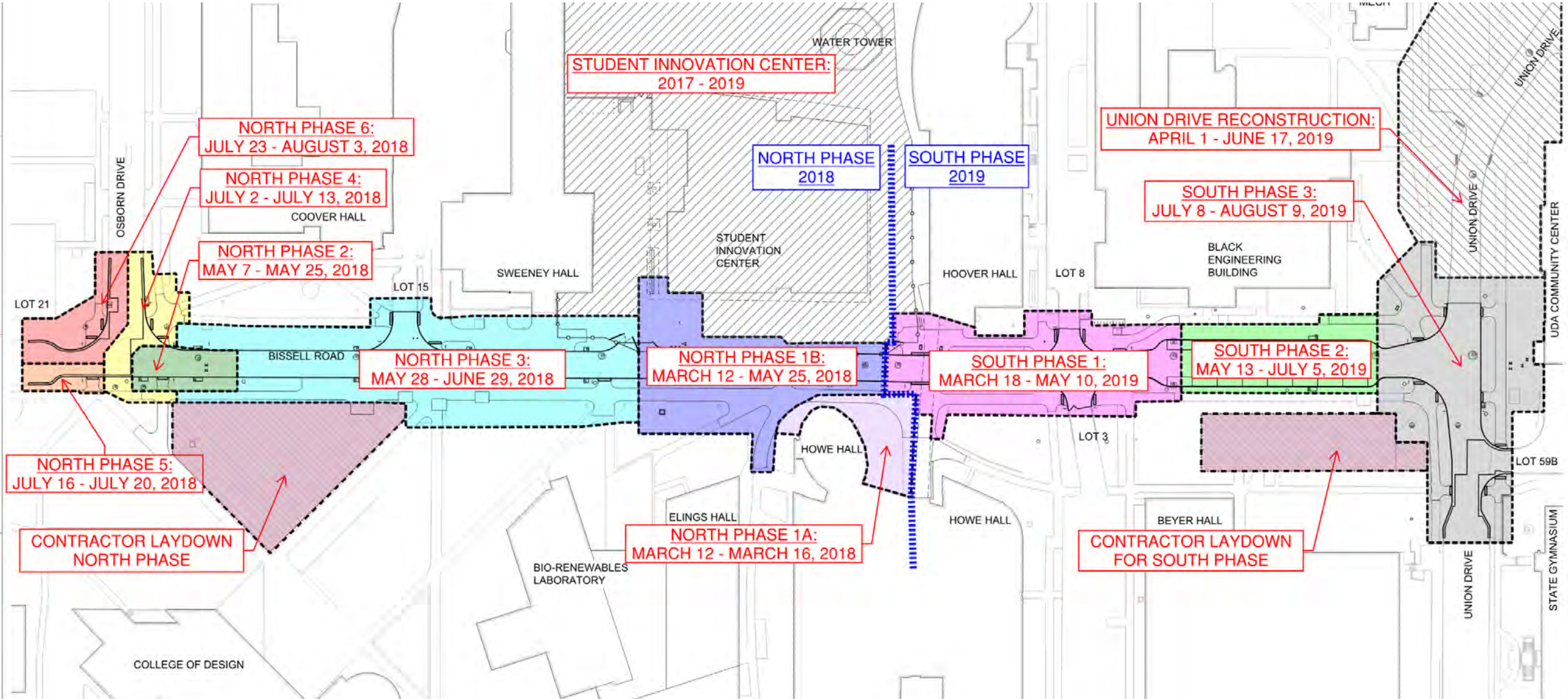
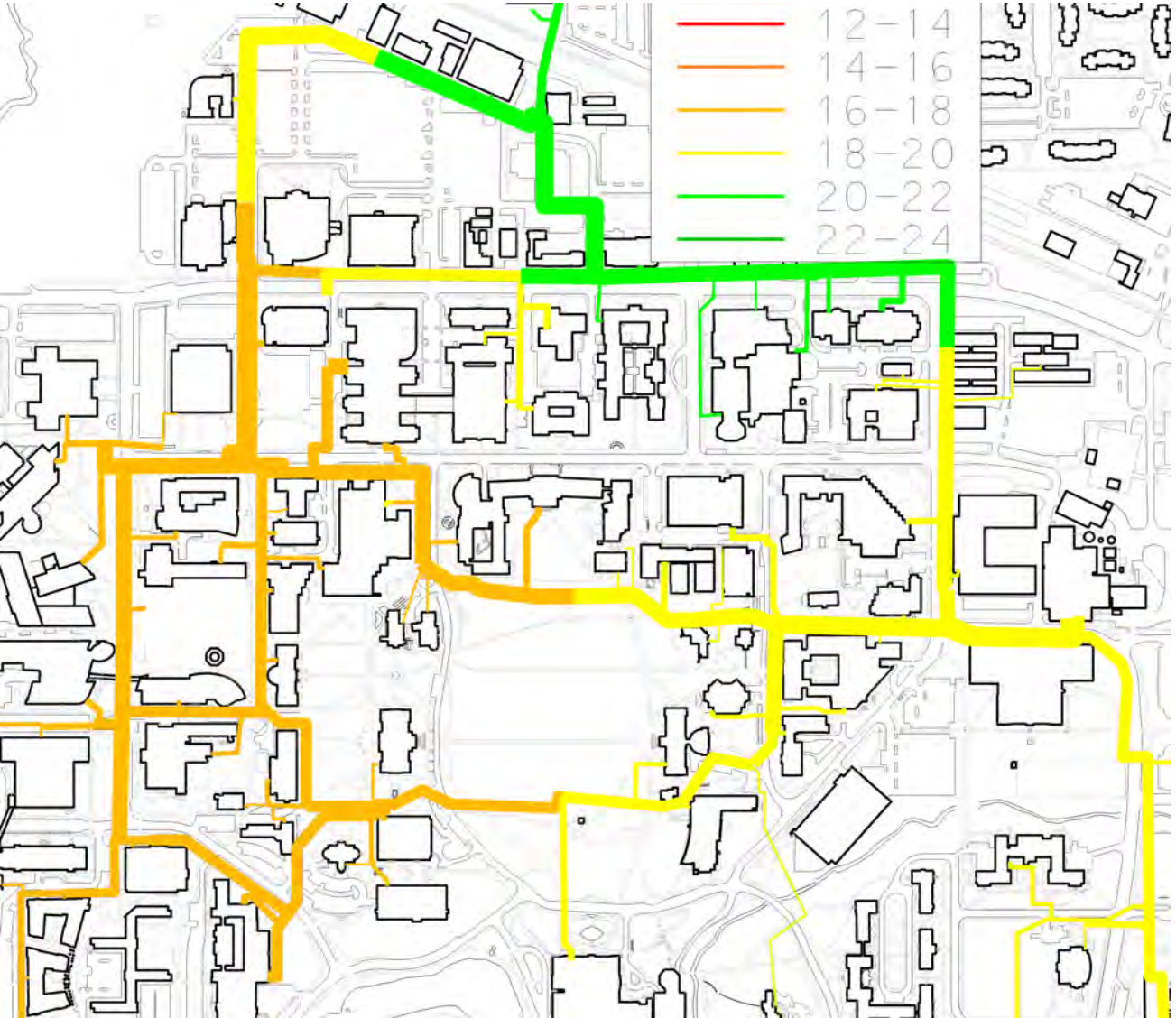
- $4M Construction Costs
- 1,300’ Chilled Water Mains – 24”
- 1,000’ Storm Sewer – 24” thru 42”
- 500’ Water Main – 10”
- 100’ Steam Tunnel Under Bissel Road
- (9) Construction Phases

Phasing: Key Plan



Bissel Road: Utility Upgrade



- The final section of pipe was put in service 7/26/19
- West campus ΔP returned to anticipated values
- Chiller plant reduced output pressure

System Pressure Improvements

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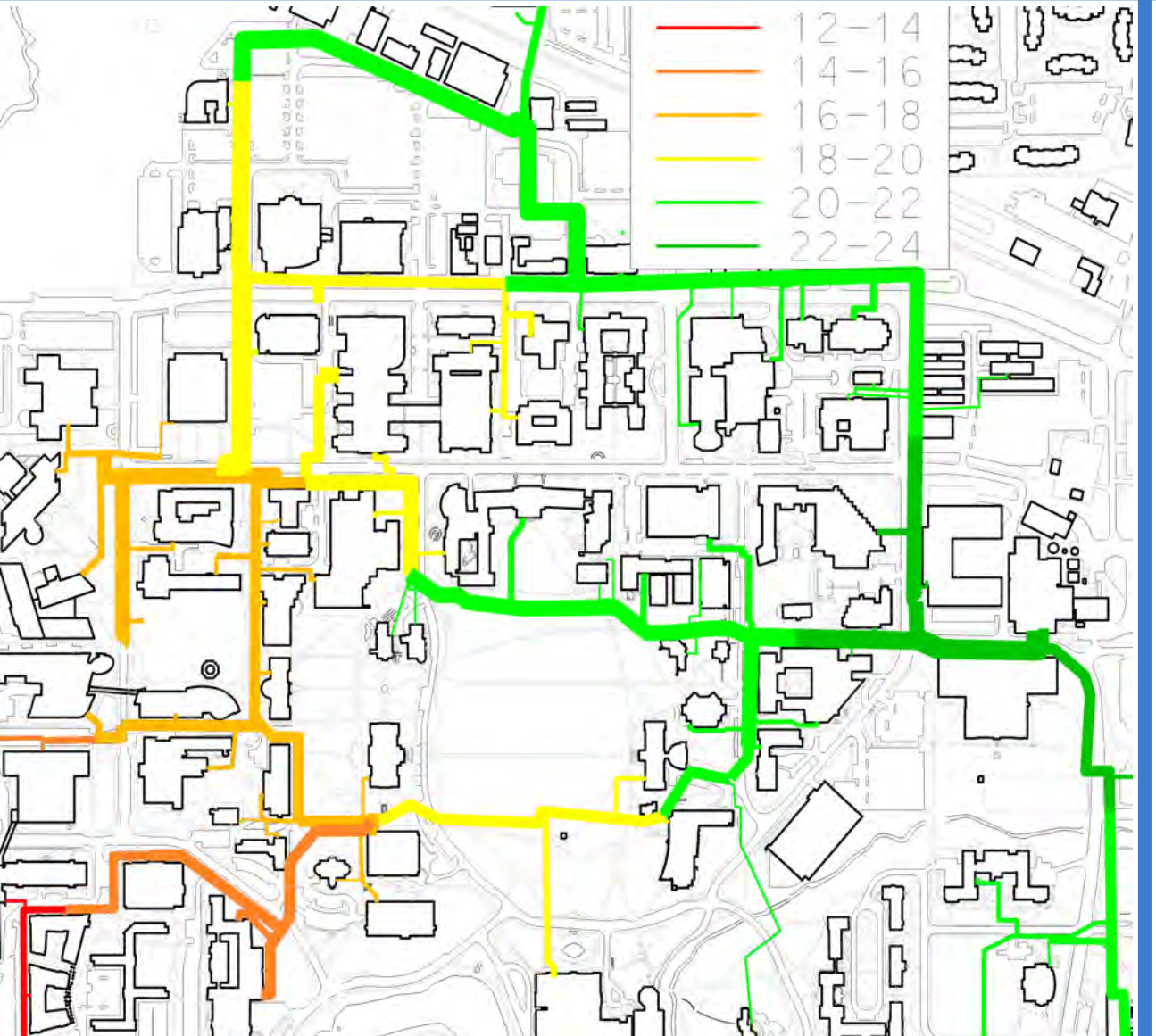

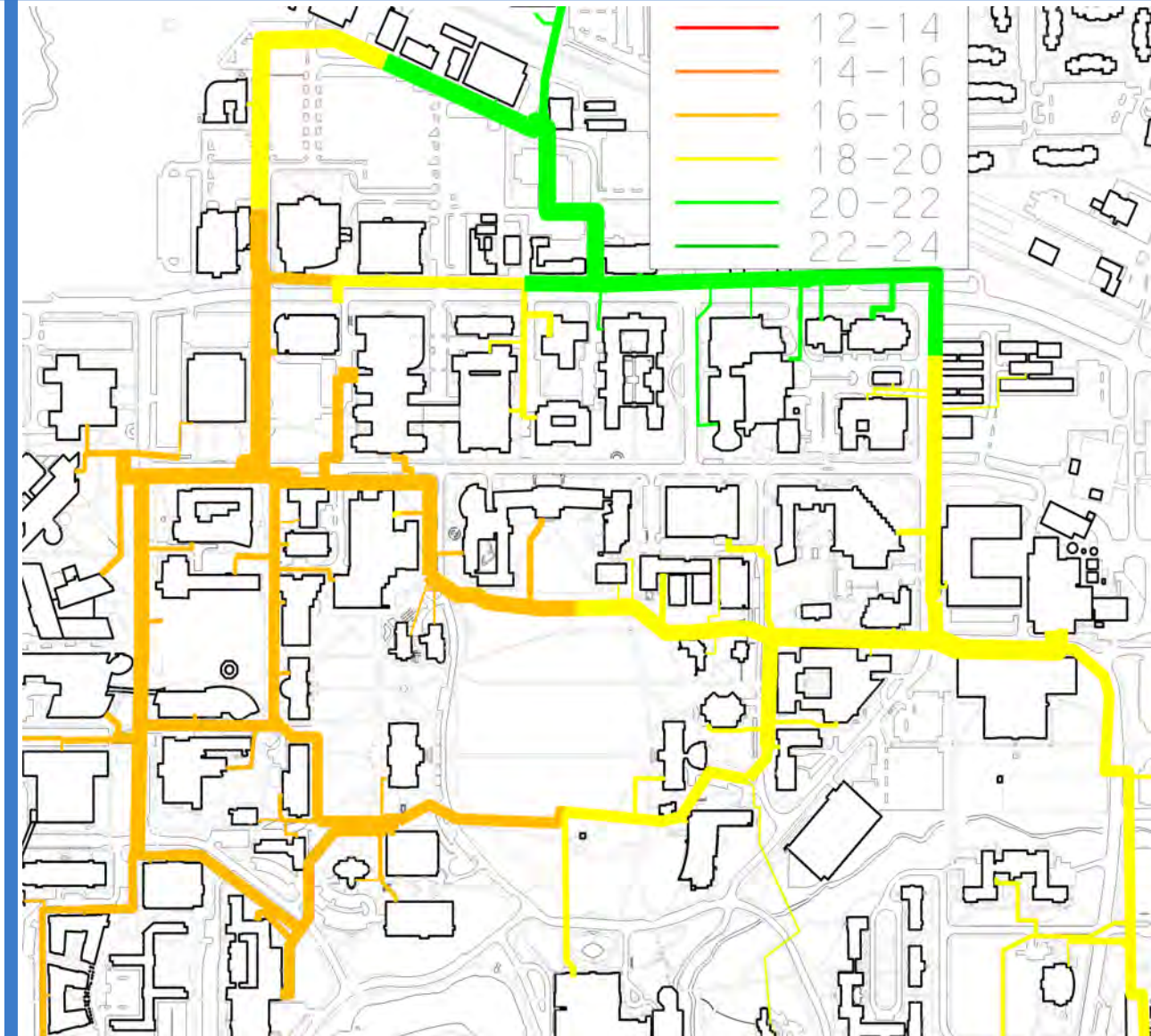

Lessons Learned

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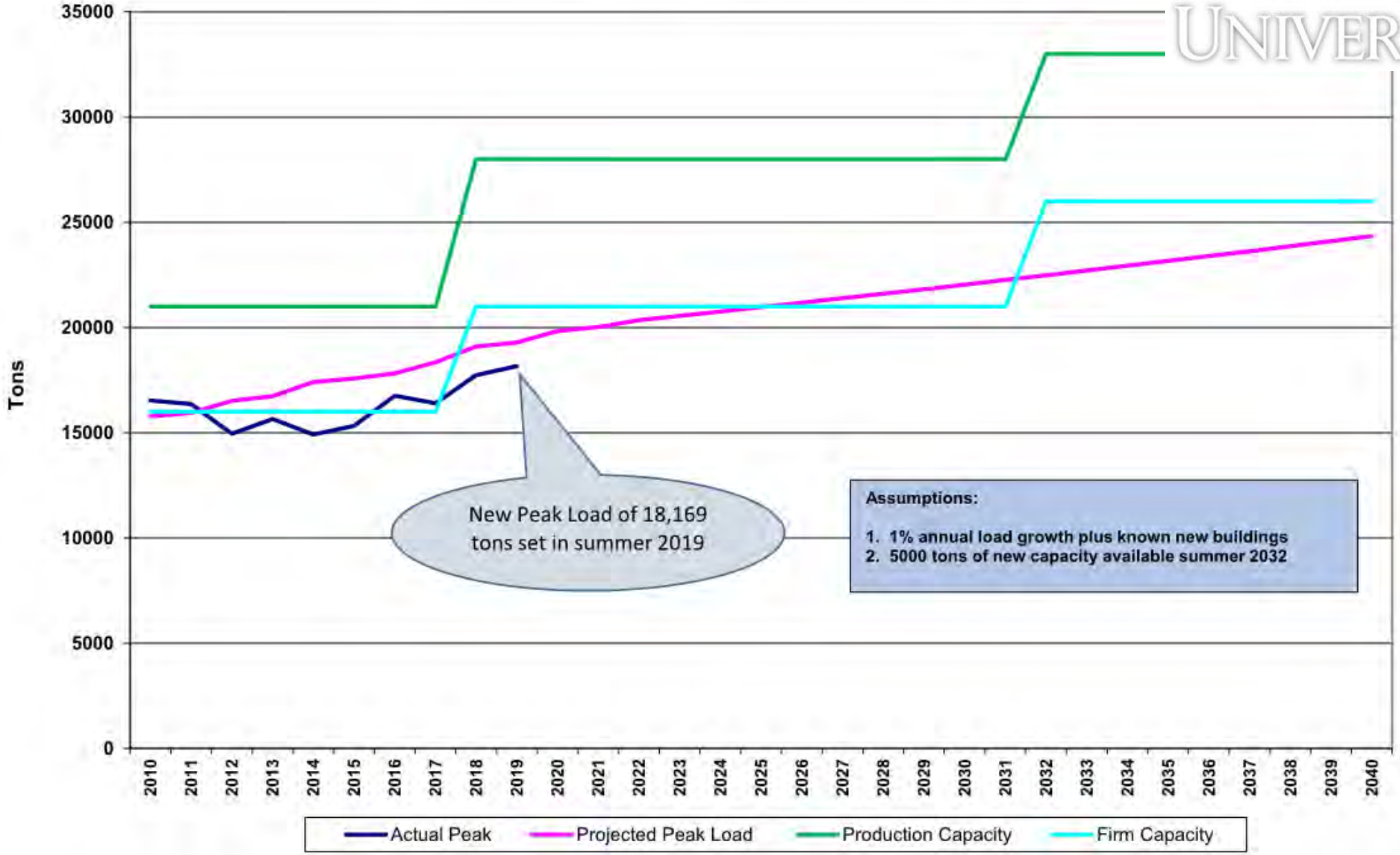
- On a well-looped system, location of additional loads not critical to overall system modeling
- Unanticipated load locations caused isolated areas of low ΔP for many years
- Forward-thinking modeling avoided capacity constraints
- Coordination with campus projects reduced disruption and costs
- Complex and disruptive projects can be completed with proper planning

Chilled Water Load Projections



Central System: Future Plant Location

- The distant future: Year 2030
  - Load growth predictions suggest campus demand will exceed the current plant capacities
  - North Chiller Plant is out of real estate
  - Piping from MPP at capacity
  - New chiller plant required

- **Siting is based on:**
  - Electric chillers are now more attractive
  - East Campus location requires several thousand feet of 36” piping
  - West Campus expansion
  - Plans for large West Campus parking ramp
  - Best use of the existing piping infrastructure

Questions

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Thank you!

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