Current Campus Master Plan
Agenda

- Summary of Existing Utilities
- Planning Criteria
- Load Management
- Load Projections
- Options for Exploring
Utilities Included

- High Pressure Steam and Condensate
- Low Pressure Steam and Condensate
- Chilled Water
- Compressed Air
- Electric Power
- IT Systems
- Domestic Water
- Sanitary Sewer
- Storm Sewer
Existing Campus Utility Services

Steam and Condensate Piping Distribution Map
Existing Campus Utility Services

Electrical Distribution Map
Existing Campus Utility Services

Water Distribution Map

Additional piping in Eagle Heights
Additional piping in Eagle Heights
Storm Sewer Distribution Map
Existing Campus Utility Services

Composite Utility Distribution
Steam and Condensate Overview

- **System Type**
  - 70% Walkable Tunnel
  - 28% Box Conduit
  - 2% Direct Buried

- **Age Distribution** (over 25 miles of piping)
  - 1% +80 Years
  - 2% 60-80 Years
  - 8% 40-60 Years
  - 16% 20-40 Years
  - 22% 0-20 Years
  - 50% Unknown
Chilled Water Overview

- **System Type**
  - 15% Walkable Tunnel
  - 0% Box Conduit
  - 85% Direct Buried

- **Age Distribution** (over 8 miles of piping)
  - 45% 20-40 Years
  - 55% 0-20 Years
Thermal Utility Upgrades

- Correct Deficiencies
  - Upgrade Control Systems
- Alleviate Distribution Piping Bottlenecks
- Replace Aging Equipment
- Cleanup Charter Street site???
- Add capacity to accommodate future growth
- Add energy meters at all significant buildings
Thermal Utility Production Overview

- **Walnut Street Plant**
  - 600,000 #/hr steam (heating for ~7,500 homes)
  - 18,000 tons chilled water (cooling for ~9,000 homes)

- **Charter Street Plant**
  - 800,000 #/hr steam (heating for ~9,000 homes)
  - 26,000 tons chilled water (cooling for ~13,000 homes)
  - 9 MWe Electric Production (power for ~900 homes)
West Campus Cogeneration Facility

- 500,000 #/hr steam (heating for ~6,250 homes)
- 20,000 tons chilled water (cooling for ~10,000 homes)
- 150 MWe Electric Production (power for ~15,000 homes) supplied to Madison area grid
### Electrical Substation Overview

<table>
<thead>
<tr>
<th>Substation</th>
<th>Capacity (MVA)</th>
<th>Homes Served</th>
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</thead>
<tbody>
<tr>
<td>East Campus Substation</td>
<td>14.0</td>
<td>~1,400 homes</td>
</tr>
<tr>
<td>West Campus Substation</td>
<td>14.0</td>
<td>~1,400 homes</td>
</tr>
<tr>
<td>Charter Street Substation</td>
<td>14.3</td>
<td>~1,400 homes</td>
</tr>
<tr>
<td>Walnut Street Substation</td>
<td>112</td>
<td>~11,200 homes</td>
</tr>
<tr>
<td>Randall Substation</td>
<td>7</td>
<td>~700 homes</td>
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<tr>
<td>Kohl Center Switching Stn</td>
<td>28.6</td>
<td>~2,900 homes</td>
</tr>
<tr>
<td>Athletic Off. Switching Stn</td>
<td>18.8</td>
<td>~1,900 homes</td>
</tr>
<tr>
<td><strong>Total Capacity</strong></td>
<td><strong>208.7</strong></td>
<td>(~20,900 homes)</td>
</tr>
</tbody>
</table>

20,000 homes ≈ 80,000 people or approximately the size of Janesville, WI

1 MVA = million volt-amperes
(Size of electrical facilities is listed in MVA, just as size of a storage tank might be listed in gallons.)
Electrical Distribution Overview

- Installed in Ductbank and Manhole System
- ~230,000 circuit feet (~175 miles of wire with 4 wires per circuit)
- Age Distribution
  - 8% +40 Years
  - 44% 20-40 Years
  - 23% 0-20 Years
  - 25% Undetermined Age
Electrical Distribution Upgrades

- Reinforce the system to improve reliability
  - Recircuit/re-cable overloaded circuits
  - Relocate cables from steam tunnels
  - Separate instances where primary and backup feeders are in the same ductbank and manholes
- Improve system monitoring to mitigate outages
- Add substation capacity for reliability/flexibility and cost control
Systems include:
- Computer networks
- Internet access
- Electronic file storage
- Email

Installed in Ductbank and Manhole System
- +180 Manholes
- +10 Miles of Underground Fiber Optic Ductbank
- +200 Building Service Entrances

Age Distribution
- ~10% +20 Years
- ~90% 0-20 Years
IT/Signal Upgrades

- Relocate cabling from steam tunnels to new ductbank locations
- 21st Century Network
  - Upgrade network speed to a 10-gigabyte backbone speed
  - Upgrade security
  - Reinforce the capacity of the three super nodes powering the network
  - Add access points for wireless access
Domestic Water Overview

- **System Summary**
  - 147,000 ft (~28 miles) of pipe ranging from ¾” to 24”
  - 25 Manholes
  - 144 Hydrants
  - 907 Water Valves

- **Age Distribution**
  - 7% 80 – +100 years
  - 55% 40 – 80 years
  - 19% 20 – 40 years
  - 19% 0 – 20 years

- **Water Supply Sources**
  - City of Madison
  - Village of Shorewood Hills
  - Direct connection to City mains

- **Water Usage**
  - 3,204,000 GPD – Average daily use
  - 32,000 people served
Domestic Water Upgrades

- Eliminate undersized mains
- Increase pressure in Eagle Heights
- Add isolation valves to high priority buildings
- Eliminate lines under buildings
- Replace obsolete piping materials
Sanitary Sewer Overview

- **System Type/Summary**
  - 102,760 ft (~19 miles) of pipe
  - Pipe size is 4” to 24”
  - 476 Manholes
  - 63% pumped - 12 pump stations

- **Wastewater flows to**
  - MMSD
  - City of Madison Interceptors
  - City of Madison Mains

- **Age Distribution**
  - 7% 80 – 100+ years
  - 50% 40 – 80 years
  - 33% 20 – 40 years
  - 10% 0 – 20 years
Sanitary Sewer Upgrades

- Improve reliability
- Televise older sewers to quantify condition
- Repair/replace older manholes
- Improve pump stations for more efficient and reliable operation
Storm Sewer Overview

- System serves:
  - Building roof drains
  - Area drains
  - Catch basins

- System Type/Summary
  - 122,640 ft (~23 miles) of pipe ranging from 3” to 68”
  - 777 Manholes
  - Pipe types: Vitrified Clay, Reinforced Concrete, Ductile Iron, or PVC

- Age Distribution
  - 4% 80 – +100 years
  - 41% 40 – 80 years
  - 32% 20 – 40 years
  - 23% 0 – 20 years
Storm Sewer Overview

790 Acres drain to Lake Mendota

230 Acres drain to Lake Monona
Storm Sewer Upgrades

- Improve system reliability
- Upgrade undersized storm sewers - Chamberlin Hall
- Routine system maintenance - entire system
- Erosion and water quality control - entire system
Storm Sewer Upgrades

- Techniques to improve quality of storm water
  - Rain Gardens
  - Cisterns
  - Water Quality Ponds
  - Swales
  - Green Roofs
  - Pervious pavements
  - Treatment units

- Reuse rain water for irrigation, etc.
Planning Principles

- Create high level of reliability and redundancy
- Implement planned phase out of old equipment
- Maximize energy efficiency and minimize energy cost
- Minimize maintenance requirements
- Maintain flexibility for future technologies
- Coordinate with building/transportation plan
- Investigate alternative energy resources
- Plan for future technologies
Load Management (Existing Buildings)

- Upgrade Boiler Controls (2-3% efficiency increase)
- Ongoing multiple year building energy conservation program through the Wisconsin Energy Initiative (WEI)
  - The energy conservation program has spent approximately $29,500,000 on building improvements
Load Management – WEI Accomplishments

- Energy audits performed for 12,000,000 SF
- Retrofitted lighting with newer lower wattage efficient fixtures
- Replaced 1000 electric motors with premium efficiency motors
- Installed variable speed driven electric motors
- Installed 2000 ultra low water usage plumbing fixtures
- Replaced/repaired 2700 steam traps
- Upgraded controls (occupancy sensors, HVAC energy monitoring)
- Adding 8000 storm windows
Load Management (New Buildings)

- **Current State Building Requirements:**
  - Building Envelope thermal insulation requirements exceeds ASHRAE Energy Standard 90.1
  - Selection of Mechanical Systems based on Life Cycle Cost Analysis
  - Mandatory use of heat recovery
  - Daylighting investigation
  - Investigation into Photo Voltaic (PV) use
Leadership in Energy and Environmental Design (LEED)

- Current State design specifications and criteria are equivalent to LEED Certification standards

Emphasis of LEED

- Sustainable site development
- Energy efficiency and atmospheric impact
- Water conservation
- Materials selection
- Indoor air quality (IAQ)
Utility Project Drivers

- Replace Obsolete Equipment due to:
  - Age
  - Condition
  - Efficiency

- Capacity Needs
  - Reduce energy consumption in buildings
  - Add new capacity when required based on load growth and distribution system
Utility Project Drivers

- **Environmental Improvements**
  - Higher efficiency usually means lower emissions
  - Evaluating fuel selection and changes in technology to reduce emissions
    - Improved boiler technologies
    - Improved controls
Load Growth Projections (Heating)

Adequate Plant Heating Capacity

WALNUT STREET CAPACITY

CHARTER STREET CAPACITY

WCCF CAPACITY

ESTIMATED HEATING LOAD GROWTH

STEAM LOAD (LBS./HOUR)

TIMELINE

Phase 1

Phase 2

Phase 3
Load Growth Projections (Cooling)

Adequate Plant Cooling Capacity

<table>
<thead>
<tr>
<th>COOLING LOAD (TONS)</th>
<th>ESTIMATED COOLING LOAD GROWTH</th>
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<tbody>
<tr>
<td>WALNUT STREET CAPACITY</td>
<td></td>
</tr>
<tr>
<td>CHARTER STREET CAPACITY</td>
<td></td>
</tr>
<tr>
<td>WCCF CAPACITY</td>
<td></td>
</tr>
</tbody>
</table>

TIMELINE

- Phase 1
- Phase 2
- Phase 3
Load Growth Projections (Electrical)

Potential Shortage of Electrical Capacity

TIMELINE

ELECTRICAL LOAD (kVA)

INSTALLED SUBSTATION CAPACITY

ESTIMATED ELECTRICAL LOAD GROWTH
Thermal Utility Expansion Requirements

- Existing Heating & Cooling Plants
- Future Cooling Plant
- Section of campus that will require additional cooling plants
Thermal Utility Expansion Requirements

Sample Campus Cooling Plants
Electrical Utility Expansion Requirements

- Existing Electrical Substation
- Future or Expanded Electrical Substation
Options for Exploring (Increase Efficiency)

- Investigate High Efficient Energy Generation Methods:
  - Cogeneration with Combustion Turbines (similar to WCCF)
  - Clean burning coal techniques (atmospheric fluidized bed combustor - AFBC)
Options for Exploring (Increase Efficiency)

New AFBC Heating Plant at UNC

- Cleaner burning coal techniques (atmospheric fluidized bed combustor - AFBC)
Options for Exploring (Increase Efficiency)

New AFBC Heating Plant at UNC
Options for Exploring (Increase Efficiency)

New AFBC Heating Plant at UNC
Options for Exploring (Increase Efficiency)

- Thermal Energy Storage (chilled water) – reduces electrical use for chilled water generation during peak times.
Commitment to Increasing the use of Alternative/Renewable Energy Resources

- Increase co-firing of coal boilers with renewable biomass energy resources
  - Waste wood products, corn stalks, energy crops (grasses, trees)
  - Historically the waste source must be in <50 mile radius
- Photovoltaic cells (electricity from solar energy)
Options for Exploring (Renewable Energy)

- Wind Power (purchase off site through utility provider)
- Hydrogen (fuel cells)
- Geothermal
Options for Exploring (Sustainable Design)

- Commitment to Sustainable Building Design
  - Storm water reuse
  - Reclaimed water
  - Day lighting
  - Heat Recovery (recovering heat from exhaust air streams)
  - Chilled beams to reduce building airflows in research labs, fan energy, cooling load, etc.