Chicago Pump Station Upgrades Expected to Achieve LEED® Certification and Reduce Carbon Footprint

Presenter:
Steven Hall, PE, LEED AP
Project Electrical Engineer
AECOM
Springfield Avenue Pumping Station
Conversion from Steam to Electric Power
Capital Improvement Project
Chicago Department of Water Management
Overview of presentation

Project background and history

Scope of project improvements

Chicago’s commitment to environmental stewardship

SAPS sustainable design focus:
- Reduction of carbon footprint
- Green roof
- Renewable energy
- Stormwater management
- LEED building design
- Community improvement: added park space
Springfield Avenue Pumping Station

Built in 1901
Steam powered pumps
Originally coal fired boilers
Now natural gas
Natatorium (swimming pool) – now demolished
Various upgrades over the years
Springfield Avenue Pumping Station

- Tight site
- Urban area
Springfield Avenue Pumping Station

5 horizontal centrifugal pumps
  • 3 - 80 MGD
  • 2 - 60 MGD

Steam turbine allows variable speed

Pump on demand operation

No distribution system storage
Scope of project improvements

Conversion of 360 MGD municipal water pumping station from steam to electric power
Scope of project improvements

Electric station

3 – 3250 hp motors

2 – 2250 hp motors

5 – Variable frequency drives

5 – 2000 kW diesel standby generators
Scope of project improvements

Green design elements included carbon footprint analysis, green roof design, photovoltaic array design and LEED certification

Reduction of energy, operations and maintenance costs are project drivers
Chicago’s Commitment to Environmental Stewardship
Chicago’s commitment to environmental stewardship

Chicago leads the nation in environmental initiatives

• Planting ½ million trees
• Installing “Green” roofs on city buildings
• Mandating environmentally friendly buildings
• Implementing storm water management
• Climate plan to lower GHG emissions
Chicago’s commitment to environmental stewardship

Roof top garden on City Hall
Chicago’s commitment to environmental stewardship

Roof top garden on City firehouse
Chicago’s commitment to environmental stewardship

Millennium Park – World’s largest roof top garden?
SAPS Environmental Design Focus

Reduction of carbon footprint
Green roof
Renewable energy
Stormwater management
LEED® building design
Community improvement: added park space
Reduction of Carbon Footprint
Reduction of Carbon Footprint

A stack like this leaves a big footprint!

- 240 feet high
- 9.75 foot top diameter
- Built in 1948
Reduction of Carbon Footprint

SAPS boiler house

4 high pressure Edgemoor steam boilers

420 psig

150 degrees F superheat

Natural gas fired with fuel oil backup

Installed 1953 & 1954
Reduction of Carbon Footprint

Existing Springfield Pumping Station (steam)
Based on annual pumpage of 27,878 MG

<table>
<thead>
<tr>
<th>Energy used</th>
<th>Energy source</th>
<th>Tons CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,901,449 Therms</td>
<td>Natural gas</td>
<td>23,271</td>
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<tr>
<td>6,970 gallons</td>
<td>No. 2 Fuel Oil</td>
<td>89</td>
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<tr>
<td>922,139 kWh</td>
<td>Electricity</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>23,724</td>
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</tbody>
</table>

23,724 Tons CO2 per year
1,702 lbs CO2/MG Emission Rate
Reduction of Carbon Footprint

Similar CDWM electric pumping station
Based on annual pumpage of 39,671 MG

<table>
<thead>
<tr>
<th>Energy used</th>
<th>Energy source</th>
<th>Tons CO2</th>
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</thead>
<tbody>
<tr>
<td>10,215 Therms</td>
<td>Natural gas</td>
<td>61</td>
</tr>
<tr>
<td>8,494 gallons</td>
<td>No. 2 Fuel Oil</td>
<td>109</td>
</tr>
<tr>
<td>22,495,974 kWh</td>
<td>Electricity</td>
<td>8,858</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>9,027</strong></td>
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</tbody>
</table>

9,027 Tons CO2 per year
455 lbs CO2/MG Emission Rate
Reduction of Carbon Footprint

UPGRADED Springfield Pumping Station (electric)

<table>
<thead>
<tr>
<th>Annual pumpage</th>
<th>Emission Rate</th>
<th>Tons CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>27,878 MG</td>
<td>455 lbs CO2/MG</td>
<td>6,344</td>
</tr>
</tbody>
</table>

Potential CO2 savings from conversion:
- 23,724 Tons using steam power
- 6,344 Tons using future electric power
- 17,380 Tons CO2 per year
Reduction of Carbon Footprint

17,380 Tons CO2 annual savings
70% reduction
Annual GHG Equivalent of:
  • 2,888 cars from the road
  • 36,667 barrels of oil
  • 1,392 homes
  • 400,000+ tree saplings planted
Projected energy savings:
  • $2.2 million annually
Green Roof
Green roof
Intensive vs. extensive design
Plant types: individual, trays or mats
Low maintenance
Plants need to be hardy, drought resistant
Native vegetation
Recommended:
Extensive monolithic system with pre-grown sedum mats
Green roof

Benefits:
Best chance of success
Instant green
Less water to establish
Quick installation
Renewable Energy
Renewable Energy

SAPS estimated annual electrical usage
16,000,000 kWh

Renewable energy could not provide a meaningful percentage for pumping requirements

Demonstration project to provide portion of station “domestic” energy needs
Renewable Energy

Evaluated 3 technologies: Wind, Solar hot water, Photovoltaic

Ease of integration
Low maintenance
Availability of alternate funding

Recommended:
Photovoltaic
Facts and Figures

30kW Solar Array
  • 4500 sq ft
Green roof
  • 9075 sq ft
Pavers (29 SRI)
  • 1075 sq ft
Stormwater Management

Chicago Stormwater Ordinance

- Detention to control runoff rate
- Detention to capture $\frac{1}{2}$ inch rainfall
- Consider entire City site, SAPS, Beilfuss, Fire Station
Stormwater Management

SAPS Site Constraints

• Crowded
• Major water mains
• Need for construction lay down area in the park
• Need to restore park area after construction
Stormwater Management

Proposed Detention:

• Buried storage
• In the park in the old Natatorium area
• Must avoid existing water shaft
Stormwater Management

460’- 84” diameter concrete pipe used as detention

132,000 gallons of capacity
LEED® Building Design
LEED® Building Design

Leadership in Energy and Environmental Design
United States Green Building Council
Goal for City of Chicago new municipal construction
New SAPS Electrical Building will be LEED® Certified
AECOM Project Summary

AECOM’s scope only included the design phase of the project

Identify potential LEED® credits

LEED Certifiable Design ready to be handed off for construction

• Access to LEED® Online with all completed templates uploaded
• Binder of completed credit templates
LEED® Building Design

Four levels of LEED-NC certification (V 2.2):

- Certified Level  26 - 32 points
- Silver Level     33 - 38 points
- Gold Level      39 - 51 points
- Platinum Level  52+ points (69 possible)

SAPS design has the ability to achieve LEED Certification

During construction it may be possible to achieve LEED Silver
## Anticipated Credits

<table>
<thead>
<tr>
<th>Prereq 1</th>
<th>Erosion and Sedimentation Control</th>
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<tbody>
<tr>
<td>SS 2</td>
<td>Development Density &amp; Community Connectivity</td>
</tr>
<tr>
<td>SS 4.1</td>
<td>Alternative Transportation - Public Transportation</td>
</tr>
<tr>
<td>SS 4.2</td>
<td>Alternative Transportation - Bike Storage and Changing rooms</td>
</tr>
<tr>
<td>SS 4.3</td>
<td>Alternative Transportation - Low emitting &amp; fuel efficient vehicles</td>
</tr>
<tr>
<td>SS 4.4</td>
<td>Alternative Transportation - Parking Capacity</td>
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<tr>
<td>SS 5.2</td>
<td>Reduced Site Disturbance - maximize open space</td>
</tr>
<tr>
<td>SS 6.1</td>
<td>Stormwater Management - Rate and Quantity</td>
</tr>
<tr>
<td>SS 6.2</td>
<td>Stormwater Management - Treatment</td>
</tr>
<tr>
<td>SS 7.1</td>
<td>Landscape/Ext. Heat Islands - Non Roof</td>
</tr>
<tr>
<td>SS 7.2</td>
<td>Landscape/Ext. Heat Islands - Roof</td>
</tr>
<tr>
<td>WE 1.1</td>
<td>Water Efficient Landscaping - 50% reduction</td>
</tr>
<tr>
<td>Prereq 1</td>
<td>Fundamental Commissioning</td>
</tr>
<tr>
<td>Prereq 2</td>
<td>Minimum Energy Performance</td>
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</tbody>
</table>

The green roof assists in obtaining these credits.
## Anticipated Credits

<table>
<thead>
<tr>
<th>Prereq 1</th>
<th>Minimum IAQ Performance</th>
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<tbody>
<tr>
<td>Prereq 2</td>
<td>Environmental Tobacco Smoke Control</td>
</tr>
<tr>
<td>EQ 1</td>
<td>Outdoor Air Delivery Monitoring</td>
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<tr>
<td>EQ 3.1</td>
<td>Construction IAQ Mgt Plan - During Construction</td>
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<tr>
<td>EQ 3.2</td>
<td>Construction IAQ Mgt Plan - Before Occupancy</td>
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<tr>
<td>EQ 4.1</td>
<td>Low-Emitting Materials (Adhesives and Sealants)</td>
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<tr>
<td>EQ 4.3</td>
<td>Low-Emitting Materials (Carpet)</td>
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<tr>
<td>EQ 4.4</td>
<td>Low-Emitting Materials (Composite Wood)</td>
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<td>EQ 5</td>
<td>Indoor Chemical and Pollutant Source Control</td>
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<tr>
<td>EQ 6.1</td>
<td>Controllability of Systems - Lighting</td>
</tr>
<tr>
<td>EQ 6.2</td>
<td>Controllability of Systems - Thermal Comfort</td>
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<tr>
<td>EQ 7.1</td>
<td>Thermal Comfort - Design</td>
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</table>
Anticipated Credits

<table>
<thead>
<tr>
<th>Prereq 3</th>
<th>CFC Reduction</th>
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<tr>
<td>EA 4</td>
<td>Enhanced Refrigerant Management</td>
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<tr>
<td>Prereq 1</td>
<td>Storage and Collection of Recyclables</td>
</tr>
<tr>
<td>MR 2.1</td>
<td>Construction Waste Management - Divert 50%</td>
</tr>
<tr>
<td>MR 2.2</td>
<td>Construction Waste Management - Divert 75%</td>
</tr>
<tr>
<td>MR 4.1</td>
<td>Recycled Content - 10%(post-consumer+1/2 pre-consumer)</td>
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<tr>
<td>MR 5.1</td>
<td>Local/Regional Materials - 10% extracted, processed &amp; manufactured</td>
</tr>
<tr>
<td>MR 5.2</td>
<td>Local/Regional Materials - 20% extracted, processed &amp; manufactured</td>
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<tr>
<td>MR 7</td>
<td>Certified Wood</td>
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<tr>
<td>ID 2</td>
<td>LEED Accredited Professional</td>
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</table>
Anticipated LEED® Credits

29 LEED credits were identified as achievable without significant additional design effort

Consistent with sustainable design practices
  • Did not add significant cost to design or construction

8 additional credits are possible during construction if LEED Silver (33 credits minimum) is pursued
  • Most of these are available for additional costs without additional design
  • Green energy purchase, recycled materials, regional materials
Community Improvement: Added Parkspace
Community Improvement: Added Parkspace

Construction an inconvenience to community

• Park to be used as lay down area during construction
• 4 year construction schedule
• Dust, traffic and noise
Community Improvement: Added Parkspace

Abandoned Firehouse at south end of park

Property vandalized

Hangout for gangs

Problem for Community residents
Community Improvement: Added Parkspace

Win – Win Plan:

• Acquire Firehouse
• Demolish
• Convert into 12,000 square feet of new park space
• Schedule in advance of SAPS construction
Community Improvement: Added Parkspace

Before                                       After                     Fall 2009
QUESTIONS