Energy Reduction Analysis at New Prague Wastewater Treatment Facility

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Minnesota Technical Assistance Program

- Created in 1984
- University of Minnesota
- Staffed by Scientists and Engineers
- Process Specific Assistance
- Confidential and Non-regulatory
MnTAP Mission

Strengthening Minnesota businesses by improving efficiency, while saving money through energy, water and waste reduction.

• Businesses remain competitive
• Improve employee and public health
• Protect the environment
MnTAP Services

- Technical Assistance
  - Site assessment visits
  - Phone and e-mail requests
  - Intern program
  - Demonstrations/Research
- Minnesota Materials Exchange
- Communications and Outreach
Company Overview

• Remove contaminants from wastewater
• 7,700 residents
• Regulated by Minnesota Pollution Control Agency
• Class A wastewater facility
• Upgraded in 2010
• Many energy savings ideas implemented, knew of more opportunities but unsure how to proceed
City of New Prague Wastewater Plant Flow Diagram

Raw Wastewater (Influent) → Rag and Grit Removal (1) → Multi Flow Clarifier (2) → Biological Aerated Filter (BAF) (3) → Membrane Filter (4) → UV System (5) → Treated Water to River (Effluent)

- Backwash Holding
- Sludge Storage
- Sludge Press (6) → Sludge Dryer (7)

- Water for plant reuse (Backwash and wash water)
- Water Softeners
- Land Application
- To Landfill

[Diagram Image]
Incentives to Change

• Operating budget covered by water and sewage fees
  • Have exceeded budget
  • Excess covered in city taxes

• Next MPCA permit may include more requirements
  • Require additional equipment
  • Minimize energy increase with optimizing

• SMMPA and MnTAP reached out to us to partner in energy savings

• St. Peter, MN had a successful project in 2016
Project Overview

1. **Characterize energy consumption plant-wide**
   - Identify energy-intensive equipment
   - Observe yearly consumption trends

2. **Quantify scrubber/HVAC reductions**
   - Determine suitable # air changes per hour (ACH)
   - Predict savings for reduced exhaust fan speeds

3. **Assess Biological Aerated Filter (BAF) blower reduction**
   - Dissolved oxygen aeration model

4. **Ultrasonic leak study**
   - Find compressed air leaks

5. **Lighting audit**
   - Determine suitable LED replacements and resulting savings
EPA Energy Assessment Tool

• Track energy usage for small wastewater facilities
  • Excel spreadsheet

• Method:
  • Collect utility bills from 2014-2017
  • Collect motor specification data

• Focus on electricity reduction

<table>
<thead>
<tr>
<th>Utility</th>
<th>Site Utility Use</th>
<th>Site Utility Costs</th>
<th>% of Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>2,183,200 kWh</td>
<td>$166,663</td>
<td>76%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>79,167 CCF</td>
<td>$48,180</td>
<td>22%</td>
</tr>
<tr>
<td>Water &amp; Sewer</td>
<td>870,000 GAL</td>
<td>$4,100</td>
<td>2%</td>
</tr>
</tbody>
</table>

$718/MGAL Treated
Top Electrical Energy Use Systems

- #1 Odor Control: 23%
- #2 Sludge Handling: 20%
- #3 BAF Treatment: 15%
- #4 Non-process HVAC: 14%
- #5 Internal Plant Pumping: 12%
- Balance of Plant Identified: 11%
- Balance of Plant Unidentified: 5%

Balance of Plant Identified
Balance of Plant Unidentified

#1 Odor Control
#2 Sludge Handling
#3 BAF Treatment
#4 Non-process HVAC
#5 Internal Plant Pumping
Balance of Plant Identified
Balance of Plant Unidentified
Quantify scrubber/HVAC reductions
## Odor Scrubbers

<table>
<thead>
<tr>
<th>Room</th>
<th>Air changes per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAF</td>
<td>7.2</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>4.8</td>
</tr>
<tr>
<td>Biosolids</td>
<td>4.0</td>
</tr>
</tbody>
</table>
## Option 1.1: 7.2 to 4.9 ACH → Implemented

<table>
<thead>
<tr>
<th>ACH</th>
<th>Annual Energy Consumption</th>
<th>Annual Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>156,490 kWh, 536 therms</td>
<td>$11,900, $332</td>
</tr>
<tr>
<td>4.9</td>
<td>50,303 kWh, 383 therms</td>
<td>$3,825, $240</td>
</tr>
</tbody>
</table>

**Savings**

106,000 kWh, 150 therms

$8,100
Option 1.2: Switch fans and reduce to 4.9 ACH

Swap biosolids and BAF scrubber fan
  • Reduce fan flow rate from 7,600 to 5,283 ACFM

<table>
<thead>
<tr>
<th>ACH</th>
<th>Annual Energy Consumption</th>
<th>Annual Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9</td>
<td>102,618 kWh</td>
<td>$7,800</td>
</tr>
</tbody>
</table>

Savings

| Savings | 21,035 kWh | $1,600 |
Option 1.2: Further investigation/not recommended

- BAF and biosolids odor scrubbers are different models
  - Undetermined volumetric capacities
- Undetermined labor costs
  - Likely a week
- Requires further investigation by Evoqua engineers
Assess BAF Blower Reduction
Biological Aerated Filter (BAF)

- **Secondary treatment**
  - Removes total suspended solids (TSS), ammonia, and carbonaceous biological oxygen demand

- **Microbes require oxygen**
  - 0.5-2 mg/L dissolved oxygen (DO)
Option 2.1: Adjust controls settings

• Reduces blower operating hours
• Optimal set point at 1.5 gallons per minute per sqft

New Prague SCADA set point screen shot
Option 2.1: Adjust SCADA settings → Implemented

<table>
<thead>
<tr>
<th>Condition</th>
<th>Annual Energy Consumption</th>
<th>Annual Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Baseline (min. 2 cells, TCV=1.0 gpm/sqft)</td>
<td>385,300 kWh</td>
<td>$29,283</td>
</tr>
<tr>
<td>2017 Baseline (min 1 cell, TCV=1.5 gpm/sqft)</td>
<td>237,693 kWh</td>
<td>$18,065</td>
</tr>
</tbody>
</table>

Savings

148,000 kWh $11,200
Option 2.2: Install VFDs to BAF Blowers → Recommended

- Reduces power consumption during operation
- Eliminate inrush
  - Reduces electric costs
  - Increase blower lifespan

Allen Bradley PowerFlex 753, the proposed VFD for installation
Option 2.2: Install VFDs to BAF Blowers

Annual Electric Costs

<table>
<thead>
<tr>
<th>mg/L DO</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>$2,000</td>
</tr>
<tr>
<td>3</td>
<td>$4,000</td>
</tr>
<tr>
<td>4</td>
<td>$6,000</td>
</tr>
<tr>
<td>5</td>
<td>$8,000</td>
</tr>
<tr>
<td>6</td>
<td>$10,000</td>
</tr>
<tr>
<td>7.16</td>
<td>$18,000</td>
</tr>
</tbody>
</table>

*Star indicates the optimal mg/L DO level.*
Option 2.2: Install VFDs to BAF Blowers

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<tr>
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<th>Annual Energy Consumption</th>
<th>Annual Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 Baseline (min 1 cell, TCV=1.5 gpm/sqft)</td>
<td>237,693 kWh</td>
<td>$18,100</td>
</tr>
<tr>
<td>4.0 mg/L target DO</td>
<td>130,560 kWh</td>
<td>$9,922</td>
</tr>
</tbody>
</table>

Savings

107,000 kWh  
$8,142
## New Prague Effluent Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit (mg/L)</th>
<th>Limit Type</th>
<th>Effective Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen (DO)</td>
<td>7</td>
<td>Calendar Month Minimum</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Carbonaceous Biological Oxygen Demand (CBOD), 05 Day</td>
<td>5</td>
<td>Calendar Month Average</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Nitrogen, Ammonia, Total</td>
<td>7.7</td>
<td>Calendar Month Average</td>
<td>Dec-Mar</td>
</tr>
<tr>
<td>Nitrogen, Ammonia, Total</td>
<td>1.3</td>
<td>Calendar Month Average</td>
<td>Apr-May</td>
</tr>
<tr>
<td>Nitrogen, Ammonia, Total</td>
<td>1.0</td>
<td>Calendar Month Average</td>
<td>Jun-Sep</td>
</tr>
<tr>
<td>Nitrogen, Ammonia, Total</td>
<td>1.9</td>
<td>Calendar Month Average</td>
<td>Oct-Nov</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>30</td>
<td>Calendar Month Average</td>
<td>Jan-Dec</td>
</tr>
</tbody>
</table>
Ultrasonic Leak Study
8 Leaks Found

Photo credit: Marcus Hendrickson
6 Additional Leaks Found
**Option 3.1: Seal compressor leaks**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Annual Energy Consumption</th>
<th>Annual loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 leaks</td>
<td>13,820+ kWh</td>
<td>$1,050+</td>
</tr>
</tbody>
</table>

- **Status: In progress**
  - 9 leaks fixed
  - $827+ saved annually

- **Implementation Cost**
  - $220
Lighting Audit
LED Technology Constantly Improving

• New Prague WWTF lighting
  • 112 lights are on 24/7

• LED refits
  • Longer lifespan (50,000 hours)
  • Lower power consumption (18 watt)
  • Compatible with ballasts

LED exterior fixture in progress of installation

Main hall lighting
Stairwell lighting
## Option 4.1: Upgrade lights to LED

<table>
<thead>
<tr>
<th>Condition</th>
<th>Annual Energy Consumption</th>
<th>Annual Operating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorescent/MH/HPS</td>
<td>70,268 kWh</td>
<td>$5,340</td>
</tr>
<tr>
<td>LED</td>
<td>41,654 kWh</td>
<td>$3,165</td>
</tr>
<tr>
<td><strong>Savings</strong></td>
<td><strong>28,613 kWh</strong></td>
<td><strong>$2,175</strong></td>
</tr>
</tbody>
</table>
# Potential Savings Summary

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Annual Reduction</th>
<th>Implementation Cost</th>
<th>Annual Savings</th>
<th>Payback Period</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce ACH to 4.9</td>
<td>106,000 kWh 150 therms</td>
<td>$0</td>
<td>$8,100</td>
<td>-</td>
<td>Implemented</td>
</tr>
<tr>
<td>SCADA change and reduce DO to 4.0 mg/L using VFD</td>
<td>254,740 kWh</td>
<td>TBD</td>
<td>$19,300</td>
<td>4-5 years</td>
<td>Recommended</td>
</tr>
<tr>
<td>Seal leaks</td>
<td>13,820 kWh</td>
<td>$220</td>
<td>$1,050+</td>
<td>2.6 months</td>
<td>In Progress</td>
</tr>
<tr>
<td>Upgrade to LED</td>
<td>28,600 kWh</td>
<td>TBD</td>
<td>$2,100</td>
<td>2-3 years</td>
<td>Recommended</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>403,000 kWh 150 therms</strong></td>
<td><strong>TBD</strong></td>
<td><strong>$30,550</strong></td>
<td><strong>TBD</strong></td>
<td>-</td>
</tr>
</tbody>
</table>
Future recommendations

• Reduce scrubber and make-up air unit to 4.0
  • Reduces 125,000 kWh and $9,500

• Study VFD installation on main lift station pump effects
  • Eliminate inrush throughout facility
  • More efficient chemical feed
  • Prolong motor life

• Sludge aeration blower
  • Possible upgrades and installations
  • Contacted Aeration Industries International
Special thanks to the following

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Questions?

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