Chloride Compliance Strategies at the Nine Springs Wastewater Treatment Plant

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Mission
Protect public health and the environment

Vision
Enriching life through clean water and resource recovery

Resources
• 40 MGD treated effluent returned
• 38 MG of fertilizer applied to region farms annually
• Generate 35% energy needed to operate our system
Every Day...110 Tons

90 Ton Pile
MMSD receives over 1,500,000 lbs of salt each week. All of that ends up in local streams.

1 tsp salt dissolved in 5 gals of water = 230 mg/l chloride
230 mg/l chloride = EPA limit for chronic toxicity in streams
Water Supply: 57%
Human contribution: 8%
Road Deicing: 8%
Industrial: 7%
NSWTP chemicals, septage, hauled wastes: 18%
Softening: 2%
Chloride Compliance Alternatives
Chloride Variability

Chloride Concentration, mg/L

Weekly Average Discharge Limit, mg/L


Chloride Concentration, mg/L

200 250 300 350 400 450 500 550 600 650 700
Flow Variability

Chloride Concentration, mg/L
Weekly Average Discharge Limit, mg/L
Flow, mgd

Flow, mgd
Chloride Concentration, mg/L
Flow, mgd
Chloride Concentration, mg/L

### Chloride Removal Targets

**Expected NSWTP chloride limit:** 395 mg/L

<table>
<thead>
<tr>
<th>Design Condition</th>
<th>Chloride Removal lbs/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current flow, average chloride load</td>
<td>8,500</td>
</tr>
<tr>
<td>Current flow, maximum chloride load</td>
<td>37,500</td>
</tr>
<tr>
<td>Future flow, average chloride load</td>
<td>26,200</td>
</tr>
<tr>
<td>Future flow, maximum chloride load</td>
<td>60,000</td>
</tr>
</tbody>
</table>
Chloride Compliance Options

• Source reduction
  • Reduce chloride in water supply due to softening
  • Reduce chloride from industrial sources

• Reduction at NSWTP
  • Minimize chemicals that contribute chloride
  • Provide treatment to remove chloride
Alternatives – Source Water Softening

Source water softening

• Reduces need for residential, commercial, and industrial softeners

• Design capacity
  • 50 mgd firm
  • 24 mgd average
  • 340 mg/L hardness as CaCO$_3$
Source water softening

- Technologies
  - Lime softening
  - Ion exchange
  - Membrane separation
- Treatment location
  - Wellhead
  - Centralized facility
Source water softening – challenges

- Multiple communities, multiple well sites
- Significant pumping and distribution modifications
- Varying level of water service (unless all water is softened)
- Increased hydraulic load to NSWTP
- Requires discontinued use of zeolite softeners
Chloride treatment at NSWTP

- Remove chloride from a portion of the effluent
- Blend treated and untreated effluent to achieve target chloride concentration
- Design capacity
  - 15 mgd firm
  - 2.6 mgd average (current); 7.3 mgd (future)
  - 400 – 560 mg/L chloride
Chloride treatment at NSWTP

- Technologies
  - Reverse osmosis
  - Electrodialysis reversal
  - Ion exchange
- Each technology produces high volume of waste
Brine handling

- Reduce volume of concentrated waste to facilitate beneficial use/disposal
- Design capacity
  - 1.5 mgd firm
- Technologies
  - Evaporation
  - Crystallization
Chloride treatment at NSWTP – challenges

- Chloride is very soluble; difficult to remove
- Technologies are not selective for chloride
- Produces significant volume of concentrated waste
- Technologies to reduce waste volume are expensive to construct and operate
- Significant space requirement
## Alternatives Development

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Source water softening at the wellhead (22 wells)</td>
</tr>
<tr>
<td>1B</td>
<td>Source water softening at centralized facility (50 mgd firm)</td>
</tr>
<tr>
<td>2A</td>
<td>Treatment at NSWTP – RO and brine disposal</td>
</tr>
<tr>
<td>2B</td>
<td>Treatment at NSWTP – RO, evaporation of brine and disposal</td>
</tr>
<tr>
<td>2C</td>
<td>Treatment at NSWTP – RO, evaporation and crystallization of brine and disposal</td>
</tr>
<tr>
<td>3A</td>
<td>Treatment at NSWTP – EDR and brine disposal</td>
</tr>
<tr>
<td>3B</td>
<td>Treatment at NSWTP – EDR, evaporation of brine and disposal</td>
</tr>
<tr>
<td>3C</td>
<td>Treatment at NSWTP – EDR, evaporation and crystallization of brine and disposal</td>
</tr>
</tbody>
</table>
Capital and Annual Costs

<table>
<thead>
<tr>
<th>Capital Cost</th>
<th>Annual O&amp;M Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$50,000,000</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>$100,000,000</td>
<td>$30,000,000</td>
</tr>
<tr>
<td>$150,000,000</td>
<td>$40,000,000</td>
</tr>
<tr>
<td>$200,000,000</td>
<td>$50,000,000</td>
</tr>
<tr>
<td>$250,000,000</td>
<td>$60,000,000</td>
</tr>
</tbody>
</table>
Net Present Value

Net Present Value

$ - $500,000,000

$1,000,000,000

$1,500,000,000

$2,000,000,000

$2,500,000,000

1A 1B 2A 2B 2C 3A 3B 3C
Triple Bottom Line Analysis

- TBL used to narrow down options and evaluate alternatives
- Manages complexity in multiple criteria decision-making
<table>
<thead>
<tr>
<th>Financial &amp; Operational</th>
<th>Weighting</th>
<th># Indicators</th>
<th>Scoring Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 Capital Cost</td>
<td>5</td>
<td>1</td>
<td>Ordinal method</td>
</tr>
<tr>
<td>F2 O&amp;M Cost</td>
<td>5</td>
<td>1</td>
<td>Ordinal method</td>
</tr>
<tr>
<td>F3 Avoided costs</td>
<td>4</td>
<td>1</td>
<td>Ordinal method</td>
</tr>
<tr>
<td>F4 Chloride efficiency</td>
<td>4</td>
<td>1</td>
<td>Ordinal method</td>
</tr>
<tr>
<td>F5 Process complexity</td>
<td>3</td>
<td>5</td>
<td>Threshold method</td>
</tr>
<tr>
<td>F6 Operational risk</td>
<td>4</td>
<td>4</td>
<td>Threshold method</td>
</tr>
</tbody>
</table>

Environmental

| E1 Energy Use           | 4         | 1            | Ordinal method |
| E2 Air Quality Impact   | 3         | 1            | Threshold method |
| E3 Noise Impact         | 2         | 1            | Ordinal method |
| E4 Plant Carbon Footprint | 3        | 2           | Ordinal method |
| E5 Land Use Impact      | 2         | 3            | Linear/Gradient method |
| E6 Byproduct reuse potential | 4      | 1            | Ordinal method |
| E7 Impact on effluent quality | 3   | 3      | Ordinal method |

Social & Community

| S1 Leadership/Community Image | 3       | 3   | Linear/Gradient method |
| S2 Public Acceptance          | 3       | 3   | Linear/Gradient method |
| S3 Worker Safety              | 4       | 2   | Linear/Gradient method |
| S4 Public Health Impact       | 3       | 3   | Linear/Gradient method |
Selecting Options and Defining Alternatives

1. Data Forms to capture project/option details

2. Interactively ‘Assemble’ Project Alternatives

3. View Summaries of Alternatives
Results of TBL Analysis
Comparison of TBL Scores
Conclusions

• Reducing chloride in the NSWTP effluent is a complex issue.

• There is no clear “best” approach; alternatives perform strongly in some categories and poorly in others.

• Chloride elimination and/or treatment is very costly.

• Study provides foundation for further development of compliance strategy.
Salt Impacts All Water

Madison/Dane County Public Health, Road Salt Reports
One Water Solutions

- Partnerships:
  - Homeowners and Businesses
  - Industries
  - Municipalities/Agencies
- New Tools:
  - Behavior Change
  - Training Programs
  - Education campaigns
  - Grant/incentive programs
- Investing resources differently

Let's be Salt Wise!

Road Salt Related News
Water Utility draws attention to Wellhead Protection Areas
A Solution to a Salty Problem
Road salt impact reaches "critical point" in Dane County

What did WI spend on salt for its highways last year?

$40,456,343!
And that doesn’t include what communities, businesses and homeowners spent!

So, how many tons of salt is that?

669,807 tons
That many tons permanently pollute almost half a trillion gallons of Wisconsin’s water.

That’s about...

52,500

www.WiSaltWise.com
Questions

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