Iowa Nutrient Reduction Strategy: Point Source Overview

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When water quality was worse:

There were times when the flow [in the Missouri River] along the west shore was literally red with blood. Great mats of congealed grease floated downstream for miles. Hair and entrails collected in scummy islands.

Omaha’s primary treatment plant went into operation only four years ago [~1965]. Before that, it too dumped all its wastes untreated into the [Missouri] river.
Nutrients and Water Quality

• Nutrient over-enrichment is creating problems for recreation, drinking water and aquatic life.

  – **Big Creek Lake (Polk Co.)**
    Recreation
  – **Lake Rathbun (Appanoose Co.)**
    Drinking Water Supply
  – **Middle Fork of South Beaver Creek (Grundy Co.)**
    Aquatic Life
  – **Gulf of Mexico Hypoxia**

Swan Lake, June 2011
Why this strategy?

– Excessive nutrients can cause water quality problems
  • In state
  • Downstream

– Numeric nutrient criteria development presents challenging problems
  • No definitive cause & effect relationship

– Tough for Iowa to apply numeric nutrient criteria
  • Difficult to comply with permit limits and costly to try
  • 10 years of new, more stringent WQ–based regs (rebuttable presumption, antideg, chloride, etc)

– A different approach needed
Iowa’s Preliminary Total Phosphorus (TP) Benchmark (0.10 mg/L) for Protection of Wadeable, Warmwater Stream Aquatic Life Uses

Analysis of nutrient and biological response data from 100 random stream sites - Perennial Stream Probabilistic Stream Survey (2002-2006)

<table>
<thead>
<tr>
<th>All 3 Nutrient Response Benchmarks (Chla, diel DO, range, diel DO minima)</th>
<th>TP Benchmark Pass</th>
<th>TP Benchmark Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>17% (Agree)</td>
<td>38% Type I error (False Positive)</td>
</tr>
<tr>
<td>Fail</td>
<td>6% Type II error (False Negative)</td>
<td>39% (Agree)</td>
</tr>
</tbody>
</table>

1 or more Nutrient Response Benchmark Fail

PS/NPS Collaboration

- Nonpoint sources
  - 41% reduction of statewide N load
  - 29% reduction of statewide P load

- Point sources
  - 4% reduction of statewide N load
  - 16% reduction of statewide P load

- Combined 45% N and P reductions
Feasibility studies

- Monitoring data analysis
- Existing facility analysis
- Optimization analysis
- Cost estimates
- Impacts on user rates
- Evaluation of new technologies
- Non water quality environmental impacts
- Construction schedule
- Preferred method selection

Point Source
Point Source Strategy

• In Iowa point sources contribute 8% of the TN and 20% of the TP
• Point sources can have greater impacts at low flows and certain watersheds

• Working closely with CWA regulated community
• Use existing rules (Chapter 567 IAC Chapter 62)

• Use performance-based limits in lieu of nutrient criteria
  – Limits based on the effect of the pollutant in the water and feasibility and reasonableness of treating such pollutant
Point Source Strategy

Focus on:
- **100** major municipal wastewater treatment plants
- **31** major industries
- **18** minor industries with biological treatment for process waste
- **Total of 149**

For major POTWs:
- Treat more than 1 million gallons of wastewater a day
- Handle **80 percent** of all municipal wastewater
- Provide wastewater treatment for **55-60 percent of Iowa’s population**
Normal Permitting Process

- Establish Effluent Limit
- Establish Compliance Schedule
- Construct Treatment
- Meet Limits

Nutrient Permitting Process

- Evaluate Existing Facility
- Establish Construction Schedule
- Construct Treatment
- Optimize Treatment
- Evaluate Treatment
- Establish Effluent Limits
Implementation Details

• Submit feasibility and planning study within two years
• DNR reviews study
• Negotiate Construction schedule
• Amend permit to incorporate the schedule
• Limits incorporated in permit following one year performance evaluation

• Implementation Flexibilities for Point Sources
  – Regulatory certainty – 10 year assurance
  – Economic Considerations
  – Ability to fine tune
  – Annual average permit limits
Potential Results

At the 130 wastewater treatment plants included in the strategy:

- Assume 25 mg/L total nitrogen (TN) and 4 mg/L total phosphorus (TP) discharge concentrations
- Use annual average flows
- Use Biological Nutrient Removal technology limits (10 mg/L TN and 1 mg/L TP)

Currently Point Source Facility Loading

18,300 tons/yr TN
2,900 tons/yr TP

After implementation

7,300 tons/yr TN
730 tons/yr TP

2/3 to 3/4 nutrient reduction possible
## Cost and Affordability

### Estimated Costs for BNR Improvements for Municipal Majors (Target Effluent TN = 10 mg/L, Target Effluent TP = 1 mg/L)

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th># of Facilities</th>
<th>Combined Design Flow (MGD)</th>
<th>Combined Annual Average Flow (MGD)</th>
<th>Total Capital Cost ($M)</th>
<th>Total Annual O&amp;M Cost ($M)</th>
<th>Total Present Worth Cost ($M)</th>
<th>Total Annual Cost ($M)</th>
<th>$/1,000 gallons Treated</th>
<th>$/1,000 gallons Treated Weighted Monthly Cost/Household</th>
<th>Weighted % of MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activated Sludge</td>
<td>56</td>
<td>533</td>
<td>355</td>
<td>348</td>
<td>25</td>
<td>686</td>
<td>51</td>
<td>0.39</td>
<td>7.75</td>
<td>0.18%</td>
</tr>
<tr>
<td>Fixed Film</td>
<td>37</td>
<td>101</td>
<td>67</td>
<td>430</td>
<td>7</td>
<td>524</td>
<td>39</td>
<td>1.59</td>
<td>25.83</td>
<td>0.73%</td>
</tr>
<tr>
<td>Aerated Lagoon</td>
<td>9</td>
<td>11</td>
<td>8</td>
<td>110</td>
<td>3</td>
<td>147</td>
<td>11</td>
<td>3.92</td>
<td>85.16</td>
<td>2.13%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>102</td>
<td>645</td>
<td>430</td>
<td>887</td>
<td>35</td>
<td>1,358</td>
<td>101</td>
<td>0.64</td>
<td>11.85</td>
<td>0.29%</td>
</tr>
</tbody>
</table>

### Estimated Costs for BNR Improvements for all Industries with Biological Treatment (Target Effluent TN = 10 mg/L, Target Effluent TP = 1 mg/L)

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th># of Facilities</th>
<th>Combined Design Flow (MGD)</th>
<th>Total Capital Cost ($M)</th>
<th>Total Annual O&amp;M Cost ($M)</th>
<th>Total Present Worth Cost ($M)</th>
<th>Total Annual Cost ($M)</th>
<th>$/1,000 gallons Treated</th>
<th>$/1,000 gallons Treated Weighted Monthly Cost/Household</th>
<th>Weighted % of MHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activated Sludge</td>
<td>20</td>
<td>44.2</td>
<td>29.3</td>
<td>2.0</td>
<td>56.1</td>
<td>4.2</td>
<td>0.26</td>
<td>0.04</td>
<td>2.67%</td>
</tr>
<tr>
<td>Fixed Film</td>
<td>1</td>
<td>0.6</td>
<td>2.7</td>
<td>0.04</td>
<td>3.3</td>
<td>0.2</td>
<td>1.06</td>
<td>0.02</td>
<td>0.41%</td>
</tr>
<tr>
<td>Aerated Lagoon</td>
<td>7</td>
<td>5.8</td>
<td>86.5</td>
<td>2.20</td>
<td>116.0</td>
<td>8.6</td>
<td>4.05</td>
<td>0.03</td>
<td>2.00%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>28</td>
<td>50.7</td>
<td>118.5</td>
<td>4.2</td>
<td>175.5</td>
<td>13.1</td>
<td>0.71</td>
<td>0.01</td>
<td>2.99%</td>
</tr>
</tbody>
</table>

**Total Present Worth Cost**

$= 1.53$ ($B)$

**Total Capital Cost**

$= 1.00$ ($B)$
Progress to Date on Point Source Side

- 92 NPDES Permits issued with studies to date; goal is 20/year
- 24 feasibility studies submitted
- Facilities beginning to commit to nutrient reductions
  - **Grinnell** – installing BNR as a part of current plant upgrade
  - **Dubuque** – Phosphorus Recovery by 2023, MLE by 2021
  - **DairiConcepts** – TN and TP targets met in 2018
  - **Rembrandt Enterprises** – TP only, treat chemically.
  - **Des Moines** – Phosphorus recovery by 2018.
  - **West Liberty** – meets goals with existing plant
- Lots of buzz around the concept of trading
Progress to Date on Point Source Side

• Created feasibility study review checklist

• Technical Review Team

• Progress tracking 2.0

• Database adjustments to accommodate progress tracking
Table 1 Performance by all facilities with 10 or more months of data.

<table>
<thead>
<tr>
<th></th>
<th>Estimate (Target)</th>
<th>POTW</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Nitrogen (average)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>raw waste (mg/L)</td>
<td>25</td>
<td>28.7 (range 0.1 – 285.0)</td>
<td>107.1 (range 3.63 – 748.0)</td>
</tr>
<tr>
<td>final effluent (mg/L)</td>
<td>10</td>
<td>15.2 (range 0.2 – 220.8)</td>
<td>22.6 (range 0.0 – 15.5)</td>
</tr>
<tr>
<td>% removal</td>
<td>66%</td>
<td>44.7% (range -10.8% - 89.1%)</td>
<td>74.7% (range 60.6% - 87.3%)</td>
</tr>
<tr>
<td><strong>Total Phosphorus (average)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>raw waste (mg/L)</td>
<td>4.0</td>
<td>4.4 (range -3.0 – 419.8)</td>
<td>27.5 (range 0.53 – 200.0)</td>
</tr>
<tr>
<td>final effluent (mg/L)</td>
<td>1</td>
<td>2.2 (range 0.0 – 23.9)</td>
<td>17.2 (range 0.05 – 176.0)</td>
</tr>
<tr>
<td>% removal</td>
<td>75%</td>
<td>43.0% (range -34.0% - 80.6%)</td>
<td>51.4% (range -40.9% - 89.2%)</td>
</tr>
<tr>
<td><strong>Annual Load Reduction (2015-2016)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total nitrogen (tons)</td>
<td>-</td>
<td>2,949</td>
<td>115</td>
</tr>
<tr>
<td>Total phosphorus (tons)</td>
<td>-</td>
<td>599</td>
<td>99</td>
</tr>
</tbody>
</table>
### Table 1: Performance by treatment type for facilities with 10 months or more of data.

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>No.</th>
<th>Total Nitrogen</th>
<th></th>
<th>Total Phosphorus</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Raw (mg/L)</td>
<td>Final (mg/L)</td>
<td>%R</td>
<td>Raw (mg/L)</td>
</tr>
<tr>
<td>POTW</td>
<td>41</td>
<td>18.1</td>
<td>8.9</td>
<td>54.10%</td>
<td>3.4</td>
</tr>
<tr>
<td>Aerated Lagoon</td>
<td>2</td>
<td>18.7</td>
<td>11.6</td>
<td>37.50%</td>
<td>2.5</td>
</tr>
<tr>
<td>Activated Sludge</td>
<td>16</td>
<td>34.6</td>
<td>18.8</td>
<td>43.10%</td>
<td>5.4</td>
</tr>
<tr>
<td>No Biological Treatment</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rotating Biological Contactor</td>
<td>3</td>
<td>65.4</td>
<td>22.9</td>
<td>68.40%</td>
<td>19.1</td>
</tr>
<tr>
<td>Sequencing Batch Reactor</td>
<td>6</td>
<td>65.7</td>
<td>16.7</td>
<td>74.50%</td>
<td>56.5</td>
</tr>
<tr>
<td>Trickling Filter</td>
<td>14</td>
<td>350.5</td>
<td>44.4</td>
<td>87.30%</td>
<td>25.9</td>
</tr>
<tr>
<td>Industry</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerated Lagoon</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Activated Sludge</td>
<td>6</td>
<td>65.4</td>
<td>22.9</td>
<td>68.40%</td>
<td>19.1</td>
</tr>
<tr>
<td>No Biological Treatment</td>
<td>1</td>
<td>30.3</td>
<td>5.6</td>
<td>81.40%</td>
<td>51.1</td>
</tr>
<tr>
<td>Rotating Biological Contactor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sequencing Batch Reactor</td>
<td>1</td>
<td>65.7</td>
<td>16.7</td>
<td>74.50%</td>
<td>56.5</td>
</tr>
<tr>
<td>Trickling Filter</td>
<td>1</td>
<td>350.5</td>
<td>44.4</td>
<td>87.30%</td>
<td>25.9</td>
</tr>
</tbody>
</table>
Questions?

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eric.wiklund@dnr.iowa.gov