DUBLIN ROAD WATER PLANT

DESIGN, BENCH AND FULL SCALE TESTING OF FILTER AND COAGULANT AID POLYMER

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City of Columbus
Dublin Road Water Plant
Presentation Topics

- Dublin Road Water Plant
- Project Background/Goals
- Approach
- Methods
- Results
DRWP Watershed

- Scioto River
- Headwaters 80 Miles North of Columbus
- Over 1000 sq. mi. of watershed
  - primarily rural/agricultural
- Griggs & O’Shauighnessy Reservoirs
  - 6.1 BG storage capacity
- Upground Reservoir
  - 9.5 BG storage capacity
Existing Site Plan
Plant Treatment Goals

- Total Hardness: 120 mg/L to 125 mg/L as CaCO3
- Alkalinity: >35 mg/L as CaCO3
- Total Organic Carbon (TOC): <2.0 mg/L
- Nitrate: < 10 mg/L as N
- Atrazine: <2.5 ppb (MCL= 3.0 ppb)
- Stage 2 DBP Compliance:
  - Target 80% of Location Running Annual Average (LRAA) and Operational Evaluation Level
- Comply with all primary drinking water regulations
- Taste and Odor
### DRWP RAW WATER PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>31</td>
<td>86</td>
<td>57</td>
<td>57</td>
</tr>
<tr>
<td>Hardness</td>
<td>76</td>
<td>384</td>
<td>243</td>
<td>250</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>52</td>
<td>248</td>
<td>149</td>
<td>151</td>
</tr>
<tr>
<td>Turbidity</td>
<td>1</td>
<td>747</td>
<td>44</td>
<td>20</td>
</tr>
<tr>
<td>TOC</td>
<td>2</td>
<td>14</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

8.5 Years of Data
Existing Treatment Plant

- Scioto River
- Conventional Lime Softening Plant
- 65 MGD Capacity
PROJECT BACKGROUND/GOALS
Figure B: Coagulated & Clarified Water Quality for 2/22/07-3/31/07

- Sludge recycle increased
- Large spikes in coagulated & clarified turbidities
- Basins in Service: All

Key:
- Coagulated Water Alkalinity (mg/L)
- Recycle Sludge Pumping, (gpm)
- Coagulated Water pH (before lime)
- Coagulated Water TOC (mg/L)
- Coagulated Water Turbidity (ntu)
- Clarified Water Turbidity (ntu)
- Flocculation 3/4 Hydroxide Alk (mg/L)
- Recarbonation pH

Notes:
- Hydroxide alkalinity drops to 0
Figure D: Finished Water Quality for 2/22/07-3/31/07

Basins in Service:
- All

Large spike in filtered water turbidity
Project Goals and Objectives

- Provide Operations Staff with Tools Required
  - Cold Water Concern
  - Rapid Changes in Raw Water Quality

- Additional Tools Considered
  - Filter Aid Polymer
  - Coagulant Aid Polymer

- Critical Issues to be Considered
  - Costs
  - Ease of Operations
  - Full time operations **NOT** required
FILTER AID POLYMER
Bench Scale
Full Scale Testing

- Filter Aid Polymer Dose (mg/L)
- Filter Effluent Turbidity (NTU)
- Filters with FAP
- Filters without FAP
- FAP Dose
DRWP Full Scale Filter Aid Test – Filter Loss of Head and Filter Rate

Filter Loss of Head (Feet)

Filters with FAP
Filters without FAP

Filter Loading Rate (gpm/sf)

Filters with FAP
Filters without FAP
Filter Loading Rate (Filters with FAP)
Filter Loading Rate (Filters without FAP)
Filter Full Scale Testing Layout

[Diagram of water treatment facility with labels and arrows indicating flow paths and components such as Basin 1, Basin 2, Grit pit, West-Sided Flume, East-Sided Flume, Coag Flume, and various sample points and feed points.]

One Water
DRWP Full Scale Filter Aid Test – Filter Turbidity after Backwash (Start of Filter Run)

![Graph showing Filter Effluent Turbidity (NTU) vs. Minutes Filter is Online after a Backwash with two lines indicating Average of Filters with FAP and Average of Filters without FAP.]

- **Filter Effluent Turbidity (NTU)**
- **Minutes Filter is Online after a Backwash**

**Legend**:
- **Blue line**: Average of Filters with FAP
- **Red line**: Average of Filters without FAP
Filter Ripening – 2 Hrs. after backwash

West Filters - No Polymer

East Filters – No Polymer
Filter Ripening – 2 Hrs. after backwash

West Filters - No Polymer

East Filters – Cationic Polymer
CONCLUSIONS

- Improvements in filtered water turbidity with the addition of polymer
- Filter headloss increase with polymer addition
- Anionic, Cationic or Nonionic polymers?
FULL SCALE TEST EQUIPMENT
COAGULANT AID POLYMER
# Jar Test Mixing Speeds

<table>
<thead>
<tr>
<th>Mix Segment</th>
<th>Duration*</th>
<th>Speed 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Mix</td>
<td>15 Seconds</td>
<td>300 RPM</td>
</tr>
<tr>
<td>Raw Water Flume</td>
<td>4 minutes 15 seconds</td>
<td>150 RPM</td>
</tr>
<tr>
<td>(Rapid Mix to Floc 1&amp;2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floc 1&amp;2</td>
<td>55 minutes 30 seconds</td>
<td>38 RPM</td>
</tr>
</tbody>
</table>

Durations calculated based upon plant flow of 53 mgd
<table>
<thead>
<tr>
<th>Polymer Type</th>
<th>Concentration</th>
<th>Test Duration</th>
<th>Settling Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cationic Polymer</td>
<td>@2.0 mg/L</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>(Nalco 8102 Plus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jar Test 4-6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Charge Anionic Polymer</td>
<td>@0.75 mg/L</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>(Polydyne A-6340)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jar Test 12-6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Low Charge Anionic Polymer</td>
<td>@0.75 mg/L</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>(Polydyne A-6320)</td>
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<tr>
<td>Jar Test 12-2</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Nonionic Polymer</td>
<td>@0.5 mg/L</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>(Nalco 8181)</td>
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</tr>
<tr>
<td>Jar Test 11-3</td>
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<td></td>
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</tr>
<tr>
<td>Nonionic Polymer</td>
<td>@0.5 mg/L</td>
<td>30 minutes</td>
<td>30 minutes</td>
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<tr>
<td>(Kemira 1000)</td>
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<tr>
<td>Jar Test 11-6</td>
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## Bench Scale Testing Results

<table>
<thead>
<tr>
<th>POLYMER</th>
<th>EXPECTED POLYMER DOSE</th>
<th>pH</th>
<th>Turbidity (NTU)</th>
<th>Partical Counts (Per 100 mL)</th>
<th>UVT (%/cm)</th>
<th>TOC (mg/L)</th>
<th>TOC Removal %</th>
<th>Color Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alum without polymer</td>
<td>NA</td>
<td>6.75</td>
<td>2.7</td>
<td>5171</td>
<td>77.8%</td>
<td>3.99</td>
<td>51.2</td>
<td>21</td>
</tr>
<tr>
<td>(1) Nonionic polymer</td>
<td>0.25 mg/L</td>
<td>6.76</td>
<td>0.27</td>
<td>97</td>
<td>80.2%</td>
<td>3.74</td>
<td>54.3</td>
<td>9</td>
</tr>
<tr>
<td>(2) Nonionic polymer</td>
<td>0.5 mg/L</td>
<td>6.76</td>
<td>0.70</td>
<td>194</td>
<td>79.6%</td>
<td>4.03</td>
<td>50.7</td>
<td>11</td>
</tr>
<tr>
<td>Anionic</td>
<td>0.75 mg/L</td>
<td>6.77</td>
<td>0.89</td>
<td>789</td>
<td>79.6%</td>
<td>3.75</td>
<td>54.2</td>
<td>11</td>
</tr>
</tbody>
</table>
## Chemical Consumption and Cost

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Expected Dose</th>
<th>Average Daily Consumption @ 67 mgd (ppd)</th>
<th>Average Annual Consumption (lbs)</th>
<th>Average Annual Chemical Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Nonionic polymer</td>
<td>0.25 mg/L</td>
<td>140</td>
<td>51,100</td>
<td>$66,000</td>
</tr>
<tr>
<td>(2) Nonionic polymer</td>
<td>0.50 mg/L</td>
<td>280</td>
<td>102,200</td>
<td>$203,000</td>
</tr>
<tr>
<td>Anionic polymer</td>
<td>0.75 mg/L</td>
<td>420</td>
<td>153,300</td>
<td>$153,000</td>
</tr>
</tbody>
</table>
FILTER / COAGULANT AID POLYMER FEED SYSTEM
CONCLUSIONS

- Jar Testing setup crucial for accurate results.
- Selecting polymers for full scale testing.
- Results versus Cost.
Questions?

Thank You