Startup & Commissioning of the Eau Claire Water Resource Recovery Facility

WWOA
49th Annual Conference
Wisconsin Dells, WI
October 8, 2015

City of Eau Claire
Steve Hayden

Donohue & Associates
Bill Marten
Tom Crouse
Presentation Outline

- Background
  - Utility/Existing Plant
  - New Equipment and Processes
- Upgrade History
  - Phased Upgrade
  - Key Considerations & Features
- Facility Startup & Transition
  - Challenges
  - Results
Eau Claire, WI Wastewater Utility

- Located ~ 85 miles East of Twin Cities, in Heart of Wisconsin
- Wastewater Utility
  - Serves Cities of Eau Claire and Altoona
    - Service Population ~75,000
  - WWTP
    - Average Daily Flow 5 mgd
    - 2030 Design ADF 6.8 mgd
    - Last Major Upgrade 1980
Eau Claire’s Existing WWTP

- Final Clarifiers
- RBCs
- RWW Pumps/Screening/Grit Removal
- Primary Clarifiers
- Secondary Digesters
- Primary Digesters
- Sludge Storage
- Chlorine Contact Basins
- Administration/Laboratory Bldg
Eau Claire’s Existing WWTP

Liquid Treatment
- Preliminary Treatment
- Primary Clarification
- Rotating Biological Contactors (RBCs)
- Secondary Clarification
- Disinfection
- Discharge to Chippewa River
Eau Claire’s Existing WWTP

Solids Treatment

- Gravity Thickening Primary Sludge
- Gravity Belt (GBT) Thickening RBC Sludge
- Anaerobic Digestion
- GBT Thickening Digested Sludge
- Biosolids Storage
- Land Application
- Biogas Used in Engine Generators
Construction Overview
Construction Overview
RBC Demo/Removal

- Recycling Was an Important Element
  - 20 Units Reused
  - All Plastic Media Recycled
Electrical Distribution
SCADA/Controls
BNR Activated Sludge System
BNR Selector Zones
BNR Aeration Basins
Solids Thickening

- WAS Thickening
- Two (2) Gravity Belt Thickeners (GBTs)

- Digested Sludge Thickening
  - One GBT
  - Odor Hood
Primary Sludge Screens
Standby Generators
Digested Gas Conditioning

Includes Provisions to Remove:

- Moisture
- Hydrogen Sulfide ($H_2S$)
- Siloxanes
Methane Generators
Methane Boilers
Digester Cover Replacements

- Primary Digesters (2)
  - New Fixed Steel Covers

- Secondary Digester (1)
  - New Floating Steel Cover
This Story Began a Decade Ago...

New Draft Permit Included Effluent NH$_3$-N Limits

<table>
<thead>
<tr>
<th>Effluent pH (s.u.)</th>
<th>NH$_3$-N Limit (mg/L)</th>
<th>Effluent pH (s.u.)</th>
<th>NH$_3$-N Limit (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0 &lt; pH ≤ 6.1</td>
<td>108</td>
<td>7.6 &lt; pH ≤ 7.7</td>
<td>29</td>
</tr>
<tr>
<td>6.1 &lt; pH ≤ 6.2</td>
<td>106</td>
<td>7.7 &lt; pH ≤ 7.8</td>
<td>24</td>
</tr>
<tr>
<td>6.2 &lt; pH ≤ 6.3</td>
<td>104</td>
<td>7.8 &lt; pH ≤ 7.9</td>
<td>20</td>
</tr>
<tr>
<td>6.3 &lt; pH ≤ 6.4</td>
<td>101</td>
<td>7.9 &lt; pH ≤ 8.0</td>
<td>17</td>
</tr>
<tr>
<td>6.4 &lt; pH ≤ 6.5</td>
<td>98</td>
<td>8.0 &lt; pH ≤ 8.1</td>
<td>14</td>
</tr>
<tr>
<td>6.5 &lt; pH ≤ 6.6</td>
<td>94</td>
<td>8.1 &lt; pH ≤ 8.2</td>
<td>11</td>
</tr>
<tr>
<td>6.6 &lt; pH ≤ 6.7</td>
<td>89</td>
<td>8.2 &lt; pH ≤ 8.3</td>
<td>9.4</td>
</tr>
<tr>
<td>6.7 &lt; pH ≤ 6.8</td>
<td>84</td>
<td>8.3 &lt; pH ≤ 8.4</td>
<td>7.8</td>
</tr>
<tr>
<td>6.8 &lt; pH ≤ 6.9</td>
<td>78</td>
<td>8.4 &lt; pH ≤ 8.5</td>
<td>6.4</td>
</tr>
<tr>
<td>6.9 &lt; pH ≤ 7.0</td>
<td>72</td>
<td>8.5 &lt; pH ≤ 8.6</td>
<td>5.3</td>
</tr>
<tr>
<td>7.0 &lt; pH ≤ 7.1</td>
<td>66</td>
<td>8.6 &lt; pH ≤ 8.7</td>
<td>4.4</td>
</tr>
<tr>
<td>7.1 &lt; pH ≤ 7.2</td>
<td>59</td>
<td>8.7 &lt; pH ≤ 8.8</td>
<td>3.7</td>
</tr>
<tr>
<td>7.2 &lt; pH ≤ 7.3</td>
<td>52</td>
<td>8.8 &lt; pH ≤ 8.9</td>
<td>3.1</td>
</tr>
<tr>
<td>7.3 &lt; pH ≤ 7.4</td>
<td>46</td>
<td>8.9 &lt; pH ≤ 9.0</td>
<td>2.6</td>
</tr>
<tr>
<td>7.4 &lt; pH ≤ 7.5</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommendation: Phased Upgrade

Phase 1: Address Critical Needs
- Additional Biosolids Storage Tank
- Major Pump Station Upgrade
- Effluent pH Adjustment System
- ~$4.5 M Cost, Constructed 2007-2008
  - Allow City to Adjust User Rates for Phase 2 Upgrade

Phase 2: Address 20 Year Planning Period Needs
- “expected to be required within next 5-10 years due to age of and potential failure of RBC units”
Major Elements of Phase 2

- Nitrifying Activated Sludge
  - With Biological Phosphorus Removal
  - Rehab Secondary Clarifiers
- Sludge Thickening Improvements
  - New GBTs & Sludge Pumps
- Anaerobic Digestion Improvements
  - Covers, Mixing, Heating
  - New Biogas Engine Generators & Boilers
- Design Complete & Construction Began 2013
Key Energy Conservation Design Features

- Aeration
  - High Speed Turbine Blowers
  - Membrane Fine Bubble Diffusers

- Mixing
  - Selector Zones – Low Energy Vertical Shaft Mixers
  - Primary Digesters – Linear Motion Mixers

- Digestion
  - New Fixed, Well Insulated Covers
  - New Heat Exchangers & Recirculation Pumps
  - New Biogas Engine-Generators & Boilers
Key BNR Challenges

Primary Effluent

➢ BOD: TP Ratio ~ 50:1
  ▪ Ideal for Enhanced Biological Phosphorus Removal (Bio-P)

➢ TKN ~ 70 mg/L
  ▪ Full Nitrification Will Consume Close to 500 mg/L Alkalinity as CaCO$_3$
  ▪ PE Alkalinity ~ 240 mg/L as CaCO$_3$
  ▪ Supplemental Alkalinity Needed!
Biowin Modeling Optimizes BNR Design

MUCT Bio-P Configuration

- Denitrification of Mixed Liquor Recycle Included
  - Maximize Denitrification & Alkalinity Production
- Effluent Ammonia-Based Aeration Control
  - Minimize Nitrification, Aeration Energy Requirement & Alkalinity Consumption
“State of the Art”
Secondary Clarifier Upgrades
Ok, Let’s Talk Some Results to Date...

➢ Energy Efficient Vertical Shaft Mixers
Primary Digesters 1 & 2

- Careful, Planned Restarts
  - Preheat with hot water
  - Transfer from active digester
  - Gradual increase in feed
  - Careful monitoring of VA/Alkalinity

- Achieving 50% VSR @ VA/Alk = 0.28
Going From RBCs to BNR Activated Sludge

- **RBCs**
  - Simple, “Run Themselves”
  - O&M Primarily Breakdown Maintenance

- **BNR Activated Sludge**
  - Proactive Process Monitoring & Control
    - SRT/Sludge Age
    - System Monitoring
    - Nitrification/Alkalinity Challenge
Transitional Startup

- October 2014 – Train 1 Startup
  - Seed Sludge: Chippewa Falls WWTP WAS
  - 50/50 PE Flow Split Between RBCs & NAS
  - Began Wasting Early November w/MLSS > 1,000 mg/L
    - Daily Target SRT/Sludge Age Wasting Basis

- January 2015 – Train 2 Startup
  - Seed From Train 1
  - Continued 50/50 PE Flow Split Between RBCs & NAS
BNR Activated Sludge Process Control

➢ Sludge Wasting

 ▪ Initially – Target SRT on Low Side – Industry Slug Load Led to Severe Digester Foaming

 ▪ Overcompensated to Extremely High SRT
  • Provide More Stable Biology With Higher MLSS
  • Mid-January 2015 – Microthrix Outbreak
Microthrix => Foam!
...and not just in the Activated Sludge System
Process Control Paradigm Shift

- Running Average Aerobic SRT Based Wasting
  - Seasonally Change From 6-14 Days
  - Daily Settleometer/SVI Analysis
  - Regular Microscopic Examination
Typical Micro Exam Results
Aeration & Denitrification Controls
Aeration & Denitrification Controls

- **Denitrification**
  - Lack of TKN Data => Hard to Quantify
  - Effluent NO3-N Data Suggests 20-30 mg/L N is being Denitrified From Forward Flow
    - 70-100 mg/L Added Alkalinity Produced
    - 50-90 mg/L O2 Demand Satisfied

- **Aeration**
  - Ammonia Control Not Yet Possible
  - D.O. Control Works Well, Ongoing Optimization
    - Initial Targets 2.0 mg/L all Three Passes
    - Later changed to Gradient Targets of 1.0/1.5/2.0
    - Recently Changed to Gradient Targets of 1.0/1.0/1.0 mg/L
Goodby RBCs

- With 50/50 PE Split Between RBCs & Bio-P
  - Effluent TP 0.7-1.1 mg/L Using Average 400 gpd FeCl$_3$

- April 6, 2015 – Second Final Clarifier Available Following Rehab
  - One Week Gradual Diversion of All PE Flow to Activated Sludge

- April 14, 2015 – Flow to RBCs Discontinued
  - Turned Off FeCl$_3$ Feed
  - Effluent TP 0.3-0.4 mg/L with no FeCl$_3$
The Bottom Line

- Effluent BOD5: < 10 mg/L
- Effluent NH3-N: < 0.3 mg/L, Typically Non-Detect

<table>
<thead>
<tr>
<th>Date</th>
<th>Today's Values</th>
<th>Ave Final</th>
<th>30 Minute</th>
<th>Yesterday's</th>
<th>Yesterday's</th>
<th>Yesterday's</th>
<th>Today's</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MLSS</td>
<td>RAS/WAS</td>
<td>Clar Blanket</td>
<td>Settling Volume</td>
</tr>
<tr>
<td></td>
<td>mg/L</td>
<td>mg/L</td>
<td>ft</td>
<td>mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09/05/15</td>
<td>2,340</td>
<td>6,000</td>
<td>1</td>
<td>160</td>
<td>5.76</td>
<td>3</td>
<td>117,000</td>
</tr>
<tr>
<td>09/04/15</td>
<td>2,460</td>
<td>5,650</td>
<td>1</td>
<td>170</td>
<td>5.31</td>
<td>3</td>
<td>115,000</td>
</tr>
<tr>
<td>09/03/15</td>
<td>2,160</td>
<td>5,400</td>
<td>1</td>
<td>160</td>
<td>5.11</td>
<td>3</td>
<td>105,000</td>
</tr>
<tr>
<td>09/02/15</td>
<td>2,320</td>
<td>6,600</td>
<td>1</td>
<td>170</td>
<td>4.72</td>
<td>4</td>
<td>94,000</td>
</tr>
<tr>
<td>09/01/15</td>
<td>2,340</td>
<td>5,900</td>
<td>1</td>
<td>160</td>
<td>5.01</td>
<td>4</td>
<td>88,000</td>
</tr>
<tr>
<td>08/31/15</td>
<td>3,840</td>
<td>8,350</td>
<td>1</td>
<td>270</td>
<td>4.68</td>
<td>3</td>
<td>87,000</td>
</tr>
<tr>
<td>08/30/15</td>
<td>4,060</td>
<td>10,900</td>
<td>1</td>
<td>270</td>
<td>5.24</td>
<td>4</td>
<td>89,000</td>
</tr>
<tr>
<td>08/29/15</td>
<td>3,920</td>
<td>10,850</td>
<td>1</td>
<td>275</td>
<td>5.35</td>
<td>2</td>
<td>91,000</td>
</tr>
<tr>
<td>08/28/15</td>
<td>4,220</td>
<td>9,300</td>
<td>1</td>
<td>280</td>
<td>5.24</td>
<td>3</td>
<td>90,000</td>
</tr>
<tr>
<td>08/27/15</td>
<td>3,760</td>
<td>9,100</td>
<td>1</td>
<td>265</td>
<td>5.47</td>
<td>3</td>
<td>88,000</td>
</tr>
<tr>
<td>08/26/15</td>
<td>3,920</td>
<td>7,600</td>
<td>1</td>
<td>270</td>
<td>5.24</td>
<td>3</td>
<td>88,000</td>
</tr>
<tr>
<td>08/25/15</td>
<td>3,860</td>
<td>8,150</td>
<td>0</td>
<td>260</td>
<td>4.74</td>
<td>1</td>
<td>87,000</td>
</tr>
<tr>
<td>08/24/15</td>
<td>3,460</td>
<td>8,250</td>
<td>1</td>
<td>260</td>
<td>5.86</td>
<td>3</td>
<td>86,000</td>
</tr>
<tr>
<td>08/23/15</td>
<td>4,100</td>
<td>9,850</td>
<td>1</td>
<td>275</td>
<td>5.06</td>
<td>2</td>
<td>86,000</td>
</tr>
<tr>
<td>08/22/15</td>
<td>4,000</td>
<td>9,750</td>
<td>1</td>
<td>270</td>
<td>5.50</td>
<td>2</td>
<td>85,000</td>
</tr>
<tr>
<td>08/21/15</td>
<td>3,900</td>
<td>9,150</td>
<td>1</td>
<td>280</td>
<td>5.40</td>
<td>3</td>
<td>86,000</td>
</tr>
<tr>
<td>08/20/15</td>
<td>4,120</td>
<td>9,750</td>
<td>1</td>
<td>270</td>
<td>5.64</td>
<td>3</td>
<td>85,000</td>
</tr>
<tr>
<td>08/19/15</td>
<td>4,080</td>
<td>9,750</td>
<td>0</td>
<td>280</td>
<td>5.06</td>
<td>2</td>
<td>85,000</td>
</tr>
<tr>
<td>08/18/15</td>
<td>3,840</td>
<td>8,450</td>
<td>1</td>
<td>255</td>
<td>5.77</td>
<td>2</td>
<td>83,000</td>
</tr>
<tr>
<td>08/17/15</td>
<td>3,740</td>
<td>8,850</td>
<td>1</td>
<td>220</td>
<td>5.18</td>
<td>3</td>
<td>82,000</td>
</tr>
</tbody>
</table>
Ongoing Challenges

- Maintaining Plant Performance as Construction Nears Completion (& Addressing Punchlist Items)
- Resolving Instrumentation & Equipment Issues
- Finding Balance Between Easy/Reliable Activated Sludge Process Control & Energy/Chemical Savings
  - Tapered DO Control, Effluent Ammonia Control
  - # Units In/Out of Service Seasonally
  - Aerated Effluent Target pH & Alkalinity Residual
Summing Up Thoughts

- Biowin Modeling Invaluable in Evaluating Alternative Strategies to Optimize Design & Performance
- Some Leading Edge Energy Conservation Strategies Are Still Evolving, While Others Have Proven Themselves
- Good, Sound Design & Control of Nitrifying Activated Sludge Leads to Great Results
- Plant Staff Must Be Involved Throughout Project, and Embrace New Facilities & Operations
The True Heroes in this Story...

The Eau Claire Wastewater Utility Staff, Including:

- Steve Hayden, Utility Engineer
- Craig Hendrickson, Plant Superintendent
- Kathy White, Lab Manager
- Jeff Pippenger, Utility Manager
- Tyler Fadness, Assistant Chemist
- Mike Thieste, Lab Tech
- Entire Plant O&M Staff
Thanks for Your Attention!

For More Info:

- Steve Hayden
  715-839-6122
  Steve.Hayden@ci.eau-claire.wi.us

- Bill Marten, PE, BCEE
  414-217-6909
  wmarten@donohue-associates.com