Expansion or Optimization: What’s in Your Future?

Presenters:
Joel Davenport – Holland BPW
Jack Rafter – FTCH
• Expansion?
• Issues
• If not, then what?
• Shaping the project
• Squeezing 10 into 5
• Retro-fit
• Conclusion
TO EXPAND OR NOT TO EXPAND, THAT IS THE QUESTION
• 2002 Facility Plan recommended expansion to 16 Million Gallons per Day (MGD) Annual Average Day Flow (AADF) in two phases.

• 1ˢᵗ phase was tentatively planned to begin in 2003/04 and would have expanded facility to 14.2 MGD AADF.

• Most major equipment replacement placed on hold until expansion.
• The great recession comes to Holland and greatly slows housing growth.

• Water conservation and efficiency efforts on the rise, reducing water usage from existing customers.

• Sewer lining and other efforts reduce infiltration and inflow (I&I) from the collection system.

What Happened to Flow Growth?
EXPANSION PLACED ON HOLD BECAUSE:

1. AADF is currently around 75% of NPDES permit basis flow. This percentage has remained relatively unchanged for approximately 15 years!

2. Increase in discharge flow above 12 MGD likely to require more stringent effluent limitations (ammonia), which in turn will require higher capital investment for the community.

3. Currently working with surrounding communities to redirect part of flow to another WWTP as part of regional planning efforts.

4. Site is currently space-constrained, making the construction of additional tankage to handle higher hydraulic flows very difficult.
Changing Influent Characteristics

Aging infrastructure
Limited funding
Public awareness
Asset management

NO EXPANSION
BUT MAJOR ISSUES REMAIN......
• Notable industrial growth occurred late in the recession and beyond.

• Food processors represent large portion of growth, which in turn has led to sizeable increases in BOD and TSS loadings to WWTP.

• Loading now at/near Average Annual Day (AAD) design, and allocations are approaching Maximum Allowable Headworks Loading (MAHL).
BOD/TSS Loading Trends
• Last major facility renovation was in 1995/96.
• Much of equipment previously planned for replacement, but work was placed on hold pending expansion.
  o Major equipment on conventional air activated sludge process (East Plant) >34 years old.
  o Major solids handling equipment >20 years old.
IF NOT EXPANSION, WHAT?
TIME TO OPTIMIZE
NOTABLE CHANGES BY BPW STAFF TO IPP PROGRAM:

1. New Special Discharge Allocation Method – BPW staff replaced the old allocation system, where industries selected their allocation, with a new system that calculates allocations and assigns them. This reduced instances of overallocation.

2. Special Discharge Allocation Maximums – BPW staff formalized maximum allocations for individual industries to further encourage pretreatment and maintain allocation capacity for new and expanding industries.
NOTABLE CHANGES BY BPW STAFF TO OPERATIONS:

1. Primary Clarifiers Efficiency Improvements – Simple changes resulted in reduced chemical costs, reduced disposal costs, and 11% increase in MAHL for BOD!

2. High-Purity Oxygen Activated Sludge Efficiency Improvements – Simple changes resulted in increased reliability and decreased oxygen usage (lower chemical and power costs).

3. Dewatering Improvements – Minor process changes allowed for more efficient blending of thickened waste activated sludge (TWAS) and primary sludge on existing belt filter presses.

These items are big in the short term, but not enough to address all identified issues. As such, planning began for capital improvement projects to replace/upgrade solids handling equipment and optimize the secondary treatment process to increase BOD capacity.
• Increase organic and solids handling capacity
• Improve process operation/control
• Improve reliability
• Replace aging equipment
• Reduce operating costs
• Use available funds efficiently
SHAPING THE PROJECT
DEVELOPING THE OPTIMIZATION SCOPE
• Establish program objectives
• Evaluate the data
• Get more data
• Reclaim lost effectiveness
• Dust off the O&M manual
• Look at process changes
- Stress testing
- Modeling – process and/or hydraulic
- Testing the effectiveness
- Instruments and instrumentation
- Lab data
- Outside expertise
BOD/TSS Loading Trends
What To Examine
• Primary Treatment
• Secondary Treatment
• Solids Handling
  ✓ Pumping
  ✓ Thickening
  ✓ Dewatering
  ✓ Stabilization
  ✓ Recycling
  ✓ Odor Abatement
  ✓ SCADA
BIOSOLIDS OPTIMIZATION

10 YARDS OF BIOSOLIDS INTO A 5-YARD BUILDING
Biosolids Handling Process

Affected Areas
Challenges

• Improved Dewatering
• Size for the Future
• Control O&M
• Budget
• Staging
• Size Constraints
• Old Infrastructure
Dewatering/Thickening Equipment Comparison

- Processing volume
- % Solids
- Recycle filtrate quality
- Number of units
- Dimensions
- Warranty
- Equipment cost
- Operation cost
STILL TIME TO CHANGE THE ROAD YOU'RE ON.

Biosolids Handling Process
Facing the Challenge

- Pilot testing
- Scanning the buildings
- Stress testing
- Code changes
- Operational changes
- Staging
- Redundancy
- Hp
- Improved blending
# Dewatering Equipment Comparison

<table>
<thead>
<tr>
<th>Make and Model</th>
<th>Capacity per unit</th>
<th>Qtv Required *</th>
<th>Cost per Unit</th>
<th>Total Cost w/ Accessories</th>
<th>HP per unit</th>
<th>Mixed Sludge</th>
<th>WAS</th>
<th>Est. Polymer Demand, lbs/DT</th>
<th>Annual Maintenance Requirements</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer A</td>
<td>715 pph 65 gpm</td>
<td>12</td>
<td>$425,000</td>
<td>$5,100,000</td>
<td>5</td>
<td>15-20</td>
<td>30-40</td>
<td></td>
<td>Typically every 5000-10,000hr depending on application including replacing the brush and bearing. The requirements are ~$7000 in parts and 6 man days to complete (2 people 3 days).</td>
<td>Price includes 316 SS construction, control panel, flow meter, progressing cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery, contractor to provide flocculation pipes</td>
</tr>
<tr>
<td>Manufacturer B.1</td>
<td>1,660 pph 254 gpm</td>
<td>3</td>
<td>$398,250</td>
<td>$1,194,750 (plus $110,000 for combined control panel)</td>
<td>7.5 for press, 1.0 for RST, 1.5 for floc tank</td>
<td>10-15</td>
<td>25-35</td>
<td></td>
<td>Routine lubrication and oil changes; see 10-Year Warranty (does not cover floc tank mixer)</td>
<td>Price includes RST, floc tank and mixer, 316 SS construction, progressive cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery</td>
</tr>
<tr>
<td>Manufacturer B.2</td>
<td>1,225 pph 190 gpm</td>
<td>4</td>
<td>$396,550</td>
<td>$1,586,200 (plus $110,000 for combined control panel)</td>
<td>7.5 for press, 1.5 for floc tank</td>
<td>10-15</td>
<td>25-35</td>
<td></td>
<td>Routine lubrication and oil changes; see 10-Year Warranty (does not cover floc tank mixer)</td>
<td>Price includes floc tank and mixer, 316 SS construction, progressive cavity feed pump, polymer makeup and feed system and injection ring, startup and delivery</td>
</tr>
<tr>
<td>Manufacturer C</td>
<td>1,225 pph 190 gpm</td>
<td>4</td>
<td>$505,180</td>
<td>$2,020,720 (plus $36,000 for startup and freight)</td>
<td>13.5 total</td>
<td>25-30</td>
<td></td>
<td></td>
<td>Typically every 5000 hrs depending on application including replacing the brush, spray nozzles, and air cylinders . The requirements are ~$50,000 in parts and 6 man days to complete (2 people 3 days).</td>
<td>Price includes rotary drum thickener, 316 SS construction, control panel, flow meter, sludge feed and wash water pumps, polymer makeup and feed system and injection ring, startup and delivery, contractor to provide flocculation pipes</td>
</tr>
</tbody>
</table>
Biosolids Handling Process

Secondary Treatment

Gravity Belt Thickener

W.A.S. Pump

Thickened Sludge Pump

Land Application

Sludge Storage and Lime Stabilization

Secondary Sludge Flow Diagram
Primary/Secondary Sludge Flow Diagram

- Primary Treatment
- Thickened Secondary Sludge
  - Feed Pump
  - Screw Press
  - Sludge Cake Pump
- Shipped to Landfill
SECONDARY TREATMENT
RETRO-FIT
Objectives:
• Replace aging equipment
• Add 30% BOD capacity
• Reallocate maintenance labor
• Redundancy
• Budget
• Staging

Upgrades Needed:
• Secondary Treatment
  ✓ Aeration/oxygen
  ✓ RAS/WAS pumping
  ✓ Reactor configuration
  ✓ Added flexibility
  ✓ Clarifier upgrades
  ✓ Building /Tank Reuse
# Optimization Alternatives Comparison

## Design Average Day BOD Treatment Capacity Comparison

<table>
<thead>
<tr>
<th>Alternative</th>
<th>East Plant Capacity (lb/day)</th>
<th>West Plant Capacity (lb/day)</th>
<th>Total WWTP Capacity (lb/day)</th>
<th>Increase Over Current (lb/day)</th>
<th>Increase Over Current (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Design</td>
<td>4,796</td>
<td>15,000</td>
<td>19,796</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1 - Fine Bubble Aeration</td>
<td>8,600</td>
<td>15,000</td>
<td>23,600</td>
<td>3,804</td>
<td>19%</td>
</tr>
<tr>
<td>2a - HPOAS with VPSAs</td>
<td>13,300</td>
<td>15,000</td>
<td>28,300</td>
<td>8,504</td>
<td>43%</td>
</tr>
<tr>
<td>2b - HPOAS with LOX</td>
<td>13,300</td>
<td>15,000</td>
<td>28,300</td>
<td>8,504</td>
<td>43%</td>
</tr>
<tr>
<td>3 - IFAS</td>
<td>12,500</td>
<td>15,000</td>
<td>27,500</td>
<td>7,704</td>
<td>39%</td>
</tr>
</tbody>
</table>

## Design Maximum Day BOD Treatment Capacity Comparison

<table>
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<tr>
<th>Alternative</th>
<th>East Plant Capacity (lb/day)</th>
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<th>Total WWTP Capacity (lb/day)</th>
<th>Increase Over Current (lb/day)</th>
<th>Increase Over Current (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Design</td>
<td>8,340</td>
<td>30,000</td>
<td>38,340</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1 - Fine Bubble Aeration</td>
<td>17,200</td>
<td>30,000</td>
<td>47,200</td>
<td>8,860</td>
<td>23%</td>
</tr>
<tr>
<td>2a - HPOAS with VPSAs</td>
<td>26,600</td>
<td>30,000</td>
<td>56,600</td>
<td>18,260</td>
<td>48%</td>
</tr>
<tr>
<td>2b - HPOAS with LOX</td>
<td>26,600</td>
<td>30,000</td>
<td>56,600</td>
<td>18,260</td>
<td>48%</td>
</tr>
<tr>
<td>3 - IFAS</td>
<td>16,600</td>
<td>30,000</td>
<td>46,600</td>
<td>8,260</td>
<td>22%</td>
</tr>
</tbody>
</table>
Cost of Optimization vs. Maintaining Existing

- Optimization largely replaces existing equipment approaching or past its design life.
- Cost to simply replace this equipment with current models (i.e. minimal or no capacity gain) estimated at approximately $5.3 million.

<table>
<thead>
<tr>
<th>Major Equipment to be Replaced as Part of Optimization Project</th>
<th>Number of Units</th>
<th>Year Installed</th>
<th>Age (Years)</th>
<th>Design Life (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 HP Centrifugal Blower</td>
<td>2</td>
<td>1979</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>75 HP Centrifugal Blower</td>
<td>3</td>
<td>1971</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Waste Activated Sludge Pumps</td>
<td>3</td>
<td>1971</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Clarifier Internals</td>
<td>2</td>
<td>1971</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Clarifier Weirs &amp; Baffles</td>
<td>2</td>
<td>1971</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>25 Hp Mixers (Aeration Basin 3)</td>
<td>4</td>
<td>1979</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>10 Hp Mixers (Aeration Basins 1&amp;2)</td>
<td>8</td>
<td>1971</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>300 Hp Joy Compressors 1 &amp; 2</td>
<td>2</td>
<td>1979</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>PSA Skid 1</td>
<td>1</td>
<td>1979</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>300 Hp Joy Compressor 3</td>
<td>1</td>
<td>1995</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>PSA Skid 2</td>
<td>1</td>
<td>1995</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Liquid Oxygen Tank &amp; Appurtenances</td>
<td>1</td>
<td>1979 (Refurbished 1995)</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>Cooling Tower &amp; Pump</td>
<td>1</td>
<td>1979</td>
<td>34</td>
<td>20</td>
</tr>
<tr>
<td>Cooling Tower &amp; Pump</td>
<td>1</td>
<td>1995</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>
## Optimization Alternatives Cost Comparison

### Relative Life-Cycle Costs of Optimization Treatment Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost per Pound of East Plant BOD Treatment Capacity</th>
<th>Cost per Pound of WWTP Net Increased BOD Treatment Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Day</td>
<td>Maximum Day</td>
</tr>
<tr>
<td>Fine Bubble Aeration with West Plant PSA Upgrades</td>
<td>$2,498</td>
<td>$1,249</td>
</tr>
<tr>
<td></td>
<td>$5,648</td>
<td>$2,425</td>
</tr>
<tr>
<td>Fine Bubble Aeration with West Plant LOX Tanks</td>
<td>$1,742</td>
<td>$871</td>
</tr>
<tr>
<td></td>
<td>$3,938</td>
<td>$1,691</td>
</tr>
<tr>
<td>HPOAS with VPSAs</td>
<td>$1,674</td>
<td>$837</td>
</tr>
<tr>
<td></td>
<td>$2,618</td>
<td>$1,219</td>
</tr>
<tr>
<td>HPOAS with LOX</td>
<td>$1,107</td>
<td>$554</td>
</tr>
<tr>
<td></td>
<td>$1,732</td>
<td>$806</td>
</tr>
<tr>
<td>IFAS with West Plant PSA Upgrades</td>
<td>$1,995</td>
<td>$1,502</td>
</tr>
<tr>
<td></td>
<td>$3,237</td>
<td>$3,019</td>
</tr>
<tr>
<td>IFAS with West Plant LOX Tanks</td>
<td>$1,488</td>
<td>$1,120</td>
</tr>
<tr>
<td></td>
<td>$2,414</td>
<td>$2,252</td>
</tr>
</tbody>
</table>
Secondary Treatment Process

Proposed East Plant Flow Diagram

- Liquid Oxygen Bulk Storage
- Primary Treatment
- Oxygen
- Reactor #1
- Reactor #2
- Reactor #3
- Reactor #4
- Final Clarifier #1
- Final Clarifier #2
- Disinfection
Floating mixer in the existing tanks

**In-Situ Oxygenation System (I-SO)**

Secondary Treatment Process
In Conclusion:
• It’s all in the Data
• Get in Shape
• Understand the Real Problems
• Keep Your Options Open
• Simplify Your Life
• Get a Bigger Box
• Look at the full picture