Biosolids Facility Planning: One Approach, Three Communities

March 13, 2019
Outline

- Background
- Facility Overviews
- Driving Factors
- Approach
- Key Alternatives Comparison
- Outcomes
- Lessons Learned
Biosolids Facility Planning

**Goal:** provide a planning document that guides upgrades to a water reclamation facility’s solids treatment train over time.

- Understand future solids production
- Evaluate potential biosolids treatment technologies
- Plan implementation strategy
- Prepare biosolids facility plan report
East Lansing

- Biosolids Master Plan completed in 2017
- Average day flow: 12.3 MGD
- Design capacity: 18.75 MGD
- Conventional Activated Sludge

Solids Handling System
Biosolids Alternative Evaluation completed in 2018
Average day flow: 9 MGD
Design capacity: 12 MGD
High-Purity Oxygen Activated Sludge System

Solids Handling System

- PSD → Blending in Thickener No. 4 → Dewatering → Roll Off Container Storage → Disposal at Landfill (Disposal)
- WAS → Thickening → 45%
- Thickening → 55%
- Un-stabilized Solids Storage → Lime Stabilization → Land Application
Grand Haven

- Biosolids Alternative Evaluation completed in 2018
- Average day flow: 3.7 MGD
- Design capacity: 6.67 MGD
- Conventional Activated Sludge

Solids Handling System

Primary Sludge → Lime Stabilization → Gravity Thickening → Biosolids Storage → Land Application

WAS → Lime Slurry
# Driving Factors

<table>
<thead>
<tr>
<th>East Lansing</th>
<th>Holland</th>
<th>Grand Haven</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aging equipment</td>
<td>• Increasing solids load</td>
<td>• Reaching capacity of existing storage due to limited biosolids load out</td>
</tr>
<tr>
<td>• Increase process redundancy</td>
<td>• Reaching capacity of existing storage</td>
<td>• Desire for increased disposal flexibility</td>
</tr>
<tr>
<td>• Potential to reduce biosolids disposal costs</td>
<td>• Rising landfilling fees</td>
<td>• Interest to move away from lime stabilization</td>
</tr>
<tr>
<td>• Improve WRF sustainability</td>
<td>• Restrictions on solids sent to landfill</td>
<td></td>
</tr>
</tbody>
</table>

- East Lansing: Aging equipment, Increase process redundancy, Potential to reduce biosolids disposal costs, Improve WRF sustainability
- Holland: Increasing solids load, Reaching capacity of existing storage, Rising landfilling fees, Restrictions on solids sent to landfill
- Grand Haven: Reaching capacity of existing storage due to limited biosolids load out, Desire for increased disposal flexibility, Interest to move away from lime stabilization
Biosolids Facility Plan Approach

- Assess existing system
- “Universe of Possibilities”
- Short List of Potential Solutions
- Economic and non-economic evaluation of potential solutions
- Selection of final solutions
- Implementation planning
Assess Existing System

- What is the expected solids loading over the planning period?
  - Existing flow or loading projections
  - Projected population growth
- What is the capacity of existing equipment?
  - Is the existing equipment capacity sufficient for the projected solids loading?
- What are existing process deficiencies?
  - Equipment age
  - Consistent operating challenges
  - Frequent repairs
“Universe of Possibilities”

- **Thickening Equipment**
  - Dissolved Air Flotation
  - Gravity Belt
  - Rotary Drum
  - Centrifuge

- **Dewatering Equipment**
  - Belt Filter Press
  - Screw Press
  - Rotary Fan Press
  - Centrifuge

- **Digestion**
  - Aerobic
  - Anaerobic
  - TPAD
  - Two-Phase Acid

- **Thermal Chemical Hydrolysis**
  - Lystek
  - Cambi
  - Pondus

- **Lime Stabilization**

- **Composting**

- **Drying**
  - Rotary Drum
  - Belt
  - Paddle
  - Fluidized Bed
Short List of Potential Solutions

- **Thickening Equipment**
  - Dissolved Air Flotation
  - Gravity Belt
  - Rotary Drum
  - Centrifuge

- **Dewatering Equipment**
  - Belt Filter Press
  - Screw Press
  - Rotary Fan Press
  - Centrifuge

- **Digestion**
  - Aerobic
  - Anaerobic
  - TPAD
  - Two-Phase Acid

- **Thermal Chemical Hydrolysis**
  - Lystek
  - Cambi
  - Pondus

- **Lime Stabilization**

- **Composting**

- **Drying**
  - Rotary Drum
  - Belt
  - Paddle
  - Fluidized Bed
Alternatives Comparison

- Thickening
- Dewatering
- Anaerobic Digestion
- Thermal Chemical Hydrolysis Processes
- Drying
# Thickening Technology Comparison

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Dissolved Air</th>
<th>Gravity Belt</th>
<th>Rotary Drum</th>
<th>Centrifuge</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Continuous, unattended operation</td>
<td>• Tried and true technology</td>
<td>• Totally enclosed – dry environment</td>
<td>• Enclosed design</td>
<td></td>
</tr>
<tr>
<td>• Low polymer usage</td>
<td>• Non-enclosed process – can easily observe thickening</td>
<td>• Fully automated</td>
<td>• Low polymer usage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Fully automated</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disadvantages</th>
<th>Dissolved Air</th>
<th>Gravity Belt</th>
<th>Rotary Drum</th>
<th>Centrifuge</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large footprint</td>
<td>• Wet environment</td>
<td>• High polymer usage</td>
<td>• May depend on sludge characteristics</td>
<td></td>
</tr>
<tr>
<td>• Requires compressed air</td>
<td>• High polymer requirements</td>
<td></td>
<td>• High energy requirement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Higher capital cost</td>
<td></td>
</tr>
</tbody>
</table>
# Dewatering Technology Comparison

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Belt Press</th>
<th>Screw Press</th>
<th>Rotary Fan Press</th>
<th>Centrifuge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Tried and true technology • Low energy use • Lower capital and O&amp;M cost</td>
<td>• Enclosed design • Low energy use • Fully automated</td>
<td>• Enclosed design • Low energy use • Fully automated</td>
<td>• Enclosed design • Low polymer usage • Fully automated</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>• Non-enclosed design • Sensitive to incoming sludge characteristics</td>
<td>• Large polymer demand • Requires wash water</td>
<td>• High capital and operating costs • Not easily scalable for larger facilities</td>
<td>• May depend on sludge characteristics • High energy requirement • Higher capital cost</td>
</tr>
</tbody>
</table>
Anaerobic Digestion

**Advantages**
- Energy generation
- Reduces mass of biosolids for storage and land application
- No chemical usage

**Disadvantages**
- Large footprint
- Large capital cost
- Increased operational complexity
- Class B application requirements/constraints
- Odor concerns
Thermal Chemical Hydrolysis

- Anaerobic digestion pretreatment techniques that convert organic solids into soluble compounds by applying heat and pressure
- Increases digestibility, reduces digester sizing, increases biogas production, changes biosolids viscosity, and provides biosolids stabilization
- Commercialized processes provide equipment packages for thermal hydrolysis
  - Pondus, Cambi, Lystek
# TCHP Technology Comparison

<table>
<thead>
<tr>
<th></th>
<th>Pondus</th>
<th>Cambi</th>
<th>Lystek</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>• Minimizes reactor volume by treating only WAS</td>
<td>• No chemical addition required</td>
<td>• Potential for stand-alone treatment process</td>
</tr>
<tr>
<td></td>
<td>• Utilizes a hot water supply as the heating source</td>
<td>• Pre-heating from Cambi may be sufficient to fully heat digester</td>
<td>• High solids content Class A liquid product</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Cannot produce Class A product because primary sludge is not sent to TCHP</td>
<td>• Highest heat requirement, relying on high pressure steam for heat</td>
<td>• Stand-alone process requires high chemical addition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For cake production, requires multiple dewatering steps</td>
<td>• Lystek re-circ may increase digester sizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses steam for additional heat after digestion</td>
</tr>
</tbody>
</table>
# Drying Technology Comparison

<table>
<thead>
<tr>
<th></th>
<th>Belt Dryer</th>
<th>Paddle Dryer</th>
<th>Fluidized Bed</th>
</tr>
</thead>
</table>
| **Advantages**   | • Lower temp  
• Simple operation  
• Potential reuse of waste heat  
• May not require biosolids cooling | • Smaller footprint  
• Single pass process  
• Minimum air handling  
• Lower vertical profile | • Smaller footprint  
• High quality end product  
• Good thermal efficiency |
| **Disadvantages**| • Large footprint  
• Less desirable end product                                                | • High temperatures  
• Non-uniform end product  
• Internal moving parts                                               | • High temperatures  
• Requires recirc. of dried product  
• Potential for short circuiting                                      |
Equipment Sizing

- Solids production is continuous, but operation of solids treatment equipment may not be
- Equipment and storage sizing must be selected based on the desired operating strategy

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>4 Hours/Day</th>
<th>8 Hours/Day</th>
<th>12 Hours/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Solids Production</td>
<td>ppd</td>
<td>15,000</td>
<td>15,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Hours Operated per Day</td>
<td>hr</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Equipment Loading</td>
<td>pph</td>
<td>3,750</td>
<td>1,875</td>
<td>1,250</td>
</tr>
</tbody>
</table>
Economic Analysis

- Capital Cost
- Annual Operating Costs:
  - O&M
  - Disposal
  - Polymer/Chemical
  - Electricity
  - Natural Gas
- Potential for revenue generation or energy offset
- Total Present Worth
Total Present Worth

- ALTERNATIVE NO. 1 - UPDATED STATUS QUO
- ALTERNATIVE NO. 2 - DIGESTION
- ALTERNATIVE NO. 3 - DIGESTION AND PONDUS
- ALTERNATIVE NO. 4A - LYSTEK
- ALTERNATIVE NO. 4B - DIGESTION AND LYSTEK
- ALTERNATIVE NO. 5 - DRYING
Non-Economic Analysis

Qualitatively discuss advantages and disadvantages

OR

Select key performance criteria and assign a score for the performance of each alternative

<table>
<thead>
<tr>
<th>Potential Non-Economic Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor generation</td>
</tr>
<tr>
<td>Land availability for biosolids</td>
</tr>
<tr>
<td>Regulatory acceptance</td>
</tr>
<tr>
<td>Operational simplicity</td>
</tr>
<tr>
<td>Operational redundancy</td>
</tr>
<tr>
<td>Flexibility for future changes</td>
</tr>
<tr>
<td>Plant traffic</td>
</tr>
<tr>
<td>Renewable use of biosolids</td>
</tr>
<tr>
<td>Construction consideration</td>
</tr>
<tr>
<td>Staffing level</td>
</tr>
</tbody>
</table>
# Non-Economic Scoring

<table>
<thead>
<tr>
<th>Non-Economic Factor</th>
<th>Weight</th>
<th>Alt 1</th>
<th>Alt 2</th>
<th>Alt 3</th>
<th>Alt 4A</th>
<th>Alt 4B</th>
<th>Alt 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upgraded Status Quo</td>
<td>Anaerobic Digestion</td>
<td>Anaerobic Digestion + Pondus</td>
<td>Lystek</td>
<td>Anaerobic Digestion + Lystek</td>
<td>Drying</td>
</tr>
<tr>
<td>Raw Score (1 to 5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffing Levels</td>
<td>5%</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Ease of Construction</td>
<td>5%</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Community Impact</td>
<td>25%</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Operational Impact</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simplicity</td>
<td></td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Redundancy</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Regulatory Acceptance</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Method of Disposal</td>
<td>25%</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Flexibility for the Future</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Changes</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Regulatory Changes</td>
<td></td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Economic Changes</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sustainability Changes</td>
<td></td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Combined Weighted Scores</td>
<td>100%</td>
<td>2.78</td>
<td>2.42</td>
<td>2.48</td>
<td>4.10</td>
<td>3.35</td>
<td>3.25</td>
</tr>
</tbody>
</table>
Selecting a Solution

- **Alt 1**: Total Present Worth (TPW) = 12.3M
- **Alt 2**: TPW = 14.7M
- **Alt 3**: TPW = 15.9M
- **Alt 4A**: TPW = 18.3M
- **Alt 4B**: TPW = 26.0M
- **Alt 5**: TPW = 26.9M

Non-Economic Score:

- **Alt 1**: Non-economic Score = 3.0
- **Alt 2**: Non-economic Score = 3.5
- **Alt 3**: Non-economic Score = 4.0
- **Alt 4A**: Non-economic Score = 4.5
- **Alt 4B**: Non-economic Score = 5.5
- **Alt 5**: Non-economic Score = 6.0

Legend:
- Green: Staffing Levels
- Red: Ease of Construction
- Orange: Operational Impact
- Purple: Method of Disposal
- Teal: Community Impact
- Blue: Flexibility for the Future
- Black: Total Present Worth
Phased Approach

- Short term needs
- Long term goals
- Intermediate steps
## Community Outcomes

<table>
<thead>
<tr>
<th></th>
<th>East Lansing</th>
<th>Holland</th>
<th>Grand Haven</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short term</strong></td>
<td>Thickening and dewatering upgrades</td>
<td>Anaerobic Digestion</td>
<td>Thickening upgrades</td>
</tr>
<tr>
<td><strong>Long term</strong></td>
<td>Anaerobic digestion</td>
<td>TCHP or Drying</td>
<td>Lystek</td>
</tr>
</tbody>
</table>
| **Decision factors** | • Local landfill provided low landfilling fees  
                          • Many upgrades needed to existing equipment  
                          • Desire for environmentally sustainable process  
                          • Largest drivers were reduction in total load out volume and multiple disposal outlets  
                          • Available building space for Lystek | • Anaerobic digestion provided lowest 20 year TPW  
                          • Space constraints  
                          • Potential for energy production  
                          • Flexibility for future improvements |
General Outcomes

- Detailed planning document
- Identification of current deficiencies and plans to address them
- Understanding of community and facility-specific decision factors
- Budgetary guidance
Lessons Learned

- Consider number of alternatives to evaluate versus level of detail during evaluation
- Assess “no-go’s” early in process
- Understand stakeholder’s needs when selecting non-economic criteria
- Consider final product: thoroughly document decisions, assumptions, and reasoning as you go
- Consider travel: example installations, conferences, equipment exhibitions
Thank You!