OPTIMIZATION OF WASTEWATER NUTRIENT REMOVAL PROCESS

- Production of fertilizer from municipal and landfill wastewater -

Casey Bushnell, Nathan Kolibaba, John Mills
Sponsored By: City of Corvallis Wastewater Reclamation Plant

Project Objective:
The primary objective of this project was to assist the City of Corvallis in optimizing the removal of magnesium from wastewater collected from Coffin Butte Landfill.

- The City of Corvallis is looking to increase the amount of landfill leachate accepted by their Wastewater Reclamation Plant.
- The landfill leachate is high in magnesium ions, which cause scaling when mixed with municipal wastewater.
- To avoid scaling, as much Mg²⁺, PO₄³⁻, and NH⁴⁺ needs to be removed in the form of struvite, as possible.
- Currently a pilot struvite reactor manufactured by Multiform Harvest, Inc is being installed and operated at the WWRP.

What Is Struvite?
Ammonium magnesium phosphate hexahydrate

\[ \text{NH}_4^+ + \text{Mg}^{2+} + \text{PO}_4^{3-} + 6\text{H}_2\text{O} \rightarrow \text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O} \]

- Commonly forms in waste streams with super-saturated amounts of magnesium, phosphates, and ammonia.
- Struvite can cause scaling inside of pipes to the point that a plant may have to shut down.

Economic Breakdown:
Sources of Income:
- Leachate processing ($0.03/0.05/gallon)
- Created struvite ($1.50/ton)

Expenses:
- Capital investment in project
- Chemical additives (ie. pH modifiers)
- Maintenance & operation

We would like to thank the following people for their help and inspiration:
- Dan Hothorn (City of Corvallis)
- Dr. Keith Turner (City of Corvallis)
- Shane Binsler (City of Corvallis)
- Keith Bowers (Multiform Harvest, Inc.)
- Dan May (Valley Landfills, Inc.)
- Chris Kaufman (Valley Landfills, Inc.)

Acknowledgements:
- Dan Hothorn (City of Corvallis)
- Dr. Keith Turner (City of Corvallis)
- Shane Binsler (City of Corvallis)
- Keith Bowers (Multiform Harvest, Inc.)
- Dan May (Valley Landfills, Inc.)
- Chris Kaufman (Valley Landfills, Inc.)

3. CH2MHill Labs (May 2011)
4. ICPO (Apr 2011)
5. leachate
6. ICP only tests for metals

Findings To Date:
- Jar testing of lagoonate and leachate was performed at a ratio similar to the full-scale reactor
- Test solutions were prepared across a pH range of 7-9
- Precipitate was settled in Imhoff cones to achieve maximum settling
- The remaining liquid was analyzed to calculate the percent removal of magnesium.
- The precipitate was then dissolved and the relative concentrations of Mg²⁺ and Ca²⁺ in order to determine the quantities of struvite and calcium phosphate formed.

Stream Characterization:

![Graph showing concentration of species in leachate and lagoonate streams.](image1)

Composition testing of both streams are scheduled through CH2MHill Labs and the HACH test, starting in August. These will be used to construct historical concentration data and monitor periodic trends.

Process Design:

![Diagram showing processing steps from fresh leachate to final fertilizer product.](image2)

```
Fresh from WRRP

<table>
<thead>
<tr>
<th>Leachate</th>
<th>Imhoff Cone</th>
<th>Struvite Forming</th>
<th>Struvite Reactor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

```
Reactor Feed

<table>
<thead>
<tr>
<th>Leachate</th>
<th>Lagoonate</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH = 7.5</td>
<td>pH = 7.5</td>
</tr>
<tr>
<td>125,000</td>
<td>34,000</td>
</tr>
<tr>
<td>gw/day</td>
<td>gw/day</td>
</tr>
</tbody>
</table>
```

```
Amount of caustic added vs. target pH
```

```
Jar testing apparatus
- A jar testing apparatus ensures simultaneous and identical mixing of multiple solutions
```

```
Settling of solids in Imhoff cones
- Imhoff cones allow the separation of fluid and settling
```

```
Webko.png
```

```
Leachate

<table>
<thead>
<tr>
<th>pH modifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaOH</td>
</tr>
</tbody>
</table>
```

```
Solids Recovery
- Bench top results show the molar amount of struvite and calcium phosphate formed for each pH tested.
```

```
Optimization of Wastewater Nutrient Removal Process

- Dan Hothorn

Wastewater Operations Supervisor
Corvallis