The objectives of this design project are as follows:
- Reduce ammonia levels in effluent water by 50%.
- Reduce COD levels in effluent water by 75%.
- Increase speed of the current system to less than 8 hours.
- Turbidity less than 20 NTU.

**Constraints**

There are a few constraints that dictate the design of the project:
- Must fit within a 17 in (width) by 17 in (depth) by 78.75 in (height).
- Be able to handle flow rates between 30 gal/hr and 120 gal/hr.
- Be able to be transported by no more than 2 soldiers.

**Design Alternatives**

There are many methods to treat wastewater that were considered in the selection of this design. The systems that were seen to be most effective for this designs purposes were aeration, ozone treatment, and nitrogen stripping.

**Aeration**
- Introduces O₂ into the water causing volatile and dissolved substances to leave the water as gases.
- Up to 60% ammonia reduction.
- 1-2 days for effective treatment of 1L.

**Ozone treatment**
- Ozone microbubbles react with ammonia to form nitrate molecules.
- Lower pH reduces ammonia reduction.
- Around an hour for effective treatment of 1L.

**Nitrogen stripping**
- Separates ammonia from water turning it into a gas.
- Up to 90% ammonia reduction with high pH.
- Minimal effect on turbidity.

**Selected Design**

Based on the different design alternative's ability to reduce ammonia levels, COD levels, turbidity, and reaction time, ozone treatment and nitrogen stripping were selected as methods of treatment for this design.
- Combination of ozonation and nitrogen stripping.
- Both treatments work better in high pH.
- Potential for 90% ammonia removal.
- High COD removal.
- Treatment time no greater than 3 hours.
- Turbidity reduction minimal.

**Design CAD Drawings**

Testing without pH adjustment:
- Ammonia: 53 % Reduction.
- COD: 8% Reduction.
- Turbidity: 16% Reduction.
Testing with pH adjustment:
- Ammonia: 95% Reduction.
- COD: 11% Reduction.
- Turbidity: 61% Increase.

The requirements for ammonia reduction were met under both tests with and without pH adjustment. The design and supplemental components (ozone generator and air blower) all fit within the prescribed area. The COD and turbidity reductions were not met, and turbidity increased with the addition of chemicals to increase pH. The design is scaled to run at 60 gal/hr and the longevity of the system will be investigated this spring with testing at this flow rate.

**Prototype Testing**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Turbidity (NTU)</th>
<th>COD (mg/L)</th>
<th>Ammonia (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretreatment</td>
<td>62.6</td>
<td>488</td>
<td>259.5</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>93.05</td>
<td>485.5</td>
<td>238.5</td>
</tr>
<tr>
<td>Stripping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone</td>
<td>51.3</td>
<td>452</td>
<td>121.4</td>
</tr>
<tr>
<td>Reduction</td>
<td>18%</td>
<td>8%</td>
<td>53%</td>
</tr>
</tbody>
</table>

**Economics**

Capital cost estimate: $2,500.
- Prototype: $1000.
- Ozone generator: $1000.
- Air fan: $500.
Variable cost estimate: $326.73/year.
- Run-time per day for 365 days: 4 hours.
- Power for devices: 0.62 kW.
- Price of electricity: $0.14/kWh.
- Water use: 87600gal/year.

**Select References**