The purpose of this competition is to bring Civil and Environmental Engineering students together to research, design, test, construct, and present a wastewater filtration treatment system using a limited amount of everyday materials. As we collaborate, students apply wastewater treatment principles and solve a real-world challenge.

On our 200 acre farm, Bearnoulli grows high-quality produce. We are committed to bringing the freshest lettuce to our customers with no traces of contaminants that may cause foodborne illnesses. Prior to shipping, we wash our lettuce with river water that has been treated in our washing facility. But recently, our treatment facility was shut down for maintenance. During this inconvenient time, a highly valued customer made a request for a small shipment of De Morges cheese. Unlike a plastic tote, it does not buckle under the weight of the top tote. Air Conditioner (AC) Filter - Untreated river water is poured through a standard AC filter placed on top of a plastic tote. At this stage, the pine needles and larger soil particles are filtered out. Physical Treatment: Prior to physical filtration, alum and pickling lime are added to every 4.5 gallons of dirty river water. Alum causes coagulation of small particles which allow them to be physically filtered out. Pickling lime raises the pH, which drastically fell from the addition of alum. Post physical filtration, 65 mL of Clorox bleach was added to the collection tote to reduce the microbial load in the effluent.

Physical Treatment:
• Air Conditioner (AC) Filter - Untreated river water is poured through a standard AC filter placed on top of a plastic tote. At this stage, the pine needles and larger soil particles are filtered out.
• First Rag Layer - The water then passes through a layer of terrycloth rags. The top layer of rags acts as a diffuser for the layer of sand below and absorbs fine particles from the wastewater.
• Sand Filter - After passing through the first layer of rags, the wastewater goes through two inches of play sand. The two inches of sand captures the fine particles that percolate through the AC filter and reduce overall turbidity.
• Final Rag Layer - The final layer of terrycloth rags prevents the sand from falling through the holes of the plastic tote. Like the first layer, it adds an additional barrier for particles that make it through previous barriers.

Testing Results

<table>
<thead>
<tr>
<th>Batch Name</th>
<th>pH</th>
<th>DO (mg/L)</th>
<th>Electrical Conductivity (μs/cm)</th>
<th>Turbidity (NTU)</th>
<th>Chlorine (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Water</td>
<td>8.31</td>
<td>7.75</td>
<td>381</td>
<td>1939</td>
<td>3</td>
</tr>
<tr>
<td>Treated Effluent</td>
<td>6.89</td>
<td>8.17</td>
<td>1464</td>
<td>150</td>
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Table 1: Influent and effluent water quality.

Teams tested their hypotheses by performing small-scale experiments. We incorporated the best designs into our first complete filter design, and with a few more iterations, we had a simple, yet effective design. We then ran the wastewater through our filter to obtain a much better water quality (Table 1).

Filter Overview

Chemical Treatment: Prior to physical filtration, alum and pickling lime are added to every 4.5 gallons of dirty river water. Alum causes coagulation of small particles which allow them to be physically filtered out. Pickling lime raises the pH, which drastically fell from the addition of alum. Post physical filtration, 65 mL of Clorox bleach was added to the collection tote to reduce the microbial load in the effluent.

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One of Bearnoulli’s primary goals is environmental sustainability. With that in mind, we maximize the amount of reusable and recyclable materials in our filter design. We split ourselves into subteams to focus on each water quality parameter and determine what materials and methods to test. Aside from water quality, environmental footprint, cost, and ease of implementation were also considered.

Filter Design

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Before beginning the design process, Bearnoulli analyzed samples of the river water for their water quality parameters at UC Berkeley’s Environmental Engineering Lab. The pH values were too high, dissolved oxygen values were lower than values at room temperature, and turbidity values were high (Table 1). We split ourselves into subteams to focus on each water quality parameter and determined what materials and methods to test. Aside from water quality, environmental footprint, cost, and ease of implementation were also considered.

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