Classroom Activity WQ3
Assessing the Effectiveness of Wastewater Treatment

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Click here for a PDF handout of the laboratory

## Background Information

Water treatment occurs in many ways, many of which can be modeled in the classroom. Preassembled kits are available from several suppliers (see resources), however it is also possible to produce the systems using less expensive materials. The exercise described below can be easily modified based on the availability of testing materials and other laboratory equipment. Students will explore two or three different types of treatment and investigate the relative benefits and efficacies of each of the technologies. The simplest system involves 24 hours of settling, the second adds filtration through a soil bed and the third filtration through a vegetative bed. None of these technologies depend on constant power or technology that may be beyond the reach of a developing country.

This activity draws on the material presented in the The Ganga Action Plan 20 Years Later and Varanasi and Kanpur broadcasts with the supplementary materials described on the Water Quality Home Page.

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## Required Materials

Equipment Needed (per group)

- 2 Oil Drain Pans or other small bucket
- 20 cm Plastic Tubing
- Nitrate/Phosphate/Iron test kit
- Sterilized Potting Soil (no nutrients added)

- Optional: planting tray, grass seed

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## Procedure

3 - 4 weeks prior to beginning lab:

Prepare a planting tray by drilling four holes at one end. Fill the planting tray with 1.0 cm of gravel and fill to within 1.0 cm of the top with a sterilized potting soil. Plant the grass or sedge seed as directed on the packet and cover to retain moisture (Figure 1)

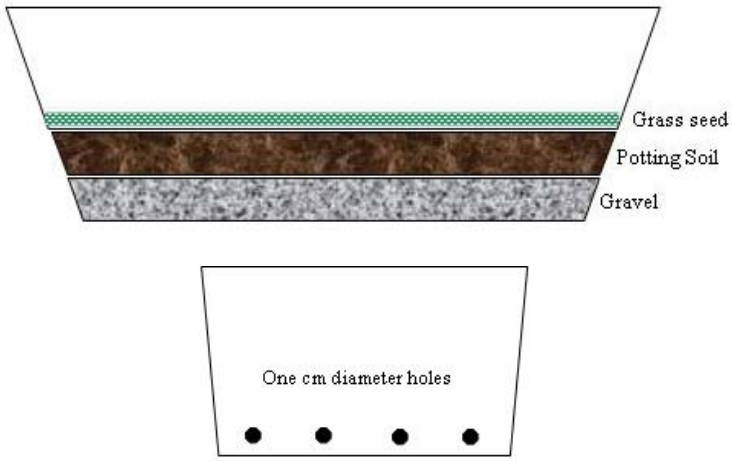


**Figure 1. Construction diagram for the planting tray.**

Within one week of the laboratory in class:

Target pollutants

Phosphate
Nitrate
Iron

'Wastewater" production – To achieve greater consistency in results, a 20 liter batch of "wastewater" should be mixed for group use prior to beginning the lab (assuming about 3 liters are needed per group). The material should consist of both dissolved and suspended material, and should contain levels of material of sufficient concentration to allow for the test kits in use to determine any change. Organic fertilizers contain nutrients that will provide an excellent source of the necessary materials. Dissolve approximately three tablespoons of fertilizer per liter of water; this should form a cloudy solution with high concentrations of nitrate and phosphate. If desired, iron can be added with iron filings. Test the concentrations of the three pollutants prior to beginning the lab! Adjust as necessary to achieve the desired concentrations.

Preparation of Materials

Settling Tank - Drill a hole in the side wall of one of the oil pans or buckets, one cm above the bottom (Figure 2) that will allow the latex tubing to pass through it snugly. Place rubber washers on either side of the tubing and affix with a waterproof adhesive. Seal the area around the washers with silicone caulking material. Place a clamp on the latex tubing that will allow for the slow release of the water.

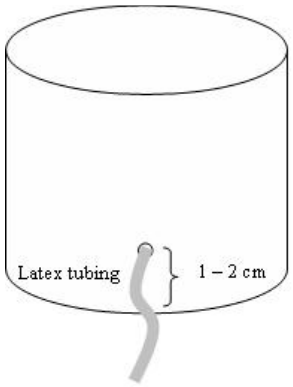


**Figure 2. Construction diagram for the settling tank.**

Soil Filtration – The structure for the soil filtration chamber is similar to that of the settling tank, with the discharge located at the bottom of the bucket. Approximately 4 cm of sterilized potting soil should be placed at the bottom of the bucket and a layer of paper towel placed over the soil (Figure 2).

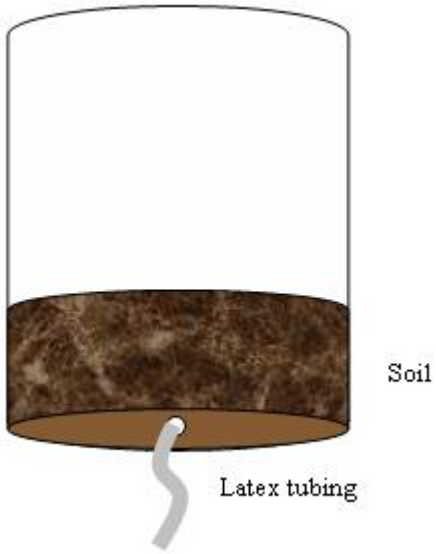


**Figure 3. Construction diagram for the soil filtration tank.**

Vegetative Filtration (tertiary treatment) – flow through an artificial wetland: The planting tray should be elevated about 2 cm from one end to the other. Make sure that this system is full saturated with distilled water prior to beginning the experiment, otherwise much of the sample water will be absorbed leaving little for analysis. It is also important to select inert potting soils as many seed starting and other mixes contain fertilizers that will confound the results.

## Student Procedure

1. Settling

Begin by stirring the "wastewater" to suspend the soil particles. Add three liters of water to the primary settling tank and record parameter values for all pollutants. Allow this tank to settle for 24 hours. Being careful not to disturb the sediments, remove as much water as possible above the drainage hole, reserving a sufficient amount of water to allow for sampling (50 ml should be adequate) and retest pollutant levels. Set the remainder of the collected water aside to for use in the next step of the experiment.

2. Soil Filtration

Take the remaining water collected after settling and slowly pour it into the soil filtration tank (with the drainage tube clamped closed) taking care not to disturb the paper towel covering the soil. Open the clamp sufficiently to allow the water to trickle out at a slow rate. After 24 hours, most of the water will have been collected in the receiving vessel. Once again, collect 50 ml of water for testing, setting the rest aside for the vegetative filtration.

3. Vegetative Filtration

24 hours prior to beginning treatment, the planting tray should be watered to saturation and allowed to drain. Failure to do this may result in excessive absorption of the water leaving too little to test. Connect the drainage tube to the distribution system and open the clamp to allow the water to slowly trickle into the planting tray. Restrict the flow such that there is no significant surface flow visible.

## Evaluation of Results

1. Calculate the percentage of material removed in each of the treatments using the formula:

$$\frac{\text{(Initial Concentration – Final Concentration)}}{\text{Initial Concentration}}$$

2. Do the results suggest that an Advanced Integrated Wastewater Pond System (AIWPS) system of ponds that allows for the treatment of wastewater at a lower cost than conventional wastewater treatment facilities would be an effective strategy for handling wastewater in developing countries?.

3. The time that the water remains in each of the treatments is critical to the extent of removal of the pollutants. However, more time of residence requires greater area for the storage of the water and therefore greater expense. How would scientists determine the optimal area for treatment?

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## Further Resources

For additional information or assistance with this activity please contact David Black at dblack@groton.org.

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