

Name	Joanna Goldsmith
Lesson Title	Methods for Cleaning Wastewater
Grade and Subject	Chemistry, Grades 10-12 Can be adapted for regular or AP chemistry classes
Standard	<u>HS-ESS3-4 Earth and Human Activity</u> Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. <u>HS-ETS1-3 Engineering Design</u> Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
Objective	Effectively clean a wastewater sample using physical and chemical processes and show that the final product is clean enough to release into the environment.
Outline	Divide the class into groups of four and assign each group one of two roles: wastewater treatment or water testing. Ideally each wastewater treatment group would be paired with a testing group. Have student groups research the wastewater treatment process with their end goal in mind (see below). General Procedure Wastewater treatment groups: • Develop a procedure for cleaning a variety of impurities out of a sample of wastewater • Work with the testing group to understand how the water samples will be tested and what the results mean • Use feedback from the testing group to adjust the procedure to maximize water purity and minimize materials costs Constraints: • No filter paper! • Students must remove impurities in a certain order (to be determined by teacher) Testing groups: • Develop a procedure for testing the quality of a water sample, including for solids of various sizes and dissolved substances • Decide where in the treatment process samples should be taken • Report your results to the water treatment group during practice Note: This is less of a single lesson and more of a unit-long or semester-long project. This can be a summative assessment to check students' understanding of physical and chemical properties, mixtures, solubility rules, precipitates, etc.

	and to the government agency (teacher) Constraints: • Must be consistent in their testing practices • Must demonstrate that their tests work using samples with known concentrations of impurities • May use additional separation methods not available to the wastewater treatment group (vacuum filtration, centrifugation, etc.) as available/needed
Assessment	• Students will be able to explain orally or in writing how each test works and why it is performed • Students will keep a chain of evidence record detailing who performed what tests at what times • A government agency (the teacher) will test effluent samples for purity (scale to be determined). Groups that do not meet requirements will receive a fine (loss of points)
Materials/Resources	• “Waste water” – water with added toothpicks (branches), paper circles from 3-hole punch (rags), salad dressing (oils), ferric chloride (dissolved impurities), glitter (other solids) • Beakers, flasks, and other containers • Graduated cylinders • Funnels • Sand, charcoal, and other filtration materials • Rubber tubing (optional)
Needs	• Resources with information about the wastewater cleaning process
Tools	• Wastewater video • Description of treatment process • Making a hand vacuum pump for filtration
Extensions	• Gravity fed – consider each “pour” (after the initial pour) to be the equivalent of a “pump”. Set up your treatment facility to minimize or eliminate “pumping” • Capacity – set a goal for the rate at which each plant needs to process waste water effectively. It never stops coming!