

Materials How-to for Grungy Groundwater Activity



Ringstand set-up for Flow-through activity (one per group)

- Ringstand, 1
- Clamps, 4
- Tubes, 4
- Tube caps, 4
- Wire mesh inserts, same diameter as tubes, 4
- Glass or plastic beads
- Sand, various grits (fine, medium, coarse)
- Clay, powdered

Sand levels should be equal in each tube (ours are approximately 15 cm above the cap/ mesh assembly). The glass bead layers should be similarly equal (ours are about 3 cm). The beads are used as a protective layer, which keeps the sand's surface at the same horizontal level (it might otherwise be cratered by the water being poured in). Tube contents are (in our setup) :

- Tube 1- coarse sand
- Tube 2 - medium sand with a clay layer in the middle
- Tube 3 - fine sand
- Tube 4 - a mixture of the 3 sands and the clay

Vial set-ups for Flow-through activity (complete set per group)

- Collection rack set:
 - Vial rack, 3 x 8
 - Graduated vials with flat caps (numbered 1-8, three of each number), 24 altogether
- Colorimetric scale rack set:
 - Vial rack, 3 x 3 (fewer slots is fine)
 - Graduated vials with flat caps (numbered 0, 2, 4, 6, 8)
 - Pollution solutions 0, 2, 4, 6 and 8
 - (see pollutants how-to, page 6)



Drills for Model activity

- Long, thin tubes (one pair per table group)

The purpose here is to “drill out” a sample, but the various techniques we tried to remove sand were not very successful. We came up with serological pipettes, 10 mL and 25 mL sizes, with the ends cut off, as seen in Figure 1. The pipettes fit into each other, as in Figure 2, with the 25 mL pipette remaining solid, while the 10 mL pipette has been drilled with hundreds of tiny holes, to mimic the porosity of coarse grit sand, Figure 3. (Coarse sand is commonly used by civil engineers to fill in the holes left by drilling samples.) To simulated “drilling”, the outer pipette is removed, leaving the porous pipette in place.



Figure 1



Figure 2



Figure 3

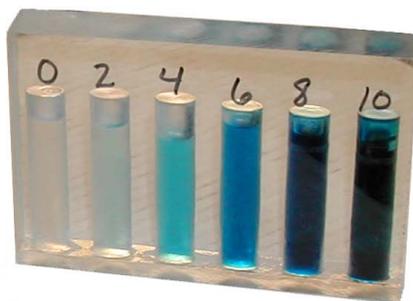


Tube set-ups for model activity (complete set per group)

- Collection rack set:
Tube rack, 6 x 6
Tubes, 36 altogether
- Colorimetric scale rack set:
Tube rack, 6 x 6 (fewer slots is preferable)
Tubes with caps (numbered 0, 2, 4, 6, 8, 10)
Pollution solutions 0, 2, 4, 6, 8 and 10 (see [pollutants how-to, page 6](#))

OR A plexiglas panel with holes drilled to match the diameter of the collection tubes. A "lid" gets attached with plexi solvent after the solutions have been added.

Pollution solutions can be saved into a variety of containers (I show two examples at the left) so long as the samples can remain upright for comparison, and won't spill. Temporary scales can be made using test tubes without caps, just take care - the blue dye lasts a very long time on skin!





Before

Fresh Water Reservoir for Model Activity

- Wire mesh form

A tea strainer (Before) has a fine enough mesh to keep most sand from coming through, and by removing the plastic handle and framing, the mesh remaining is flexible enough to fit nicely into the model.



After

The mesh will have sharp edges, so take care to wrap the upper edge with duct tape, which will remain intact for a great number of sessions of use (After).

Pollutants How-To for all portions of Groundwater Activity

If you have chosen to use water tracing dyes as pollutants (another option is food coloring pastes, not the little bottles), you will have some very concentrated pollutants. In terms of the flow-through tubes, the pollutant added to the tubes has already been diluted.

I have been working with a 5% solution of liquid dye to water, and the color is still quite intense. The colorimetric scales, labelled with values of 0, 2, 4, 6 and 8, are diluted further, as follows:

- vial 8 - the 5% solution
- vial 6 - 10% of the vial 8 solution, 90% water
- vial 4 - 10% of the vial 6 solution, 90% water
- vial 2 - 10% of the vial 4 solution, 90% water
- vial 0 - pure water

The colorimetric scales for use with the buried pollutant in the model are created in the same manner, except that vial 10 is the original concentration of the dye, and there

- vial 10 - original liquid dye
- vial 8 - 10% of the original dye, 90% water
- vial 6 - 10% of the vial 8 solution, 90% water
- vial 4 - 10% of the vial 6 solution, 90% water
- vial 2 - 10% of the vial 4 solution, 90% water
- vial 0 - pure water



I have pre-mixed a large volume of the 5% solution for the flow-through tubes, as the students will need to use 2-5 dropper bottles' worth of the pollutant for every student group. The dropper bottles are filled to only 5mL or so, but it is nice to be able to have back-up solution to make refilling the bottles an easy task. The dye solutions for the model colorimetric scales can be made just once, so long as the colorimetric scales do not leak. The original intensity of the liquid dye is used because the buried pollutant is in solid (pellet) form, and therefore not itself diluted in intensity.

Finally, the "road salt" is made by crushing some of the dye tablets (fun with mortar and pestle!). A very small amount of this is portioned into a small container for polluting, I use very small lidded vials, and the rest can be stored in a larger container for future refillings.

Random Other Stuff

There are other items that you are going to need to run Grungy Groundwater that don't require assembly. Just purchasing.

For each group, it is good to have the following sorts of things:

- pitcher
- measuring cup
- small cup (able to fit inside width of plexi model)
- GLOVES!! (you cannot believe the colors you will turn if you touch the pollutants....)
- basins to catch the dripping water
- something to raise the plexi model above the level of the basin (we built mini-tables out of scrap wood)
- a plastic, disposable tablecloth (Being able to pick up the tablecloth, and toss the spilled sand, clay and water is heavenly!)
- Sand, sand and more sand. You will need the same grits of sand as used in the flow-through tubes when building the plexi models.
- Clay. Ditto on needing the same kind as in the tubes.

For cleanup, there's a few things that come in handy that you may want to get:

- sifters - these are great for holding the sand while you rinse out the dye. A very reasonable set is available from Delta Education (see vendors list)
- rubber spatulas - great for removing clay from the insides of the model. Also surprisingly useful in scooping out layers of sand without mixing them
- long handled scrub brush

If, like me, you do not have an unlimited materials budget, you are going to want to conserve and reuse at least some of the materials that you will be using to model the soil layers within the plexi model. Before I go on, let's just say that this is NOT the most fulfilling portion of running this activity, but it is the most cost-effective.

First of all, the sand, clay and beads that are in the flow-through tubes should be flushed with clear water and then allowed to dry right where they are. The mixture of soils is the most difficult to clean, and will require more time and more water to return to clear, but at least the tubes are already attached to a ringstand, and will happily rest in a sink.

As for the model, I recommend buying yourself at least one set of sorting sieves, with varying meshes, to allow for rinsing out the dyes from the sands. A very reasonably priced set can be purchased from Delta Education (see the Materials Vendors appendix), that has something resembling the mesh sizes that you'll need.

Why do you need these? You could run water through your models for the hours it might take to "rinse out" the dyes. It *might* work, but you can't guarantee how quickly. We begin cleanup by scooping the sand out of the model while it is still wet, because you will have a better chance of keeping the different grits separate. Once scooped (by hand, with a rubber spatula, and WEARING GLOVES, since the dye is not *that* diluted), the sand can be placed into the appropriate sieve, and water can be run through it until it runs clear. The sand can then be laid out to dry. We just use cookie sheets, and hope for a sunny window.