CHILDREN'S CLEAN WATER FESTIVAL
Where Youth Are Making Waves!

Water Quality

Background:

Water quality is highly variable, from place to place and from time to time, even within a particular river system. It is dependent on many factors, both natural and as a consequence of human activities. Rainwater is by no means pure, and when it reaches the earth its quality is further affected by the soils, rocks and vegetation over and through which it passes. Another major influence on river water quality is the rate of stream flow, in part due to the fact that at low flows, groundwater can make up a larger proportion of total flow to streams.

Water quality must be sufficient to maintain the ecological integrity of rivers, streams, lakes, wetlands, and estuaries, including the sustained growth and propagation of aquatic organisms (fish, invertebrates, insect larvae, macrophytes and plankton), semi-aquatic organisms, and terrestrial wildlife dependent on surface water for survival.

All sources of water contain some naturally occurring contaminants. Because water is the universal solvent, many materials are easily dissolved upon contact. At low levels, these contaminants generally are not harmful in our drinking water. Removing all contaminants would be extremely expensive and in nearly all cases would not provide greater protection of health. A few of the naturally occurring substances may actually improve the taste of drinking water and may have nutritional values at low levels.

Water Quality: How Small is a Part Per Million?

CIM CORRELATION: Math

- Common Curriculum Goal: Understand measurable attribute of objects and the units, systems, and process of measurement.
- Common Curriculum Goal: Analyzing and interpreting results: summarize, analyze, and interpret data from investigation

How Small is a Part Per Million?

This activity was adapted from Science Demonstration Projects in Drinking Water (Grades K-12) by the US Environmental Protection Agency, Office of Water, EPA 570/9-90-007, April 1990.

Materials:

One set for each group of students.

- 1 stirrer (solid coffee stirrers or tooth picks)
- 2 containers of clean water (one for diluting and one for rinsing)
- 2 dropping pipettes (medicine droppers)
- food coloring (can have different colors for each group)
- set of 10 white plastic spoons, clear containers, or Styrofoam egg carton
- white paper (if clear containers are used)

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Purpose:

- To demonstrate the concept of parts per million (ppm) and parts per billion (ppb) measurement terms which are used to describe the amount of a substance that is found present in drinking water.

- To explain how chemicals may be present in very small amounts in water such that they cannot often be detected by sight, taste, or smell, even though they may still possibly pose a threat to human health.

Background:

Concentrations of chemical pollutants in water are frequently expressed in units of "parts per million" (ppm) which is the same as milligrams per liter (mg/L). Chemical fertilizers contain nitrate, a chemical that can be dangerous to infants in quantities as small as 10 parts per million. Trichloroethylene (TCE), a common industrial solvent, is more dangerous than nitrate and when present in drinking water in quantities as small as 5 parts per million can cause a higher than normal incidence of cancer among people who drink the water regularly.

Procedure:

1. If clear containers are used, line them up side-by-side, place a piece of white paper under each, and number 1 to 10 (left to right). If egg cartons are used, number each cup.

2. Place 10 drops of food coloring into container #1 (food dye is already diluted 1:10).

3. Either place one drop of food coloring into container #2, or take one drop from #1, transfer it to #2, and rinse dropper. Transferring the drop of food coloring requires more rinsing but is consistent with the procedure for the remaining containers. (You may double the drops to obtain more volume, just be certain that you also double the dilution water in step #4).

4. Add 9 drops of clean water to container #2 and stir the solution. Rinse the dropper.

5. Use the medicine dropper to transfer 1 drop of the solution from container #2 into container #3. Add 9 drops of clean water to container #3 and stir the solution. Rinse the dropper.

6. Transfer 1 drop of the solution from container #3 to container #4. Add 9 drops of clean water to container #4 and stir the solution. Rinse the dropper.

7. Continue the same process until no more color is visible in the last spoon, container, or egg carton cup.

Discussion:

1. The food coloring in container #1 is a food coloring solution, which is one part pigment per 10 parts liquid. What is the concentration for each of the successive dilutions? Use table below (each dilution decreases by a factor of 10 - 1/10, 1/100, 1/1000, etc.).

2. What was the concentration of the solution when the diluted solution first appeared colorless?

3. Do you think there is any of the colored solution present in the diluted solution even though it is colorless? Explain. (Yes. The solution is still present but has been broken down into such small particles that it cannot be seen.)

4. What would remain in the containers if all the water were removed? (Residue from the food coloring, i.e., the pigment.)

Extensions:

1. Allow the water in the containers to evaporate and have students record their observations on what remains in the containers.

2. Discuss chemical contamination in drinking water. Use the list of maximum contaminant levels (MCLs) for some toxic or carcinogenic chemicals in drinking water (as regulated by the U.S. Environmental Protection Agency) located at the end of the activity. These MCLs represent the maximum amount of a chemical that

can occur in drinking water without the water being dangerous to human health. [Note: Some of the MCLs listed are subject to revision by the EPA shortly.]

3. Explain the relationship between ppm and ppb and the conversion of these units to milligrams and micrograms per liter. For example: 1 ppm = 1000 ppb; 1 ppm = 1 mg/L; and 1 ppb = 1 ug/L.

4. Try different colored food colorings. Does the eye perceive color differently? Do some colors "disappear" sooner than others?

Resources:

Websites:

- EPA Monitoring and Assessing Water Quality: http://www.epa.gov/owow/monitoring/ and http://www.epa.gov/safewater/kids/grades_4-8_water_filtration.html
- AWWA Drinking Water Week Activities: http://www.awwa.org/Government/Content.cfm?ItemNumber=1400&navItemNumber=3871
- What is in Water?: http://www.waterqualityreports.org/
- American Water Works Association: http://www.drinktap.org/kidsdnn/

Local Contacts:

Clackamas River Water Providers
14275 S. Clackamas River Rd.
Oregon City, OR 97045
Contact: (503) 723-3511

Joint Water Commission Water Treatment Plant (Washington County)
4475 SW Fern Hill Rd.
Forest Grove, OR 97116
Contact: (503) 615-6732

Columbia Boulevard Wastewater Treatment Plant (Multnomah County)
5001 North Columbia Boulevard
Portland, OR 97203
Contact: 503-823-2400

Clean Water Services (Washington County)
155 N. First Avenue, Suite 270
Hillsboro, OR 97124
Contact: 503-681-3600

Water Environment Services (Clackamas County)
15941 S. Agnes Ave.
Oregon City, OR 97045
Contact: (503) 353-4567