

Lesson 3 – Cause and Effect of Water Pollution

Grade 5–8 (Science and Social studies)

Grade 9–10 (Science and Social studies)

Topic: The causes and effects of water pollution.

Time: 60 minutes

Space Requirement: Regular classroom

Methodology: Jigsaw, cooperative learning, Venn diagram development, poster making

Materials: One copy of the “Types of Pollutants Completed Chart” handout per student, handouts and pictures for each group, poster materials (paper, markers, scissors, glue)

Objectives: Students will be able to list different sources of water pollution and understand which types of pollutants are produced by these sources. They will also be able to describe the effect of water pollution on aquatic life and humans.

For the Teacher: The goal of this lesson is to make students aware that all sectors of society contribute to water pollution. Also, students should be aware of the major types and sources of water pollution. The students may become discouraged after this lesson but reassure them that they can make a difference and that in a future lesson they will be given concrete strategies to improve water pollution.

Directions/Procedure:

1. Explain to the students that this lesson will be about the sectors of society that generate water pollution and that they will be looking at three general sources: industry, agriculture and domestic. Optional: hand out copies of the “Types of Pollutants Completed Chart” from lesson 2, and review the pollutants that were discussed. (2 min)
2. On the board write the word “Industry” and with the students, develop a list of pollutants that this sector of society may create. (5 min)

- a. May include the following items: gas, oil, plastics, mining, batteries, radioactive material, acid rain, greenhouse gases, warm water and sediment.
3. On the board write the word “Agriculture” and with the students, develop a list of pollutants that this sector of society may create. (5 min)
 - a. May include the following items: gas, oil, pesticides, herbicides, insecticides, fungicides, automobile exhaust, animal waste, soil erosion, greenhouse gases and sediment.
4. On the board write the word “Household” and with the students, develop a list of pollutants that this sector of society may create. (5 min)
 - a. May include the following items: gas, oil, automobile exhaust, plastics, batteries, solvents or cleaning products, pesticides, sewage, greenhouse gases, medicines and sediment.
5. From these lists develop a Venn diagram (see below for an example). Each student should copy all three lists and the Venn diagram into his/her notes. (5 min)
6. Divide the class into six groups and explain the activity to the students: (20 min)
 - a. Each group will be assigned one type of water pollution and will receive a handout and pictures about that type of pollution. The student handouts are found below, and include information about wastewater pollution, gas production and oil spills, mining, pesticides, marine dumping and industrial wastes). The picture links are also found below. Each group will read the information and make a poster about that type of pollution.
 - b. The posters must identify the source of pollution, which of the three sectors of society cause the pollution, how common the pollution is, and include pictures of that type of pollution.
7. Each group presents their poster to the rest of the class. The posters are to be put up in the hallway for other students to read and learn about water pollution. (20 min)
 - a. The presentations should be no more than 3 minutes long.
8. Remind the students to keep filling in their water bottle charts (instructions in lesson 1, will use data in lesson 8).

Evaluation: Students can be assessed on their participation in the group, including the creativity and completeness of the poster, and the quality of the presentation to the class.

Resources: The following resources and handouts are found below:

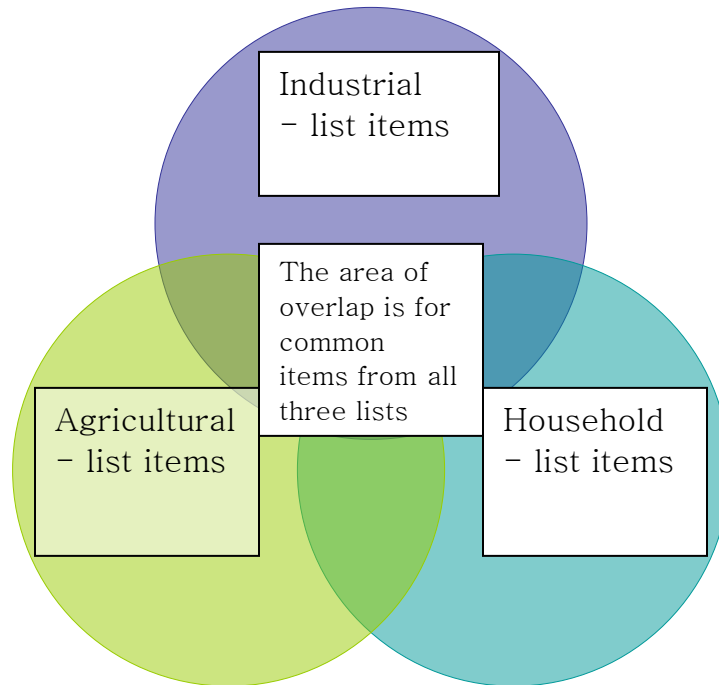
- Sample Venn Diagram
- Student Handouts about Types of Water Pollution (Wastewater Pollution, Gas Production and Oil Spills, Mining, Pesticides, Marine Dumping and Industrial Wastes)
- Pollution Picture Links (should be printed out in colour for maximum effect)

Extension Activity: The Safe Drinking Water Foundation has other educational programs that can be taught with this set of lessons. Operation Water Drop examines the chemical contaminants that can be found in water; this program is designed for a science class. Operation Water Flow explores the use of water and where it comes from; this program is designed for a Social studies and Math collaboration. Operation Water Spirit presents a First Nations perspective of water and water issues and is designed for a Native Studies or Social Studies class. Operation Water Health explores common health issues surrounding drinking water in Canada and around the world and is designed for a Health, Science and Social Studies collaboration. To access more information on these and other educational activities visit the Safe Drinking Water Foundation website at www.safewater.org.

Sources and Related Links:

- [Acid Rain](#) – a SDWF fact sheet
- [Cost-Benefit Analysis: Treat the Illness or Treat the Water?](#) – a SDWF fact sheet
- [Emerging Contaminants](#) – a SDWF fact sheet
- [Groundwater](#) – a SDWF fact sheet
- [Oil Fields](#) – a SDWF fact sheet
- [Oil Spills](#) – a SDWF fact sheet
- [The Great Lakes](#) – a SDWF fact sheet
- [Wastewater Treatment](#) – a SDWF fact sheet

Sample Venn Diagram:



Group 1 – Wastewater Pollution:

On the Magic School Bus show there was an episode where the bus and school children went inside Arnold to learn about digestion. They traveled through the stomach, small intestine and large intestine but stopped before completing the digestive process because, as Phoebe said, “At my old school, we weren’t allowed to end up in the toilet”. Have you ever wondered where the Magic School bus would have ended up if they had completed the journey?

Unfortunately the bus might have ended up in the ocean or a lake or river without being treated first. Every day untreated wastewater is dumped into water sources and somewhere further downstream a town, city or First Nations community will use that water to drink.

In a study by the Sierra Legal Defense Fund, 21 Canadian cities were found to be dumping more than ONE TRILLION LITRES of untreated wastewater right into water sources every year! The United States Environmental Protection Agency estimates that 4.9 TRILLION LITRES of raw sewage are dumped into American water sources each year! That is unacceptable. There are still many Canadians who do not have access to wastewater treatment facilities.

Even wastewater that has been treated often contains high levels of biological contaminants, phosphates, nitrates and even some medications. Before treated wastewater can be released back into a water source, it has to meet certain guidelines regarding quality and level of contaminants. But accidents can happen and wastewater can be released without being treated at all. For example, in 2001, there were 144 sewage “bypasses” (where the sewage is released untreated) in Ontario, as a result of power outages or system maintenance.

When drinking water becomes polluted with wastewater there is the potential to enable waterborne diseases, such as cholera and gastroenteritis caused by *E. coli*, *Shigella*, and *Campylobacter*, to spread within a community.

Sources:

- [Wastewater Treatment](#) – a SDWF fact sheet
- <http://www.epa.gov/ebtpages/water.html>
- <http://www.water-pollution.org.uk/causes.html>
- <http://library.thinkquest.org/C0111040/Types/water.php>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Group 2 – Gas Production and Oil Spills:

Thousands and thousands of vehicles drive on streets all over the world every day. These cars all run on oil byproducts: diesel or gasoline. The huge demand for gas and crude oil to make gasoline has oil companies drilling for oil wherever they can, as fast as they can. When industries are working quickly, there are bound to be mistakes; oil and gasoline leaks are common and have hard and long-lasting impacts on the environment.

Most oil is collected in the ocean where massive oil rigs drill for oil under the ocean floor. Oil leaks from the rigs every day but especially if a tropical storm or hurricane occurs. After Hurricane Katrina in the Gulf Coast there were at least 20 oil rigs missing, sunk, or adrift in the ocean. There were also a number of oil refineries along the coast that had storage tanks float off or crack open and spill oil into the streets and ocean.

Perhaps the most infamous oil spill in history occurred on March 24, 1989 when the oil tanker *Exxon Valdez* ran aground on the Bligh Reef in Alaska. 41,600,000 L of oil (enough to fill 16.5 Olympic-sized swimming pools) was released into the ocean, affecting 1,770 km of coastline. The company responsible for the tanker had to pay \$900 million for the natural resource damage that it caused. This number barely takes into account the loss of fish, plants, sea birds, otters and other marine and aquatic life destroyed by the oil.

As the amount of oil found in the sea decreases, companies are turning to the tar or oil sands, found in northern Alberta. These sands are full of oil but require a large quantity of water to separate the oil from the sand. So, in an effort to increase oil production, water is being sacrificed as it is pumped into the ground to displace the oil. This misuse of water is a form of water pollution that is being ignored for the sake of oil. Oil spills and leaks have the potential to pollute all water on earth, resulting in contaminated water that is no longer usable for fishing, recreation or drinking.

Sources:

- [Oil Spills](#) – a SDWF fact sheet
- <http://www.epa.gov/ebtpages/water.html>
- <http://www.water-pollution.org.uk/causes.html>
- <http://library.thinkquest.org/C0111040/Types/water.php>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Group 3 – Mining:

Almost every country in the world gets resources from mining. Gold, silver, uranium, coal and many other minerals and ores are collected from the earth through mining.

There are many different types of mines, including open pit mines, strip mines and trench mines. Despite their different techniques, all mines have the potential to create water pollution.

Some water pollution occurs while the mine is active. Most of the water pollution comes from mining processes that expose heavy metals and sulfur compounds. When rainwater comes in contact with the pollutants, it can carry toxins into water sources from the piles of mining waste (tailings) outside the mine. Mining companies will usually dump the tailings into tailings ponds, which are storage units that are dug in the ground. Tailings ponds can leak, overflow or leach into the groundwater.

When water enters abandoned mines (and sometimes active mines) and begins to fill up the mines, the water becomes acidic. The acidic water dissolves many types of minerals and enables heavy metals and other buried toxins to enter water sources.

The increase of heavy metals and other toxins in water can lead to increased rates of cancer among aquatic life and humans. The acidic mine water that enters a water source can lower the pH to a point where fish and plants cannot survive. There is also a decrease in the amount of fish and other aquatic life in waters polluted with mining residue.

Mining also has potential to create large amounts of sediment pollution. Strip mining, in particular, clears trees and vegetation from large areas of land. Wind and precipitation can then carry the dirt to nearby water sources.

Sources:

- [Oil Fields](#) – a SDWF fact sheet
- <http://www.epa.gov/ebtpages/water.html>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Group 4 – Pesticides:

Pesticide is a general term applied to a group of chemicals that are used to control weeds, insects and diseases. Specifically, herbicides control weeds, insecticides control insects, and fungicides control diseases.

Pesticides are applied to fields, ditches and home gardens. When pesticides are overused, misused, improperly disposed of, or even used according to the manufacturer's instructions, they can become a source of water pollution.

Overuse of pesticides means that the chemicals sit on the soil until precipitation or irrigation mix with the pesticides and carry them into the water source. It is generally assumed that farmers are largely to blame for the majority of pesticide pollution. Even though farming does contribute to the amount of pesticide pollution, home owners must share some of the responsibility. It is estimated that home owners use 10 to 15 times more pesticides and fertilizers than is necessary for plant health! Unlike farmers, who are often well informed about the chemicals they are using, most home owners are unaware of the potential effects of the chemicals they are using in their own backyard.

Pesticide containers that are not disposed of properly pose another risk to water sources. The containers often end up in landfills and eventually are buried. However, containers are supposed to be rinsed out before being thrown away. The residue in these containers can leach through the soil and water sources.

A large amount of research links pesticides with cancer and birth defects in both animal and human populations. Increased use of pesticides can potentially affect large populations in urban and rural areas.

Sources:

- <http://www.epa.gov/ebtpages/water.html>
- <http://www.fao.org/docrep/W2598E/w2598e07.htm>
- <http://www.water-pollution.org.uk/causes.html>
- <http://library.thinkquest.org/C0111040/Types/water.php>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Group 5 – Marine Dumping:

Marine dumping is a process commonly practiced by many large cities and countries around the world. When marine dumping occurs, large barges filled with garbage or sewage go out into the ocean and dump their loads.

Sounds ridiculous doesn't it? But it actually happens every day. The sewage is most often dumped without being treated at all. There are even some cities that have sewer pipes that run directly into the oceans (for example Victoria, BC and Halifax, NS)! The large amount of nutrients leads to increased algae growth and makes some beaches unusable because of the risk of people becoming ill.

Cities on the coasts of Canada and the United States, for example New York City, Halifax and Victoria, often have no room for garbage dumps. What are you to do with garbage generated by millions of people every day? It has to go somewhere.

The garbage travels around the world with ocean currents and in some locations around the world becomes trapped in the vortex of a gyre. A gyre is a large-scale ocean current that moves in a circular pattern and creates a vortex or centre. For example, the North Pacific Gyre moves in a clockwise manner and creates a current that draws in the dumped garbage. This gyre is also called the Great Pacific Garbage Patch.

In June 2006, the United Nations Environmental Programme released a report on the state of garbage in the oceans. The report estimated that there are, on average, 46,000 pieces of plastic debris (garbage) floating at or near the surface of EVERY square mile of ocean in the world. There is a lot of debate surrounding how long garbage lasts in the oceans. It takes cardboard about 2 weeks to break down. Styrofoam takes over 80 years to break down. Plastic can take 400 hundred years or longer to break down.

Sources:

- http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm
- <http://www.epa.gov/ebtpages/water.html>
- <http://www.water-pollution.org.uk/causes.html>
- <http://library.thinkquest.org/C0111040/Types/water.php>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Group 6 – Industrial Wastes:

Everywhere you look, you can see the impact that industry has on the world. In fact, there are very few people that are not affected by industry in some way. Industry is also a leading source of water pollution.

Plastics, cardboard, oils, cars, energy, and thousands of other products are made each day. Water is used to make most, if not all, of these products. In many cases, water is also used to carry away the wastes from the manufacturing site. For example, water is used to cool the nuclear reactors that produce energy and the heated water can be pumped out into water sources.

Asbestos, lead, mercury, nitrates and phosphates are examples of chemicals that are industrial byproducts, and have to be put somewhere. Some companies illegally dump industrial waste directly into the ocean. Other companies pay another company to store the waste or to dispose of it safely.

One of the most toxic chemicals ever produced are called PCBs. PCBs, or polychlorinated biphenyls, were made to be insulating and cooling materials for industrial transformers and capacitors (fancy electrical equipment) although they could also be found in paints, fire retardant materials, and cements. PCBs were banned from production in 1977 and even after thirty years, they are still a focus of concern and can be found in high concentrations in the environment.

Industrial pollution can have a widespread effect on the environment and life in general. There are links to cancer and birth defects in people and animals that have been exposed to specific forms of industrial waste. The prevalent effect in water sources is that aquatic life is killed: fish, plants and aquatic life die, and algae may take over all other life forms. People become sick with rashes, respiratory problems and sometimes digestive problems, especially if they drink water contaminated with industrial waste.

Sources:

- <http://www.epa.gov/epaoswer/non-hw/industd/questions.htm>
- <http://www.epa.gov/ebtpages/water.html>
- <http://www.water-pollution.org.uk/causes.html>
- <http://library.thinkquest.org/C0111040/Types/water.php>
- <http://www.grinningplanet.com/2005/09-06/water-pollution-causes-article.htm>

Pollution Picture Links:

- A) Wastewater Treatment:
 - a. www.bjulrich.blogspot.com
- B) Gas Production and Oil Spills:
 - a. <http://www.clarkson.edu/news/photos/oilspill.jpg>
 - b. http://www.offshore-technology.com/contractor_images/hebo/oil_spill_4.jpg
 - c. http://celebrating200years.noaa.gov/events/exxonvaldez/valdez_grounded.html
 - d. <http://www.bbc.co.uk/radio4/news/inbusiness/images/oilsands.jpg>
- D) Pesticides:
 - a. <http://homepage.mac.com/sjphotog/valley-portfolio/pictures/pesticide%20cans-uc157.jpg>
 - b. http://www.ens-newswire.com/ens/aug2006/20060829_pesticide.jpg

- c. <http://www.pesticidereform.org/img/original/CropDuster-Helicopter-crop1.jpg>
- d. http://www.oceanservice.noaa.gov/education/kits/pollution/media/supp_poll04agriculture.html

E) Marine Dumping:

- a. <http://www.epa.gov/owow/oceans/regulatory/mprsa/before.html>
- b. http://www.ens-newswire.com/ens/mar2006/20060310_sludgedump.jpg
- c. http://www.farallones.org/e_newsletter/2006-10/images/sewage.png

F) Industrial Wastes:

- a. <http://www.wesleyan.edu/ctgeology/GroundwaterPollution/Slide6.jpg>
- b. <http://www.hydramet.com.au/cproot/375/4492/Industrial%20Waste%20Water.JPG>
- c. http://www.ohiocitizen.org/campaigns/dupont_c8/dupont_c8.2006.htm
- d. http://www.humanillnesses.com/original/images/hdc_0001_0002_0_img0102.jpg