Oceans
High School Lesson Plan

Objective	In this lesson, students will design a model of a local watershed and develop a plan to use the model in an educational program about contaminated runoff for one or more specific audiences. Students will also establish current contaminants existing in Nunavut.
Title	**The Point of Pollution**
Subject	Environment
Grade level	High School
Time duration	3-4 class periods

Materials

- Materials for constructing a three-dimensional watershed model: topographic map covering the area of your watershed; plywood, foamcore, or heavy cardboard for base; material for constructing contour cutouts; suitable materials include cardboard, foamcore, corrugated plastic used for signs, or foam used for carpet underlayment; tools for cutting selected material; waterproofing: either exterior latex paint, or polyester resin, or plaster-of-paris and cheesecloth; materials for model details (e.g., toy animals, people, buildings, sponges, floral foam, dried moss, colored fleece fabric, asphalt shingles); small watering cans or spray bottles
- One copy of the Three Dimensional Watershed worksheet for each student group (included with this lesson)
- One copy of the Pollutants and Contaminants workshop for each student (included with this lesson)
- Computers with Internet access/access to Google Earth
- Chalkboard, marker board, or overhead transparency, and appropriate marking materials.
- Oceans video (5:28)

Learning Activities

Preparation

- Coastal ecosystems provide human communities with food, economic opportunities, recreational resources, and aesthetic enrichment. But despite their importance, these systems are under increasing stress from human activities. Each year, degradation of coastal resources costs millions of dollars.

- Pollutants include:
  - fertilizers and pest control chemicals from farms and home landscapes;
  - oil, grease, and toxic fluids from roads, parking areas, leaking underground storage tanks, and improper disposal of used motor vehicle lubricants;
  - sediments from poorly managed construction sites, forest lands and stream banks;
  - acid drainage from abandoned mines; and
  - bacteria and nutrients from livestock, pet wastes, and faulty septic tanks.

- A key concept closely linked to runoff pollution is the idea of "watershed." The simplest definition of a watershed is the area of land that catches precipitation and channels this water into a marsh, stream, river, lake, or underground reservoir (groundwater). These water bodies can be contaminated by runoff that carries pollution from land surfaces anywhere within the watershed. Every location on land is part of one or more watersheds, which can range in size from a few acres to millions of square miles. Most watersheds are part of larger watersheds.

- Because it is a serious and pervasive problem, contaminated runoff (also known as nonpoint source pollution) has been the focus of numerous state, local, and national efforts. A key element of many initiatives is education and information, because contaminated runoff can come from such a wide variety of human activities that almost everyone contributes to the problem in some way, often without realizing it.

Learning Activities

Activity1: ***Watershed Model***

1. Briefly introduce the concept of watersheds, contaminated runoff, the relationship to ocean pollution, and ask students to brainstorm potential sources of this type of pollution.

2. Show the Oceans video. Do the effects of the problem seem

"obvious"? What was the strongest message they heard? Did anything inspire them? Worry them? Anger them? Make them want to learn more about a specific area or issue?

3. Ask students to explain the connection between the video and watersheds, and in particular, runoff that is contaminated.

4. Tell students that their assignment is to design a scale model of a local watershed and its connection to oceans, and develop a plan for using the model to provide information about causes and prevention of contaminated runoff to oceans. Discuss the idea of "target audiences." Students should realize that because there are so many potential sources of contaminated runoff, there are also many different groups of people ("target audiences") who need specific information about what they can do to reduce this problem. In addition, the most effective way to communicate this information depends upon the target audience.

   Discuss the idea of using a three-dimensional watershed model in programs to provide information about runoff pollution. Demonstrations using this type of model typically involve placing various "pollutants" on the model, and then causing these to run off into one or more simulated water bodies by "raining" onto the model surface with small watering cans, spray bottles, or large sponges. This approach allows hands-on audience involvement and provides a memorable experience; but students may have ideas about other ways to use their model. Be sure students understand that the design for their model should be based on a real watershed, and real sources of contaminated runoff in that watershed. Students should complete their research and plan their informative presentation before designing the model, so they will know which features and processes will need to be demonstrated.

5. Have each student group make a presentation about their watershed model design and planned information program. Have each group add to a running list of suggestions for preventing contaminated runoff on a chalkboard, marker board, or overhead transparency. Suggestions should include:
   - keeping trash, pet waste, chemicals, etc., out of storm drains, since these typically drain directly to lakes, streams, rivers, and then oceans;
   - always follow instructions when using lawn and garden chemicals, and minimize their use with natural alternatives and by planting native species;
   - properly dispose of used oil and hazardous household chemicals;

- control soil erosion by stabilizing erosion-prone areas and planting buffer strips of trees, shrubs, and ground cover next to water bodies;
- purchase detergents low in phosphorus to reduce nutrient loads to natural water bodies;
- manage farm wastes to minimize contamination of surface water and ground water;
- minimize the use of pesticides through integrated pest management;
- minimize impermeable surfaces in landscaping by using porous pavers instead of solid asphalt or concrete; and
- dispose of pet wastes in the garbage or toilet.

Activity 2: **Pollutants in the North**

- Begin by discussing the following questions with the students: Is there pollution created in the north? A lot? A little? What sources? Do pollutants and contaminants come to the north from other areas? Where?

- Refer to a large print map of the world, using Google Earth as well as a globe to orient students. Zoom in towards Nunavut on both. Guide students as they find each of each of the following maps:
    - Industrial Discharge Sites Map
    - Sewage Treatment Map
    - Mining Sites Map
    - Active and Closed Mines in Nunavut Map
    - Drainage Basins (Nunavut) Map

- Have students work in small groups for about 30 minutes, and then report back to the class. Provide each student with the Pollutants and Contaminants Worksheet.
    - Students can use an atlas of Canada, the Internet, library, or text resources to locate the major ocean currents and prevailing winds and locate them on maps.
    - Students transfer the specific ocean currents and prevailing winds that enter these regions from other parts of the world to their outline maps of Nunavut, the North Circumpolar Region and the World.
    - Students interpret maps to determine the level of pollution created both within and outside of Nunavut.

- Ask students to share and discuss their ideas, either in small groups or as a large class discussion.

Assessment	• Monitor student participation in class activities and discussions. • Evaluate the neatness and detail of the watersheds/maps generated. • Have students hand in the completed worksheets after they add information to their answers following the class wrap up.
Activities for Extension and/or Integration	• Determine the difference between pollution and contaminants. • Explore the chemistry of contaminants. What are the differences between organochlorines, metals and radionuclides? • How do contaminants enter the food chain? What is the difference between bioaccumulation and biomagnification? • How do contaminants affect wildlife and people?
Subject and Level Learning Outcomes (Alberta)	This classroom activity will help students understand concepts related to environmental issues (for example, global warming, loss of biodiversity, deforestation, ozone depletion, air pollution, water pollution, acid precipitation and disposal of solid waste). It will also help students make inferences and draw conclusions from maps and other geographic representations, as well as use the processes of analysis, synthesis, evaluation and explanation to interpret geographic information from a variety of sources.
Resources	http://oceanservice.noaa.gov/education/lessons/wheres_the_point.html http://atlas.nrcan.gc.ca/site/english/learningresources/lesson_plans/high_school/nu_hs.html

THREE-DIMENSIONAL WATERSHED

Name: ______________________ Date: ____________________

Three-dimensional watershed models are constructed by cutting out selected contours shown on a topographic map of the area being modeled, and then stacking the cutouts together. Demonstrations using this type of model typically involve placing various "pollutants" on the the model, and then causing these to run off into one or more simulated water bodies by "raining" onto the model surface with small watering cans, spray bottles, or large sponges. You may want to visit *http://www.pyr.ec.gc.ca/EN/IPM/index.shtml* for examples of watershed models.

Materials:

- topographic map covering the area of your watershed (available from stores that sell outdoor or camping equipment, as well as from the U.S. Geological Survey at http://topomaps.usgs.gov/ordering_maps.html; maps typically cost between six and eight dollars)
- plywood, foamcore, or heavy cardboard for base
- material for constructing contour cutouts; suitable materials include cardboard, foamcore, corrugated plastic used for signs, or foam used for carpet underlayment
- tools for cutting selected material
- waterproofing: either exterior latex paint, or polyester resin, or plaster-of-paris and cheesecloth
- materials for model details (e.g., toy animals, people, buildings, sponges, floral foam, dried moss, colored fleece fabric, asphalt shingles; see step 12)
- small watering cans or spray bottles

Step 1

Determine the desired overall size of the finished model. Larger models can accommodate more detail, but are heavier and more awkward to transport than smaller models. Typical models range in size from a 2 ft square to a full sheet of plywood (4 ft x 8 ft).

Step 2

Make one or more copies of the topographic map for your watershed, enlarging or reducing if necessary to the desired size.

Step 3

Decide whether the horizontal and vertical scales of the model will be the same or different. Many models exaggerate the vertical scale by a factor of 3 or 4 to make topographic features more visible. On the map in Figure 1, a distance of 6000 ft is represented by one inch, so a hill 1000 ft high would be 1000 ÷ 6000 = 0.166 inch high without any vertical exaggeration; with a 4-fold exaggeration the hill would be 0.66 inches high on the model.

Step 4

Decide which contour lines will be used to construct the model. This will usually depend upon the overall range of elevations represented on the map, and how much time is available for cutting out the individual contours. Most models will need at least five contours; the more contours there are, the smoother the slopes will be on the finished model. So, if the highest point on the topographic map is 2300 ft and the lowest point is 200 ft, the overall range of elevations is (2300 ft – 200 ft) = 2100 ft, and the minimum interval would be (2100 ft ÷ 5) = 420 ft. Use a colored marker to trace the selected contour lines on the map copy to make the lines easier to follow when cutting.

If the contour interval on the map does not match the desired interval, use a smaller interval that will match the map interval. For example, if the desired interval is 420 ft and the interval between contour lines on the map is 100 ft, use 400 ft instead of 420 ft. So, using the map of Figure 1, we would use the 400 ft, 800 ft, 1200 ft, 1600 ft, and 2000 ft contours.

Step 5

Determine the proper thickness of material from which the contours will be constructed. The scale of the map in Figure 1 is one inch = 6000 ft, so a 400 ft contour interval would be represented by a thickness of 400 ft ÷ 6000 ft/inch = 0.0667 inch. If we use a 4-fold vertical exaggeration, the required thickness would be 4 x 0.0667 inch = 0.267. So one-fourth inch thick foamcore display board would be a suitable material for this model. In some cases, more than one layer of the material may be needed for each contour.

Step 6

Cut the map copy along the lines representing the next-to-lowest elevation, since the lowest elevation is the base on which the model will be built (plywood, etc). In the example of Figure 1, the lowest elevation is 200 ft, so the first cutout would be done along the 400 ft contour line (see Figure 2).

Step 7

Trace the outline of the cutout onto the material that will be used to construct the contours, and cut along the traced line (see Figure 3).

Step 8

Place the cutout on the base, but don't glue it down yet. You may want to glue another copy of the topographic map onto the base to help position the cutouts.

Step 9

Repeat steps (6), (7), and (8) for the next contour interval (which would be along the 700 ft contour line in the example). Continue until all contours have been cut.

Step 10

Starting with the lowest (largest) contour, carefully glue successive contours together to build the three-dimensional model. Some contours may be in several pieces (See Figure 4).

Step 11

Waterproof the model. There are several ways to do this, depending upon the material used to construct the contours. Exterior latex paint or polyester resin are the simplest options, but it may be difficult to cover the model thoroughly if porous material (such as foam) has been used to make the cutouts. A more elaborate technique, that gives smoother results, is to drape the model with pieces of cheesecloth soaked in a plaster- of-paris mixture. The plaster is added to approximately 2 liters of water in a bucket until the mixture is smooth and thick, but still pourable. The cheesecloth is pressed into the bucket until it is completely coated with plaster, then draped over the model. The process is repeated until the entire model is covered with at least two layers. The "stair-steps" of the contours can be smoothed out with additional plaster. After the plaster has dried, the model can be painted with exterior latex paint. Sand can be sprinkled over the wet paint to provide texture.

Step 12

Add details to the model, according to the features and processes to be demonstrated. Students may be willing to contribute toy animals, people, buildings, etc. from model kits. Sponges, floral foam, or dried moss may be cut into appropriate shapes to simulate structures and vegetation. Colored fleece fabric can represent vegetation as well as bare earth. Asphalt shingles can simulate paved areas. If students plan to use the model to simulate runoff conditions as described above, they will need to decide on materials that will simulate pollutants. Some commonly used options are cocoa powder (motor vehicle exhaust), chocolate syrup (motor oil), colored drink powder (chemical runoff), and chocolate cake sprinkles or chips (animal waste).

POLUTANTS AND CONTIMINANTS IN THE NORTH

Name: ______________________ Date: ____________________

1. List **5** possible sources of pollution in the North. Please be specific.
    a. ____
    b. ____
    c. ____
    d. ____
    e. ____

2. Where do pollutants and contaminants come from outside of Nunavut specifically? List **5** areas.
    a. ____
    b. ____
    c. ____
    d. ____
    e. ____

3. How do pollutants get to Nunavut?

4. Once pollutants get to the North, where do they end up?

5. What do you think are the effects of pollutants and contaminants in general on plants, animals and wildlife?

6. List **5** species that are at risk in the north:

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

7. As a step in the right direction, what could your community do to decrease the amount of pollution it creates? Give **5** suggestions.

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________