



# Not In My Back Yard!

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## **Not In My Back Yard! Curriculum Unit Overview**

### **Summary**

What to do with hazardous waste? Our modern society produces it, but can we find a way to deal with it and protect the environment at the same time? ONYX ENVIRONMENTAL SERVICES is one of many companies finding creative solutions to a problem that won't go away. ONYXES is a hazardous waste transfer facility. The main activities at the plant involve solvent recovery, fuel blending and water processing. ONYXES field personnel go on-site to hazardous waste generators, determining the chemical characteristics of sometimes-unknown hazardous waste. They then identify a waste stream (category) for the hazardous waste stream and ship the waste to one of several ONYX facilities across the country depending on the particular chemical characteristics of the material. The West Carrolton facility where I worked specialized in solvent recovery. They accept a wide variety of solvent mixtures then distill them, separating recoverable pure solvents that they can then re-sell. The "bottoms" - the remaining part of the mixture - are blended and then shipped to other facilities such as cement kilns where they are burned for fuel. This whole process is designed to segregate hazardous waste streams, recycle/reuse products, minimize the volume of waste and properly dispose of the remaining waste.

This curriculum module is designed to teach students the chemistry behind the segregation and distillation processes similar to those at ONYX, regulatory issues related to hazardous waste facilities and communication skills used in the environmental industry. The students will gain an understanding of issues surrounding hazardous waste, how some industrial facilities are dealing with hazardous waste, how hazardous waste is regulated and what impact this has on their community. The module is designed for implementation in an Environmental Technology Tech Prep class, but parts or all of it could be adapted to high school Environmental Science or Chemistry classes. The communication section of the module could be implemented in high school Applied English classes in conjunction with Tech Prep programs or other integrated curricula. Though designed with a specific hazardous waste facility in mind, any RCRA or Superfund site would be applicable to the environmental technology section. The chemistry and communication sections would be easily adaptable to a wide variety of industries.

This curriculum will be implemented over the course of several weeks in my Environmental Tech Prep class.

### **Big Picture**

Introducing the curriculum module will be an activity designed to help students define what hazardous waste is, what products they have at home that could be classified as hazardous waste, and to identify sources of hazardous waste in their community. Students will read a document from the Environmental Protection Agency (EPA) on hazardous substances and hazardous waste for homework. When they return to class, we will discuss different types of

hazardous chemicals (corrosive, toxic, flammable, reactive) and how they become hazardous waste. We will focus discussion on these questions:

- What household chemicals do you have at home or in your garage that are hazardous and could become hazardous waste?
- Do you think you or your family contributes to the problem of hazardous waste?
- How do you dispose of hazardous chemicals at home? Where does your garbage go when it is picked up? Do you recycle?
- What businesses in town might use hazardous materials or produce hazardous waste?
- What problems could you or the community face as a result of exposure to hazardous waste?
- How is hazardous waste disposed of?
- What are some ways you could prevent or reduce the use of hazardous substances at home?

The students will then be given a map of Miamisburg and some color markers.

- They will identify and mark in **green** landmarks such as schools and shopping malls.
- I will ask the students what factories or industrial facilities are in town. They will identify and mark in **blue** the location of these factories and industrial sites in the city.
- I will ask the students again what factories/industries in town might use hazardous chemicals or what other sources of hazardous waste may be in town. They will identify and mark in **red** possible sources of hazardous waste in the community.
- I will ask the students again where the waste goes. They will identify and mark in **brown** the location of landfills and recycling centers.

When they have completed their maps, I will point out that we will be studying issues related to hazardous waste disposal. They will be looking at how one local facility works to reduce the amount of waste by reclaiming and reusing solvents, and the chemistry behind their process. We will examine the how the federal, state and local governments regulate hazardous waste and how industry monitors to check compliance with these laws. They will be using technology to create presentations and manage data. All this will culminate in a simulation of how our local government, the community, and area business deal with hazardous waste issues.

### **Preparation for the Unit**

Work with Tech Prep Coordinator and Applied English Instructor to:

- For the lab portion of the unit, a traditional chemistry lab is needed only for the distillation lesson. The rest may be done in any traditional high school science lab.
- Computer time must be arranged for the communications section of the module.
- Some of the environmental monitoring sections require working outside - it is best to do this in the fall and spring.
- The communications section requires a guest speaker - the mayor or other city official - call them to set this up well in advance
- The communication section also

- The communication section also asks students to watch a city council meeting. The schedule for these is available by calling City Hall. In Miamisburg and other communities the meetings are taped for broadcast on cable TV. The students may be able to substitute viewing this for actually attending a meeting.
- In the environmental tech unit there is an option of having a guest speaker on the topic of hazardous waste regulation. This will need to be set up ahead of time.
- Materials described in these activities are generally available in high school chemistry and environmental science classrooms. Alternative materials can be substituted as needed.

## **Overview**

On the following page is a summary of the unit including brief summaries of each Authentic Learning Task (ALT). This table provides an overview of the tasks in the unit sections and shows how the activities in the different teaching areas relate to each other.

## Not In My Back Yard! Curriculum Unit Summary

Chemistry	Environmental Technology	Communication
<p><b>ALT 1 - Separating Mixtures</b> Students will identify physical properties of substances in a mixture, design an implement a procedure for separating the components, and analyze their results.</p>	<p><b>ALT 1 – Examining a Hazardous Waste Site</b> Students will examine a fictitious hazardous waste site, identifying sources and effects of contamination. They will model movement of contaminants through groundwater and examine the effectiveness of environmental impact assessments</p>	<p><b>ALT 1 – What Have We Done to Ourselves?</b> Students will research environmental regulations and prepare and present a PowerPoint presentation on one regulation and its impact on industry and the environment.</p>
<p><b>ALT 2 – Distillation</b> Students will distill an organic mixture to separate the components by boiling point. Students will analyze the effectiveness of distillation in isolation the components of a mixture.</p>	<p><b>ALT 2 – Toxicology – How much is too much?</b> Students will measure the effect of various toxic chemicals on brine shrimp in order to calculate the LD50. They will relate toxicity measurements to humans.</p>	<p><b>ALT 2 – Managing Data</b> Students will create a data spreadsheet for the correlation of data from the EPA web site</p>
<p><b>ALT 3 – One in a Million</b> Students will construct models representing concentrations of one part per million and relate these to environmental toxicity of hazardous substances.</p>	<p><b>ALT 3 – Identifying Risks and Response Methods</b> Students will examine a fictitious hazardous waste site identifying risks and evaluating the effectiveness of various methods of pollution containment and cleanup.</p>	<p><b>ALT 3 – Community Meeting</b> Students will attend/view a city council meeting, identify the roles of various officials and assess effective forms of speech at the meeting.</p>

### Transfer Activity

The unit will conclude with a role-playing exercise in which students will conduct a city council meeting to determine the fate of a hazardous waste Superfund site. Different groups of students will represent government officials, community activists, EPA officials, workers at the plant, environmental action groups and community members during the meeting. Various groups will draw upon what they have learned previously about the solvent reclamation process (distillation), environmental regulation and identifying and managing environmental hazards.

## Section One: Chemistry

### ALT One: Separating Mixtures

#### Summary

Students will identify physical properties of substances in a mixture, design and implement a procedure for separating the components, and analyze their results.

#### Competencies: using reference materials with 85% accuracy:

1. Identify chemical and physical properties of substances
2. Relate knowledge of properties to the task of separating items
3. Identify as many methods for separating items as possible
4. Separate the components of a mixture
5. Analyze the results for purity
6. Design and implement a procedure

#### Time

120 min

#### Materials

Distilled water  
Sample of Mixture (iron filings, poppy seeds, salt, sand)  
8-well microchemistry strip  
Aluminum foil  
Cellophane  
Cotton balls  
Filter paper  
Forceps  
Glass funnel  
Hot Plate  
Magnets  
Micro funnel  
Notebook  
Paper clips  
Paper towels  
Petri dish  
Pipets  
Plastic forks and spoons  
Plastic straws  
Rubber stoppers  
Tape

Test-tube clamp  
Test-tube rack  
Test tubes  
Tissue paper  
Watch glass (Pyrex)  
Wood splints.

### **Instructions**

1. Before the lab begins, give the students a list of the materials they will have available and describe the problem. They will be given a sample of a mixture containing sand, salt, poppy seeds and iron filings. They are to separate the components of the mixture using the materials provided, storing a sample of each component in the 8-well micro strip. Tell them they will be graded on the purity of their sample and the speed with which they separate the mixture.
2. Divide the students into groups of 2-4. Have the students brainstorm properties of each component of the mixture and how they might be separated. They are to use these properties and the materials listed above to design a method for separating their mixture and estimate the time it will take to complete each part of the separation. They are to write down in their lab notebooks their entire plan and have it approved by their teacher before they may proceed. Remind the students that they will be graded on the purity the individual samples and time it takes to complete the lab. Each sample will be stored in a separate well of the 8-well micro strip.
3. Review the group plans and pass out samples of the mixture along with 8-well micro strips. Have the students record the time they start the lab and the time they complete each separation in their lab notebooks. As each component is separated, they are to place a small sample of it in the micro strip. Seal the opening or put a small piece of tape over the opening on the 8-well micro strip. They do not need to place their entire separated sample in the 8-well micro strip – just a sample large enough to fill the micro well will do. If any other lab materials are used, they should be listed in the lab notebook.
4. When the separation is complete, examine each student group's results – have the students compare their results to other groups and record their observations. Have the students clean up their lab materials. Excess material should be disposed of in separate containers and not necessarily down the sink (iron filings). Have separate containers available for the proper disposal of lab materials. If you are particularly industrious, materials for this lab can be recycled and used again next year.
5. Complete the scoring section of the student question/scoring sheet.
6. Pass out a copy of the questions sheet/scoring sheet. Have the students complete the sheets in their groups. Each student is responsible for handing in his or her own copy.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated on the speed with which they separate the samples and the purity of the sample (see scoring sheet). In addition, a question sheet is provided to further assess the students' understanding of the material.

## **Closure**

Have the entire class gather together. Ask groups of students to describe their method of separating the mixtures and compare these to other groups. Have them reference their lab notebooks if necessary. How did the times and purity of the samples compare between groups. What could have been done differently to speed up the process or make it more pure? Which is more important – speed or purity? What about in industry – who would be most concerned about purity, which would be concerned about speed? Ask how they would separate a mixture that was all liquids – such as in rubbing alcohol, which is a mixture of alcohol and water? Describe to the students that their next task will be to separate just such a mixture.

**Separating Mixtures ALT One: Handout One****Separating Mixtures Student Handout– Scoring and Question Sheet**

- Scoring for speed: Rank the students in order of completion of the entire separation procedure. 10 points possible.

Starting Time: \_\_\_\_\_ Completion Time: \_\_\_\_\_ Total Time: \_\_\_\_\_  
 The top two teams receive 10 pts, the next two 8 points and so on.

- Scoring for purity: Rank the students according to their purity using the following rubric.

3	2	1
Samples are nearly pure containing only the smallest traces of other substances	Samples are mostly pure with some contamination visible	Samples are contaminated with large quantities of impurities easily visible

- Write a paragraph summarizing your procedure. In your own estimation, rate the recovery of each component on a scale of 1 to 10 (1 being low and 10 high). Justify the estimations of your success based on both purity and time. (6 points)
- What made you decide to do your procedural steps in the order you did them? Would it have mattered if you had done them in a different order? Would another way have been faster? Explain your answers. (4 points)
- If you were to do the lab all over again, what specific things would you do differently? (2 points)
- Name any tools or materials that were not available that would make the separation easier. (2 points)
- For each of the components describe **specific physical properties** that it has that enabled you to separate it from the rest of the mixture. What methods could you use to test the purity of each of the separate samples? (8 points)

Substance	Salt	Sand	Iron Filings	Poppy Seeds
<b>Physical Properties</b>				
<b>Test for Purity</b>				

- What relationship would you expect to find between the speed with which the samples were separated and the purity of the samples? Review your notes – was this true in your class? Explain why or why not. (4 points)
- Differentiate between chemical and physical properties. Were chemical properties of substances used to separate the mixture in this lab? Explain why or why not. (4 points)

TOTAL POINTS = 50    YOUR SCORE = \_\_\_\_\_

## Section One: Chemistry

### ALT TWO: DISTILLATION

#### Summary

Using a distillation apparatus, students will separate components of a liquid mixture based on the boiling points of the components.

#### Competencies: using reference materials with 85% accuracy:

7. Identify chemical and physical properties of substances
8. Relate separation techniques to the process of distillation
9. Use proper lab techniques to separate a mixture of alcohol and water
10. Analyze the results for purity
11. Safely implement a procedure

#### Time

90 min

#### Materials

Beakers  
Graduated cylinders – 100ml  
Florence flasks  
Funnels  
Thermometers - -10 to 100 C  
Hot plates (do not substitute Bunsen burners)  
Ring stands  
Clamps  
Stoppers 2-hole  
Condensers  
Corks  
Wooden splints  
Distillation solution – 420ml distilled water and 180ml of iso-propanol  
Boiling chips  
Glass tube – 90-degree bend  
Rubber tubing  
Iodine crystals  
Forceps  
Notebook

#### Instructions

7. Divide the students into groups of 2-4. They are to read the entire procedure. Have them construct a data table in which to record their observations in their lab notebook, and determine a purpose and a brief summary of the procedure to be used. Assemble one standard distillation apparatus using a hot plate, Florence flask, thermometer, condenser and distillate collection beaker. Describe the function of the condenser to the students along with how industries such as the petroleum industry use distillation columns to separate the components of mixtures by their boiling points.
8. Have the student groups assemble a distillation apparatus similar to the one you constructed. They are to label their two collection beakers **Distillate 1 and Distillate 2**.
9. Pass out a sample of the alcohol/water mixture (**do not let the students know what substance are in the mixture**) in a Florence flask – have the students record their observations. Place the flask on the hot plate; attach the flask to the condenser and the condenser to a water faucet. Place the Distillate 1 beaker at the end of the condenser. Ensure that all connections are tight and will not leak. Turn on the water to the condenser and turn on the hot plate (medium setting). The mixture will slowly heat.
10. Have the students record the temperature when the first drop of distillate falls from the condenser in to the beaker labeled Distillate 1. At this point the temperature should be fairly constant. Continue to record the temperature every 30 seconds until the temperature begins to sharply raise again. At this point replace the beaker labeled Distillate 1 with the beaker labeled Distillate 2. Continue heating and recording the temperature every 30 seconds. Record the temperature at which the first drops of distillate 2 drop from the condenser. Collect 1 or 2 ml of this second distillate. **CAUTION: DO NOT ALLOW ALL OF THE LIQUID TO BOIL FROM THE FLASK**
11. Have the students turn off the hot plates. While the apparatus is cooling, test the relative solubility of solid iodine crystals in each beaker - Distillate 1 and Distillate 2 by adding a few crystals of iodine to each beaker and recording their observations. **IODINE CRYSTALS CAN CAUSE LESIONS – HANDLE THEM WITH FORCEPS.**
12. When cool, have them repeat the experiment if time permits or disassemble the apparatus if not.
13. The students should observe the 2 beakers noting differences in physical properties. Have the students examine the results of other groups and record their observations in their lab notebook. Pass out the questions sheets and have the students complete their lab write-up.
14. **ALTERNATIVE PROCEDURE:** use a temperature probe and TI graphing calculator/CBL unit to monitor and record data.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated on purity of their sample as judged by the iodine test. They will complete a brief lab report of their results.

### **Closure**

Have the entire class gather together. Ask groups of students to evaluate the purity of their samples as compared to others. Have the students record their temperature data on the board. Compare and analyze the results – determine a class mean. Relate the distillation process to the processes used at ONYXES to separate the components of solvent mixtures. Ask the students to compare their process to that used at ONYX. What other considerations might be made at a large-scale facility such as ONYX? Ask the students how they could determine the concentration of the original mixture – they should be able to identify that concentration is usually expressed as “part over whole”. Explain that in the next activity, they will be studying very small concentrations.

**Distillation ALT TWO: Handout One****Distillation Student Handout– Scoring and Question Sheet**

Observations of Distillate color:

Distillate 1 \_\_\_\_\_ Distillate 2 \_\_\_\_\_

10. Create a graph of your temperature data. Plot time (x-axis) vs. temperature (y-axis). Use good graphing skills – make the graph large, use graph paper, label the x and y axis, scale each axis evenly with the appropriate units and title your graph.
11. Using your graph, identify the temperature at which the first substance distilled and the temperature at which the second substance distilled. Hint: look for “flat” areas of the graph where the change in temperature is less.  
How well do these points on your graph match your temperature data points you recorded when the first drops of distillate were recorded?

<b>Properties of Possible Distillation Mixture Components</b>			
<b>Substance</b>	<b>Formula</b>	<b>Boiling Point (C)</b>	<b>Appearance with Iodine Crystals</b>
2-propanol	C <sub>3</sub> H <sub>7</sub> OH	82.4	Bright yellow
Acetone	C <sub>3</sub> H <sub>6</sub> O	56.5	Yellow brown
Water	H <sub>2</sub> O	100	Colorless
Cyclohexane	C <sub>6</sub> H <sub>12</sub>	80.7	Magenta

12. Using the data table above and your own lab data, identify each distillate substance.

Distillate 1 \_\_\_\_\_ Distillate 2 \_\_\_\_\_

13. Compare your data with other groups – calculate the mean and mode for the class data.  
Why would all groups not get the same data?
14. Get the correct identity of the distillates from your instructor. Calculate the relative deviation and relative error for your data.
15. Of the substances listed in the data table above, which would be the most difficult to separate out? Explain why.
16. Imagine that the experiment is repeated using a flask containing all four of the substances listed above. Sketch a graph of time vs. temperature for this mixture – describe the features of the graph.

## Section One: Chemistry

### ALT Three: ONE IN A MILLION

#### Summary

Students will construct a model representing one part per million (ppm). Many environmental contaminants are hazardous at very low concentrations. At ONYXES samples are taken from much of the hazardous waste stream arriving at the plant in order to detect any possible polychlorinated biphenyls (PCB's). ONYXES does not have a permit to deal with these contaminants, which are hazardous at levels as low as a few parts per million. This activity is designed to give the students a representation of just how small a concentration one ppm really is.

#### Competencies: using reference materials with 85% accuracy:

12. Define concentration and identify units of concentration
13. Construct a model representing one ppm
14. Relate the concentration of hazardous materials to their toxicity

#### Time

60 min over two separate days – students may need a few days' homework or additional class time to construct their models.

#### Materials

Students will supply their own materials

Reference materials

Beaker

Water

Sugar

Scale

Notebook

#### Instructions

15. Divide the students into groups of 2-4. Measure out about 40g of sugar. Tell the students this represents the amount of sugar in a typical soda pop. Put the sugar in the beaker and fill the beaker with water until the total level of water/sugar solution is about 355ml (12 oz.). Tell the students that this represents a typical soda pop. How could we express the concentration of the sugar in the soda? Point out concentration is often expressed as part over whole. This is similar to the way a percentage (such as batting average in baseball) is calculated. Have the students calculate the percentage of sugar in the "soda pop" mixture you created. They should record this in their notebooks.

16. Describe for them a brief history of PCB's and the risk of exposure – remind the students that PCB's are potentially toxic at levels of parts per million. (You can use a book such as **Hazardous Substances: A Reference** published by Enslow Publishers, or other reference materials). Have the students calculate the percentage concentration if PCBs were at a level of 8 ppm ( $8 \times 10^{-6}\%$ ). This very low concentration is potentially toxic to wildlife. This very small number is often hard to picture – the students will be constructing a model to represent this ppm concentration.
17. Describe the assignment: the students are to construct a model or analogy that represents one part per million. They may use any common materials or pictures from magazines or the Internet. A million is far too many to count, so they will need to use some math in order to relate a small countable number to the larger number of a million. For instance, you could make a model from the very small sprinkles used to decorate cakes – if you count out say 1,000 of these and measure the volume, you could estimate that a volume 1,000 times that would contain a million. There are many other analogies you can lead the students with – you may want to have a class brainstorming session to gather ideas for their model/analogy if you feel the students are stuck. The students can also create a poster that represents their analogy of one per million.
18. Remind the students that the models are due at a future class period – typically 3-5 days depending on how much class time you want to give them. Also tell them they will be graded on both the creativity (many times students make a game of it, as in can you find the one red sprinkle out of all the blues, etc.) and accuracy of their model.
19. Second class session. Have each group of students get up in front of the class and discuss their model and/or analogy. They must explain how this demonstrates one in a million. Leave the models or posters in the room, so that students may refer to these throughout the module.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated on the accuracy of their models and the creativity of the analogy or materials that they use.

### **Closure**

Students will get up in front of the class and describe their model and how it represents one in million. Remind the class that many hazardous substances are toxic at levels such as ppm; however, some extremely toxic substances are dangerous at levels of parts per billion or even parts per trillion. In part 2 of this module they will investigate how toxicity levels are calculated and how hazardous substances are regulated.

## Section TWO: Environmental Technology

### ALT ONE: EXAMINING A HAZARDOUS WASTE SITE

#### Summary

Students will examine a fictitious Superfund site looking into its history and how the hazardous waste at the site may affect the environmental and local cities. The students will model the groundwater flow at the site in order to access possible contamination of drinking water. Students will examine test methods for determining the presence, concentration and possible effects of hazardous substances by reading a case study.

#### Competencies: using reference materials with 85% accuracy:

15. Identify key components of RCRA, SARA and other regulatory acts related to hazardous waste
16. Differentiate between hazardous waste and hazardous substances
17. Identify types and extent of pollution
18. Outline movement and distribution of water in the environment

#### Time

4 - 90 minute class periods

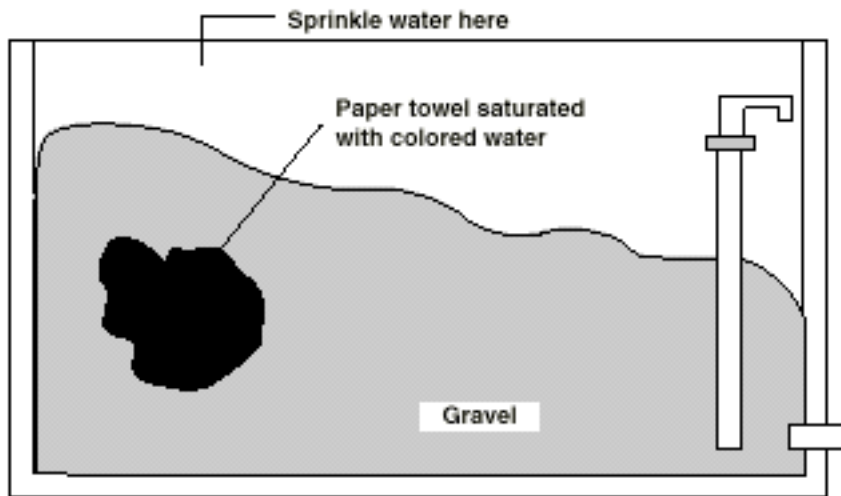
#### Materials

Bottom part of a clear, plastic two-liter bottle  
Pump mechanism from a liquid soap dispenser  
Small piece of nylon fabric  
Tape  
Re-sealable plastic bags with 2 cups of small pebbles or aquarium gravel (white or light-colored)  
Re-sealable bag with 2 cups of clean white sand  
Lair coffee filter (rounded bottom not cone)  
Clean spray bottle  
Red food coloring  
Beaker  
Wax Pencil  
Copies of Fact Flash 1,2,3,4,5 (see appendix 1)  
Overheads of maps from Fact Flash 3  
Notebook

#### Instructions

20. Divide the students into groups of 2-4. Pass out copies of Fact Flashes 1 and 2. Have the students read these. Discuss the difference between hazardous substances and hazardous waste. Ask students to identify key ideas from the Resource Conservation and Recovery Act (RCRA) and Superfund Amendment Reauthorization Act (SARA).
21. Distribute Map 1 from Fact Flash 3 – Map of Flowing Railroad Site. From the Fact Flash describe the past history of the site. Distribute Map 2 from Fact Flash 3 – which shows the area in which the railroad site is located and the surrounding residential and agricultural areas. Ask the students in their groups to brainstorm ideas on how they think contaminants might spread from the site and how they would affect the area surrounding the railroad facility. Ask students to also come up ways in which these contaminants would specifically effect the plants and animals in the area (such in the Flowing River) as well as people living in the area – including the towns of Ruralville and Utopia. In addition, have them judge what factors would affect the amount of contamination exposure from the site.
22. Go around the room and ask each group to share some of their ideas on the possible effects of the hazardous waste at the Flowing Railroad site might have on the surrounding environment. It would be helpful to have an overhead of the two maps in order to record the student responses. Explain that they will next look at how hazardous waste at the site might affect groundwater in the area.
23. Distribute Fact Flash 5: Groundwater and assign the students to read this prior to the next class.
24. Review and discuss the key ideas from Fact Flash 5. Point out that the Dayton area gets almost all of its drinking water from underground aquifers as described in the Fact Flash. Groundwater such as that in Dayton can flow (in our case roughly along the same path as the Miami River) and that if contaminated, there is very little that can be done to clean up the polluted drinking water and make it safe to drink.
25. Distribute Map 3, Diked Sludge Pond from Fact Flash 3. Discuss that groundwater contamination is a big concern of the EPA when dealing with a Superfund site. The diked sludge pond at the railroad facility is just one example of how contaminants may enter the groundwater. The students will next be constructing a model of how their contaminants may migrate through the groundwater and so pollute drinking water supplies.
26. Have each group construct a model of groundwater movement. Use the illustration below as a guide. Tape the pump mechanism, with the nylon fabric attached to the bottom, to the side of the container. Fill the container about one-third full with pebbles. Spread out the coffee filter and place it on top of the pebbles and tap it to the sides of the container. Fill the rest of the container with sand leaving a little space at the top. The students are

ready to run their tests.



27. The students should spray water from the bottle until the sand is saturated. The water will filter down through the sand and into the gravel simulating rainfall percolating through the soil and sand that lies below much of the Miami Valley. The top portion of the sand/gravel that is completely saturated with water is called the water table. Have the students mark the level of their water table with a wax pencil.
28. Push down the pump mechanism and slowly draw a little water from the gravel through the tube and out of the pump. Place the beaker outside the container to catch the water as it is removed. Explain that the pump mechanism creates vacuum to draw out the water. This is essentially the same method used to pump groundwater from our local aquifer.
29. Spray more water on the sand until the original water table level is reached. Add a few drops of red food coloring on top of the sand. Place one of the drops near the edge of the sand, near the wall far from the container away from the pump. Explain that the food coloring represents a hazardous waste, such as gasoline that dissolves in water. Make it rain by spraying the bottle 5-10 times.
30. Continue pumping, the water in container should be partially red. This red color should migrate towards the pump as the students continue to pump water from the container. Have the students describe the flow of the red coloring. Remind them this simulates the flow of a surface contaminant such as gasoline spilled out on the ground.
31. NOTE: Another way to illustrate this is to build your model using only gravel. Attach the pump mechanism the same way as for the other model. Roll a paper towel into a ball and saturate it with red coloring. Bury it beneath the surface (in the gravel). The buried paper towel represents an abandoned waste site. Add water until 1/4 of the pump is submerged. Then spray more water on the surface until 1/2 the pump is under water. Press the pump 20 to 30 times, catching the water in another container. Have students discuss what they observe.
32. To simulate the addition and removal of other types of contaminants, you can put other additives into the water. For example, use molasses or maple syrup to represent a dense non-aqueous phase liquid (DNAPL)—a substance that is heavier than water and will not mix with water. Contaminants like TCE and PCB are DNAPLs. Use vegetable oil to

represent a light non-aqueous phase liquid (LNAPL)—a substance that is lighter than water and will not mix with water. Jet fuel is an LNAPL. The amount of water that will have to be flushed through the groundwater; model should be significantly greater to remove these contaminants than what was needed to remove the red food coloring. Ask students how your small groundwater model represents contamination at a Superfund site. Ask students what is different between your experimental groundwater model and a real Superfund site. Ask students to consider the situation at the fictional Flowing Railroad site. Would the residents of Utopia be in greater danger from contaminated groundwater if the groundwater beneath the Flowing Railroad site were flowing north toward Utopia or south away from Utopia? (The answer is that residents would be in greater danger if the groundwater were flowing away from Utopia. This may sound surprising, but the reason is that, if the groundwater is flowing away from Utopia, it is flowing towards their drinking water wells located 3 miles south of the Flowing Railroad site.)

33. **ALTERNATIVE METHOD:** Separate the class into 3 groups. Have each group make a different model: (1) use red food coloring to simulate a water-soluble contaminant; (2) use the buried paper towel described in the note and illustration on previous page; and (3) use maple syrup to simulate a DNAPL and/or vegetable oil to simulate an LNAPL. Have students observe a demonstration of each model and discuss the differences.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated on in class discussion of the Flowing Railroad scenario – their ability to identify potential hazards, define hazardous waste, and predict possible threats to the community. Their groundwater models will be assessed on how well they were assembled and on the student's explanation of the movement of the red dye and their ability to relate this to groundwater movement and to predict the outfall of the leaking dike at the Flowing Railroad site.

### **Closure**

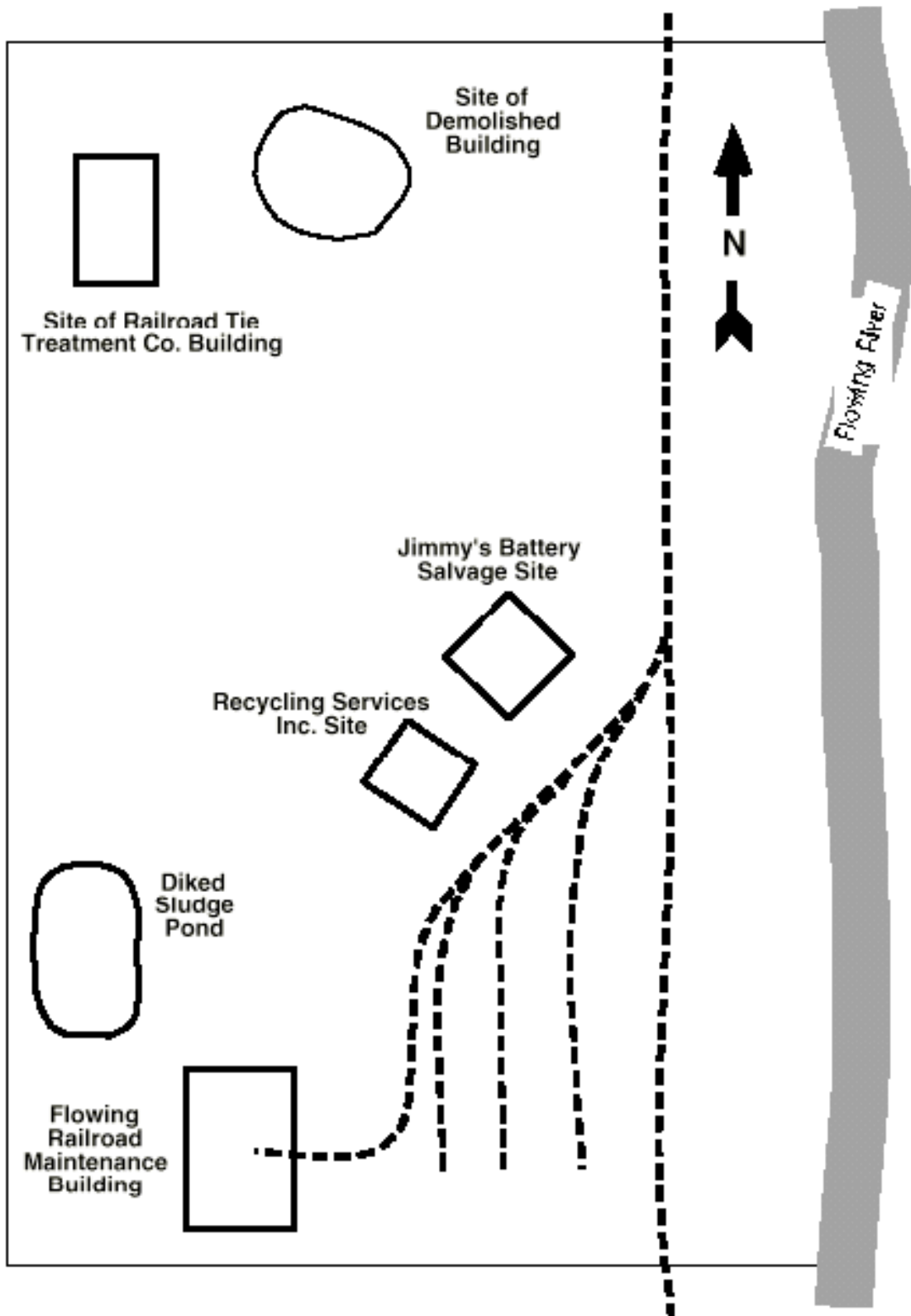
Invite an EPA or state Superfund employee involved in overseeing hazardous waste cleanup projects to discuss a real Superfund site such as Valleycrest or the Mound facility in Miamisburg. Students should relate this experience to a real-world hazardous waste site. Point out that they have discussed hazardous substances, but not how the level of danger to people and the environment is calculated. In the next lesson they will be doing just that.

**EXAMINING A HAZARDOUS WASTE SITE**

**ALT ONE: Handout One**

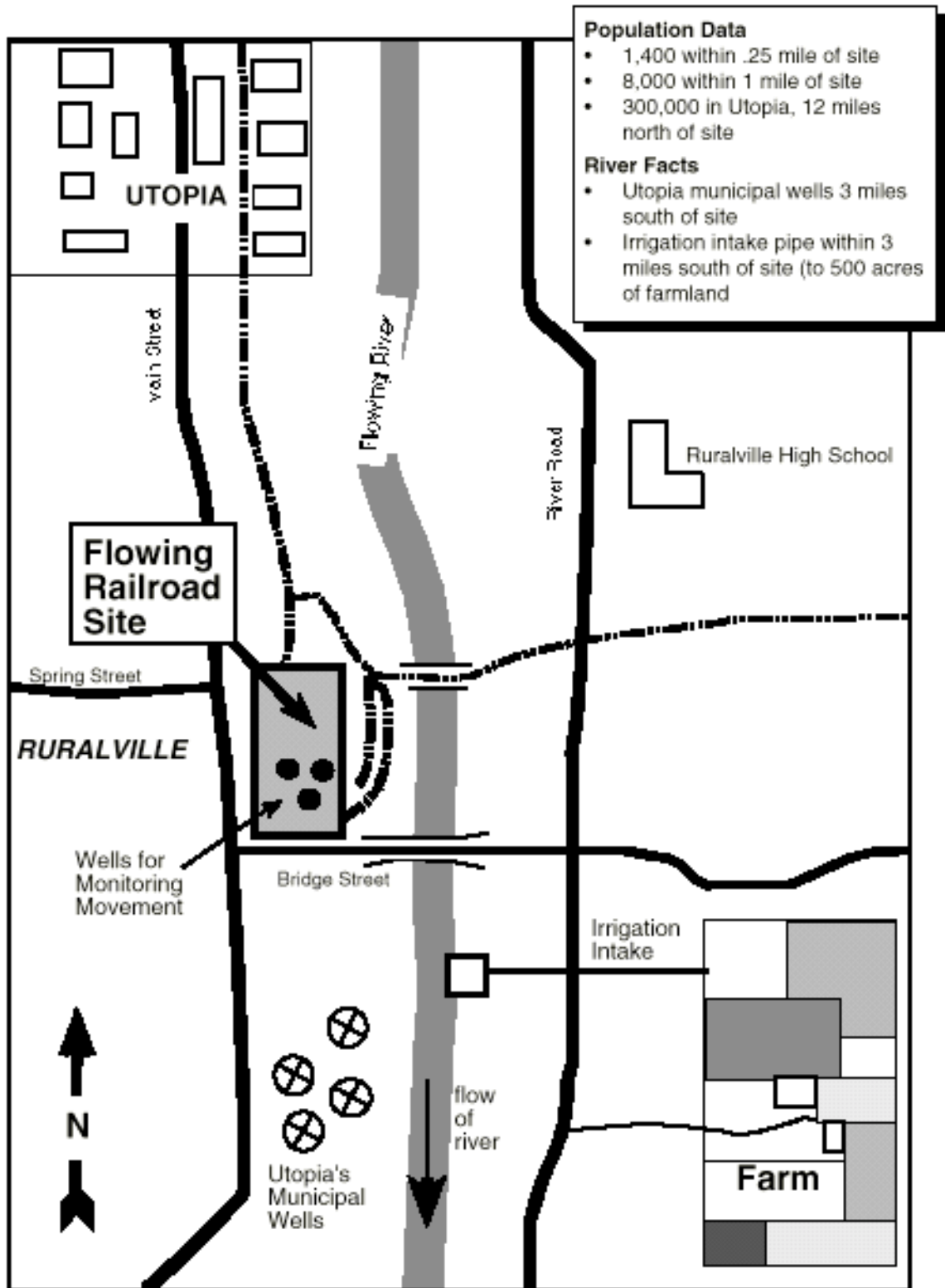
**EXAMINING A HAZARDOUS WASTE SITE – MAPS OF FLOWING  
RAILROAD SITE**

Map 1  
Flowing Railroad Site

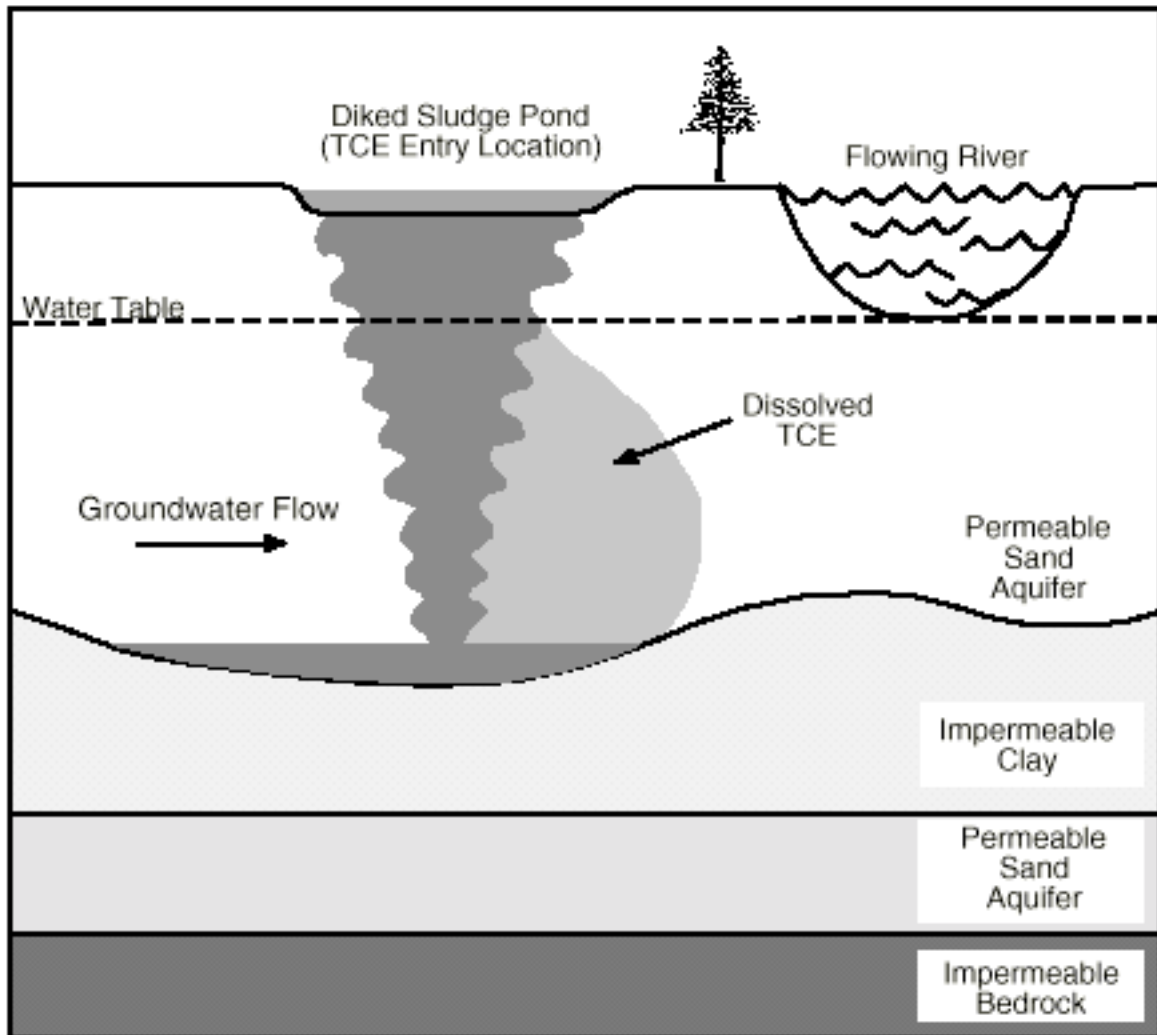




Map 2  
Flowing Railroad Site Area



**Map 3**  
**Diked Sludge Pond, Cross-Section**



## Section TWO: Environmental Technology

### ALT TWO: TOXICOLOGY – HOW MUCH IS TOO MUCH?

#### Summary

Students will determine the LD 50 (lethal dose 50%) for various toxic substances using brine shrimp. This is a common test performed to find the relative toxicity of substances. The students will make a series of dilutions of copper II sulfate and other household substances in order to determine the sensitivity of the brine shrimp to these toxins.

#### Competencies: using reference materials with 85% accuracy:

19. Measure the effect of various toxic materials on the brine shrimp
20. Determine the LD50 for household substances

#### Time

3- 90-minute class periods

#### Materials

Petri dishes

Copper II sulfate

Brine shrimp and salt water medium

Household chemicals – ammonia, hydrogen peroxide, gasoline, vinegar, coffee, nicotine, rubbing alcohol, etc

Eyedropper

Graduated cylinder

Notebook

#### Instructions

34. Divide the students into groups of 2-4. Give each group 5 petri dishes.

35. The students label each of the dishes:

10% CuSO<sub>4</sub>

1% CuSO<sub>4</sub>

0.1% CuSO<sub>4</sub>

0.01% CuSO<sub>4</sub>

0% CuSO<sub>4</sub>

Note: do not use distilled water as the 0% control – use the salt-water mixture the brine shrimp are kept in.

36. Place enough of the solution indicated in to the petri dishes to cover the bottom of the respective petri dishes.
37. Have the students use an eyedropper to place ten brine shrimp in each of the dishes. Count the brine shrimp carefully and be sure that they do not get any unhatched brine shrimp eggs in the petri dish.
38. Record the time and date in the student notebook.
39. Examine the petri dishes at 24 hours and 48 hours and have the students record the number of brine shrimp that have died in each dish.
40. The students should plot their data on a graph and determine the approximate concentration at which 50% of the brine shrimp died at the end of 24 and 48 hours. They will have two lines on the graph and will have to determine the LD50 for both 24 and 48 hours.
41. Have the students determine the LD50 for two other common household chemicals. They may choose one of those listed above or bring in one of their choice. Do NOT use distilled water to dilute the solution to the proper concentration, use the salt water that the brine shrimp are raised in. Have them record their results and share them with the class.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated by the accuracy of their data and their calculation of the LD50 for each chemical. They will prepare a written report detailing the experiment, their data and conclusions.

### **Closure**

The students will get up in front of the class and describe how they calculated their LD50 for their particular household chemical. Toxicity levels are important in determining the amount of risk a hazardous waste site might prove to the community and environment. In the next lesson, students will return to the fictitious Flowing River hazardous waste site and assess contamination and risk of exposure to the people of Utopia and Ruralville.

**TOXICOLOGY – HOW MUCH IS TOO MUCH?** ALT TWO: Handout One**TOXICOLOGY – HOW MUCH IS TOO MUCH? DATA TABLES**TYPE OF SUBSTANCE:  $\text{CuSO}_4$ 

	<b>NUMBER OF BRINE SHRIMP DEAD</b>	
<b>CONCENTRATION</b>	<b>24 HOURS</b>	<b>48 HOURS</b>
<b>10%</b>		
<b>1%</b>		
<b>0.1%</b>		
<b>0.01%</b>		
<b>CONTROL 0%</b>		

TYPE OF SUBSTANCE: \_\_\_\_\_

	<b>NUMBER OF BRINE SHRIMP DEAD</b>	
<b>CONCENTRATION</b>	<b>24 HOURS</b>	<b>48 HOURS</b>
<b>10%</b>		
<b>1%</b>		
<b>0.1%</b>		
<b>0.01%</b>		
<b>CONTROL 0%</b>		

TYPE OF SUBSTANCE: \_\_\_\_\_

	<b>NUMBER OF BRINE SHRIMP DEAD</b>	
<b>CONCENTRATION</b>	<b>24 HOURS</b>	<b>48 HOURS</b>
<b>10%</b>		
<b>1%</b>		
<b>0.1%</b>		
<b>0.01%</b>		
<b>CONTROL 0%</b>		

## Section TWO: Environmental Technology

### ALT THREE: IDENTIFYING RISKS

#### Summary

Students will identify and assess risks found a hazardous waste site. They will examine typical contaminants found at hazardous waste sites, methods of cleanup and will examine the applicability of various cleanup methods to the Flowing Railroad site in terms of future use of the site. They will draw picture representing the current site and proposed cleanup methods as well a picture of the future use for the site.

#### Competencies: using reference materials with 85% accuracy:

21. Describe and identify hazardous materials
22. Perform Phase one site assessment
23. Assess contamination cleanup methods and select most viable choices based on future uses of the site

#### Time

3- 90-minute class periods

#### Materials

Fact Flashes 1-4 from ALT 1

Fact Flash 8 and 9

Handout – Assessment & Site Inspection of Flowing Railroad Site

Poster paper

Notebook

#### Instructions

42. Divide the class into groups of 2-4. Pass out copies of Fact Flash 3. Have the students read about the history of the Flowing Railroad site and the types of hazardous waste found at the site. Discuss with the entire class.
43. Pass out Fact Flash 9. This details each of the common contaminants found at hazardous waste sites. Assign each group to read one of the sections: asbestos, PCB's, etc. they will report to the rest of the class. In their report each group should include:
  - What their substance is.
  - How or for what purpose was this originally used?
  - How is it dangerous to people or the environment?

How could exposure occur?

Where might this contaminant pose a threat? (Air, surface water, groundwater, soils, etc.)

The other groups should take notes on each of these and record them in their notebook. They will need this information later.

44. Have them get out the Flowing Railroad Maps from ALT 1. Review from ALT 1 how contaminants at the site might spread. Ask the students what areas of the community might be at risk of exposure and have them suggest how.
45. Pass out Site Inspection Handout. Have each group read the inspection report and answer the questions as a group. Bring the class back together and have them share the results. Ask them why the EPA uses these questions when assessing a site. What is the difference between direct contact and food chain contamination – which is more dangerous? Which is more important – protecting the river or the groundwater? Why?
46. Pass out Fact Flash 4 and have them read that for homework.
47. Put them back in their groups and discuss the reading from the previous class – Fact Flash 4. What contamination problems did the EPA find at the site? What good news was there?
48. Divide them back into their teams of 2-4. Pass out Fact Flash 8 – Methods of Cleanup. Assign each group to read about one clean up method. They will again report to the class, make sure they answer these questions:
  - Describe the cleanup method.
  - Explain how it works
  - Explain why it is used instead of another method
  - Describe how well it works
 Have each group report on their results. Again the students should take notes – they will need this information later.
49. Have each team discuss the options below and decide how the Flowing Railroad site should be used in the future:
  - a. Should the site become a park, residential area, school, or playground?
  - b. Should the site remain a restricted area for limited industrial use only?
  - c. Should the site be zoned for a landfill or for hazardous waste storage since it already had been polluted?
 Have each team record their decision in their notebook.
50. Instruct the teams to discuss and record the various cleanup methods from Fact Flash 8.
51. Have each team use the Flowing Railroad Map from ALT 1 to create 2 drawings.

One will show the site as it exists, identify various areas of contamination and the type of contamination found there (they may need to review Fact Flash 4)

The second will show the future use of the site after cleanup.

Supply the students with poster paper.

52. Reassemble the class and have the students show their posters and discuss and compare the various groups' decisions.

### **Evaluation/Assessment of Student's Competency**

Students will be evaluated on their responses during class discussion, completion of the site assessment handout, posters prepared for contamination cleanup and future use of the site. The students cleanup methods should relate to the contaminants found on site – their future use proposal should accurately reflect the contamination, its cleanup and the health and safety of the community.

### **Closure**

The students will get up in front of the class and describe how they identified risks at the site, made decisions about cleanup and future use of the site. Many of these same skills will be used in the Transfer Activity at the end of this module.

## **ALT THREE: IDENTIFYING RISKS**

### **Handout One**

## **The Preliminary Assessment and Site Inspection for the Flowing Railroad Site**

Discuss within your group the following questions about the Flowing Railroad site. The only information you have about the site is contained in the fact sheet you just read.

Your group should answer these questions (space is provided after each question) and select a spokesperson to present your answers.

### **1. What are your biggest concerns regarding the site and why?**

Health concerns (e.g., cancer, neurological disorders) from drinking polluted water, food chain contamination, or breathing air contaminated by the site?

Environmental resource concerns, including fish in the Flowing River?

### **2. What are the ways in which the contamination can spread? (These are commonly referred to as “routes of migration.”)**

Melting snow?

Rain?

Humans trespassing on the site?

Fish?

Wind?

Are there other ways?

### **3. How would you rank the threats to human health and the environment from this site? Choose from the list of threats below, or come up with your own. What is the rationale for your ranking of the threats?**

Groundwater, the source of drinking water for the neighboring Town of Ruralville and the nearby City of Utopia?

Flowing River, which serves as a source for irrigation and municipal wells, in addition to recreational and subsistence fishing?

Soil?

Air and wind?

**4.What actions could be taken now?**

Put up a fence?

Provide drinking water?

Are there others?

## **Section THREE: COMMUNICATIONS**

### **ALT ONE: WHAT HAVE WE DONE TO OURSELVES?**

#### **Summary**

Students will create PowerPoint presentations reviewing the major environmental regulations that impact hazardous waste facilities. Each student will work in cooperative teams to research and present one regulation, its history and its impact on industry and the environment.

#### **Competencies: using reference materials with 85% accuracy:**

24. Use multimedia techniques and resources
25. Identify key components of various environmental regulations
26. Use proper business speaking and presentation skills

#### **Time**

4- 90-minute class periods

#### **Materials**

Computer with PowerPoint software  
Resource materials  
Notebook

#### **Instructions**

53. Divide the class into as many as 8 groups if you choose to do every regulation listed. Pass out the handout listing the regulations. Assign each group one of the laws to investigate and research (or let them choose one from the list). Explain to them that they will be required to produce a PowerPoint presentation based on their research and present this to the class.
54. List for them the basic requirements of the presentation:
  - The presentation must be at least 10 minutes long, but no more than 15.
  - They will need at least 10 to 15 slides for a presentation of this length
  - They must incorporate graphics into their presentation
  - There are certain elements of each regulation that must be addressed in the presentation. See the handout for the details.
  - Provide a copy of your presentation in “notes” format for the entire class

On the day of the presentation, dress in appropriate business dress and present the slide show in a professional manor.

Be prepared to answer questions.

The other groups should take notes on each of these and record them in their notebook. They will need this information latter.

They will be evaluated on the content of the presentation, the quality of the presentation, the creativity of the presentation design, their speaking skills and professional dress and the length of the presentation.

55. They will have a number of resources available in the Media Center as well as the computer lab – including digital cameras, web access, Photoshop and Illustrator software, etc. Students not proficient in the basics of PowerPoint or other software may need some extra help.
56. On the presentation days (it will take two if you do all regulations), choose an order or ask for volunteers. Presenters will load their presentation on to the teacher's computer. They will pass out copies of the presentation in "notes" format for the entire class and give their presentation.

### **Evaluation/Assessment of Student's Competency**

The students will be evaluated on the content of the presentation, the quality of the presentation, the creativity of the presentation design, their speaking skills and professional dress and the length of the presentation.

### **Closure**

Summarize the laws and regulations presented. Remind the students that the oldest of these laws was enacted in 1969 – these are very recent developments. These laws form the basis for the EPA and other regulatory agencies. Industry spends a great deal of money every year in order to comply with these regulations. Both industry and regulatory agencies monitor industrial processes and the environment to insure compliance with these and other regulations. This monitoring for compliance is topic of the next ALT.

## **ALT ONE: WHAT HAVE WE DONE TO OURSELVES?**

### ALT ONE: Handout One

#### ENVIRONMENTAL REGULATIONS

1. Comprehensive Environmental Restoration and Compensation Liability Act (CERCLA)

List goals of this regulation

Historical Basis for enacting the regulation

Impact of the regulation on industry

Identify key components

List major sections

Key parts of site evaluation and remediation

Hazard ranking system

National priority sites

Key elements of toxic substance control act (TSCA) relative to CERCLA

2. Superfund Amendment Reauthorization Act (SARA)

List goals of this regulation

Historical Basis for enacting the regulation

Impact of the regulation on industry

Identify key components

List major sections

Explain Toxic Release Inventory (TRI)

Describe area Superfund Sites

3. Occupational Safety and Health Administration (OSHA)

List goals of this regulation

Historical Basis for enacting the regulation

Impact of the regulation on industry

Identify key components

List major sections

Control of hazardous energy (OSHA 29 CFR 1910.147)

Commercial diving in the environmental field (OSHA 29 CFR 1910.424/1926.1070)

Chemical hygiene

Hazard Communication Laws

4. Resource Conservation and Recovery Act (RCRA)

List goals of this regulation

Historical Basis for enacting the regulation

- Identify key components
- Identify key components
- List major sections
- Identify categories of hazardous waste
- Hazard ranking system
- Describe “cradle to grave” concept
- Identify secondary containment requirements for above and below ground storage

5. Clean Water Act

- List goals of this regulation
- Historical Basis for enacting the regulation
- Identify key components
- Identify key components
- List major sections
- Identify categories of hazardous waste
- Identify key components of National Pollutant Discharge Elimination System (NPDES)
- Explain pretreatment program
- Describe the Great Lakes Initiative (GLI)

6. Safe Drinking Water Act (SDWA)

- List goals of this regulation
- Historical Basis for enacting the regulation
- Identify key components Identify key components
- List major sections
- Identify categories of hazardous waste
- Explain purpose of Well Head Protection Program
- Describe Sole Source Aquifer Designation

7. Clean Air Act

- List goals of this regulation
- Historical Basis for enacting the regulation
- Identify key components
- Identify key components
- List major sections
- Identify categories of hazardous waste
- Explain Title V Air Emissions Inventory
  
- Explain hazardous air pollutants (HAP’s)
- Explain why Montgomery County is a “non-attainment” area
- Describe key components of e-check

8. Nuclear Waste Policy Act

List goals of this regulation

Historical Basis for enacting the regulation

Identify key components

Identify key components

List major sections

Identify categories of hazardous waste

List key agencies involved in high-level radioactive waste management program

List defining characteristics of nuclear waste

List methods of storage and disposal for each type of waste

## Section THREE: COMMUNICATIONS

### ALT TWO: MANAGING DATA

#### Summary

Students will create spreadsheet of environmental monitoring data based on data collected from the EPA's web site (or alternately from their own monitoring of local streams).

#### Competencies: using reference materials with 85% accuracy:

27. Use spreadsheet software packages to prepare spreadsheet
28. Analyze and interpret sampling data
29. Demonstrate proficiency in technical recording of data

#### Time

2- 90-minute class periods

#### Materials

Computer lab with spreadsheet software

Resource materials

Notebook

USGS water quality monitoring data web site

**[www.rvares.er.usgs.gov/wqn96cd/html/wqn/wq/wq.htm](http://www.rvares.er.usgs.gov/wqn96cd/html/wqn/wq/wq.htm)**

Teachers should become familiar with this site before the lesson. There are 21 regions of the US and Caribbean the students can choose from, they then pick a site within the region.

#### Instructions

57. The students will work individually on this project. Explain to the students the importance of maintaining easy to understand and easy to access records of sampling data collected in the field. Ask them why the EPA collects water quality data? What types of factors do they test for? Explain that they will be constructing a spreadsheet based on water quality data collected by the EPA that will make judgements about assessing water quality much easier.
58. Take them to a computer lab where they can all access a computer. Show the EPA water quality database. They will select a stream from the national map. They may select any stream they like; it is more interesting to have a variety of streams – urban, industrial, and those in more undisturbed natural areas. Have a few students work on local streams for a comparison.

59. Each student will create a spreadsheet for his or her stream. Each should include the following:

Title

Stream location

Dates of data collection

**Data fields for:**

Dissolved Oxygen

Conductivity

Total dissolved solids

Nitrates

Phosphates

PH

Biological oxygen demand (BOD)

Temperature

Turbidity

Fecal Coliform

Ammonia

Alkalinity

Calcium

Chloride

Stream Flow

Units of measurement for each factor

Water quality standards for each of the factors listed above

Attainment status for each factor (high, low, normal)

Average values for each of the factors

Factors that may influence the water quality of the stream – i.e. industrial areas

60. When all students have completed the spreadsheet, have them save a digital copy for the instructor and a printed copy for the class, gather back in class and have them share their results. Ask the students to make comparisons of water quality data collected in different locations. What comparisons can be made from one area to another?

61. ALTERNATIVE METHOD: have the students collect data on a local stream and make the spreadsheet using their own data.

### **Evaluation/Assessment of Student's Competency**

The students will be evaluated on the content of their spreadsheet, the use of formulas, and interpretation of the results.

### **Closure**

Review the spreadsheet data from different streams as a class. Make comparisons and contrasts between different streams. Ask the students how this data can be used to assess compliance by industry with environmental regulations. In the Transfer Activity they will be investigating compliance issues – an understanding of data management is important in understanding how industrial sites maintain an environmentally safe work place.

## Section THREE: COMMUNICATIONS

### ALT THREE: COMMUNITY MEETING

#### Summary

Students will observe a city council meeting, assess the roles of various individuals in conducting the meeting and forms of effective speaking in preparation for conducting their own meeting. They will hear from the mayor as a guest speaker in order to learn about the role of local government in environmental regulation and in dealing with local Superfund sites.

#### Competencies: using reference materials with 85% accuracy:

30. Identify roles of individuals in community meetings
31. Identify forms of effective public speaking
32. Describe the role of the mayor and city council in environmental monitoring of area businesses

#### Time

1- 90-minute class period

#### Materials

Videotape of council meeting (available through public access channels)  
Mayor and or City Manager as guest speaker  
Handout  
Notebook

#### Instructions

62. Pass out the handout. Tell the students they will be viewing parts of a recent city council meeting. The goal of this is to prepare them for their own meeting they will be conducting as a class. The questions on the handout focus on the roles different members play in the meeting, how they conduct themselves and their speech.
63. Show the videotape of the council meeting. Have the students complete the handout. Discuss the answers – make sure the students understand the roles of the individuals and how the meeting is conducted.
64. Bring in the mayor (this may be done on different class session). Prep him/her to speak for a few minutes on what their job entails and how they conduct city council meetings. Have them speak about the role of the mayor in getting new industry to locate in your city. How they deal with environmental concerns, the EPA, “right to know” laws, etc. Leave time for the students to ask questions.

### **Evaluation/Assessment of Student's Competency**

The students will be evaluated on their ability to identify roles of city council members and others at the meeting and to describe the role of the mayor and others in attracting new industry to Miamisburg and ensuring that they are environmentally safe. The students will be further evaluated on this during the Transfer Activity as they act out roles as the mayor, city manager and others.

### **Closure**

Review the council meeting and the mayor's guest talk. Remind the students that they will be role-playing a city council meeting. What important information did they learn that would help them in conducting their own meeting?

**ALT Three: COMMUNITY MEETING**  
**ALT THREE: Handout One**

**Community Meeting**

1. Community meeting date \_\_\_\_\_ and location  
\_\_\_\_\_
2. Who calls the meeting to order? What happens next?
3. List those who are seated at the council table by their title.
4. Describe how the meeting is conducted.
5. How are speakers from the audience recognized? How are community members recognized?
6. What is the overall tone of the meeting?
7. List ways in which council members and others speak effectively?
8. Is anyone at the meeting try to be persuasive?
9. If speakers at the meeting are trying to be persuasive, what are some things they say that make their speech more effective?
10. What is your overall impression of the meeting?

### **Guest Speaker**

1. Name and title of the guest speaker: \_\_\_\_\_
2. What is his main duty for the city?
3. How does he attract industry to the city?
4. How does the city help to insure that industry is environmentally safe for the community?
5. Describe his role in the Superfund cleanup at the Mound Facility.
6. How were decisions made as to how to cleanup and reuse the Mound facility?  
What ere some of the options available?
7. What voice do citizens have in what type of industry moves into the city?
8. What helpful ideas does he have in how to conduct a city meeting?
9. What would he advise someone who wants to get up and speak at a community meeting? How can they be persuasive?
10. List three more interesting things the speaker had to say.

## Transfer Activity

### MAKING DECISIONS ABOUT HAZARDOUS WASTE

#### Summary

Students will take part in a role playing simulation of a community meeting in which they must decide what action will be taken to cleanup the Flowing Railroad Superfund site.

#### Competencies: using reference materials with 85% accuracy:

33. Identify participants in decision making process and their perspectives on environmental issues
34. Make informed judgements about the potential effect of new industry on their city
35. Write statements, formulate questions and articulate views in a community meeting setting

#### Time

3- 90-minute class periods

#### Materials

Character Background Sheets  
Analysis of Alternatives for Flowing Railroad cleanup  
Fact Flash 4  
Notebook

#### Instructions

65. Pass out the handouts. Explain to students that they will be acting out a situation that illustrates the sometimes-difficult process of making decisions about hazardous waste sites. For this role playing exercise, they will assume they are one of participants in a community meeting to discuss what will happen to the fictitious Flowing River Railroad site from section 2 of the module.
66. Divide the class into nine teams. Explain that each team will represent one of the "players" in this drama. Assign a role to each team and explain that later each team will have to choose 1 team member to be the actor when the first part of the drama is played out. Team member should prepare a written statement for their character to deliver, as well as a list of questions that character would want to ask or have answered at the meeting. Tell the students that they will need to draw on all of the previous activities in order to

understand the background of the meeting. The second handout – Analysis of Alternatives for Flowing Railroad cleanup is useful in preparing character statements – review the options with the class. Encourage student to talk to their parents, local city officials, business owners (such as ONYXES and BWXT Mound Technology) and others to help develop their perspectives. Also remind students that some of their characters – EPA’s RPM and CIC, the mayor, and the official from the local Health Department and possibly others would probably consult with each other in real life to prepare for the meeting. Encourage teams responsible for the characters to do so.

67. For the role-play activity, have the students representing g the Mayor and the CIC arrange desks or a table at the front of the room with chairs for the mayor, EPA CIC, EPA RPM and the moderator. Place a lectern somewhere else from which the other characters will make their statements. Explain that at the end of the meeting the EPA representatives and the mayor will make a recommendation to rest of the class as to what course of action will be taken and present a rationale for the decision.
68. Have the mayor speak first to open the meeting and call it to order and introduce the EPA personnel. The EPA personel make an opening statement reviewing the findings of the status of the railroad site (Fact Flash 4) and the cleanup alternatives. After that, have other characters raise their hand to be recognized to ask questions and make their statements.
69. The next classes period, have the EPA and the mayor present their final decision and rationale. Discuss with the class what were the various perspectives of the characters in the drama? Which were competing? Which would you expect to have carried the most weight? Why? Did those points of view appear to influence the final decision? How will the decision affect each of the characters from the community? Is it positive for the community?

### **Evaluation/Assessment of Student’s Competency**

The students will be evaluated on their written statements regarding their character and their ability to play that character convincingly in the drama. The character statements should show an understanding of previous activities in the module and the perspective on these that their character would have.

**TRANSFER ACTIVITY**

Handout One

**Character Background Sheet****EPA Remedial Project  
Manager (RPM)**

You are the RPM assigned to the Flowing Railroad site. Your job is to direct the response effort and coordinate all cleanup activities at the site. You are responsible for coordinating not only with EPA Regional and Headquarters staff, but also with other Federal, state, and local agencies.

Although you live and work in the city where the EPA Regional Office is located, many of the sites for which you have been responsible were in small towns and rural areas like this one, so you can empathize with the concerns of the citizens of Ruralville. Your purpose at the community meeting is to tell people about the investigation of the problems at the site and the sort of cleanup options you are weighing as a result. In addition, you want to give them the opportunity to ask any questions and express any concerns they have about the cleanup in general or about specific cleanup options.

When the meeting is over, you will have to make a final decision about how to recommend that the site be cleaned up, balancing the data from your investigation and the other information at your disposal with what you hear in the meeting about what the community thinks. This is not an easy decision to make, because there are a lot of needs and interests you must try to satisfy—the requirements in the law, the needs of the people who live in the community, the wishes of those who run businesses in the community, the interests of FRR Enterprises which is a major employer in the community, etc.

You are responsible for choosing a cleanup option that:

#Protects human health and the environment

#Complies with existing Federal and state laws and requirements

Your choice also must:

- #Be effective in the short-term, as well as over the long-term
- #Reduce the toxicity, mobility, or volume of the contaminants
- #Be realistic
- #Be reasonably cost-effective
- #Be acceptable to the community

You will prepare a Proposed Cleanup Plan describing your decision and discussing why you chose to proceed in this way. You will have to present that plan to the same group of people from the community And hear their reaction

## **Character Background Sheet EPA Community Involvement Coordinator (CIC)**

You are the CIC assigned to the Flowing Railroad site. Your job is to manage all EPA's community involvement activities to provide an opportunity for public participation in the Superfund process.

You grew up in Ruralville but left to go to college. Now you live in the city where EPA's Regional Office is located. You still know a lot of people in Ruralville and you are eager to help them understand what's involved in cleaning up the site and how the cleanup will and will not affect their lives.

Your purpose at the community meeting is to help explain the cleanup options being considered, answer citizens' questions, and listen to community concerns. You have already met most of the people at the meeting because your overall responsibility has been to ensure that the community knows what to expect and how to participate in Superfund decision making. You have been sharing information about the Superfund process with the community and obtaining information from them since EPA's activities at the site began. You've visited with individuals, families, and business owners in the community, written fact sheets about various stages in the process, gathered and distributed information about the site itself and the data EPA collected during its investigation of the site. When the meeting is over and the RPM has made a final decision about how to clean up the site, you will prepare a fact sheet that summarizes the decision and help the RPM respond to comments from the community about the selected cleanup strategy.

You lead the meeting for the EPA.

## **Character Background Sheet**

### **Local Health Official**

You are a Health Advisor for the Ruralville Health Department. Although you have more than 10 years of experience in the health field, this is the first time you have encountered a situation involving a hazardous waste site.

Your purpose at the community meeting is to learn as much as possible about any potential health effects that could result, now or in the future, from contamination at the site and from efforts to clean it up. You need this information to be able to accurately advise townspeople of any health-related dangers and how to avoid them.

## **Character Background Sheet**

### **Mayor of Ruralville**

You have been Mayor of Ruralville for six years. Your job is to protect the health and welfare of the community and its citizens and to make sure the interests of the community is considered as Superfund decisions are made.

You are a well-respected member of the community. Most of the townspeople believe you have done good things for Ruralville. Your purpose at the meeting is to demonstrate the leadership residents expect from their Mayor and to ensure the continuing economic well-being of the community, as well as the safety of its citizens.

You support town growth and have helped several small businesses get established in the community.

Some people credit you with being instrumental in Flowing Railroad's decision to open its Flow Automations factory in Ruralville. The factory employs many of the people who work in Ruralville. In fact, some of them originally worked for the Flowing Railroad and were retrained so they could work at the new factory.

Your family is very important to you. You are especially close to your oldest child who happens to be married to the president of Flow Automations.

You lead the meeting.

## **Character Background Sheet**

### **Attorney for FRR Enterprises**

You are the general counsel for FRR Enterprises, which owns the Flowing Railroad Company site, and Flow Automations. Your purpose at the meeting is to protect the company's interests. You want to make sure the government and individual residents realize how the cleanup decisions in this case will affect the company and, in turn, the town's tax revenue and all the townspeople employed by the company.

You are concerned because FRR Enterprises already has spent more than \$1 million on studies required to determine the extent of contamination at the site, and more bills are on the way. FRR Enterprises also will have to bear much of the cost of any cleanup remedy selected. You want people to understand that the contamination at the site resulted from activities that were legal at the time. You intend to argue that to make the company bear the financial burden for that is unfair, because the company did not do anything wrong. Besides, the Flowing Railroad was not the only business operated on the site, and if FRR Enterprises has to pay, even though they did nothing wrong, so should all the other businesses who operated on the site. FRR should not be penalized just because it is still around.

Although FRR Enterprises is financially stable now, company officials—your bosses—are concerned about the long-term impact of the cleanup since it is hard to predict what the total cost will be.

## Character Background Sheet

### Local Environmental Activist

You are a resident of Ruralville and the founder of the local chapter of Everlasting Earth. Everlasting Earth is a national advocacy organization dedicated to preventing pollution and fighting threats to public health and the environment. You are passionate in your belief that polluters should pay to clean up the problems they create.

Your purpose at the meeting is to make sure that no one lets FRR Enterprises off the hook. You believe they have damaged the environment and, as a result, the health of community residents could be in danger. You were one of the first people to learn (from your friend at the bank) about the environmental audit of the Flowing Railroad site. As soon as you heard the consulting firm's findings, you began lobbying to get the town to demand the site be cleaned up; you want the most stringent cleanup standards applied in this case.

You do not believe the town should be concerned with how much the cleanup might cost; FRR Enterprises must be made to pay, no matter what the cost. You also do not believe there is any danger that FRR Enterprises could go bankrupt or that Flow Automations could go out of business as a result of paying for the cleanup. You think the company is just trying to scare people.

## **Character Background Sheet**

### **Worker at Flow Automations Factory**

You are employed as an assembler at the Flow Automations factory. Prior to this job, you worked for the Flowing Railroad.

Your purpose at the meeting is to learn as much as you can about the problems at the site and the cleanup being proposed. You feel like you are being asked to choose a “side” on this issue but you are confused. You have a number of concerns about the situation but no one answer seems to satisfy them.

You are a single parent with three young children. On the one hand, you need your job at Flow Automations; you have no other source of income. Besides that, Flowing Railroad was good to you; the company got you the job at Flow Automations and paid for the training you needed to do it. On the other hand, you and your children live near the site and you have the children’s health and well-being to consider.

## Character Background Sheet

### Owner of a Farm near the Flowing River

You own 75 acres of farmland, some of which borders the Flowing River. The farm has been in your family for generations.

Your purpose at the meeting is to get some straight answers about the contamination from the site and how far it has spread. You want to know if it is affecting your crops and what can be done to stop it. You grow several crops and sell them to supermarkets in Ruralville and in several towns throughout the state. You depend on sales to stay in business and to pay your employees.

Your farm has had a number of hardships over the years. First, you lost many of your crops to a severe drought 2 years ago. Then, an electrical storm last June started a fire that burned several acres before it could be stopped. These things have cost you a lot of money. Now, some of your customers are asking you if your crops are contaminated because of what's happened at the Flowing Railroad site.

You feel like your farm's reputation and your whole future is at stake. You intend to let the Mayor and the people from the government know that and demand that they do whatever is necessary to solve the problem.

## Character Background Sheet

### Local Carpenter

You, your spouse, and your 4 children have lived in a rented cottage on the banks of the Flowing River for about a year. The Long Shot Cafe, where your spouse worked as a bartender, closed several months ago. Your spouse has not been able to find another job, so you have been the sole supporter for the family.

You earn money by doing odd jobs around town, but there haven't been many lately. You've had to depend on fishing in the river to feed your family; 3 of 4 main meals a week over the last few months have come from the river.

You have become increasingly frightened and angry over the last few weeks as you have heard more and more rumors about possible contamination of the river. You are convinced that, because you and your family are poor, your welfare will not be considered as the government makes decisions about how to deal with the Flowing Railroad site.

Your purpose at the meeting is to make them listen to your concerns.

## **TRANSFER ACTIVITY**

### **Handout Two**

# **Analysis of Alternatives for Cleaning Up Flowing River Site**

## **Alternative #1: Provide Security**

### **Brief Description**

This alternative is used as a baseline against which to compare other alternatives. It allows for continuous monitoring of site conditions; action can be taken if conditions change. It includes fencing the contaminated area and erecting signs to indicate potential health hazards.

### **Advantages**

Because no threat to drinking water exists (the deep aquifer is not connected to the shallow aquifer), funds for this site may be used for more hazardous sites.

The fence prevents direct contact with contamination.

### **Disadvantages**

It does not address the contamination.

Contaminated water may continue to move toward the flowing river.

Asbestos particles may be released during windy weather if erosion continues to occur.

The site is not available for future use.

## **Alternative #2: Only Cap**

### **Brief Description**

This alternative places layers of waterproof material like clay and plastic over the contamination. It reduces the amount of water reaching the contamination, and the contamination is slowed from moving and reaching water sources.

### **Advantages**

A short period of construction is required, so the site is addressed quickly.

This technology is inexpensive, reliable, and commonly used. It will last with proper maintenance.

The cap will reduce the rate at which the contamination in the shallow aquifer will move toward the Flowing River.

### **Disadvantages**

The cap does not neutralize or eliminate the contamination.

The cap requires maintenance and monitoring and is not always 100% effective.

It limits the site's reuse; in order to maintain the cap, nothing can be built on top of it.

## **Alternative #3: Cap, Air Stripping, Chemical Precipitation**

### **Brief Description**

This alternative uses a cap to address soil contamination, as described in Alternative #2.

Air stripping and chemical precipitation of contaminated water requires building a large tower on the site and drilling wells into the aquifer. Contaminated water is pumped to the top of the tower where the volatile

pollutants can evaporate and form into a gas. The gas is then filtered through a layer of carbon to remove the contaminants.

After air stripping, the water is treated by chemical precipitation to remove heavy metals. Chemicals are added to the water to create a sludge. The water is filtered from the sludge, treated, and pumped back into the environment. The sludge is sent off site to a licensed disposal facility.

### **Advantages**

The cap addresses the asbestos. See discussion of capping advantages in Alternative #2.

This technology effectively removes most of the contamination from the shallow aquifer over 2-10 years.

Most of the contamination is addressed through treatment, without having to move it from the site.

An air stripper is relatively easy to operate and is not technically complex.

Metals and PCBs are captured in the sludge. A licensed off-site facility can contain the sludge through extensive controls.

### **Disadvantages**

See the discussion of capping disadvantages in Alternative #2.

The air-stripping tower needs to be monitored carefully to ensure that any contamination released into the air meets State standards.

Air stripping is 90% efficient and the tower needs to be monitored to prevent releases of contaminants.

Contaminated sludge needs to be disposed of properly offsite.

## **Alternative #4: Incineration, Air Stripping, and Chemical Precipitation**

### **Brief Description**

This alternative involves digging up and burning contaminated soils at high temperatures in an on-site incinerator. The incinerator destroys TCE and PCB contamination. The remaining ash containing heavy metals is shipped off site to a landfill.

As described in Alternative #3, air stripping and chemical precipitation of contaminated water require building a large tower on the site and digging wells into the aquifer. Contaminated water is pumped to the top of the tower where some of the pollutants can form a gas that may be filtered through carbon. Heavy metals are removed from the water by chemical precipitation.

### **Advantages**

The site is "clean" and available for reuse.

The incinerator destroys at least 99.9999% of the organic (burnable) contaminants in the soil.

An air stripper is relatively easy to operate.

### **Disadvantages**

Stringent permits are required to operate an incinerator. Hazardous emissions from incinerators have been associated with health risks so careful monitoring is required.

Public resistance from incineration often occurs. Treatment residuals from the incinerator must be managed and disposed of.

Air stripping is 90% efficient. The air-stripping tower needs to be monitored carefully to ensure that any contamination released into the air meets State standards.

Asbestos is not addressed.

## **Alternative #5: Complete Excavation**

### **Brief Description**

This alternative requires digging up a large volume of the contaminated soil and shipping it to an off-site hazardous waste facility.

Groundwater contamination is treated on site with an air stripping and chemical precipitation, as described in Alternative #3.

### **Advantages**

This technology removes contaminated soil completely in a short period of time and requires no future maintenance.

An air stripper is relatively easy to operate and is not technically complex.

The site is safe for future use.

### **Disadvantages**

Trucks that carry contaminated soil (and those that deliver clean backfill) drive through town. A risk that something could go wrong during the removal and export of soil exists, which could result in public exposure to the contaminants through the air. Concerns may be raised over odor caused by excavation and transporting contaminated soil.

Contamination is not addressed or treated on-site, but is passed elsewhere.

Dust from excavation activities must be controlled.

Roads may need to be repaired.

## **Appendix One: FACT FLASHES for UNIT 2: ENVIRONMENTAL TECHNOLOGY**

Unit 2 – Environmental Technology contains two ALT’s (#1 and#3) based in large part on information available from the Environmental Protection Agency’s Superfund web site. The ALT’s use what the EPA calls “Fact Flashes” to provide basic background information. These are available in the easy to use *pdf* format from the EPA.

The Fact Flashes used in this model can be downloaded at these addresses:

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff01.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff01.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff02.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff02.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff03.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff03.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff04.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff04.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff05b.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff05b.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff08.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff08.pdf)

[http://www.epa.gov/superfund/students/clas\\_act/haz-ed/ff09.pdf](http://www.epa.gov/superfund/students/clas_act/haz-ed/ff09.pdf)

The EPA web site is a great resource for the Communications ALT 1 on environmental regulations – they have a summary and complete text of the regulations. You can access this at [www.epa.gov](http://www.epa.gov)

Also a great source of information is the RCRA Hotline – they will answer any regulatory related questions – 1-800-424-9346

Finally, the Ohio EPA’s Southwest District Office is a source for local information, especially on local Superfund sites such the Mound and Valleycrest. On the web at <http://swdoweb.epa.state.oh.us/>

## Appendix Two: Evaluation Rubric

For most of the activities, I use this 6-part rubric when scoring student work.

### *General performance tasks scoring rubric*

6 Points	5 Points	4 Points	3 Points	2 Points
Work is superior with no serious inaccuracies or inaccuracies are minor.	Work is effective, with no serious inaccuracies and few minor inaccuracies.	Work is satisfactory, with few serious inaccuracies and some minor ones, or with many minor inaccuracies.	Work is marginal, with some serious inaccuracies and some minor ones.	Work is unsatisfactory, with many serious inaccuracies.
Conceptual understanding is clearly demonstrated throughout the performance of the task.	Conceptual understanding is apparent throughout the student's work.	Conceptual understanding is somewhat apparent.	Conceptual understanding is not always apparent.	Conceptual understanding is lacking.
Reasoning is logical throughout.	Reasoning is generally logical.	Reasoning is somewhat weak from a logic perspective.	Reasoning is not always logical.	Reasoning is very weak.
Communication is exemplary.	Communication is effective.	Communication is satisfactory.	Communication is marginal.	Communication is unsatisfactory.