WATER QUALITY SCENARIO TABLE OF CONTENTS

HYDROVILLE CURRICULUM PROJECT

WATER QUALITY SCENARIO

AN ENVIRONMENTAL SCIENCE CURRICULUM FOR HIGH SCHOOL STUDENTS

WATER QUALITY SCENARIO

ACKNOWLEDGMENTS

HYDROVILLE CURRICULUM PROJECT

WATER QUALITY SCENARIO –
AN ENVIRONMENTAL SCIENCE CURRICULUM FOR HIGH SCHOOL STUDENTS

Other Curricula in this Series:

- ***Pesticide Spill Scenario***
- ***Indoor Air Quality Scenario***

Produced By

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Environmental Health Sciences Center at Oregon State University
The overall goal of the Environmental Health Sciences (EHS) Center Community Outreach and Education Core (COEC) is to increase the public's ability to understand and to make informed decisions on issues relevant to the role of environmental factors in human health and disease. The COEC also strives to develop an understanding among the public about environmental health science research and its importance in assessing risks to human health. Through community outreach and education, the Center seeks to increase the public's awareness of the resources of the NIEHS in general and the EHS Center, specifically. To achieve these goals, the COEC enlists the expertise of EHS Center investigators and actively collaborates with existing outreach programs, university affiliates, community organizations, and other NIEHS Center COECs.

Disclaimer
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WATER QUALITY SCENARIO

CURRICULUM OVERVIEW

HYDROVILLE CURRICULUM OVERVIEW

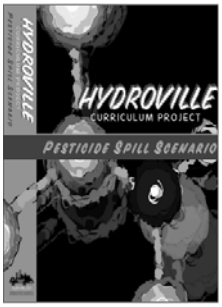
Background

In September 2000, the National Institute of Environmental Health Sciences (NIEHS) awarded a seven-year grant to the Environmental Health Sciences Center at Oregon State University. This grant, entitled "Learning Through Environmental Health Scenarios," was used to create the Hydroville Curriculum Project. The Hydroville Curriculum Project seeks to improve high school students' academic performance and to provide experience in problem solving, environmental health science, decision making, team work and social responsibility. The curricula use environmental health topics to enhance connections between science, language arts, mathematics, social studies, health and technology.

Introduction

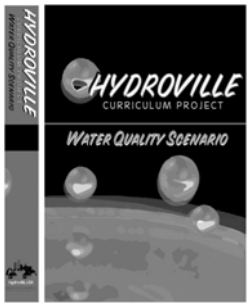
The project has developed three curricula, each dealing with a real-life problem using real-life data. The town of Hydroville, which could be a town anywhere in America, is experiencing one of three environmental health problems: a pesticide spill, an indoor air quality problem, and a water quality problem.

Pesticide Spill



Indoor Air Quality

Water Quality



Students participate in a series of background activities to develop specific concepts and skills. Students then assume the roles of experts on a team brought in to solve the environmental health problem. As a team, they must develop and formally present a solution based on data collected through laboratory experiments, interviews, and research. The curricula are structured to help students understand the complexity of environmental health issues and to emphasize that many real-world issues have many acceptable answers.

Meeting National Educational Standards

The Hydroville Curricula integrate environmental health science themes of toxicology, risk, and decision analysis with concepts in science, language arts, social studies, mathematics, technology, and health. Emphasized skills common for all these disciplines are problem solving, reading, evaluating, analyzing, calculating, writing, graphing, communicating, and teamwork. The principal standard that is covered in depth by these curricula is the science standard *Science as Inquiry*.

Science as Inquiry Standard

The Hydroville Curricula use real-life problems to help students master the seven abilities necessary to do science inquiry (NCR 1996). Research results have shown that through their emersion in the Hydroville problems, students begin to think more like scientists. They formulate hypotheses, use data from investigations to support or modify those hypotheses, and develop skills in communicating their findings to diverse audiences. Students take more responsibility for their own learning and have used these inquiry skills to design and continue research on local problems related to the Hydroville topic. Teachers using the curricula repeatedly cite the development of inquiry skills as one of the major strengths and advantages of teaching the quarter-long Hydroville Curricula.

Abilities Necessary to do Scientific Inquiry*

1. Identify questions and concepts that guide scientific investigations
2. Design and conduct scientific investigations
3. Use technology and mathematics to improve investigations and communications
4. Formulate and revise scientific explanations and models using logic and evidence
5. Recognize and analyze alternative explanations and models
6. Communicate and defend a scientific argument
7. Understandings about scientific inquiry

*National Science Education Standards. National, National Research Council, 1996

Hydroville Curriculum Framework

The Hydroville Curricula have been developed around a carefully designed learning framework that reflects how scientists and experts solve real-world problems. This framework models the scientific method and widely used problem-based learning models (Table 1).

1. **Define the Problem:** Students are introduced to an environmental health problem in Hydroville by watching a video which provides facts and background information.

2. **Collect Data:** Students complete background activities to learn the concepts necessary to understand the problem and develop skills that environmental health experts use in the real world.

3. **Analyze Data and Develop Hypothesis(es):** Students form teams of experts to investigate the problem, test, analyze data and propose and test hypotheses.

4. **Synthesize Data and Generate Solutions:** Student experts share data, revise their hypotheses, and develop an action plan to address the problem.

5. **Present Solutions:** Student teams develop presentations within the context of the scenario and present their findings to the problem's stakeholders.

Table 1. A Comparison of the Hydroville Curriculum Framework

Step	Hydroville Curriculum Framework	Problem-Based Learning Model[1]	Scientific Method[2]
1	• Define the problem	• Meet the problem	• Define problem
2	• Collect data • Develop hypothesis(es)	• KNK (know, need to know) • Define problem statement	• Derive hypothesis(es) • Review the literature
3	• Analyze data to test hypothesis(es)	• Gather and share information	• Test hypothesis • Decide on a procedure • Develop methodology • Data collection and analysis
4	• Synthesize data • Generate solutions	• Generate possible solutions • Evaluate fit of solutions	• Derive conclusion • Interpret results
5	• Present solutions	• Present findings	• Disseminate findings

[1] Problem-based learning model. Center for Problem-Based Learning, Illinois Mathematics and Science Academy, 1998-2001. http//www.imsa.edu/team/cpbl/whatis/model.html

[2] Scientific method. http://www2.selu.edu/Academics/Education/EDF600/Mod3/sld001.htm

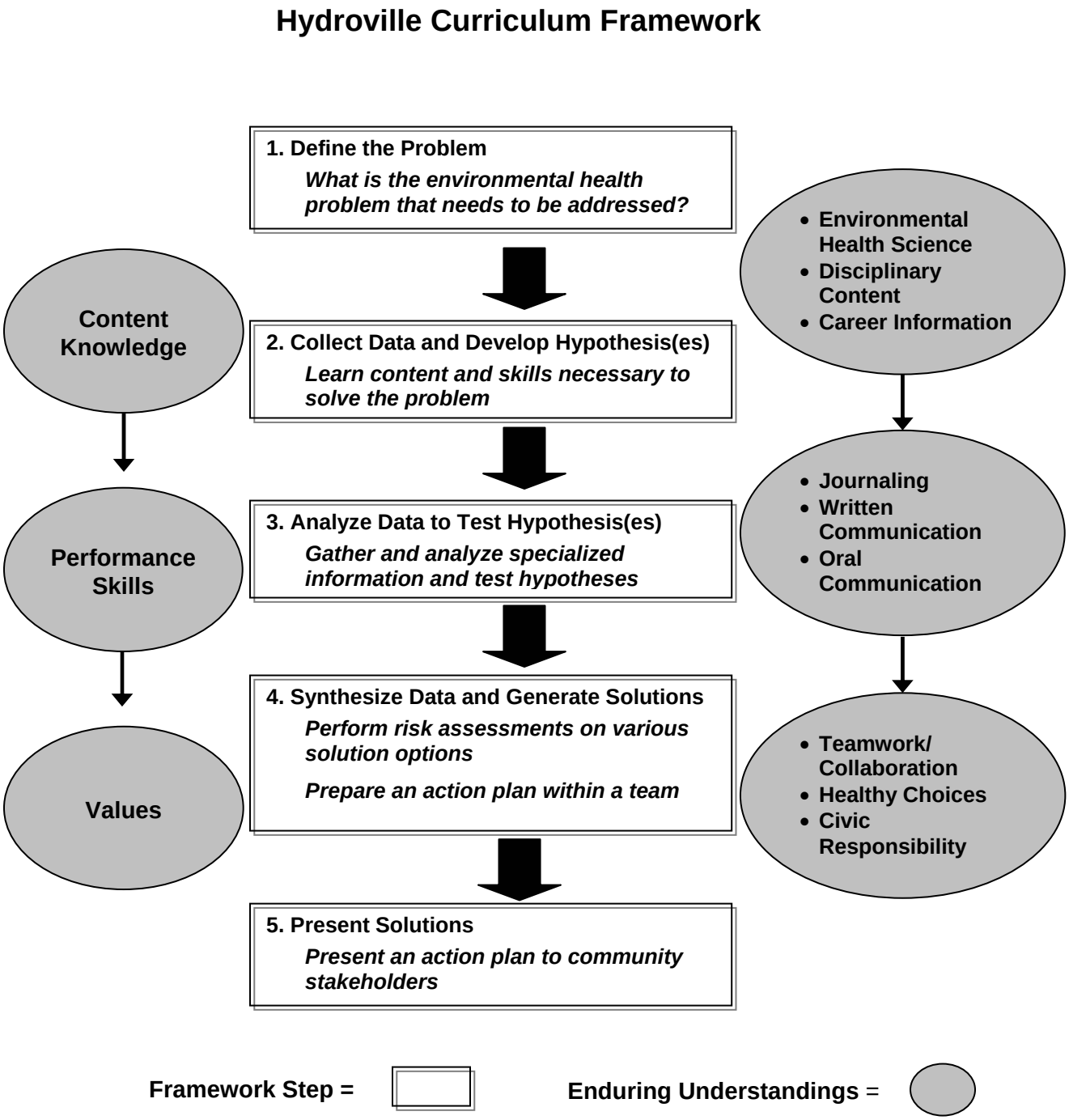
Strengths of Hydroville Curricula

Research results from quantitative and qualitative data collected during field testing, show that Hydroville Curricula:

- Teach science inquiry as a process rather than a subject to be learned, resulting in students that think more like scientist when approaching a problem.
- Develop higher-order and critical problem-solving skills.
- Teach group process and team-building skills
- Create an environment where students take responsibility and become self-directed learners which requires teachers to be a facilitator of learning.
- Stress written and oral communication.
- Include final solutions that are open-ended with no one right answer and require students to use decision-making skills to develop an action plan that is supported by data collected and is responsive to the stakeholders involved.

Embedded in the Hydroville curricular framework are content knowledge and skill development that create enduring understandings that students translate to other courses and their personal lives (Figure 1).

Figure 1. Hydroville Curriculum Framework and Enduring Understandings



Curricula Logistics

Grade Levels
The Hydroville Curricula are designed primarily for students in the 9th and 10th grades. They are also appropriate for use in alternative or charter schools; for 11th and 12th grade electives in biology, chemistry, and environmental science; or in programs for at-risk or gifted students. Additionally, many of the activities can be modified for advanced middle school students. The Pesticide Spill and Water Quality problems are recommended for 9th grade integrated or physical science classes. The Indoor Air Quality Scenario is recommended for 10th grade biology.

Teaching Teams
Ideally, these curricula should be taught collaboratively by a team of teachers in science, language arts, social studies, math, and health who are interested in integrating across disciplines. Working in teams allows teachers to share in the preparation and implementation. However, a science teacher can use the Hydroville Curricula independently.

Time Requirements
The Hydroville Curricula were developed on the belief that students cannot be successful if they are thrust into a problem-based learning situation without sufficient preparation. Therefore, they require nine weeks to complete. Specific time requirements are given in the Scope and Sequence section of each curriculum. The background activities can be used alone or integrated into existing lesson plans or state-mandated curricula.

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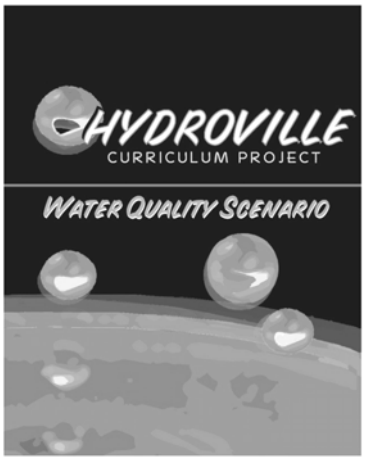
WATER QUALITY SCENARIO

SCOPE AND SEQUENCE

Water Quality Scenario

In this curriculum, student teams will be investigating a drinking water contamination problem. This problem is hypothetical, but based on an actual occurrence in Scappoose, Oregon. The town of Hydroville is experiencing some of the social, political, and environmental problems associated with rapid growth and development. The city council's agenda contains the annual drinking water report from the city water department. The report shows that certain pollutants in the drinking water sources have increased significantly. Students take on the role of the environmental consulting team brought in to determine the sources of the contaminants and to recommend remediation options to the Hydroville City Council.



Essential Information

The Environmental Protection Agency's website, *Ground Water and Drinking Water* http://www.epa.gov/safewater is the most complete reference you will need to present this curriculum to your students. This website will be referenced often in the curriculum so it is helpful to acquaint yourself with its resources before beginning to teach this unit.

Concept Map

A concept map has been developed for each Hydroville Curriculum (see the Water Quality Concept Map on the next page). The map is a very useful tool to share with students. It helps them see where they are in the process of working on the water quality problem. Make an overhead transparency of the concept map and use it as you move through the five parts of the curriculum framework. Students see how the background activities relate directly to the expert work and the solution to the problem in Hydroville.

Materials

Required materials are listed at the beginning of each activity. Information for ordering all materials can be found in Appendix A. *Materials List.* Hydroville curricula have been designed to keep the recurring cost for using the curriculum at a minimum.

WATER QUALITY CONCEPT MAP

1) DEFINE PROBLEM: Welcome to Hydroville

What is causing the drinking water problem in Hydroville?

2-3) COLLECT AND ANALYZE DATA; DEVELOP HYPOTHESIS(ES)

Site Investigator

What historical events may have contributed to this problem? What are the potential contaminant sources in Hydroville?

Drinking Water Specialist

What contaminants have been detected in Hydroville's water supply and what are their health effects?

Environmental Chemist

Which raw water sources in Hydroville contain the detected contaminants?

Environmental Solutions, Inc.

Hydrogeologist

Based on the direction of the groundwater flow in Hydroville's aquifer, where are the contaminant sources?

Environmental Engineer

Which remediation technologies will remove the contaminants from the drinking water and clean up the contaminated site?

4) SYNTHESIZE DATA, GENERATE SOLUTIONS:

What combination of remediation technologies and monitoring plans are the best solutions for Hydroville's drinking water problem?

5) PRESENT SOLUTIONS

Teams present proposed solutions to the Hydroville City Council and concerned citizens.

Timetable for Using the Water Quality Curriculum

The table below shows the suggested time requirements for implementing this curriculum. The estimated *Prep Time* covers the time necessary to organize and prepare materials and photocopy student worksheets and activity pages. Prep time does not cover the time for reading background information or preparing lesson plans which will vary significantly based on the background of the instructor.

Table 1. Timetable for the Water Quality Curriculum

#	Activity Title	Prep Time (minutes)	Homework Assignment	Activity Time (50-minute periods)
1	*Welcome to Hydroville*	30-60	Yes	3-5
2	*Topographic Maps and Models*	120	Yes	3
ES	*Team Meeting #1*	30	Optional	3
3	*Source to Sink*	60	Yes	1-2
4	*What's in Your Drinking Water?*	30-60	Yes	2
5	*Reading Water Quality Reports*	30-60	No	1-2
ES	*Team Meeting #2*	30	Yes	2
6	*Solution Concentrations*	30-60	Yes	1-2
7	*Sampling and Monitoring*	60	No	1
ES	*Team Meeting #3*	30	No	2-3
8	*Groundwater Basics*	30-60	Yes	2
9	*How Contaminants Move in Groundwater*	60	Yes	2
ES	*Team Meeting #4*	30	Yes	2
10	*Water Treatment Solutions for Homes*	60	No	2
11	*Remediation Technologies for Contaminated Sites*	20	No	2
ES	*Team Meeting #5*	30	No	2-3
	Solution Presentation	30	No	5
	Total # of 50-minute class periods	**36-43**		
	Total # of weeks	**7-9**		

Managing Time When Using the Water Quality Curriculum

If you are running short of time, here are some suggestions of ways to consolidate parts of the curriculum so that students get the information that they need and have plenty of time to plan and deliver their presentations.

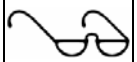
Activity	What to Do	Class Periods Saved
BA 1	Omit the Optional Career Information pages	2
BA 6	Delete Background Activity 6: *Solutions and Concentrations*	2
BA 8	Use the groundwater video and worksheet	0.5
BA 11	Delete the preparing of the Remedial Technology Posters and give the students Worksheet 4: Table 1 Answer Key so that they can complete Worksheet 4: Table 2	1

Organizational Structure of the Curriculum

Background Activities

Table 2. *Organizational Structure for Background Activities* on the next page lists the organizational sections found in each activity. All of the sections are in the same order in each activity for easy reference and use. The first part of an activity is the Teacher Section. The first page of the Teacher Section gives an overview of the activity at a glance: description, student outcomes, student products, prerequisites, national standards, teamwork skills, time estimates, materials, etc. The pages that follow provide the teacher with background information, a suggested lesson plan, suggested assessment, and resources. The second part of the activity is the Student Section, including transparencies, student background readings, and worksheets.

Table 2. Organizational Structure of Background Activities: Symbol, Heading, and Description

Teacher Section		
	Description	A short description of the activity
	Student Outcomes	A list of the knowledge and skills the students will gain from this activity
	Student Products	List of items students will produce: worksheets, tables, graphs, models, etc.
	Prerequisites	Previous activities required for the activity
	**National Standards**	Reference to subject area national education standards covered in the activity
	**Teamwork Skill**	The suggested teamwork skill to practice or evaluate during the activity
	**Activity Timing**	The suggested timing for the activity including prep time and homework assignments
	**Materials**	A list of all of the materials required for the activity listed for individual students and student groups
	Teacher Information	Resource and content information for teachers
	**Terminology**	List of key vocabulary terms introduced in the activity (See Appendix B - Glossary)
	**Suggested Lesson Plan**	Suggested lesson plan divided into three sections: *Getting Started, Doing the Activity*, and *Wrap-up*
	Assessment	Recommended assessments
	**Resources**	A list of sources for additional information from books, articles, videos, and the web
	**Teacher Keys**	Answer keys for student worksheets
Student Section		
	**Pages to Photocopy**	All transparencies and student pages that need to be photocopied for use during the activity
	Transparency Masters	Transparencies to be used with the activity
	**Background Reading**	Important background information including terminology and key concepts
	**Worksheets**	Student products used for assessment and stored in the Hydroville Journal

Team Meetings

The background activities give the students the content knowledge and skills of a specific expert that would work on the team investigating the water quality problem. Environmental Solutions (ES) team meetings are key to this curriculum. They require the students to use those skills to address a specific piece of the problem in Hydroville. Also included are teamwork skills that teams use to enhance their team's performance. ES Team Meeting #5 asks the students to synthesize all they have learned about Hydroville in ES Team Meetings #1-4 and use decision analysis to develop a solution. Table 3 provides a guide and summary for these team meetings.

Table 3. Environmental Solutions Team Meetings

ES Team Meeting	Expert	Purpose	Question to be Addressed
1	Site Investigator	Site investigation	What historical events may have contributed to this problem? What are the potential contaminant sources in Hydroville?
2	Drinking Water Specialist	Contaminants of concern	What contaminants have been detected in Hydroville's water supply and what are their health effects?
3	Environmental Chemist	Contaminant concentrations	Which raw water sources in Hydroville contain the detected contaminants?
4	Hydrogeologist	Groundwater flow	Based on the direction of the groundwater flow in Hydroville's aquifer, where are the contaminant sources?
5	Environmental Engineer	Remedial technologies	Which remediation technologies will remove the contaminants from the drinking water and clean up the contaminated site?

Appendices

A. *Materials List*
Materials required are listed at the beginning of each activity. The complete list of materials and supplies is found in this appendix. Ordering information is provided for those items not readily available in several locations. Hydroville Curricula have been designed to keep the recurring cost for using the curriculum at a minimum.

B. *Glossary*
This appendix contains definitions for all of the words found in the *Terminology* section of each activity.

C. *Scoring Guides*
All of the scoring guides referenced in the water quality activities are found in this appendix. The list of scoring guides is found on the first page of the appendix.

D. *National Education Standards*
This section identifies specific content standards in geography, health, language arts, mathematics, science, social studies, and technology covered by each activity in the curriculum.

WATER QUALITY SCENARIO

HYDROVILLE JOURNAL

HYDROVILLE JOURNAL

Description
This activity has students create their Hydroville Journal which will be used throughout the Water Quality problem and will form the student's portfolio.

Student Outcomes
Students will:
- Organize a notebook to record information and save completed worksheets.
- Use the information in their journals to analyze and synthesize data, construct hypotheses, and organize materials for the presentation of their team's solution.

Student Products
- Hydroville Journal

Prerequisites
None

Activity Timing

Time Estimate	One 50-minute Class Period
30-90 min	Prep Time: (if you plan to provide completed class notebooks)
30 min	Activity Time: (if students will organize notebooks in class)

Materials
- Three-ring binder
- Notebook paper
- Colored paper or cardstock (for dividers)

Teacher Information

Gathering and accurately noting information is an essential prerequisite for managing it. Scientists, engineers, and other experts in technological fields must analyze and synthesize data, grasp and apply new concepts, and communicate effectively. A journal helps them gather and manage the raw material for these activities.

The Hydroville Journal is central to the Hydroville Curriculum Project. As team members and experts-in-training, students will use the Hydroville Journal to keep track of their discoveries as they encounter new skills, new terms, and new challenges.

This journal gives students a place to record responses to journal prompts and questions, define new terms, make notes on teamwork skills, and store readings and completed worksheet pages. The journal provides a place for students to apply, reflect, analyze, and evaluate information, test their understanding, and question and challenge their own assumptions. The journal becomes the raw material of their thinking: their record of data, events, information, and reflection.

Benjamin Bloom, an educational psychologist, introduced a generally accepted model for the thinking process, tracing it from the least to the most complex level shown in Table 1.

Table 1. Model for the Thinking Process

Lowest ↓	**Knowledge:** Learning specific facts, theorems, theories; having information
	Comprehension: Showing understanding of basic knowledge
	Application: Using previously gained information in a new situation
	Analysis: Classifying or breaking materials into components and recognizing the principle that organizes the system
	Synthesis: Putting something together from disparate pieces
Highest	**Evaluation:** Creating standards of judgments and examining issues, problems, etc.

Bloom, B.S. (Ed.) (1956) Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook I, Cognitive Domain. New York; Toronto: Longmans, Green.

The Hydroville Journal makes possible the close integration of skill-building, reading, recording, writing, and thinking, and thus students will become more aware of their own writing and thinking processes (see Table 2). This journal promotes critical thinking skills, preparing students for their roles as experts and decision-makers.

Table 2. Teaching, Learning, and Writing Objectives

Cognitive Area	Intellectual Activity	Sample Writing Task
Knowledge	Having information, remembering	List, define, and tell: who, what, where
Comprehension	Translating, demonstrating what something means	Put this in your own words
Application	Using previously learned information in a new situation	Use this rule to solve this problem
Analysis	Breaking down problem into components	Describe the parts Explain what you find
Synthesis	Putting something together from disparate pieces	Explain how these components fit together Account for unexpected results
Evaluation	Judging, weighing, evaluating	Argue which method is better Assess x in terms of y

Bloom, B.S. (Ed.) (1956) Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook I, Cognitive Domain. New York; Toronto: Longmans, Green.

This activity is designed to accompany Background Activity 1: *Welcome to Hydroville*. As a teacher, feel free to structure the Hydroville Journal assignments to the academic needs and styles of your students. The more regularly students write in their journals, the more effective the process will be. Student writing should strive to model scientific journaling, with students keeping a daily record of observations, measurements, hypotheses, and conclusions.

Teachers may use the students' journal writing as a basis to pre-assess their knowledge of a particular subject or concept. Giving students a journal writing prompt at the beginning of the class period is a particularly useful time to pre-assess students. Likewise, concluding class with a prompt allows students to reflect upon what they have learned, what they are still unclear about, and to generate questions for further inquiry.

Suggested Lesson Plan

Getting Started

Option 1: Teacher-Prepared Journals

1. Collect enough three-ring binders for each class. Number journals and put class period and number on the spine. (Journals can be reused from year to year.) Designate a box or shelf in your room for the Hydroville Journals for each class.

2. Print out *Student Journal Divider Pages* from the Hydroville Water Quality CD.

3. Photocopy them on colored paper or cardstock and place them in the binders.

4. Print all pages from the *Student Journal Pages* file on the Hydroville CD.

5. Place the *Student Binder – Table of Contents* in front of the divider pages and activity pages behind the appropriate divider page.

6. Add notebook paper to *Journal Prompt* and *Glossary* sections.

7. Assign each student a binder number.

Option 2: Student-Prepared Journals

1. Students bring a three-ring binder to class and prepare their Hydroville Journals.

2. Print out *Student Journal Divider Pages* file on the Hydroville CD.

3. Photocopy them on colored paper or cardstock and have students place them in the binders.

4. Have students place the *Student Binder – Table of Contents* in front of the divider pages.

5. Add notebook paper to *Journal Prompt* and *Glossary* sections.

6. Print out all pages from the *Student Journal Pages* file on the CD. Place pages in file folders labeled for each activity.

7. Hand out photocopied activity pages to students as you begin each background activity.

 **Tips from Teachers:**

- Teachers using the Hydroville Curriculum often begin each day by assigning the Journal Prompt, using the time to take care of roll and other classroom business.

Doing the Activity

1. For the first day of *Welcome to Hydroville*, students should be assigned a binder or directed to create their Hydroville Journal.

2. On subsequent days, class can begin by students picking up their journals and writing their answers to daily journal prompts as the teacher takes care of roll and other duties.

Wrap-up

At the conclusion of this curriculum unit, the Hydroville Journal will represent the student's experience, observations, information, and perspectives. It functions as a resource for numerous social studies and language arts assignments. It stands as the student's portfolio for the project: a record of the event and a site for further inquiry and assessment.

Assessment

The primary means of assessment for the Hydroville Journal should be formative, which involves assessing students informally as part of the instructional process. In a formative assessment, students are not given a final grade; therefore, the students' writing in the journal should not be thought of as a final measure of what was learned. An efficient and meaningful assessment method is the check/check-plus/check-minus system (see Table 3). An example of a journal prompt assessment is shown in Table 4.

Students may use the *Student Binder – Table of Contents* to help them organize their journals, and teachers may use it for grading of the journal when it is submitted by a student for a portfolio.

Table 3. Suggested Assessment Rubric

Grade/Mark	Level of Thinking
✓— (check-minus)	• Consistently inadequate responses to writing prompts • Thinking does not reflect attempts to draw connections
✓ (check)	• Consistently adequate responses to writing prompts • Thinking is oftentimes more than superficial and reflects genuine attempt to write coherently about the subject at hand
✓+ (check-plus)	• Writing quality and quantity is above average • Thinking continually. Attempts to draw connections and extend and apply written thoughts to more than just the topic at hand

Table 4. Sample Journal Prompt Assessment

Grade/Mark	Student Answer
✓— (check-minus)	The health of the environment is important for understanding diseases.
✓ (check)	Environmental health science is the study of how the environment affects our health and it is important to study it to understand how air, water, and food can cause diseases.
✓+ (check-plus)	Environmental health science is the study of how the environment affects human health. It is important to study this topic to understand how the food, water, and air around us can cause disease. Lawmakers need to understand environmental health science to set appropriate limits on what is in our water, air and food.

Resources

See the Hydroville Water Quality Curriculum Web Resources webpage for current links:
http://www.hydroville.org/links/wq_resources.aspx

PAGES TO PHOTOCOPY

Note: For ease of photocopying, Transparency Masters appear first in the student pages.

Handouts and Transparency Masters

Day	What is Needed	Type*
1	Hydroville Journal divider pages (printed from the Hydroville CD)	
	Hydroville Journal student pages (printed from the Hydroville CD) **Note:** Student pages are for Background Activities only.	

* Type = Transparency Master (TM), Background Reading (BR), Worksheet (WS), Map (M)

HYDROVILLE JOURNAL – TABLE OF CONTENTS

Activity	Document Name	Grade
Divider 3 – Background Readings and Worksheets (continued)		
BA 3	Background Reading: *Making Water Safe to Drink*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Source to Sink Poster*	
BA 4	Background Reading: *Is Your Drinking Water Safe?*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *What's in Your Drinking Water?*	
	Worksheet 3: *The Drinking Water Game*	
BA 5	Worksheet 1: *Water Quality Report Scavenger Hunt*	
BA 6	Background Reading: *Solutions and Concentrations*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Making Serial Dilutions*	
	Worksheet 3: *Representing the MCL of a Water Contaminant*	
BA 7	Background Reading: *Water Sampling and Monitoring*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Sampling and Sampling Size*	
BA 8	Background Reading: *Groundwater Basics*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Groundwater Vocabulary Quiz*	
	Worksheet 3: *Groundwater Model Demonstration*	
BA 9	Background Reading: *Understanding Groundwater Movement*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Smithville Activity*	
BA 10	Background Reading: *Water Treatment Solutions for Homes*	
	Worksheet 1: *Reading for Understanding Questions*	
	Worksheet 2: *Water Treatment Lab – Day 1*	
	Worksheet 3: *Water Treatment Lab – Day 2*	
	Worksheet 4: *Water Treatment Lab Report*	
BA 11	*Remediation Technology Fact Sheet*	
	Worksheet 1: *Remediation Technology Posters*	
	Worksheet 2: *Remediation Technology Poster Scoring Guide*	
	Worksheet 3: *Terminology Crossword Puzzle* (optional)	
	Worksheet 4: *Comparing Remediation Technologies*	
Divider 4 – Glossary		
	Definitions of Assigned Terminology	

WATER QUALITY SCENARIO

TEAMWORK SKILLS

TEAMWORK SKILLS

Description
This activity introduces students to important teamwork and problem-solving skills and tools to use when practicing those skills.

Student Outcomes
Students will:
- Identify the relationship between specific teamwork skills and team success.
- Distinguish verbal and non-verbal behaviors that contribute toward teamwork.
- Participate in a team-building activity.

Student Products
- *Teamwork Skills Analysis T-chart*
- *Teamwork Skills Practice Guide*

Prerequisites
None

Activity Timing

Time Estimate	One 50-minute Class Periods
20 min	Prep Time: photocopying; organizing materials
Day 1	Overview of Skills, T-chart, Team-building Activity

Materials
- Hydroville Journal

Team-building Activity 1: Paper Tower (per group of 4-6 students)
- Four large textbooks or binders
- 20 sheets of 8½" x 11" paper
- Six feet of masking tape

Team-building Activity 2: Toxic Popcorn (per group of 4-6 students)
- Masking tape for ten-foot diameter circle
- Two 1 lb coffee cans, one half filled with popcorn
- Three pieces of rope each 7 feet long
- One bicycle inner tube

Teacher Information

The Hydroville activities require students to emulate real-life situations by working in teams. Working together and communicating effectively are important for student success in each of the background activities, the Environmental Solutions (ES) team meetings, and the final presentations. This section offers tools and activities to develop and practice teamwork skills.

Problems faced by communities, businesses, schools, and other institutions are seldom solved by people working alone. Teams of colleagues, often with very different values and points of view, must work together to develop and complete plans of action. Their success depends on each one's ability to work well with others. Good teamwork skills are not innate—they must be taught, often even to adults.

This activity is designed as part of the Background Activity 1: *Welcome to Hydroville*. Several cooperative skills have been selected for emphasis in the background activities (see Table 1).

The models presented are adaptations from the cooperative skills research of David W. Johnson, Roger T. Johnson, and Edythe Johnson. 1994. Holubec in *The New Circles of Learning: Cooperation in the Classroom and School*. Association for Supervision and Curriculum Development.

Table 1. Teamwork and Problem-solving Skills Emphasized in Hydroville Problems

Teamwork Skills	Problem-solving Skills
1. Stay on task with your group: Everyone contributes and helps.	1. Give and receive feedback in a positive manner.
2. Listen attentively to others.	2. Identify where there is disagreement within the group and work toward compromise or consensus.
3. Praise helpful actions or good ideas.	3. Work with others to develop shared decisions and goals.
4. Ask teammates for help if you need it.	4. Ask for justification for team member's conclusion or answer.
5. Check to make sure that everyone understands.	
6. Work to manage conflict within the group.	

When a student first practices a new skill, she or he experiences an awkward, self-conscious stage. Students may feel a degree of phoniness as they try to do or say phrases on purpose. Assure students that this is a natural process as they transition from forced, mechanical use of the skill to automatic and routine use of the skill. The teacher's active listening and monitoring for use of cooperative skills will encourage the students to keep trying.

Tips from Teachers:

- Occasionally only one or two teams need help with specific cooperative skills. In these cases, teachers act as a coach, helping students identify a useful skill and its importance, and the verbal and non-verbal behaviors that portray that skill.
- Designate defined roles such as starter, summarizer, recorder, technician, etc., and either select a student to fill each role or allow the teams to assign roles to their own members. This can be an opportunity for students with special talents, organizational skills, or learning styles to be recognized for their value to teams.

Suggested Lesson Plan

Getting Started

1. Introduce the Teamwork Skills activity before or during Background Activity 1: *Welcome to Hydroville*. The students should be in their Environmental Solutions Teams.

2. Make a wall poster of the transparency *Teamwork and Problem-solving Skills Emphasized in Hydroville Problems* (TM-2). Emphasize that each team is working toward proficiency in all these skills.

3. Throughout this curriculum, emphasize key teamwork skills that students need to practice, observing them using the *Teamwork Skills Practice Guide* (WS-2), and then debriefing what you observed with the class.

Doing the Activity

1. Assign **Journal Prompt-1 (TM-1):**
   a. Think about your or your parents' work environment. Do people work alone or in a group or team?
   Today a person working alone rarely solves problems in communities, businesses, academic research, and most other social structures. Teams of colleagues, often with very different values and points of view, must work together to agree on and complete plans of action. Your success in a job will often be determined by how well you work with others.

   b. Are laws or regulations that govern society made by one person or a group of people?
   A group of people.

   c. How do you know how to work in a group? Are you born with this skill, or do you have to learn it?
   Not necessarily, the skills necessary for team success must be learned.

   d. Name an example of a team or group for each category:
   - Sports
   - Community
   - Government

2. Since teamwork is critical to be successful in almost any job, we will be practicing these skills throughout our time in Hydroville.

3. Show transparency *Teamwork and Problem-solving Skills Emphasized in Hydroville Problems* (TM-2).
   a. Emphasize that this is the list of teamwork and problem-solving skills that students will need to successfully complete this Hydroville unit. *You will be working in all sorts of teams. You will be graded on your ability to work together to solve a problem.*
   b. Stress the importance of each of these skills to the success of the teams in solving the indoor air quality problem. This chart can be enlarged and posted in the classroom as a reference and reminder for the students throughout the curriculum.

4. Put up the *Teamwork Skills Analysis T-chart* transparency (TM-3).
   For the skill being practiced, we will develop a Teamwork Skills Analysis chart, called a T-chart that you will keep in your Hydroville Journal.

5. Explain that students will fill in the T-chart when they are introduced to a teamwork skill for the first time. Each T-chart is kept in their Hydroville Journal for reference when that skill is being assessed.

6. Using the T-chart transparency, practice one skill together as a class.
   a. Hand out the T-chart as a worksheet or refer students to the copy in their Hydroville Journals.
   b. Have each student complete the worksheet and file it in the teamwork section of the Hydroville Journal.
   c. The following example will help the students in filling in their T-chart as you go through the steps.
   d. Name the skill to be analyzed; for example, *"Listen attentively to others."*
   e. Have the students analyze and list ways the skill is important to the success of the team. This list could be divided into two sections: one listing how the skill can lead to a successful product for the team, and the other listing how the skill is important to the feelings the team members develop about each other and themselves.
   f. Stress the importance of both product (outcome) and process (feelings) to the team's success:
      (Product) In a team, everyone's ideas are important to the success of the team. Successful solutions often happen when you build on the ideas of others.

      (Process) When everyone listens carefully to your ideas, you feel like a valuable member of the team and are more willing to work hard and participate.
   g. Have students brainstorm specific verbal and non-verbal (body-language) behaviors that they can use to practice this skill, and list them on each half of the T-chart. It is important that they devise short descriptions or phrases to describe the behavior, such as the examples given in Table 2.

Table 2. Verbal and Non-verbal Team Skills

Verbal (Sounds Like)	Non-verbal (Looks Like)
• Only one person is talking • Other members ask questions of the person speaking	• Members are looking at the person speaking • Members aren't talking with others in other groups • Members are taking notes

7. Time often doesn't allow the class to produce a T-chart for each skill during the activities. Instead, assign teams one or two specific skills and have the team make T-chart posters for those skills. Place the posters around the room for quick reference and emphasis.

8. Prior to assigning the team-building activity, go over the *Teamwork Skills Practice Guide* (WS-2) and give students their copies for their Hydroville Journals.
This is the scoring guide that I will use or that team member observers will use to evaluate how a team is doing on a specific skill.

9. Assign one of the team-building activities found on the transparencies:
   a. Activity 1: *Paper Tower* (TM-4), Activity time with testing is 20-30 minutes.
   b. Activity 2: *Toxic Popcorn* (TM-5 and WS-3), Activity time with testing is 60 minutes.

10. During the team-building and background activities, note examples of skills displayed using the *Teamwork Skills Practice Guide* (WS-2). Then share these examples during the wrap-up of the activity. It is interesting to observe how all groups tend to take ownership for the positive skill usage.

11. During the team meetings, one member of the team can use the *Teamwork Skills Practice Guide* to observe, tally, and share the other members' skill usage. In this case, give students these directions:
    a. A member of your team serves as the observer. The observer does the following:
       - Watches and listens to the other team members as they work on tasks and discuss ideas.
       - Listens but does not participate in any tasks.
       - Analyzes and records the teamwork behaviors on the Practice Guide using the T-chart to help with the analysis.
    b. Your team may want to select an alternate observer to record behaviors during the second half of the activity.
    c. When the task is completed, the observer(s) should review their results with the team members. Focus on positive uses of skills. No putdowns!
    d. Each team member completes the rating row on the *Practice Guide*.
    e. As a team, discuss how the skill helped you and write a teamwork skill goal for the future.

Wrap-up

1. Debrief by sharing classroom observations of verbal and non-verbal skills and the results of the *Teamwork Skills Practice Guide*.

2. Allow the students to comment and reflect in their Hydroville Journals on their experiences working together as a team.

3. Highlight and revisit the teamwork skills frequently during the Hydroville activities. Students need to understand that teamwork skills are an integral component of the activities, and repeated use and review will remind them of their importance.

 **Tips from Teachers:**

- Recognize and reinforce positive verbal and non-verbal behaviors rather than negative.

PAGES TO PHOTOCOPY

Note: For ease of photocopying, transparency masters appear first in the student pages.

Handouts and Transparency Masters

Day	What is Needed	Type*
1	*Journal Prompt- 1*	TM-1
	Teamwork and Problem-solving Skills Emphasized in Hydroville Problems	TM-2
	Teamwork Skills Analysis T-chart	TM-3, WS-1
	Teamwork Skills Practice Guide	WS-2
	Team-building Activity 1: *Paper Tower*	TM-4
	Team-building Activity 2: *Toxic Popcorn*	TM-5
	Instructions for *Toxic Popcorn*	WS-3

* Type = Transparency Master (TM), Background Reading (BR), Worksheet (WS), Map (M)

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JOURNAL PROMPT-1

1. **Think about your or your parents' work environment. Do people work alone or in a group or team?**

2. **Are laws or regulations that govern society made by one person or a group of people?**

3. **How do you know how to work in a group? Are you born with this skill, or do you have to learn it?**

4. **Name an example of a team or group for each category:**

   a. **Sports**

   b. **Community**

   c. **Government**

TEAMWORK AND PROBLEM-SOLVING SKILLS EMPHASIZED IN HYDROVILLE PROBLEMS

Teamwork Skills
1. Stay on task with your group: Everyone contributes and helps.
2. Listen attentively to others.
3. Praise helpful actions or good ideas.
4. Ask teammates for help if you need it.
5. Check to make sure that everyone understands.
6. Work to manage conflict within the group.

Problem-Solving Skills
1. Give and receive feedback in a positive manner.
2. Identify where there is disagreement within the group and work toward compromise or consensus.
3. Work with others to develop shared decisions and goals.
4. Ask for justification for team member's conclusion or answer.

TEAMWORK SKILLS ANALYSIS T-CHART

1. Skill:

2. Importance to:

a. Team's success in completing team task/product:

b. Team members' feelings:

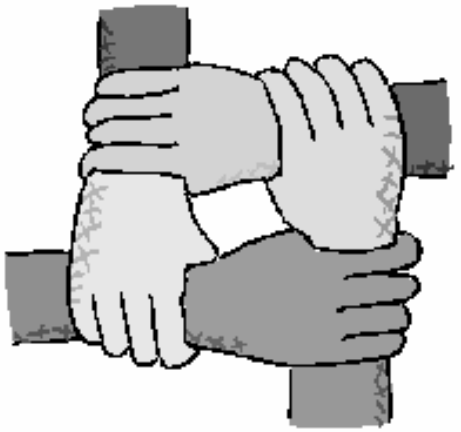
Verbal (Sounds Like)	Non-verbal (Looks Like)

TEAM-BUILDING ACTIVITY 1

Paper Tower

Instructions:
Each team uses 20 sheets of paper and six feet of masking tape to build a tower that will support at least four textbooks.
(The best tower will use the least materials and support the most textbooks.)

1. As a team design your tower.
2. Show your plan to your teacher to obtain your tower materials.
3. You have 15 minutes.



Together
Everyone
Achieves
More

TEAM-BUILDING ACTIVITY 2

Toxic Popcorn

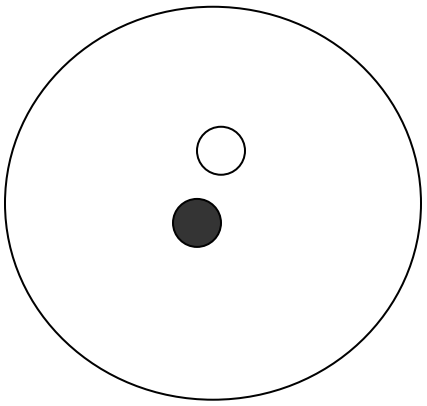
Objective:

Transfer the toxic popcorn from the unsafe can to the safe can, using only the materials provided to you.

Diameter of circle = 10 feet

Safe can ○

Unsafe can ●



Materials:

- Three pieces of rope
- Inner tube

Rules:

See instructions on Worksheet 3.

Name_____
Date_____Period____

WORKSHEET 1: TEAMWORK SKILLS ANALYSIS T-CHART

1. Skill:

2. Importance to:

a. Team's success in completing team task/product:

b. Team members' feelings:

Verbal (Sounds Like)	Non-verbal (Looks Like)

Blank Page

Name_____
Date_____Period____

WORKSHEET 2: TEAMWORK SKILLS PRACTICE GUIDE - DIRECTIONS

Instructions

1. Before you begin the Background Activity, *work together* to do the following:

2. Write the teamwork skill you will practice today on the *Teamwork Skills Practice Guide.*

3. Write a sentence that describes how the use of this skill can benefit your team members and help you accomplish your tasks.

4. Briefly examine the T-chart for this skill to refresh your understanding of verbal and non-verbal behaviors that demonstrate the skill you are practicing.

5. A member of your team should serve as the *observer.* The observer should watch and listen to the other team members as they work on tasks and discuss ideas. While they are listening, the observer does not participate in the team tasks. The observer must analyze what team members are doing and record the teamwork behaviors on the *Practice Guide.* The observer should use a T-chart of the skill to help with the analysis. Your team may want to select an alternate observer to record behaviors during the second half of the activity.

6. Before the end of the class period, or when the task is completed, each observer should review his or her results with team members. The observer should point out only examples of positive use of the skill—no putdowns!

7. After practicing the teamwork skill, each team member should complete the rating row on the bottom of the *Practice Guide.*

8. As a team, discuss how the skill helped you work together and write a teamwork skill goal for the future.

Name_____
Date_____Period____

TEAMWORK SKILLS PRACTICE GUIDE

Observer(s): **Date:**

Skill:

Importance to Team's Success:

Team Members

	Name:	**Name:**	**Name:**	**Name:**	**Name:**
Demonstrates Skill: Tally each time a team member is observed using the skill.					
Notes: List one or two verbal or non-verbal behaviors each team member demonstrates.					
Rating: Each team member should consider her or his tallies, notes, and experiences. Then check all ratings that apply to their use of the skill.	__I need more practice __I am improving __I am pretty good at this __I show excellent use of the skill	__I need more practice __I am improving __I am pretty good at this __I show excellent use of the skill	__I need more practice __I am improving __I am pretty good at this __I show excellent use of the skill	__I need more practice __I am improving __I am pretty good at this __I show excellent use of the skill	__I need more practice __I am improving __I am pretty good at this __I show excellent use of the skill

Future Skill Goal:

Name_____
Date_____Period____

WORKSHEET 3: TOXIC POPCORN

Background

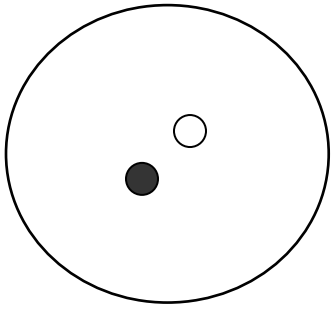
A can of highly toxic popcorn has contaminated a circle approximately 10 feet in diameter. The toxic area makes a cylinder that extends to the ceiling. If the poisonous popcorn is not transferred to a safe container for decontamination, the toxic popcorn will explode and destroy the population of the entire city. You do not have time to contact authorities and evacuate the city. The lives of thousands of people are in your hands, and you must act immediately.

Inside the circle you will find two cans. The unsafe can is about half full of the toxic popcorn. The safe can is to be used to neutralize the toxic popcorn.

Diameter of circle = 10 ft

Safe can ○

Unsafe can ●



Objective

In 30 minutes or less, transfer the toxic popcorn from the unsafe can to the safe can using only the materials provided to you.

Materials (per group of 4-6 students)

- Three pieces of rope (each 7 feet long)
- One bicycle inner tube

Rules

- No participant may cross the plane of the circle with any part of the body. If this occurs, the person must be taken to the hospital immediately and may no longer participate. One member of the group, the designated Emergency Medical Technician (EMT) is responsible for the safety of all members and watches to make certain no one enters the circle. If a member crosses the line, the EMT must remove that member from the group.
- No participant may sacrifice himself or herself to aid in the transfer of popcorn.
- If any popcorn spills, it will explode, and the mission has failed.
- Participants may only use the materials provided. However, they can be used in any way desired.
- The popcorn will not spread its toxicity to the safe can, the ropes, or the tube. The participants have no protection inside the imaginary cylinder created by the 10-foot diameter circle.
- The safe container may move anywhere in or outside of the circle. The unsafe container must stay inside the circle and may not be moved more than one foot from the center of the circle.
- **Remember, the popcorn must be transferred within 30 minutes, or there will be a tremendous disaster.**

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WATER QUALITY SCENARIO

CAREER INFORMATION

CAREER INFORMATION

Description
This activity introduces students to the four experts that are part of the Environmental Solutions, Inc. team. Students research information on these careers.

Student Outcomes
Students will:
- Conduct online research on careers.
- Identify background characteristics and roles for one of the four career occupations that will contribute to solving the water quality scenario.
- Create a two-minute videotaped team career presentation or write-up for the class.

Student Products
- *Career Information Form*
- Team career presentation and written script (optional)

Prerequisites
None

Activity Timing

Time Estimate	Two 50-minute Class Periods	
	Option 1: Pre-Activity Homework	**Option 2: In-Class Assignment**
Homework	Research careers	
Day 1	Prepare script and practice	Research careers
Day 2	Present scripts to the class	Teams prepare and write out scripts to turn in for a grade

Materials
- Hydroville Journal
- Computers with access to the Internet for each team

Teacher Information

An important part of the high school experience is to expand students' thinking about possible career opportunities. Each Hydroville curriculum introduces students to a variety of careers in health, science, engineering, and technology. There are many ways in which students can be introduced to these careers, only one of which is presented here. This activity is optional and may be used as a stand-alone activity apart from the Hydroville Water Quality Curriculum.

Suggested Lesson Plan

Getting Started

Suggest to the students that they are working for Environmental Solutions, Inc., the firm that has been hired by the city council to investigate the water quality problem in Hydroville. Brainstorm the types of knowledge or expertise that would be important for team members to have. What careers or professions have those skills? The students often can come up with the skill or knowledge needed but do not know the profession that would have this knowledge.

Doing the Activity

1. Write the names of the four expert areas featured in the curriculum on the board. Discuss how each expert might be needed to analyze the drinking water problem.
   a. **Drinking Water Specialist** – knowledgeable about the Safe Drinking Water Act and will inform the public about the health hazards of specific contaminants.
   b. **Environmental Chemist** – understands the chemical properties of contaminants and analyzes water samples for specific contaminants.
   c. **Hydrogeologist** – an expert on groundwater and groundwater movement who will help determine where the contaminants are coming from.
   d. **Environmental Engineer** – knowledgeable in technologies that will clean up the contaminants and protect the drinking water from further contamination.

2. Review *Getting Factual and Accurate Information from the Web* (WS-1).

3. Randomly assign each student to one of the four expert groups. Students in the same expert groups will work together in groups of four to research a specific career.

4. Either as a homework assignment or as an in-class activity, students research their expert occupation and fill out their *Career Information Form* (WS-2).

5. Students share the data they collected with others in their expert groups.

6. The teams create a script for a catchy two-minute career information video or commercial to persuade people to choose their expert profession for a career.

7. Students present their videos to the class or turn in a written script.

Wrap-up

1. Share observations of the video or written scripts.

2. Students write a paragraph in their Hydroville Journal on the following: Do you want to keep your career or change it for one of the others presented? Why?

Assessment

Grade videos (or scripts) on creativity, information shared, and staying within the time allotted.

Resources

See the Hydroville Water Quality Curriculum Web Resources webpage for current links:
http://www.hydroville.org/links/wq_resources.aspx

Teacher Keys

1. Hydrogeologist
2. Drinking Water Specialist
3. Environmental Chemist
4. Environmental Engineer

1. *Hydrogeologist - Career Information Form (WS)*

Job Description

A hydrogeologist is concerned with the occurrence, circulation, and distribution of water flowing through the ground. By developing an understanding of the recharge volumes, mechanisms of flow, and discharge outlets, they are able to define sustainable development strategies.

Hydrogeologists study the quality of groundwater, for both natural and man-made constituents. Developing a model of water quality evolution and the study of how contaminants move through the ground aid in understanding the complexities of groundwater flow. Hydrogeologists are more concerned with deep groundwater whereas a hydrologist's primary focus is surface water.

The work can vary considerably with different types of employer, but in general work activities include using geology skills and knowledge (especially the relationships between rock types) to relate with water-bearing capacity of the formations and exchanges between them. Maps, records, models, and reports of the distribution and occurrence of groundwater are used extensively by these professionals especially in the monitoring of groundwater quality and groundwater levels. They develop sustainable groundwater use strategies, and assist in the management and protection of groundwater in compliance with regulatory and environmental legislation. This profession works closely with consultants, regulators, and public/private organizations.

Training and Qualifications

Training consists of mostly in-service activities (e.g. seminars, conferences, and short courses) to update knowledge. It would be typical in both consulting and the public sector for employees to be further trained in technical subjects through short courses/coaching, but also common is developing other abilities such as IT skills, project management, report writing, contract management, presentation skills, and also salesmanship and personal relations skills for those

working in consultancy. Practical hands-on coaching and mentoring by senior staff is common. It is common to aim to achieve chartered geologist status as part of this training. Full professional accreditation requires at least five years' relevant postgraduate experience following a first degree in geology, or from seven to ten years' experience for graduates whose first degree contains at least 25% geology/earth science. Professional hydrogeologists normally have a master's of science in Hydrogeology or a closely related discipline. The number of universities offering specialist training has decreased markedly over the past five years, but it is possible to specialize further in aspects of hydrogeology.

Working Conditions/Typical Day
Over the past few years, there has been a considerable increase in awareness of the impact of development and similar activities on the environment and a corresponding increase in stringent legislation. Hydrogeologists are involved in assessing pollution which can be caused by rusting tanks at a disused petrol station or pesticides and fertilizers leaching from farm land into the water supply. Other issues such as water scarcity, disposal of radioactive waste, and reclamation of coal fields have all required the skills of hydrogeologists also. Information analysis and knowledge of legislation and regulations are major components of this job, and thus there is work indoors. However, fieldwork and site visits for investigative and monitoring purposes are just as common.

Employment Opportunities
Freelance work and self-employment is possible, though not as common as with other careers. Working for consulting firms related to environmental quality is more common when you have the necessary credentials. There are many opportunities for various agencies and companies both private and public to work as a hydrogeologist some of which are land developers, local authorities, water companies, mining companies, and land fill managers.

Salary
$45,000-$90,000, depending on background and experience

Why would the skills of this expert be important for the Environmental Solutions, Inc. team to have?

- *Identifying how has the topography around the contaminated site changed from 1930 to present*
- *Identifying soil types located near the contamination site*
- *Identifying the direction of groundwater flow near the contamination site*
- *Identifying which public and private wells are affected*
- *Identifying what are possible sources of contamination*
- *Identifying in which direction does the groundwater near the old dump flow*
- *Identifying where is contamination in relation to the dump*
- *Identifying what is the surface area and volume of the dump*
- *Identifying what is the size of the contaminant plume*
- *Identifying what is the level of risk that other wells will be contaminated*

Reference:

- *Hydrogeologist Occupational Profile* from the UK's official graduate careers website: http://www.prospects.ac.uk/downloads/occprofiles/profile_pdfs/R2_Hydrogeologist.pdf
- Environmental education for kids. http://www.dnr.state.wi.us/org/caer/ce/eek/job/hydrogeologist.htm

2. *Drinking Water Specialist - Career Information Form (WS)*

Job Description
Drinking water specialists analyze water samples with the purpose of maintaining appropriate water quality by following the standards derived from legislation. These scientists compare data from investigations to the standards, and work to bring the quality up if a problem is detected. Some jobs necessitate the scientist's developing relationships with businesses, customers, or specialists in other disciplines related to water quality. They advise businesses and agencies, making sure they are aware of governmental regulations. Chemical and microbiological lab tests on the samples are performed, followed by an analysis of the data. These professionals visit the site of pollution in order to determine the sources of contamination so that the problem may be solved. Many participate in projects concerning water quality improvement, and arrange for emergency action in response to incidents.

Training and Qualifications
A degree in a science field is usually required by employers, and a solid background in sciences such as chemistry and biology is essential to the position. Communication skills and experience in water business is helpful as well. Lab experience also provides the candidate with knowledge useful to this position. Employers usually provide training specific to the job.

Working Conditions/Typical Day
Job requirements include working outside much of the time whether it is sunny or raining. The work load varies, because not only are water quality experts needed to monitor daily conditions but they also are involved in emergency situations.

Employment Opportunities
Drinking water specialists may be employed by a variety of governmental agencies including the EPA, as well as major companies subject to the laws and regulations of water quality. Self-employment is next to impossible unless a specialist has considerable experience in consultancy.

Salary
The starting salaries for these positions usually range from $26,000 to $33,500 a year. This is only an approximation and is specific to those with less than a graduate level education in this field. Many people begin with a lower salary with the goal of rising to higher positions. Those with more education or who have been working in the field for longer make $48,000 to $75,000.

Why would the skills of this expert be important for the Environmental Solutions, Inc. team to have?
- *Identifying the contaminants present*
- *Identifying the location where contaminant levels are of concern and who is affected*
- *Knowledge of key properties of detected contaminants (i.e. use, how it gets into the environment, how do you remove it)*
- *Routes of exposure and human health effects of detected water contaminants*
- *Control measures required or optional to control water contaminants of concern*
- *Pros, cons, and costs for control measures*
- *Identifying what the public need to know to protect their health*
- *Process of sharing information with the public*

Reference:
- "Water Quality Scientist" from ***Prospects***: http://www.prospects.ac.uk/links/WatQualinsp/

3. *Career Information Form (WS) - Environmental Chemist*

Job Description
The fate and effects of chemicals on the environment are matters of increasing concern to those specializing in the management of our environment. "Fate" involves studying where chemicals show up in streams, rivers, and air. The environmental pollution contains certain molecules that have not been removed in water treatment plants, caught by the filters in industrial smoke stacks, disposed of properly, or have leaked out of their containers. Whatever the cause, environmental chemists study how the chemicals travel into the environment and their effects.

Environmental chemist is a general term. In fact, most chemists in the field would probably describe themselves more specifically by the work they do. This may be collecting and analyzing samples, developing remediation programs, changing production processes to ones that yield a more environmentally friendly product, advising on safety and emergency response, or dealing with government regulations and compliance issues.

Training and Qualifications
Because environmental chemistry is so interdisciplinary, excellent communication skills, teamwork, the ability to associate with people and express ideas efficiently to a nonscientific audience are all important. This last challenge will become apparent when dealing with regulations or with sales and marketing individuals in your own company. As environmental management expands globally, chemists with the added knowledge of other languages may be even more successful.

Environmental chemists come from a variety of backgrounds, and there is no one path into the field. Candidates with a Ph.D. degree will find more interesting work more quickly than those with a master's or bachelor's degree. However, because the field is growing so rapidly, opportunities do exist for individuals with an associate's degree. Companies often hire graduates from schools with well-established programs. Employers also look for candidates who demonstrate the ability to broaden their skills and think in an interdisciplinary manner. Course work in subjects related to the environment is one indication of this.

Working Conditions/Typical Day
Workplaces for environmental chemists are as varied as their job descriptions. Often their work is done in an indoor lab environment. However, when studying the fate and effects of chemicals in the environment, a river bed or stream may become their lab. Some companies have sophisticated indoor ecosystems in which they test their products. Others collect data outside and miles away from their own production sites.

Employment Opportunities
Due to increased government regulations, job opportunities for environmental chemists continue to grow. Despite downsizing, companies are placing greater emphasis on compliance and environmental processes. Opportunities exist for chemists to move into different areas of expertise outside a traditional job in the lab. By studying law, business, or public policy, opportunities can be found in the regulatory area as well as in health and safety functions.

Salary
The starting salary for a Ph.D. chemist is in the mid $40,000-per-year range. For master's candidates, $34,000 is an average starting salary. Bachelors candidates can earn anywhere from the mid-$20,000s per year to the low $30,000s. An individual going into the regulatory side of environmental chemistry is likely to start out at a higher salary and continue to be paid more

throughout his or her career because these jobs are more high profile and require taking responsibility for a company's liability. Although the work an analytical chemist does to reduce contamination is important, the chemist-regulator who negotiates a company out of trouble will receive more recognition and better compensation.

Why would the skills of this expert be important for the Environmental Solutions, Inc. team to have?

- *Identify the contaminants that are present*
- *What do the contaminants tell us about the source of the hazard, the location of the hazard, the extent of the hazard?*
- *Which contaminants are found in levels that need to be remediated?*
- *Which hazards are of most concern?*

Reference:

The American Chemistry Society:
http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2%5C3wk%5Cwk3_env.html

4. *Career Information Form (WS) - Environmental Engineer*

Job Description

Environmental engineers review all remediation options appropriate in the removal of the high concentrations of pollutants in groundwater. They communicate advantages, disadvantages, and costs of remediation methods. Environmental engineers help others make informed decisions about which ballot measures to support given their investigations and the group priorities. Assessments and management of the effects of human and other activity on both the natural and man-made environment are performed by environmental engineers. An understanding of pollution control and the ability to identify, define, investigate, and assess environmental problems are qualities crucial to this position. Environmental engineers work to prevent pollutants from being released into the air or water and to insure that solid waste is properly disposed of. Some environmental engineers devise and build equipment to aid in the creation of a cleaner environment. Others work in management, developing environmental protection plans.

Using the principles of biology and chemistry, environmental engineers develop solutions to environmental problems. They are involved in water and air pollution control, recycling, waste disposal, and public health. Environmental engineers conduct hazardous-waste management studies in which they evaluate the magnitude of the hazard, offer analysis on treatment and containment, and develop regulations to prevent serious problems. Some design municipal water supply and industrial wastewater treatment systems. Others conduct research on proposed environmental projects, analyze scientific data, and perform quality control checks. Environmental engineers are concerned with both local and worldwide environmental issues. They study and attempt to minimize the effects of acid rain, global warming, automobile emissions, and ozone depletion. They also are involved in the protection of wildlife.

Training and Qualifications

A four-year college degree is required for most environmental engineering jobs. Many have civil engineering degrees while others are certified in environmental, agricultural, chemical, or mechanical engineering.

Entry into this field requires earning a bachelors of science degree in engineering --- whether civil, chemical, mechanical or environmental. It is advisable that you study past undergraduate and earn a masters degree in environmental engineering. An increasing number of employers prefer those who have obtained a masters degree. You are also encouraged to work for a Ph.D.; though not required, a doctorate serves as another credential, surely providing additional advantages in your career.

You should try to excel in the math, science and engineering courses that comprise all engineering degrees. Equally important is developing knowledge in the area of humanities. Since environmental engineering always involves people, it is necessary that you understand how people and societies function. Through both formal training and activities during your college career, one needs to work on developing writing and speaking skills. An environmental engineer must be able to communicate effectively with diverse people if he or she hopes to succeed in solving problems. These skills can only be learned by action on knowledge gained.

Working Conditions/Typical Day

Since environmental engineers focus on the environment, there is usually an outdoor component to their jobs. Many work in industry, but some work with local and federal governmental

agencies. Their work hours are the standard 40-hour week, but can vary depending on the project or employer under which they work.

Employment Opportunities

Environmental engineering graduates have favorable job opportunities. Employment of environmental engineers is expected to increase much faster than average for all occupations through 2012. Much of the expected growth will be due to the emergence of this occupation as an independent engineering specialty rather than as an area under other engineering specialties, such as civil engineering. More environmental engineers will be needed to abide by environmental regulations and to develop methods of cleaning up existing hazards. A shift in emphasis toward preventing problems rather than controlling them once they are created, as well as increasing public health concerns, will spur demand for environmental engineers also.

Salary

Median annual earnings of environmental engineers were $61,410 in 2002. The lowest 10 percent earned less than $38,640, and the highest 10 percent earned more than $91,510. Median annual earnings in the industries employing the largest numbers of environmental engineers in 2002 were:

Architectural, engineering, and related services	*$58,620*
Management, scientific, and technical consulting services	*$57,800*
State government	*$54,160*

According to a 2003 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in environmental/environmental health engineering received starting offers averaging $44,702 a year.

Why would the skills of this expert be important for the Environmental Solutions, Inc. team to have?

- *Identifying contaminants present*
- *Measure contaminant levels that need remediation*
- *Knowledge of techniques to remove contaminants from the dump or groundwater*
- *Identify advantages, disadvantages, and costs of various remediation methods*
- *Choosing the proper remediation methods*
- *Identifying what the public needs to know about the remediation process*
- *Choosing the method of informing the public*

References:

- National Academy of Engineering, Engineer Girls. http://www.engineergirl.org/
- U.S. Department of Labor Bureau of Labor Statistics. http://www.bls.gov/oco/ocos027.htm
- American Academy of Environmental Engineers. http://www.aaee.net/newlook/careers.htm

PAGES TO PHOTOCOPY

Note: For ease of photocopying, Transparency Masters appear first in the student pages.

Handouts and Transparency Masters

Day	What is Needed	Type*
1-2	*Getting Factual and Accurate Information from the Web* *Career Information Form*	WS-1
	Career Information Form	WS-2

* Type = Transparency Master (TM), Background Reading (BR), Worksheet (WS), Map (M)

Name_____
Date_____Period____

WORKSHEET 1: GETTING FACTUAL AND ACCURATE INFORMATION FROM THE WEB

How do you know what information is reliable and what is questionable?

- **There are no quality standards for statements posted on the Internet.**
- **Anyone with a computer and internet access can have a webpage and post whatever information she or he wants.**
- **Using a search engine, you can often find thousands of documents on the topic you selected**.

When using the web as a resource, keep in mind the following:

- Be reasonable. Don't believe everything you read. Maintain a healthy skepticism. Watch out for loaded words like "poison" or "conspiracy."
- Beware of "never" and "always." Science is rarely absolute. Think twice about advice to never eat this or always do that.
- Be cautious of anecdotes (personal stories). One individual's personal story and word-of-mouth reporting does not qualify as scientific evidence. Is the information you found based on reports published in leading scientific journals? Are there references? If there are no references, the information may be based on opinion and not fact.
- Be wary of results from initial or small studies which are often presented as fact. For a hypothesis to become a theory, it must be tested repeatedly on different models and conditions.
- Look at the sources of the information. Professional or government organizations such as the Centers for Disease Control or the U.S. Environmental Protection Agency are more likely to have credible, reliable information than an unknown person or group of people or a single-issue site. Web addresses that end in "gov", "org", or "edu" are most likely to contain reliable information. Anyone can get an address ending in "com".
- Check the author and dates. As they say, old news is no news. Make sure the information is up-to-date. Unless websites are continually updated with the latest facts and findings, what you find may not be current.

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Name_____
Date_____Period____

WORKSHEET 2: CAREER INFORMATION FORM

Instructions

1. Fill in the expert area line with the name of your assigned expert.
2. As you investigate this occupation, complete each section listed on the *Career Information Form*.
3. See the Hydroville Water Quality Curriculum Web Resources webpage for current links: http://www.hydroville.org/links/wq_resources.aspx to help you get started in your investigation.
4. Using the information that you gathered about this expert area, explain why the skills of this expert might be important to have on the team from Environmental Solutions, Inc.

Expert Area:

Job Description:

Training and Qualifications:

Working Conditions/Typical Day:

Employment Opportunities:

Salary:

Why would the skills of this expert be important for the Environmental Solutions, Inc. team to have?