



United Nations Association in Canada  
Association canadienne pour les Nations Unies



In partnership with

Canada



Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



# UNEP@50

## Indigenous Conservation

### Toolkit

HIGH SCHOOL TEACHER RESOURCE GUIDE

# contents

3-8 Powerpoint Presentation

9-10 Curriculum

11-22 Teacher's Script

23-25 Haudenosaunee Creation Story

26-29 Haudenosaunee Maple Syrup Story

Class Trip

30-34 Caring for Creation

35-42 Ohèn:ton Karihwatéhkwèn

(Thanksgiving Address)

43-57 Pollution/Waste Info + Exercises

58 Minnow Recognition Exercise



# Caring for Creation - Conservation through a Haudenosaunee Lens

High School Age Curriculum



## Introduction



Caring for creation as the  
Haudenosaunee do.

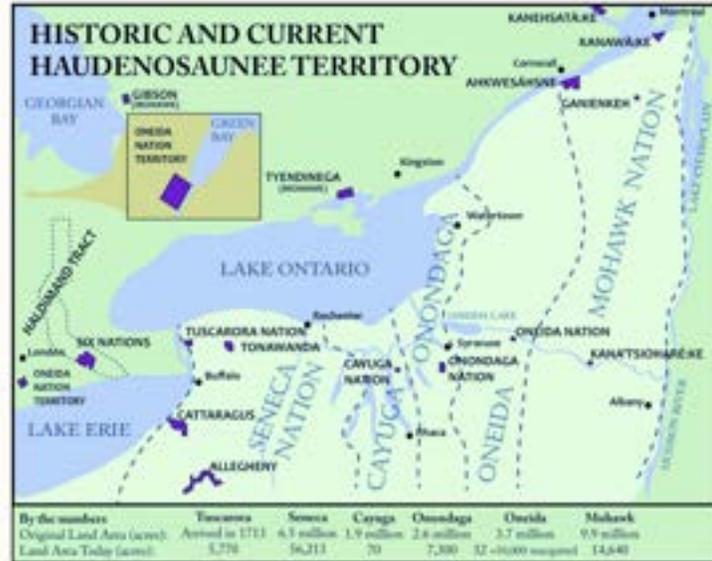
Our roles and responsibilities to  
Mother Earth

Take care, just as we take care of  
our loved ones.

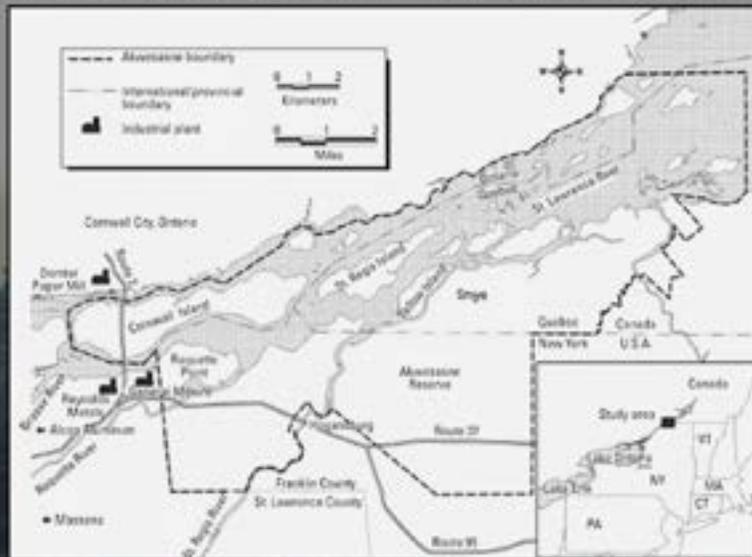
Creating healthy relationships  
with the land, air, and water, and  
all the natural beings that live  
here.

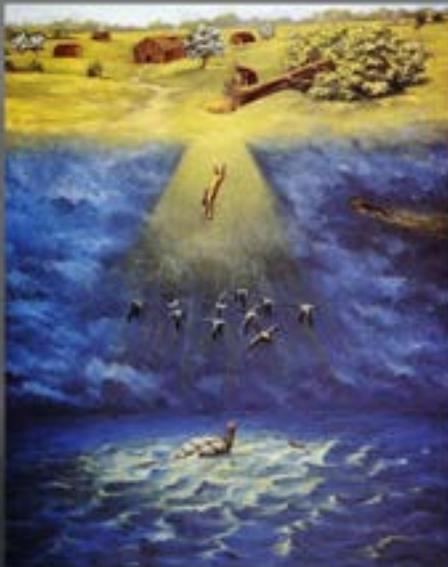


# The Haudenosaunee Confederacy



## Akwesasne Kanienkehaka Nation





IROQUOIS CREATION MYTH. Sky Woman, 1936, by Ernest Smith

## The Creation Story

- Creation is in balance.
- With every hardship or loss, there is a gain.
- The Twins lost the Grandmother but gained her as the overseer of the night in the moon.
- Where their mother was buried, grew the foods they would need to survive.

## Ohénton Kariwatékwen: The Words Before All Else



- Giving thanks based on their original purpose, to be in sync with Mother Earth and all of creation
- Respect and appreciation
- Practice saying "thank you" to the water you drink and the food you eat



## Pollution

Pollution impacts our water, air, land, and the sounds around us (noise pollution). Simply, it is putting harmful materials into the environment.

## Mindfulness

Assess the things you can change at home  
Take time to reconnect back to the earth  
Reduce, Reuse, and Recycle.

## Diversity of the Environment



### Plants

We give thanks to the food, medicinal, and air purifying plants, how they keep us alive and keep us healthy. We thank them for providing us with oxygen and sustaining our families. There are many uses for plants that may surprise you!

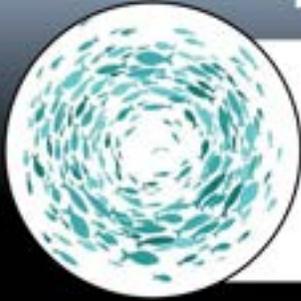
### Water

For all of the plants to grow, and for us to grow, we need water. Water is life. The Kalenkehaka give thanks to the water, as it provides life to the world. Giving thanks for the waters as they quench our thirst and provide us with strength to grow.





## Diversity of the Environment



### Fish

The fish were given the responsibility to feed the people as well as clean the water. They give us strength, so we do not go hungry.

### Trees

For the Kanienkehaka, trees represent unity, strength and the cycles of life. Each tree represents different gifts and medicine for the

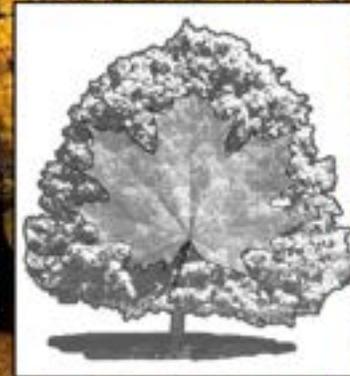


### Wah:ta

An annual ceremony is held to give thanks to the Creator, for providing the maple sap and the maple tree (leader of all trees) for our good health and good fortune.



In the spring, you can often spot white smoke billowing out of homes around Akwesasne. This is when wah:ta oh:ses (maple sap) flows and it's time to make maple syrup.





Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



United Nations Association in Canada  
Association canadienne pour les Nations Unies



## Where do we go from here?

We can think about how we would treat our mother or father, our grandparents. What kind of ways can we continue to care for the earth, with that same kind of care? What kind of actions will you take, now that you see through the eyes of the Kanienkehaka people? Do you see the Land & Body Connections? What are some things that you can do?



# Educational Curriculum

## High School Curriculum

### Caring for Creation - Conservation through a Haudenosaunee Lens

Note: We have given multiple activities for each theme within the module. Please choose which activity works for your classroom within your timeframes. This flexible broad range of choice, will ensure that the information is retained for your students in an interactive and engaging way.

Lesson	Activity	Materials	Time	Environment	Resource Links	Learning Objectives
1	Introduction	Slide Deck or printout	5-8 min	In Classroom/ Outside in a talking circle	Refer to Resource Folder for terminology, audio recording	<ol style="list-style-type: none"> <li>1. Create an understanding of individual and the collective responsibility of building a consensual relationship with the creation</li> <li>2. Begin dialogue on an Indigenous worldview through the Haudenosaunee</li> <li>3. Be introduced to the Kanawakohka terms</li> </ol>
2	Ohaston Kariw with wew: The Woods Before All Else	Creation Story Slide Deck or printout, Resource folder, videos on Youtube -Phone or laptop to play media	10 min	In Classroom/ Outside in a talking circle	Creation Story Hand Out	<ol style="list-style-type: none"> <li>1. Understanding the interconnectedness of all on Earth.</li> <li>2. Knowledge shared in experiences of caring for creation and reconnecting to it with respect and reciprocity.</li> </ol>
3	Ohaston Kariw with wew: The Woods Before All Else	Relationship with the Earth Slide Deck or printout, Resource folder, videos on Youtube -Phone or laptop to play media	10 min	In Classroom/ Outside in a talking circle	Address with Photos Address with Students Hand Out	<ol style="list-style-type: none"> <li>1. Recognizing that they have an integral role to play in their home and community. They are responsible for their relationship with the Earth.</li> </ol>

Lesson	Activity	Materials	Time	Environment	Resource Links	Learning Objectives	
4	How we treat Irdi/nistenda Ohaston (land/water)	Thinking about pollution	Materials Needed- search the internet and research Alowesane superfund sites or contaminated sites in your local area	20-30 min	Discussion throughout, Break up class in teams based on the type of pollution they choose. Groups can do a short presentation on the site including source of pollution and impact, and people impacted, short and long term effects	Canada Contaminated Sites US Superfund sites	<ol style="list-style-type: none"> <li>1. Reflect their connection to their home communities</li> <li>2. Connecting their actions to the environmental impact</li> <li>3. Creating environmental models that show that impact on multiple levels.</li> </ol>
	How we treat Irdi/nistenda Ohaston (land/water)	Walkabout Collection Learn about the magnitude of the global plastic issue	Jars (Plastic or Glass) Notepads	20-30 min	Outside, Grounds	Are Microplastics in Our Water? Becoming a Microproblem? National Geographic Living Video	<ol style="list-style-type: none"> <li>1. Reconnection back to the earth</li> <li>2. Understanding the impact of pollution outside your door</li> <li>3. Fresh air and practical simple activity</li> </ol>
4	Diversity of the Environment	Plant Identification- ohaston/shon'a (grasses), omowidwa/shon'a (medicines), ohaston/shon'a (roots) Learn about the scientific names with the history Linnaean classification.	Waterfall App, Class Camera or Notepad, Clipboards and pens. - Phone or laptop for media	20 min	Divide class up into groups of 3, outside activity on school grounds	Waterfall App or any other plant identification app online Simple Key for Plant Identification: Go Botany: justaplantthatgrows.com Linnaean Classification: Definition, Levels & Examples with Chart: science.org.com	<ol style="list-style-type: none"> <li>1. Providing an opportunity to connect/reconnect with nature through this new understanding and lens</li> <li>2. Hands on group activity</li> <li>3. Explore the environment, discovering plants that have multiple uses and meanings</li> <li>4.</li> </ol>



# Educational Curriculum

6	Ontario- The Water	Water Testing Learns the parameters of water quality and their connection with each other.	Water Testing Kits, Youtube Video, Slide Deck or Print Out - Phone or laptop to play media	30 min	In Classroom/ Outside in a talking circle	<a href="#">Water Song</a> Video <a href="#">Water Testing Kit</a> - <a href="#">Water Rangers</a> - <a href="#">Other Options</a> <a href="#">Water Theme Teachings</a>	Building upon existing knowledge to integrate the teachings of pollution, habits, and health with the understanding of the individual's role in protection and prevention.	3
		Water Cycle Watersheds	Print out Find out the name of your watershed.	20 min	In Classroom	Water Cycle Print Out- One per student <a href="#">Great Lakes watershed locator</a>   <a href="#">ontario.ca</a>	<ol style="list-style-type: none"> <li>The Theme of water is life &amp; water is sacred.</li> <li>Simple and proactive approaches to water protection</li> <li>Discussion on the origins of the water, integrated with the scientific teachings surrounding its cycle</li> </ol>	
7	Ontario- The Fish	Identifying Minnows (optional)	Slide Deck or printout, Resource folder, video on Youtube -Phone or laptop to play media	15 min with a 3 min 30 sec video or an afternoon field trip	In Classroom/ Outside in a talking circle or at a conservation authority	<a href="#">Fish Habitat</a> Video Search your local conservation authority that works with their local Indigenous community <a href="#">Ontario Fishes - A Folding Pocket Guide to the Most Common Names and Introductions</a>   <a href="#">ontario.ca</a>	<ol style="list-style-type: none"> <li>Connecting the health of fish, to the health of individuals, to the health of the community.</li> <li>Simple and proactive approaches to fish habitat protection</li> </ol>	
	<b>Lesson</b>	<b>Activity</b>	<b>Materials</b>	<b>Time</b>	<b>Environment</b>	<b>Resource Links</b>	<b>Learning Objectives</b>	4
8	The Trees- Okwiro'shon'a	Wah'ta oh'ses Forests: Community amongst trees	Slide Deck or printout, Resource folder, PDFs available with activities, video on Youtube - Phone or laptop to play media	50 min or an afternoon field trip	In Classroom/ Outside in a talking circle or at a sugar shack	<a href="#">Wah'ta</a> Video Wah'ta printouts Traditional Maple story <a href="#">Origins story</a> <a href="#">Sugar-Maple Trees</a>	<ol style="list-style-type: none"> <li>Connect to the Maple Story, Leader of the Trees, First Medicine of the Year, Maple Ceremony</li> <li>Maple Sugar Processing &amp; the function of the trees</li> </ol>	
9	Where do we go from here?	Land as Family	Slide Deck or printout	5-8 Min	In classroom or outside- talking circle		<ol style="list-style-type: none"> <li>Create an understanding of individual and the collective responsibility of building a consensual relationship with the creation</li> <li>Caring for Creation is conservation but it is more than conserving, it is about creating these healthy relationships with other living beings.</li> </ol>	



## Caring for Creation- High School Teacher's Script

*\*Note- We have given multiple activities for each theme within the module. Please choose which activity works for your classroom within your timeframes. This flexible broad range of choices will ensure that the information is retained for your students in an interactive and engaging way.*

### **Introduction (5 Min)**

Today, we will talk about caring for creation. As we look at our roles and responsibilities to Mother Earth, we will grow in our understanding of how we all play a part in our communities to take care, just as we take care of our loved ones. We create healthy relationships with the land, air, and water, and all the natural beings that live here.

The Haudenosaunee (hoe-dee-no-SHOW-nee) (People who build a house) are a distinct and diverse population of Indigenous people, belonging to several communities along the St. Lawrence River, the Finger Lakes and Mohawk Valley of New York State, and the Great Lakes. Their connection to the earth is different from others, the Earth is a woman, and the Haudenosaunee care for her as she cares for them. Healthy relationship building is part of their culture and all creation cares for each other, as is their role and responsibility.

For the Haudenosaunee, caring for creation is similar to conservation, but different in its expression. The people protect and preserve the gifts from the earth, through respectful treatment on every level of relations: Self, Family, Clan, Community, Nation, Confederacy, and World. In Akwesasne, the community shares in the care of the land, through environmental advocacy, community gardens, and recycling programs. Making decisions that impact Mother Earth need to be carefully thought out in order to protect her from exploitation, destruction, or neglect. Each community member of Akwesasne has the responsibility to keep protecting and being mindful of their relationship with the earth, everyday.



There are 6 Nations of the Haudenosaunee- the Tuscarora, Seneca, Cayuga, Onondaga, Oneida, and the Kanienkehaka (commonly referred to as Mohawk). For the purposes of this lesson, we will be focusing on the Kanienkehaka and their viewpoint of caring for Creation. To begin truly understanding how they view the world, we will talk about their Creation story and how they came to exist.

### Activity 1: Creation Story (10 Mins)

- Resources include a 2-page Creation Story or a 5-minute video.
  - Discussion Points: Creation is in balance. With every good, there is bad but isn't seen as one or the other. Roses need protection from the thorn. The sun must rest and the moon must come out every day. With every hardship or loss, there is a gain. Again, the balance within the story. They lost the Grandmother but gained her as the overseer of the night by becoming the moon. Where the mother was buried, grew the foods they would need to survive. There is an opportunity to connect with Western Science through the first law of thermodynamics, which states that energy can neither be created nor destroyed. Our relations take on new shapes and forms in cycles - nothing is static or lost. It just takes on a new form and in this way is how we care for each other across time and space.
- What do you think of when you hear the word Thanksgiving or gratitude or acknowledgment?
- Discussion Points: Each word can carry a different meaning for folks. The connotation of each word to each individual is meaningful. These words help communicate the simplest form of the words, but often mean much more in the language of the Kanienke'haka. Many say that it is like a picture being painted in detail when spoken fluently. The reason this occurs is that Kanien'keha is a verb-based language unlike English, which is a noun-based language. This means that the Kanienkehaka are focused on motion and action, which connects to the roles and responsibilities of all of creation that continue to do their work so we can all live for which we are grateful. So we must do our work too!



## **Ohénton Kariwatékwen: The Words Before All Else (10 Min)**

We are familiar with our use of the term, Thanksgiving. (Ask what they think of when they hear that word.) For the Kaienke'haka, it is gratefulness for all of the gifts that the earth has provided for the people and how they return their gratitude through acknowledgment and care. The Thanksgiving Address or the Ohénton Kariwatékwen: means the Words Before All Else- For all Haudenosaunee, it is a practice of giving thanks based on their original purpose, to be a good relative to Mother Earth and all of creation (Native North American Travelling College [NNATC], 2017). This act is meant to move forward with respect and appreciation, as all come together into the circle of understanding.

From these words, all are greeted in the Haudenosaunee ceremony and celebrated for all they do for each other. This greeting is spoken in the Kanien'keha language and has been adopted in different events outside of the longhouse ceremony like meetings, lectures, and community gatherings. The speech is given before any important meetings or events are held. This is done in order to bring everyone's minds together as one to focus and keep all our relations in mind as decisions are made or celebrations are held. It is through this thinking that we create community and build family with all our relations.

The Ohénton Kariwatékwen "thanksgiving address" reminds everyone of the importance of understanding mindfulness and the connection we all have to Mother Earth. This thankfulness shows how Kanien'kéhaka in Akwesasne relate to the earth, their families, and their lives. In the address, each verse ends with "now our minds are one." This final phase of each section helps join people together in that common goal. Ask them to come up with ideas of how to be mindful in their daily lives.

### **Activity 2: Relationship with the Earth (Play the video from YouTube)**

Ask the students to begin thinking about what beings from the natural world that they are grateful for. This can become a discussion for the students, listing which things came to mind on the front board. You can then compare them to the list within the Ohénton Kariwatékwen. Discussion on the reflections of the relationship with the Earth



and its gifts - how do we care for her? How does the earth care for us?

- Akwesasne TV Video (3 Min Ohenton Kariwatekwen with photos) - [https://www.youtube.com/watch?v=eJH\\_5TXzCjw](https://www.youtube.com/watch?v=eJH_5TXzCjw)
- Project 562 Video (2 min 10-sec Ohenton Kariwatekwen spoken by high school youth on Native American Day)- <http://www.project562.com/blog/a-real-thanksgiving-address-the-words-that-come-before-all-else/>

### **How we treat lethi'nistenha Ohontsia (land/earth) (30 Min)**

Now we must take what we have learned about caring for creation and the relationship we all have with the earth and apply it to our actions. Pollution impacts our water, air, land, and the sounds around us (noise pollution). You may look at the news or read stories about how bad pollution is around the world. It can be overwhelming and make you feel like there's nothing that can be done. However, we are here to remind you that your piece is important and valuable, even the little things like picking up a small piece of garbage or recycling a plastic water bottle. You carry a responsibility to the world to do your part because collectively we can affect these massive global issues like climate change.

### **Activity 3: Thinking about pollution**

- Hands-On Pollution Activity:
  - Materials needed- representing Earth, Air, and Water, so items like Dirt, Water, Mason/Bell Jars, Classroom Debris like paper, pencil shavings etc., aerosol spray or a match to enclose in a jar quickly (by the teacher), snow or ice. Youth can create their own scene of pollution with the jars and compare it with a clean environment. The activity is common in many classrooms and can be found here. It includes printable cards for each type of pollution. Discuss the difference between both environments, the origins, and the ways that pollution changes the earth. This is a great time to talk about plastic pollution around the world.



Pollution discussion: Why do people do this? For the Haudenosaunee, we are taught to be in constant gratitude for all our relations as our role and responsibility to past, present, and future generations. The Haudenosaunee understand their relations through roles and responsibilities and Western Science is just another way of looking at the world, neither is more important than the other. There is an important discussion to be had about selfishness and how this is reflected in littering and pollution. We need to care for all our relations and not abuse their gifts.

- Walkabout Collection: The children can be taken on a walk outside and collect stuff they find and categorize them in the classroom jars - best done in spring after the snow just melts. Document the length of the walk and the number of different kinds of waste.

Discussion Points: How can they be mindful? Talk to your family about things you can change around your home, Take time to reconnect back to the earth, Pick up trash (anytime), Turn off the lights and electronics, Use energy-efficient products, Walk when you can or ride a bike, Use eco-friendly products, Compost, Conserve Water, Plant trees, Reduce, Reuse, and Recycle. What other actions can we add to these?

## **Diversity of the Environment**

The way that the Address is spoken, represents all of the beings from the smallest insect to the spirit beings in the sky. This includes the trees, the birds, the four winds, the thunder beings, Brother Sun, Grandmother Moon, the stars, and the Creator.

In order to strengthen how we care for the environment, we must look at how diverse it is, meaning how many unique types of beings live here. There are 900 hundred thousand kinds of insects and over 60,000 types of trees in the world. Today, we are going to look at a few different gifts on Mother Earth and what they mean to the Kaienkehaka people. Allowing you the opportunity to see what they mean to you. Let us grow together in our knowledge of these beings through the eyes of the Haudenosaunee people. Just like new friends, we will get to know them.



## **Activity 4: Plant Identification- ohente'shon:'a (grasses), ononhkwa'shon:'a (medicines), ohtera'shon:'a (roots)**

Have the students go around their school grounds and find different plant species. Take pictures of them or notes describing them based on the criteria provided below. Come back and learn about each one through identification. Have students break up into small teams and assign them a plant group and begin separating them into subgroups. Teachers could also take photos of multiple plants or print some from google (note your region) for the class, should accessibility be unavailable for this outdoor activity. Additionally, they can use the [iNaturalist](#) app to document their observation, which is part of citizen science and adds to a body of data that can help with caring for creation. There are also other plant identification apps that can be used, depending on availability and learning curve. The students can be challenged to research the medicinal use or edible use of some of the plants discovered. They will be surprised to see how interesting each plant is. Criteria can include [Simple Key for Plant Identification: Go Botany \(nativeplanttrust.org\)](#). This is a simple version of how plant identification books include identification keys to help direct you to the plant species name by finding similarities amongst the different plants!

1. Plant Groups: (1) Woody Plants; (2) Aquatic Plants; (3) Grass-like plants; (4) Orchid and related plants; (5) Ferns; (6) All other flowering non-woody plants
  - a. Subgroups: (1) Broad-leaved woody plants; (2) Needle-leaved woody plants
  - b. Subgroups: (1) Water plants with leaves and stems; (2) Tiny water plants with no true stem
  - c. Subgroups: (1) Sedges; (2) True grasses; (3) All other grass-like plants
  - d. Subgroups: (1) Orchids; (2) Irises, lilies, and other "monocots"
  - e. Subgroups: (1) True ferns and moonworts; (2) Clubmosses and relatives, plus quillworts; (3) Horsetails and scouring-rushes
  
2. Describe Area Plant Picked: Temperature; Exposure to Sunlight (i.e. direct, partial, or shade); Soil Type (i.e. Dry, Wet, Sandy, Organic Material, Rocky, etc.); Habitat Type (i.e. Forest, Yard, Sidewalk, etc.) [Bonus if you get a picture!]



**Optional Approach:** For the 10th graders, you can challenge them to do research on the plants themselves and present this to the rest of the class. The process of research can be exciting and helps make the information stay with folks longer. An additional layer of connection is identifying the scientific name of the plant. This will require a conversation about the Linnaean Classification. The following resource explains this well, [Linnaean Classification: Definition, Levels & Examples \(with Chart\)](#) ([sciencing.com](#)).

### **Ohne:ka- The Water (30 min)**

For all of the plants to grow, and for us to grow, we need water. Water is life. The Kaienkehaka give thanks to the water, as it provides life to the world. Giving thanks for the waters as they quench our thirst and provide us with strength to grow. We know its power in many forms- waterfalls and rain, mists and streams, rivers, and oceans. With one mind, we send greetings and thanks to the spirit of Water. ([Water Song](#)- 1 min 30 sec )

### **Activity 5: The Water**

1. Classes can obtain **Water Ranger kits** and go to a body of water to sample its water quality. This can be a great activity for the students to see differences in qualities (compared to tap water in the classroom) and learn about citizen science. You can find one of these **kits here**. There are kits in a **variety** of price ranges and by contacting the founder, Kat Kavanagh at [kat@waterrangers.ca](mailto:kat@waterrangers.ca), she may be able to facilitate free ones. The Field Guide ([testkit-guide.pdf \(waterrangers.ca\)](#)) explains the water quality parameters nicely for before a water sample is collected. The parameters are outlined below:

- Weather and Location;
- Air Temperature;
- Chlorine;
- pH;
- Alkalinity;
- Hardness;



- Conductivity;
- Water Temperature;
- Dissolved oxygen; and
- Water Clarity.

For 10th graders, you want to emphasize the simple definitions of these parameters, but you want to communicate the interconnectivity amongst them. For example, warmer water does not absorb much water. Taking multiple measurements at a particular site will help show this variation. The guidebook includes explanations for: Safety; Waste Disposal; Why test water?; Choosing sample sites; and Schedule. A really great activity is to communicate how to identify pollution and what to do about it. This can be an entire lesson in itself.

- Water Cycle Activity- Keeping our water clean is a large project but with the support of you, we can make an impact. The cycle of water consists of evaporation (liquid to gas), transpiration (plant exhaling water vapor), precipitation (rain), and runoff (streams, rivers, etc. - water flowing across a landscape). Each of these phases should be clean from pollution. \* Teachers can also discuss the importance of water during the pollution activity, on clean versus polluted water. See printables in the resource folder.

Many traditional activities come from the water including singing and dancing while using a water drum (5 minutes), and of course swimming, canoeing, fishing. Water is sacred. This is an excellent resource from the Planet Protector Academy (3 min 19 sec) showing how all Indigenous people including the Cree Nation featured here, protect the water and the fish.

Additionally, there is a great opportunity to learn about the watershed that you live in! A watershed is defined by the Oxford Dictionary as, “an area or ridge of land that separates waters flowing to different rivers, basins, or seas.” Think about when it rains and how the water flows across the landscape to the lowest point, which is where rivers and streams are. Identify your watershed! Once identified, research what is in place to protect the watershed. Ask them how they can contribute to these efforts or how they can be improved.



## The Fish- Kentsionshona (10 min with a 3 min 38-sec video)

Within those waters, we give thanks to the fish- including the minnows and the sturgeon (the leader of the fish). The fish were given the responsibility to feed the people as well as clean the water. They give us strength, so we do not go hungry. The relationship between the Haudenosaunee people and fish is an integral part of their livelihood. In the past, fish were a major part of the Haudenosaunee people's diet. The lakes, rivers, and streams provided the men with bass, trout, whitefish, sturgeon, and perch. Nets and spears brought in the greatest amount but they also used hooks and lines to catch the fish. The environment that the fish live in must remain clean, so they can grow healthy and strong. Here is an example of preserving the habitat of the fish in Akwesasne, and making sure they can travel up the St. Regis River. If the fish are poisoned by pollution, they will also make the people eating them sick due to biomagnification, which is where the toxins in the environment work their way up the food chain. Biomagnification has severe human health implications as mercury causes neurological problems. Many communities, including Akwesasne, have to be careful when fishing, to not catch sick fish - this is why we have fish advisories ([92713draft.indd \(epa.gov\)](#)). How can we keep our water clean for the wildlife that live there? How can we protect a safe environment for them to live and thrive?

- We can protect water for the fish (ask your guardians to):
  - by limiting our use in our homes while doing dishes, running laundry cycles, and short showers.
  - use a rain barrel in your yard and use that water for things around the house like watering plants and playing
  - Find out what a rain garden is, and plant where the waterfalls- even on your doorstep or balcony!
  - Look for a local youth environmental advocacy group and see how they help protect their fish.

Earlier, when we talk about pollution prevention and the importance of water, notice how it is a holistic issue- meaning one area overlaps with another. We protect the water, we keep the fish healthy, and then the people will stay healthy as well. Keep doing what you can. You have an important role in your community and you are an active participant in protecting the earth. Every step counts!



### **Activity 6 (optional): Identifying Minnows**

Contact a local Indigenous community environment program and engage with a local conservation authority. This organization will be able to show how to seine net and identify minnows. There are certain species of minnows with certain habitat requirements. It can also tell us how healthy an ecosystem is, which shows the connection back to the water quality sampling. Most people think of minnows as baby fish, but this is not the case. Minnows are from a family called Cyprinidae. The Kanienkahaka called them Kanionta. Minnows have three specific characteristics that make them a family, kind of like your own! (See Minnow Graphic). Research what minnows are in your area and what their water quality/habitat requirements look like, such as where do they prefer to live. Fish can be characterized in a similar way to plants.

### **The Trees- Okwire'shon:'a (30 min or Field Trip Option)**

The Haudenosaunee give thanks for the trees, especially maple (Wahta), the head of their family, that it still creates sap that cleans the bugs from your stomach after a long winter.

Wahta- 3 minute video- [https://www.youtube.com/watch?v=nZTd\\_1LdgLA](https://www.youtube.com/watch?v=nZTd_1LdgLA)

### **Activity 7: Wah:ta oh:ses**

After reading the origin story of the Maple trees and the importance of sap collection, there are several activities available to engage in. A powerful activity could be going to a maple sugar shack, and tapping trees to process it for maple syrup. It is important to note that sap is not only a product of Maple trees, but it is maple trees that have the highest concentration of sugar in their sap. Some important approaches to doing tree tapping. Also, here is a list to help identify the different kinds of maples in Ontario, but we are focused on Wahta; Sugar Maple; or *Acer saccharum*.

[How to identify and properly tap a maple tree – Ontario Maple](#)

[Maple Trees: Types, Leaves, Bark - Identification Guide \(Pictures\) \(leafyplace.com\)](#)



Maple sap is a good diuretic (make you use the bathroom), so be careful! It is good medicine and considered the first medicine of the year. The Haudenosaunee honor this time annually with ceremony to remind themselves of their roles and responsibilities to all of creation. The story communicates a message of not becoming lazy and forgetting to fulfill your roles and responsibilities. The only way to tell when it is time to honor the tree is by being in relation to the Maple when the sap runs during the freeze and thaw cycle of the end of Winter. A deeper explanation is provided at this link: [How sugar maple trees work | Massachusetts Maple Producers Association \(massmaple.org\)](https://www.massmaple.org/How-sugar-maple-trees-work).

Sugar Maples are known to be slow-growing and shade tolerant and exist in communities within Forests. Sugar Maples tend to occupy space in forests with the American Beech (*Fagus sylvatica*). The American Beech is a fast-growing and shade-intolerant species. The two are in a symbiotic relationship with each other. The American Beech will grow up quickly and form the canopy of the forest first while the Sugar Maples work their way up there. The Sugar Maples will make it to the forest canopy after many decades and can occupy a large portion. However, the Sugar Maples will die and when they fall, they create a gap habitat, which allows the American Beech to proliferate. In their death, the trees decompose due to microorganisms in the soil, which helps keep the nutrients in the forest and helps the other trees and plants grow! There are so many relationships in a forest ecosystem and this is only one example of the different relationships among trees.

### **Where do we go from here? (5- 8 Min)**

For the Kanienkehaka, the way you treat the land is the same as how you treat your body. It is also how you treat others. As we come to the end of our lesson, we want to discuss building these relationships in a healthy way. Our mother earth is a living being that gives us life and allows us to live upon her. When people try to control or disrespect her, we will see the impact, which can come in the form of floods, landslides, forest fires, and other natural disasters occurring more often, which we see with climate change. You will notice, if you take the time to connect to the earth, it will ultimately bring you happiness. The sunshine makes you happy, digging your hands in the earth, and even a strong rain can bring you calm, as you know all living beings will be getting a drink to help them grow. A well-documented phenomenon is a way that forests help lower your stress (drop in cortisol) and improve your health.



The link below helps explain how forest help: boosts the immune system; lowers blood pressure; reduces stress; improves mood; increases ability to focus, even in children with ADHD; accelerates recovery from surgery or illness; increases energy level; and improves sleep.

### **Activity 8: Land as our family**

We can think about how we would treat our mother or father, our grandparents. What kind of ways can we continue to care for the earth, with that same kind of care? What kind of actions will you take, now that you see through the eyes of the Kaienkehaka people? Do you see the Land & Body Connections? What are some things that you can do? How do you build a healthy relationship with the world around you and carry yourself mindfully as you tread across the land?

- Kindness, Respect, Take only what we need, Ask permission, Give gratitude and Thankfulness, Acknowledge what the earth has done for you. Being Mindful.



## The Haudenosaunee Creation Story

Long, long ago, the earth was deep beneath the water. There was a great darkness because no sun or moon or stars shone. The only creatures living in this dark world were water animals such as the beaver, muskrat, duck and loon.

Far above the water-covered earth was the Land of the Happy Spirits, where the Great Spirit dwelled. In the center of this upper realm was a giant apple tree with roots that sank deep into the ground.

One day the Great Spirit pulled the tree up from its roots creating a pit in the ground. The Great Spirit called to his daughter, who lived in the Upper World. He commanded her to look into the pit. The woman did as she was told and peered through the hole. In the distance, she saw the Lower World covered by water and clouds.

The Great Spirit spoke to his daughter, telling her to go into the world of darkness. He then tenderly picked her up and dropped her into the hole. The woman – who would be called Sky Woman by those watching her fall – began to slowly float downward.

As Sky Woman continued her descent, the water animals looked up. Far above them they saw a great light that was Sky Woman. The animals were initially afraid because of the light emanating from her. In their fear, they dove deep beneath the water.

The animals eventually conquered their fear and came back up to the surface. Now they were concerned about the woman, and what would happen to her when she reached the water. The beaver told the others that they must find a dry place for her to rest upon. The beaver plunged deep beneath the water in search of earth. He was unsuccessful. After a time, his dead body surfaced to the top of the water.

The loon was the next creature to try to find some earth. He, too, was unsuccessful. Many others tried, but each animal failed. At last, the muskrat said he would try. When his dead body floated to the top, his little claws were clenched tight. The others opened his claws and found a little bit of earth.

The water animals summoned a great turtle and patted the earth upon its back. At once the turtle grew and grew, as did the amount of earth. This earth became North America, a great island.



During all this time, Sky Woman continued her gentle fall. The leader of the swans grew concerned as Sky Woman's approach grew imminent. He gathered a flock of swans that flew upward and allowed Sky Woman to rest upon their back. With great care, they placed her upon the newly formed earth.

Soon after her arrival, Sky Woman gave birth to twins. The first born became known as the Good Spirit. The other twin caused his mother so much pain that she died during his birth. He was to be known as the Evil Spirit.

The Good Spirit took his mother's head and hung it in the sky, and it became the sun. The Good Spirit also fashioned the stars and moon from his mother's body. He buried the remaining parts of Sky Woman under the earth. Thus, living things may always find nourishment from the soil for it springs from Mother Earth.

While the Good Spirit provided light, the Evil Spirit created the darkness. The Good Spirit created many things, but each time his brother would attempt to undo his good work.

The Good Spirit made the tall and beautiful trees, including the pines and hemlock. The Evil Spirit, to be contrary, stunted some trees or put gnarls and knots in their trunks. Other trees he covered in thorns or poisoned their fruit.

The Good Spirit made bear and deer. The Evil Spirit made poisonous animals such as lizards and serpents to destroy the animals created by his brother.

When the Good Spirit made springs and streams of pure crystal water, the Evil Spirit poisoned some and placed snakes in others. The Good Spirit made beautiful rivers. The Evil Spirit pushed rocks and dirt into the rivers creating swift and dangerous currents.

Everything the Good Spirit made his wicked brother attempted to destroy.



After the Good Spirit completed the earth, he created man out of red clay. Placing the man upon the earth, the Good Spirit instructed the man about how he should live. The Evil Spirit made a monkey from sea foam.

Upon completion of his work, the Good Spirit bestowed a protecting spirit upon all of his creations. This done, he called his brother and told him he must cease making trouble. The Evil Spirit emphatically refused. The Good Spirit became enraged at his brother's wickedness. He challenged his evil twin to combat. The winner would become the ruler of the world.

For their weapons they used the thorns of the giant apple tree. The battle raged for many days. The Good Spirit triumphed, overcoming his evil brother. The Good Spirit took his place as ruler of the earth and banished his brother to a dark cave under the ground. In this cave the Evil Spirit was to remain.

The Evil Spirit, however, has wicked servants who do his bidding and roam upon the earth. The wicked spirits are able to take any form and cause men to do evil things.

This is the reason that everyone has both a good heart and a bad heart. Regardless of how good a man is, he still possesses some evil. The reverse also is true. For however evil a man may be, he still has some good qualities. No man is perfect.

The Good Spirit continues to create and protect mankind. It is the Good Spirit who controls the spirits of good men upon their death. His wicked brother takes possession of the souls of those who are evil like himself. And so it remains.

\*Story from the Oneida Indian Museum



## The Haudenosaunee Story of Maple Syrup

When our ancestors arrived here they came upon a land which was rich in its ecological diversity. Perhaps no other place in North America had such a wealth of life forms from mammals to birds, pure waters and open meadows. The ancestors learned to cultivate the soils and to plant not only crops but trees as well. They brought with them black walnuts and chestnuts, then planted other trees to create complex ecosystems which were beneficial to humans and other species.

They also identified certain trees as "leaders" like the eastern white pine, the oak, willow and especially the maple. It was the Iroquois who invented maple syrup (wah:ta oh:ses in Mohawk) and the technology which went into taking sap and making it into that most delicious of sweeteners. It is the maple which tells us that spring has come and it is time to celebrate. To begin we tell our children the following story.

At one time, long ago, the Creator came to realize that the long winters of this land meant the health and well being of the people suffered. They would become physically ill and their spirits would be sad. Many months would pass since they had fresh food and deep snows meant hunting was also difficult. Something had to be done. The Creator went to the people and said he would give them a special gift. The Creator would go to the maple trees and ask them to share their blood at a certain time so the people could come and be nourished and made happy by drinking directly from the tree. They would only have to insert sumac tubes beyond the outer bark of the tree and pure syrup would flow. The people did so and were made stronger in body and mind.

The Creator was pleased with this and then left the earth to attend to other worlds. He was gone a long time. While he was away he wondered about the human beings and how they were doing with the gift he had given to them. He decided to return to earth and to the Iroquois village where he had taught them how to obtain syrup. When he arrived he saw that the longhouses were empty of people, that there were no hearth fires, no children playing about and no dogs barking. He did see dog and human footprints in the snow which went in a single direction towards a grove of maple trees. He followed the tracks and came across an amazing sight.



There, lying prone beneath the branches of the trees were the people with the long sumac tubes extended from the maples to their mouths. So great was their desire for the pure maple syrup that they had forsaken all of their normal duties including the care of their homes and their own children. The Creator also noticed that the dogs were also using the tubes to drink the sweet water with their paws waving in the air.

This was not good. The Creator awaked the people and brought them together. He said that since they had abused his gift they would have to work to make the syrup. He told them that no longer would syrup flow directly from the trees but they would have to use taps and then prepare to heat the sap over many hours and watch it very carefully until, with labour and care, it became maple syrup. They would also have to hold a ceremony of thanksgiving for the maples by which they would not only ask for this gift but express their gratitude directly to the trees.

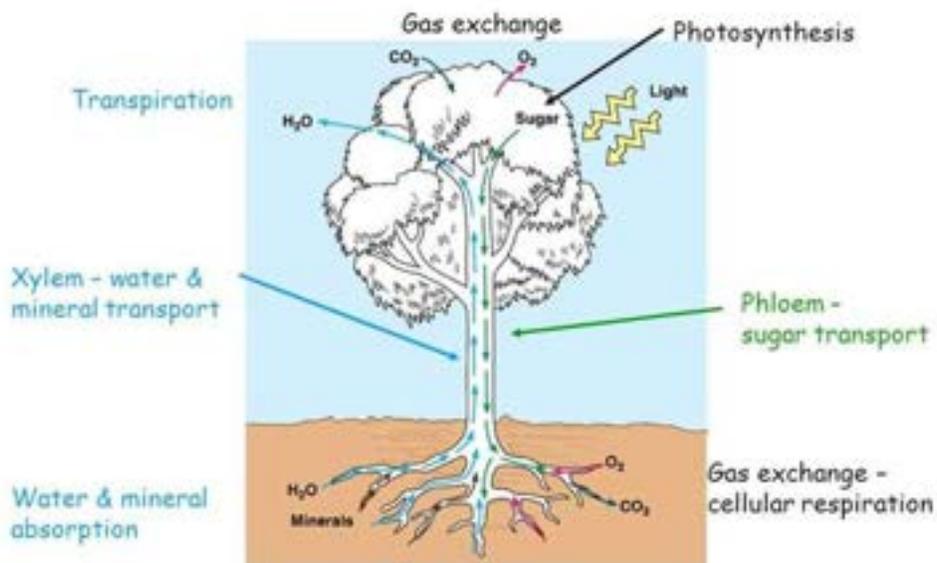
This is how maple syrup came about, one of the many things developed by the Iroquois and shared with the world. It is also one of the 13 ceremonies the Iroquois hold to this day to mark the lunar years and to celebrate the blessings of life.

Resource: Doug George-Kanentiio, Akwesasne Mohawk, is the vice-president of the Hiawatha Institute for Indigenous Knowledge. He has served as a Trustee for the National Museum of the American Indian, is a former land claims negotiator for the Mohawk Nation and is the author of numerous books and articles about the Mohawk people. He may be reached via e-mail at: [Kanentiio@aol.com](mailto:Kanentiio@aol.com) or by calling 315-415-7288.

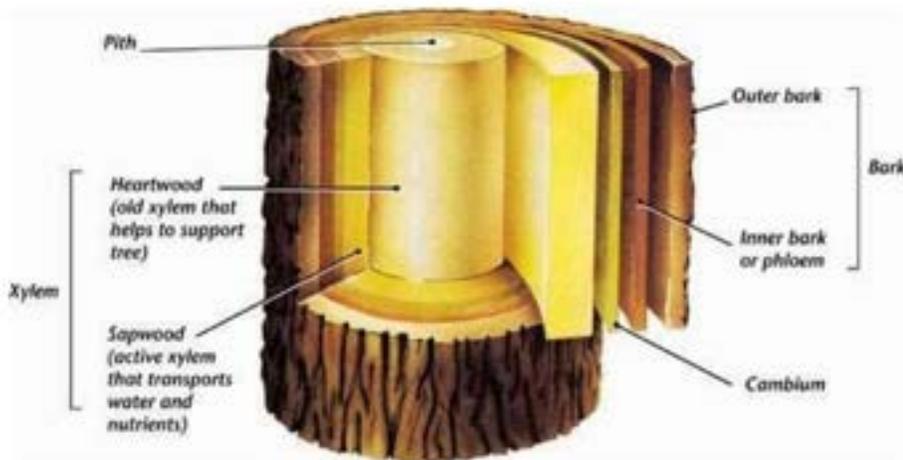


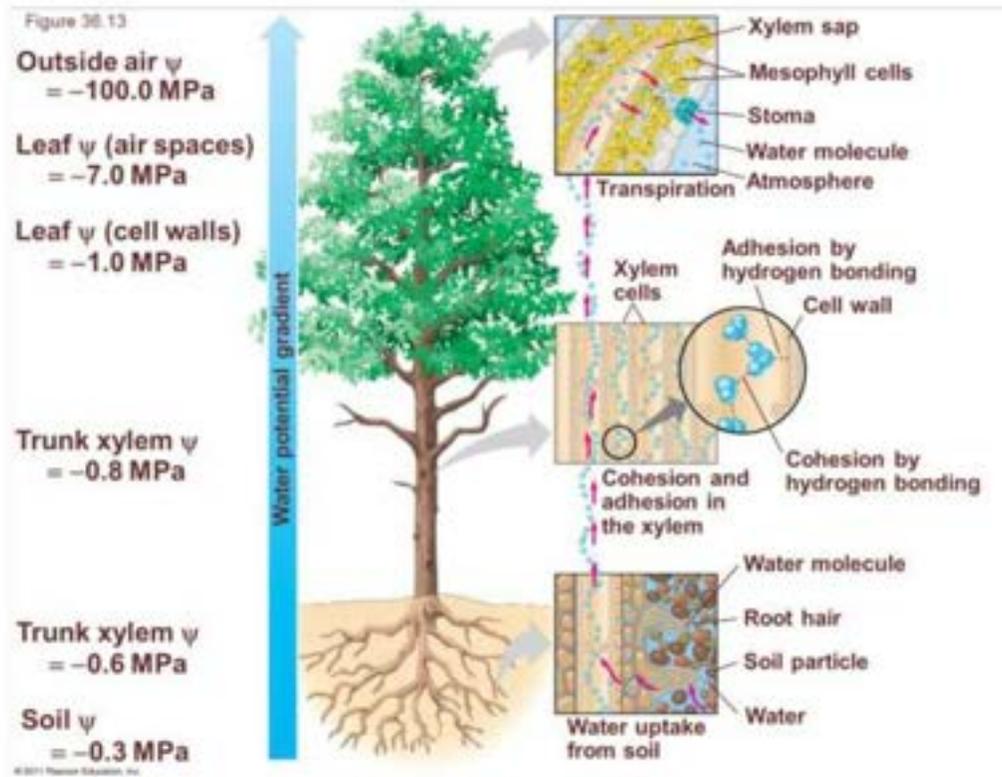
### Wahta Diagrams

# TRANSPORT IN PLANTS



Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.





Worksheet Links for further activities:

<https://extension.psu.edu/from-the-woods-maple-syrup-a-taste-of-nature>

# Caring for Creation Terminology

- Haudenosaunee (hoe-dee-no-SHOW-nee) (People who build a house or People of the Longhouse including the Seneca, Cayuga, Onondaga, Oneida, and Mohawk of the Confederacy).
- Akwesasne- The land where the partridge drums. This location is in New York State, Quebec, and Ontario. It is the traditional hunting and fishing lands of the Kanienkehaka (Mohawk)
- Onkwehonwe- the original beings
- Kanienkehaka- people of the flint
- Kanien'keha - language of the people of the flint- how they speak
- Ohénton Kariwatékwén- the words that come before all else, also known as the Thanksgiving Address
- Ohne:ka- water
- Iethi'nistenha Ohontsia- land/earth
- Kentsionshona - the fish
- Kanionta- Minnows
- Okwire'shon:'a- the trees
- Ohente'shon:'a- grasses
- Ononhkwa'shon:'a- medicines
- Ohtera'shon:'a- roots
- Wah:ta oh:sés- maple tree
- Onen'takwenhten:sera- cedar tree



## Caring for Creation Supplemental Resource List

### Indigenous Conservation Contribution to Canada

Indigenous peoples are the original stewards of their lands and waters. Historically and today, a relationship between all diverse populations will grow the strength needed to protect the environment. It is critical for the future of healthy ecosystems and communities, and it results in effective and durable sustainable management over time in balance and reciprocity with Mother Earth.

### Indigenous Role Models

Waneek Horn Miller (Water Polo Olympian), Ashley Callingbull (Miss Universe), Sarain Fox (Activist & Filmmaker), Roxanne Whitebean (Film Maker), Tracey Deer (Film Maker), Shannen Koostachin (Shannen's Dream)

<http://education.afn.ca/afntoolkit/web-modules/plain-talk-13-first-nations-role-models-and-scholarships/role-models/>

Autumn Peltier & Xiuhtezcatl Martinez <https://www.dosomething.org/us/articles/7-young-indigenous-activists-standing-up-for-their-communities>

Tara Houska

<https://www.aptnnews.ca/facetoface/tara-houska-resistance-line-3-minnesota-police/>

### Children's Books:

- We Are Water Protectors by Carole Lindstrom, illustrated by Michaela Goade
- Nibi's Water Song Hardcover – Aug. 1 2019 by Sunshine Tenasco (Author), Chief Lady Bird (Illustrator)
- The Water Walker Hardcover – Picture Book, Sept. 5 2017

Ojibwa edition by Joanne Robertson (Author)

- Stand Like a Cedar Hardcover – Picture Book, Feb. 23 2021

by Nicola I. Campbell (Author), Carrielynn Victor (Illustrator)

Ontario Plant Identification Fieldguide

Plants of Southern Ontario: Dickinson, Richard, Royer, France: 9781551059068: Books - Amazon.ca

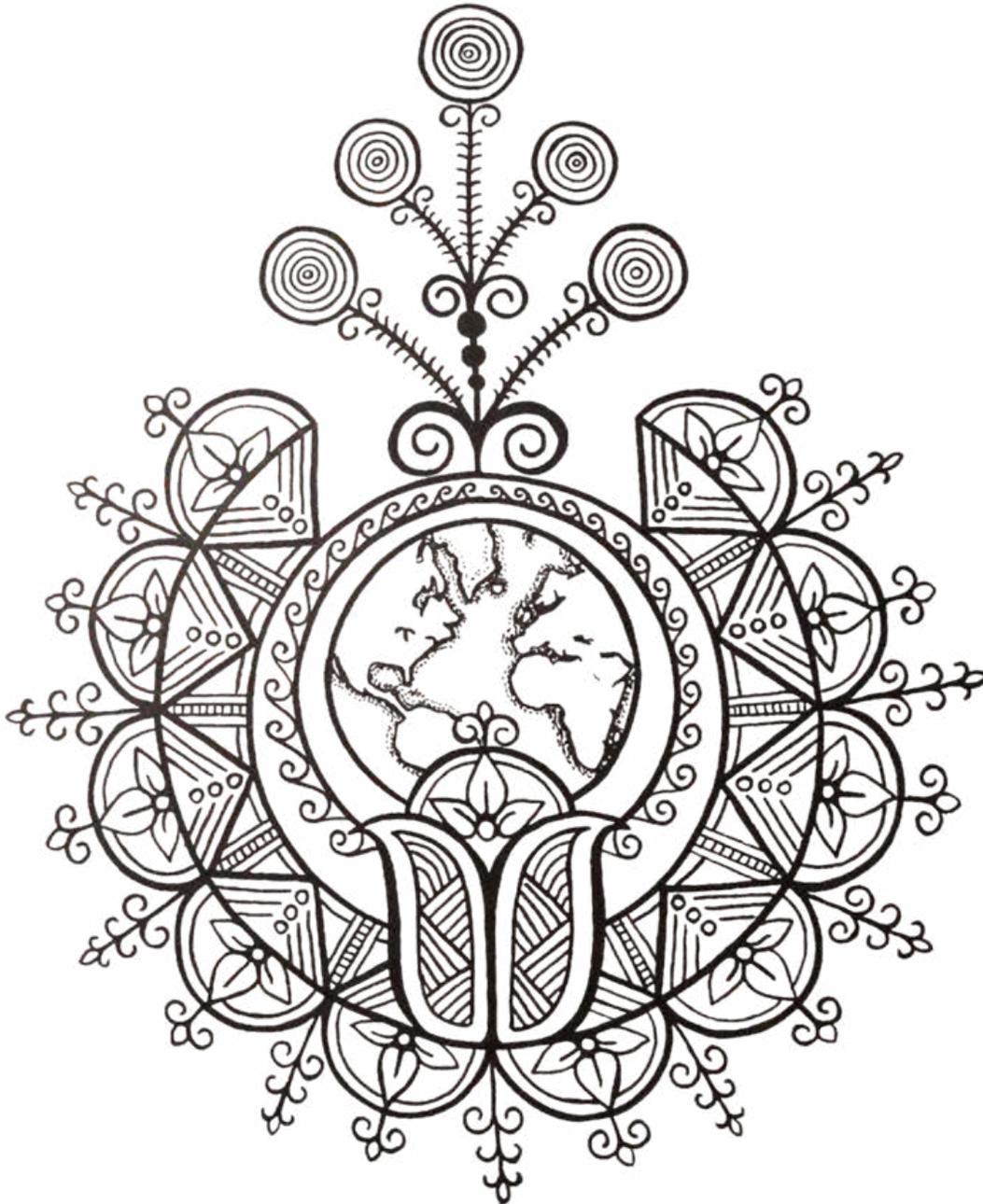


Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



United Nations Association in Canada  
Association canadienne pour les Nations Unies





Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



United Nations Association in Canada  
Association canadienne pour les Nations Unies



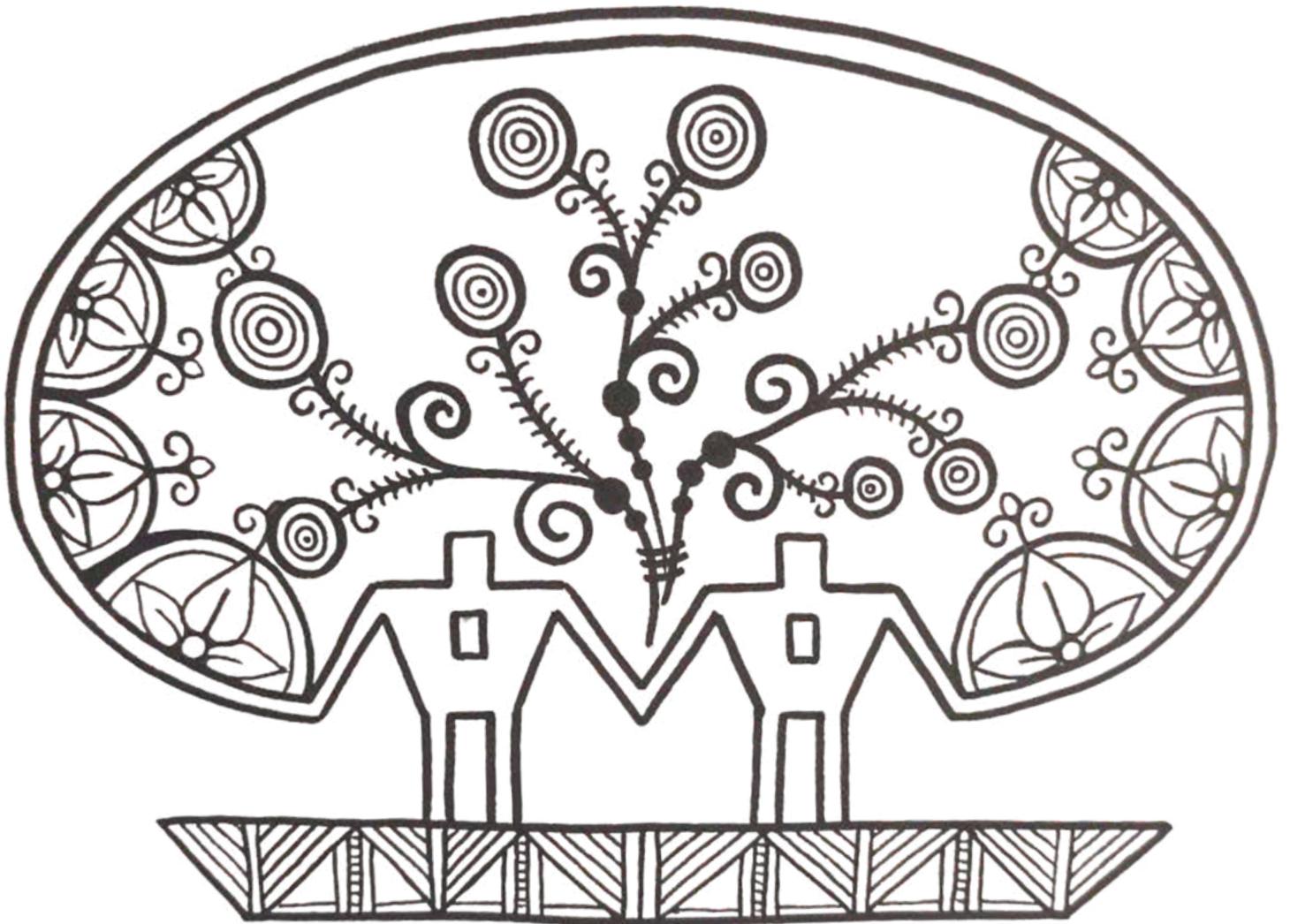


Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



United Nations Association in Canada  
Association canadienne pour les Nations Unies





# Ohén:ton Karihwatéhkwen (Thanksgiving Address)

In oral tradition, the Rotinonhsyón:ni “open” gatherings of people with the Ohén:ton Karihwatéhkwen, commonly referred to as the “Opening Address” or the “Thanksgiving Address”. A more literal translation, in the words of Elder Tom Porter is “what we say before we do anything important”.

This ceremony acknowledges and recognizes the importance and relationship of all life forces in Creation. The purpose is to bring the minds of everyone at the gathering together as one.



Below is a short version of the Ohén:ton Karihwatéhkwen; there are many written versions, all reflecting the same purpose. In oral tradition, as the Speaker is speaking in the moment and from his heart, rarely will the exact wording be used each time it is conducted.



<b>Mohawk</b>	<b>English</b>
Kentsyóhkwa sewatahonsí:yohst kén' nikarihwéhsha	Everyone (the group) listen well for a short time.
Ne kati tentshitewanonhwera:ton ne Shonkwaya'tishon ne wahi rohsa'anyon tsi nahoten teyo'tawenrye ne kentho tsi ohwentsya:te.	I will give thanks to the Creator for the things that go about on the earth.
Akwé:kon éhnska entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne onkwe'shon:'a. Etho niohtónha'k ne onkwa'nikón:ra.	We will make our minds one and give thanks to the people. Now our minds are one.
Akwé:kon éhnska entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne yethinihstenha tsi ohwentsya:te.Etho niohtónha'k ne onkwa'nikón:ra.	We will make our minds one and give thanks to our mother the earth. Now our minds are one.
Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne ohneka'shon:'a. Etho niohtónha'k ne onkwa'nikón:ra.	We will make our minds one and give thanks to the waters. Now our minds are one.
Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne kentsyon'kshon:'a. Etho niohtónha'k ne onkwa'nikón:ra.	We will make our minds one and give thanks to the fish. Now our minds are one.



<h2 style="text-align: center;">Mohawk</h2>	<h2 style="text-align: center;">English</h2>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne ohtera'shon:'a. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the roots. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne ohente'shon:'a. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the grasses. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne ononhkwa'shon:'a. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks to the medicines. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne otsinonwa'shon:'a. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks to the bugs. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne tyonnhehkwen. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks to the sustenance foods. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne kahi'kshon:'a. Etho nyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the fruit. Now our minds are one.</p>



<h2 style="text-align: center;">Mohawk</h2>	<h2 style="text-align: center;">English</h2>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne kontirio. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the animals. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne karonta'shon:'a. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the trees. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne otsi'ten'okon:'a. Etho niyohtónha'k ne onkwa'nikonhra.</p>	<p>We will make our minds one and give thanks for the birds. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne kaye:ri nikawera:ke. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the four winds. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon tetshitewanonhera:tons ne etshitewa'tsi:'a entyekhenhnekha karahkwa. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for our elder brother the sun. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne yethihsosha ahsonthennekha karahkwa. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for our grandmother moon. Now our minds are one.</p>



<b>Mohawk</b>	<b>English</b>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon teyethinonhwera:tons ne ostistohkaronnyon. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for the stars. Now our minds are one.</p>
<p>Akwé:kon éhnska't entitewawenon:ni ne onkwa'nikonhra táhnon tetshitewanonhwera:tons ne Shonkwaya'tishon tsi niyoyaneres nahoten'shon:'a rosa'anyon ne sken:nen aetewatonnyonhseke. Etho niyohtónha'k ne onkwa'nikón:ra.</p>	<p>We will make our minds one and give thanks for our Creator for the good things we will continue to think peacefully about.</p>
<p>O:nen tho niyore wa'katerihwatkwé:ni, tokat othe:nen shonke'nikónhrhen, i:se kí' ne'e aesewatashón:teron. É:tho'k nikawén:nake.</p>	<p>Now I have done all I can do, if there is anything I have forgotten, it's up to you to fix it. That is all.</p>



# Personal Gratitude

## Basic words you can use when giving thanks alone

Tekhenonhwerá:tons ne  
(I thank them) (the)

1. Onkwehshòn:'a – People
2. Ionkhi'nisténha Ohóntsia – Our Mother Earth
3. Ohneka'shòn:'a – Waters
4. Kentsion'shòn:'a – Fish
5. Ohonte'shòn:'a – Grasses
6. Ohtehra'shòn:'a - Roots
7. Ononhkwa'shòn:'a – Medicines
8. Kaienthóhsera/Kionnhéhkwen – Food plants
9. Kahihsòn:'a - Fruit
10. Otsi'nonwa'shòn:'a – Insects
11. Kontírio – Wild animals
12. Okwire'shòn:'a – Trees
13. Otsi'ten'okòn:'a – Birds
14. Ionkhihsothokòn:'a Ratiwè:ras – Our Grandfathers the Thunders
15. Kaié:ri Nikawerá:ke – Four Winds
16. Shonkwahtsi:'a Enkiehkehnhéhkha Karáhkwa – Our Elder Brother the Sun
17. Ionkhihsótha Ahshonthenhénéhkha Karáhkwa – Our Grandmother Moon
18. Otsistohkwa'shòn:'a – Stars
19. Kaié:ri Niionkwè:take – Four Beings
20. Takia'tison – My Creator

Onkwehshòn:'a

Ionkhi'nisténha Ohóntsia



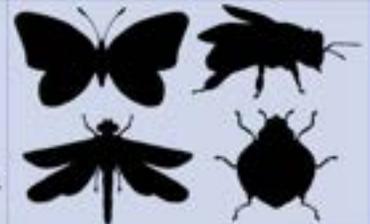
Ohneka'shòn:'a

Kentsion'shòn:'a



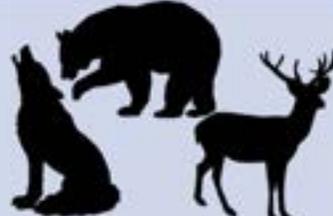
Kahihsòn:'a

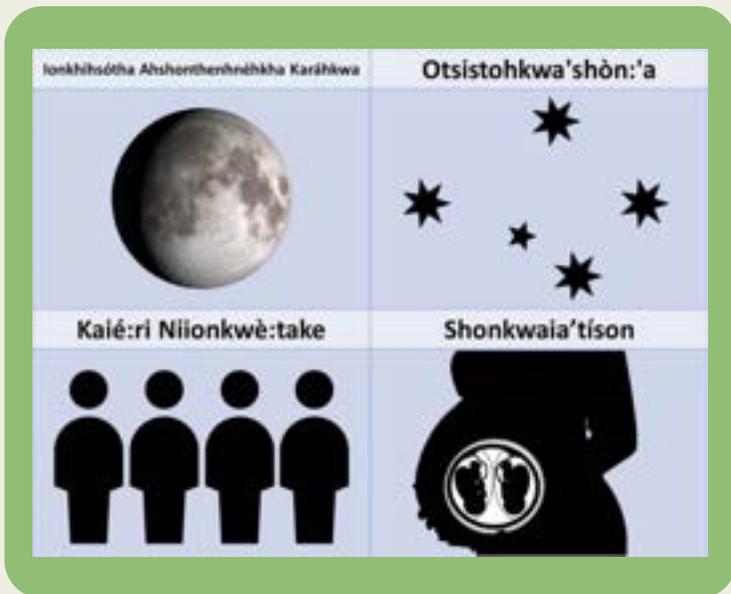
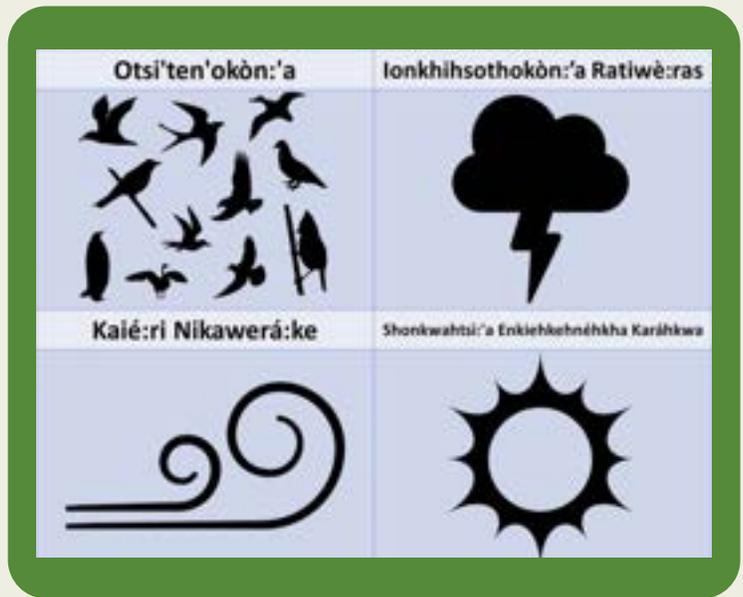
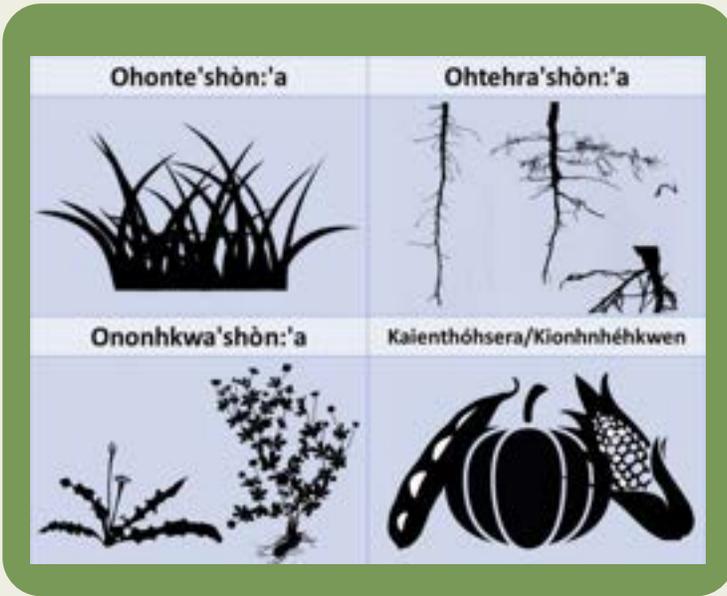
Otsi'nonwa'shòn:'a



Kontírio

Okwire'shòn:'a







Environment and  
Climate Change Canada

Environnement et  
Changement climatique Canada



United Nations Association in Canada  
Association canadienne pour les Nations Unies





### Water Muddle Up and Clean Up

In this activity, adapted from the lesson *There Is No Point to This Pollution* in the *Water Quality Educators Guide* by *Healthy Water, Healthy People*, students use critical thinking to predict how water becomes polluted. This activity is designed to safely model the ways in which pollutants and hazardous chemicals may react when they reach water and the cumulative effect of land uses on water quality. Common household items (food coloring, vegetable oil and corn syrup) represent pollutants and also hazardous chemicals that are commonly found at hazardous waste sites, including Superfund sites, across the country. By simulating the contamination of water by various kinds of chemicals, students are introduced to current information on hazardous waste sites in North Carolina and the clean up techniques being employed.

#### Alignment to North Carolina Standard Course of Study for Science

This lesson addresses the Science in Personal and Social Perspectives strand along with specific learning objectives:

##### 8<sup>th</sup> Grade Science

Objective 3.07: Describe how humans affect the quality of water:

- Point and non-point sources of water pollution in North Carolina.
- Economic trade-offs.
- Local water issues.

Objective 3.08: Recognize that the good health of environments and organisms requires:

- Monitoring of the hydrosphere.
- Water quality standards.
- Methods of water treatment.
- Maintaining safe water quality.
- Stewardship.

Objective 4.01: Understand that both naturally occurring and synthetic substances are chemicals.

##### Earth and Environmental Science

Objective 1.01: Identify questions and problems in the earth and environmental sciences that can be answered through scientific investigations.

Objective 1.05: Analyze reports of scientific investigations and environmental issues from an informed scientifically literate viewpoint.

Objective 1.06: Identify and evaluate a range of possible solutions to earth and environmental issues at the local, national, and global level.

Objective 4.04: Evaluate water resources:

- Environmental impacts of a growing human population.
- Causes of natural and manmade contamination.

##### Essential Questions

- How do chemicals of varying properties and densities behave in water?
- How does water become contaminated by one or more chemicals?
- How does land use impact water quality?
- How can hazardous chemicals be removed from water?

##### Materials:

- Large clear bowl or clear 2-liter bottle
- Tap water
- Food coloring
- Gravel (optional)
- "Water pollutants/hazardous chemicals:"
  - two small dropper bottles of diluted food coloring (blue and red are easy to see)
  - one bottle of vegetable oil
  - one bottle of corn syrup
  - powdered cocoa or hot chocolate mix



- Transparent, small plastic cups (1 per student or student pair if working as partners; fewer if used as instructor demonstration)
- Copies of *Student Worksheet*, *Loop Lake Map*, and *Pollutant Description Sheet*, one per student or student pair

#### Duration

- One 50 minute class period or less, depending on how you utilize the lesson.

#### Teacher Preparation

1. Fill a large clear bowl (or clear 2-liter bottle) half-full with clear water and gravel (optional) to create a shoreline, and place it in a central location in the classroom. Tell students that this bowl of water represents a lake that is surrounded by properties with different land uses. This "lake" could also represent a local lake or stream and students could be prompted to consider the types of properties that surround this local water resource.
2. Ask students to brainstorm a list of land uses and the types of pollutants that might end up in this lake as a result of these different land uses. Write student responses on the board.
3. Next, explain the difference between point source pollution (pollution source is a known point, for example, an effluent pipe from a factory), and nonpoint source pollution (pollution source is not defined by a point, also called runoff, for example, oil and gas washed off city streets from cars).
4. Go through the list of pollutants on the board and have students identify whether each pollutant they listed would be classified as a point source or nonpoint source pollutant.
5. To conclude this discussion, introduce the following phrases that are often used to describe the chemical nature of water pollutants: water-soluble, light, non-aqueous phase liquids (LNAPLs), dense, non-aqueous phase liquids (DNAPLs) and ask the students to consider the chemical nature of each pollutant they listed in Step 2. LNAPLs and DNAPLs are commonly found at hazardous waste sites, including Superfund sites, across the country. A Superfund site is a hazardous wastes site that has been identified by the US Environmental Protection Agency (EPA) as a candidate for clean up because it poses a risk to human health and/or the environment. Additional details about these classes of water pollutants can be found on the *Pollutant Description Sheet*.

#### Option for Extension

- Ask your students to visit EPA's Drinking water website at <http://www.epa.gov/safewater/index.html> and identify chemical contaminants that arise from man-made sources/different land uses.

#### Procedure (Also works well as an instructor demonstration)

1. Distribute one copy of the *Student Worksheet*, the *Pollutant Description Sheet*, and the *Loop Lake Map* to each student or student pair.
2. Provide each student/student pair with approximately 25 ml of tap water in a small transparent cup.
3. Each student/student pair will represent one property owner and the water in their cup represents the water that flows across their property and into Loop Lake, which is surrounded by the various land uses.
4. Assign each student/student pair a property from the list below. One way to assign properties is by highlighting the property on the Loop Lake Map prior to passing out to students. The table below highlights each property (land use), provides examples of a pollutant that might result from such land use and indicates how the pollutant would be classified based on the phrases introduced in Step 5 above.

	Property (Land Use)	Example of Pollutant	Class of Pollutant
1	Older Housing Development	Pesticides and Fertilizers	Water-soluble
2	Plant Nursery	Pesticides and Fertilizers	Water-soluble
3	Strip Mall Parking Lot	Gasoline	LNAPLs
4	The Holstein Farm with a leaking underground fuel tank	Gasoline	LNAPLs
5	Electrical Transformer Factory	PCBs	DNAPLs
6	Dry Cleaners	TCE or PERC	DNAPLs
7	Subdivision (Under Construction)	Sediment	
8	Loop Lake Park and Dog Park	Sediment	

5. Ask students to complete questions #1 and #2 on the *Student Worksheet*. Depending on their assigned property, students may come up with a variety of pollutants; ask them to select one to focus on for the remainder of the activity.



6. For question #3 on the Student Worksheet, show students the “contaminants” they will select from to represent the pollution arising from the land use on their assigned property. Additional materials can be used to represent other common pollutants such as pet waste and litter.

Pollutant	Pollution Indicator
Water soluble contaminants <i>Examples: pesticides and fertilizers</i>	Food coloring – dilute 5 drops in ½ cup of water
Light non-aqueous phase liquids (LNAPLs) <i>Example: gasoline, MTBE</i>	Vegetable oil
Dense, non-aqueous phase liquids (DNAPLs) <i>Example: TCE, PCBs</i>	Corn syrup with red food coloring added
Sediment	Powdered cocoa or hot chocolate mix
Pet Waste/Sewage	Instant Coffee
Litter	Colored Sprinkles

7. Have each student/student pair place a small amount (e.g., a couple drops of diluted food coloring, cooking oil, or colored corn syrup or a pinch of cocoa) of pollutant into his or her cup. Depending on the available time and the level of students, students do enjoy selecting more than one “pollutant” to add to their cup.
8. Ask students to complete questions #4, #5, and #6 on the Student Worksheet.

**Question #4 Observe your pollutant in water. Describe how it behaves and its chemical properties (solubility, density, etc.):**

*Water soluble chemicals easily mix with water.*

*LNAPLs are less dense than water and are not water soluble so they float on the surface.*

*DNAPLs are more dense than water and are not water soluble so they sink to the bottom of the cup.*

**Question #5 Locate your property on the Loop Lake Map; describe how your pollutant might travel from your property to Loop Lake:** *Pollutants may travel to the lake by surface runoff (storm water moving over the surface) or subsurface flow (e.g., a leaking storage tank can release a pollutant that moves via groundwater, moving down-slope through the soil) and reach the lake directly or first enter a stream and then get transported by the stream to the lake. Depending on the level of students, you may also choose to prompt them to consider the topography of their property relative to Loop Lake.*

**Question #6 Based on the behavior of your pollutant in water, how do you think a scientist would try to remove it from water?** *For hazardous substances, students may discuss treatments for groundwater (pump and treat, containment, treat in ground through natural processes) or surface water (prevent spreading, treat with natural processes, or skim from surface). For sediment, students may discuss dredging, preventing erosion, etc. For more detailed descriptions about clean-up options, read below:*

**Clean-Up of Water-soluble contaminants**

*One possibility might include dilution where the additional water is added to the existing groundwater and thus the pesticide is eventually present in fewer parts per million (ppm). Ask, “What are some of the disadvantages to this method?” Another possibility is the pump and treat method where groundwater is pumped out, filtered to remove the contaminant and then the cleaned water is returned to the ground. Ask, “What are some of the advantages and disadvantages to this method?”*

**Clean-Up of Light non-aqueous phase liquids (LNAPLs)**

*Possible answers include: drilling and then pumping out the oil, filtering, containing the oil from spreading, using absorbent materials to remove the oil, etc. Another method is bioremediation, which is the use of bacteria or plants to remove or neutralize pollutants. Dr. Mike Aitken and Dr. Fred Pfoender, scientists with UNC Chapel Hill’s Superfund Research Program, study ways to use bioremediation to clean up a specific class of chemicals found in some LNAPLs, called polycyclic aromatic hydrocarbons (PAHs). PAHs are major contaminants in soil and groundwater at a number of sites across the U.S., and many of the PAHs are known or suspected carcinogens.*

**Clean Up of Dense non-aqueous phase liquids (DNAPLs)**

*Clean up of DNAPLs is challenging due to the density and insolubility of the chemicals. Because DNAPLs sink to the bottom of the aquifer, they are particularly hard to clean up. Clean up options include allowing natural processes to breakdown the contaminant, using a detergent to clean contaminated soil, applying thermal desorption technologies*



(using high heat to remove contaminants from sediment), and isolating the contaminated area using concrete dikes or by capping with impervious layers of plastic/clay.

#### Clean Up of Sediment

To decrease the amount of sediment reaching our waterways and prevent unnecessary erosion, farmers use techniques such as contour tilling, loggers leave buffer zones of trees along rivers, lakes and oceans, and builders and homeowners plant or leave vegetation along stream banks.

An interactive Superfund hazardous waste site activity designed to help students read about how to clean up groundwater contamination, surface water contamination, soil and air contamination is available at:

<http://www.epa.gov/superfund/students/wastsite/index.htm>

#### Option for Extension

- You may also choose to prompt students to identify any impervious surfaces that might be present on their property. The lesson *Rescuing Water from the Roof* <http://www.niehs.nih.gov/health/docs/water-roof.pdf> can be integrated into Water Muddle Up, Clean Up in order to emphasize the impact of impervious surfaces on water quality.
8. Next, ask each property owner either individually or grouped by contaminant to come to the front of the room and empty their cups containing their "contaminant" in "Loop Lake". This is a great time for a variety of discussions. One way to conduct this portion of the activity is as follows: Ask students who had a water-soluble contaminant to pour their water into Loop Lake, announcing their property and indicating which pollutant is present in their cup of water. Prompt students to identify some of the contaminant's properties, such as solubility and density, and describe how scientists might clean it up, and identify if their contaminant pollutes water via nonpoint or point source pollution.
  9. Point out to the students that although each individual property contributed only slightly polluted water, once the whole class added their polluted water, the lake became very polluted. Students should be able to see through each of their individual samples, but the lake water should become murky and dark. This illustrates the cumulative effect of point and nonpoint sources of pollution.
  10. If PCBs were released by the electrical transformer property, "Loop Lake" has now become a hazardous waste site; thus, this activity provides an engaging segue into a discussion of hazardous waste sites and the methods that can be used to clean up pollution of water, soil and sediment.
  11. The following activities can be used to further explore hazardous waste sites, including Superfund sites, and to explore options for clean up (remediation).
    - Have your students use various items to try and clean up "Loop Lake" now that it is polluted. Provide them with paper towels, cups, pipettes, liquid pump dispensers, etc. Inform your students that scientists are researching the most effective ways to clean up chemical contamination of ground and surface water. This is also a good activity to illustrate that clean up is never one hundred percent efficient; there are always going to be chemicals left behind in water and soil (this may also be demonstrated by the amount of pollutant left behind in the students' cups after they pour their contaminated water into the lake).
    - Students can investigate the characteristics of specific Superfund sites in North Carolina by visiting <http://www.epa.gov/region4/waste/npl/index.htm#NC> and clicking on the site of interest. They may be surprised to learn that a Superfund site exists nearby! A worksheet that students can use to investigate a Superfund site of interest is available for download from LEARN NC: [http://www.learnnc.org/lp-media/uploads/2010/12/investigating\\_a\\_superfund\\_site.pdf](http://www.learnnc.org/lp-media/uploads/2010/12/investigating_a_superfund_site.pdf)
    - Remind your students that scientists are also researching the health effects of exposure to hazardous chemicals. To find out the biomedical research taking place within the UNC Superfund Research Program, visit [www.uncsrp.org](http://www.uncsrp.org)

#### Additional Resources

EPA's Superfund Program

Resources for Students and Teachers

[http://www.epa.gov/superfund/students/class\\_act/index.htm](http://www.epa.gov/superfund/students/class_act/index.htm)

UNC Superfund Research Program

<http://www.uncsrp.org/>



**Water Muddle Up and Clean Up**

*Adaptation of There Is No Point To This Pollution!*

**Student Worksheet**

**Procedure:** You will be given a map of Loop Lake Map along with a Pollutant Description Sheet; refer to these to fill out this worksheet. You will also be given a cup with water; this represents the water that flows across your property and into Loop Lake.

1. Observe the highlighted property on your map. Write the name of this property below:
  
2. Consider the activities that take place at this location and review the Pollutant Description Sheet. List one or more pollutants that your property might be responsible for generating:
  
3. Pick one of the pollutants from your list and place a small amount (e.g., a couple drops of diluted food coloring, cooking oil, or colored corn syrup or a pinch of cocoa) of pollutant into your cup according to the pollution indicators provided by your teacher.

Write the name of the pollutant you selected here: \_\_\_\_\_

4. Observe your pollutant in water. Describe how it behaves and its chemical properties (solubility, density, etc.):
  
5. Locate your property on the Loop Lake Map; describe how your pollutant might travel from your property to Loop Lake.
  
6. Based on the behavior of your pollutant in water, how do you think a scientist would try to remove it from water?
  
7. When instructed, pour the contents of your cup into Loop Lake.



## Pollutant Description Sheet

---

### Water-soluble contaminants

Many pesticides and fertilizers are water-soluble contaminants, meaning that they readily dissolve in water. Lawns may be one source of pesticides and fertilizers. Another source may be a nursery or farm. Barber Orchard is an example of a hazardous waste site, or Superfund site<sup>1</sup>, contaminated with arsenic, lead, and pesticides. Located in Waynesville, Haywood County, NC, this property was used as a commercial apple orchard from 1903 until the mid 1980's. In the late 1980's, some of the land was sold and homes were built on it. In 1999, contaminants were found in the soil, and/or in the majority of drinking water wells.

### Light non-aqueous phase liquids (LNAPLs)

LNAPLs do not dissolve in water and are less dense than water, and therefore, they float on top of the water table. Benzene, toluene, jet fuel and gasoline are all examples of a LNAPL. LNAPLs' low solubility contributes to their ability to remain as groundwater sources of contamination for extended periods. However, over time the liquids spread laterally and begin slowly dissolving into the water, making the chemicals harder to extract. Parking lots may be one source of gasoline and oil. Potter's Septic Tank Service Pits in Sandy Creek, Brunswick County, NC, is a hazardous waste site contaminated with LNAPLs. Nearby groundwater was contaminated with LNAPLs from an oil spill, which was traced to one of the four disposal pits at the site.

### Dense Nonaqueous-Phase Liquids (DNAPLs)

DNAPLs do not dissolve in water and are denser than water. These toxic chemicals sink and form pools at the bottom of an aquifer. DNAPLs can enter moving groundwater and potentially pollute large areas over time. Trichloroethylene (TCE) and tetrachloroethylene (PERC) are examples of DNAPLs that are more commonly known as chlorinated solvents. They are often used in metal cleaning, degreasing, dry cleaning, leather tanning, pharmaceuticals and paints. They are highly carcinogenic chemicals that can be found at many Superfund sites including the Massachusetts site featured in the book and movie, *A Civil Action*. Both of these chemicals were also found at the Camp LeJeune Superfund site in Onslow County, NC. Another example of DNAPLs is polychlorinated biphenyls (PCBs), which were used as a coolant in electric transformers. PCBs are found at the Ward Transformer Superfund site in Raleigh, NC.

### Sediment

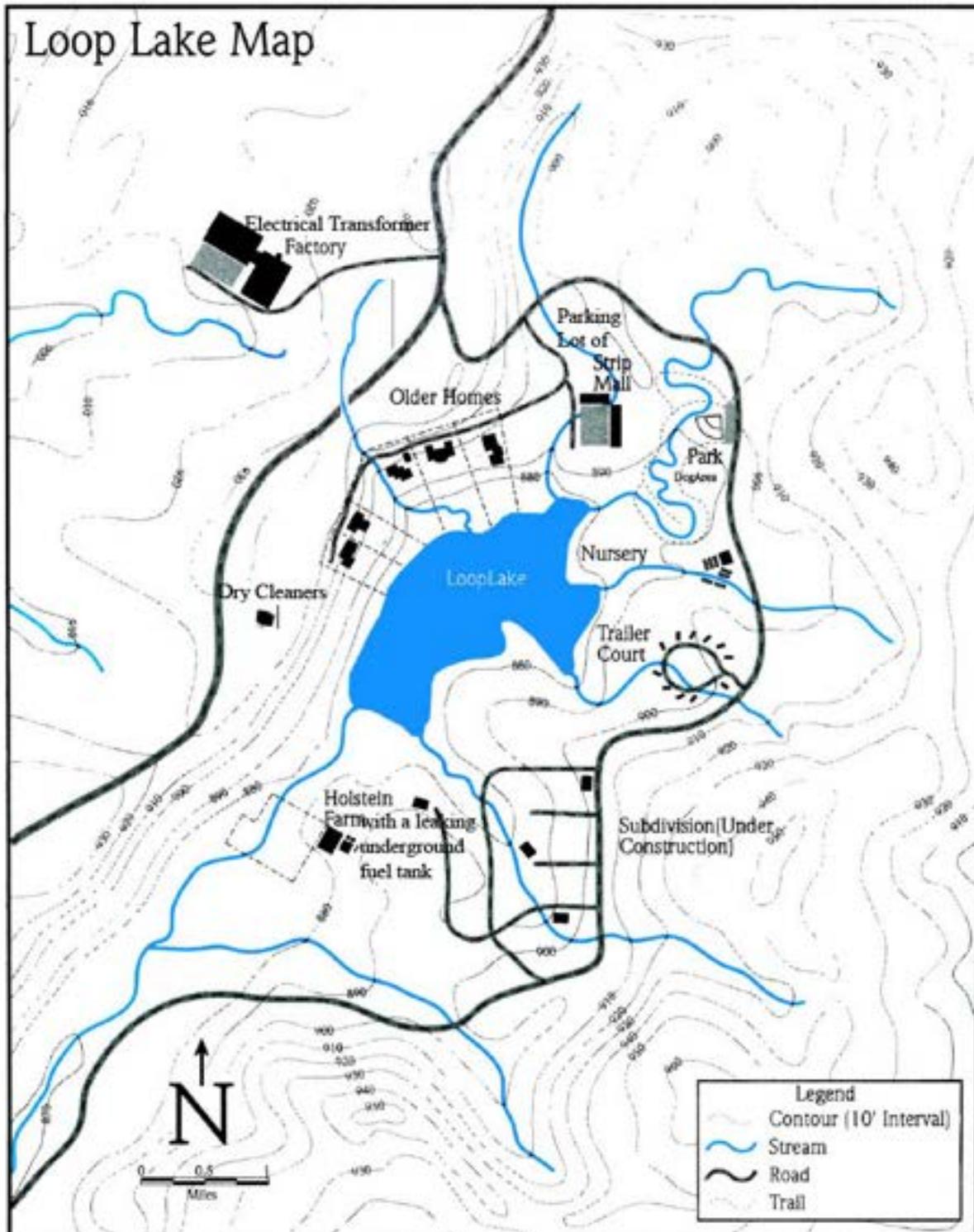
Sediment is soil that can be transported in water. The leading water quality problem in many water ways is sediment coming from storm water runoff. Construction sites can be a significant source of sediment as can bare spots on lawns and stream banks. The particles in sediment may be suspended in the water, making it look cloudy, and over time they may settle to the bottom. Sediment can make it difficult or impossible for aquatic plants to grow and can destroy aquatic habitats. Chemicals may also bind to sediment particles and accumulate on the bottom of a lake or river, where they can adversely affect aquatic habitats.

---

<sup>1</sup> A Superfund site is a site where hazardous wastes are located and the US Environmental Protection Agency (EPA) has identified it as a candidate for cleanup because it poses a risk to human health and/or the environment.



Student Copy Page  
Adapted from Project WET USA and IT's Our Water





## Activity 2

# Examining a Hazardous Waste Site



<b>Duration</b>	2 class periods
<b>Grade Level</b>	9-12
<b>Key Terms/ Concepts</b>	Aquifer Contamination Hazardous waste Superfund Water table
<b>Suggested Subjects</b>	Chemistry Earth Science Geology Physical Science

## Purpose

This activity helps students understand how Superfund sites are created. They discuss what activities produce hazardous waste, and how contaminants are released and spread into the air, water, soil, and groundwater. Students learn what types of pollution can be cleaned up using Superfund authority and what types are addressed through other laws. Students construct a model to observe how contaminants move in groundwater.

## Background

The U.S. Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in response to growing concern about health and environmental threats from hazardous waste sites. This law is commonly called **Superfund**. Working with states and Indian Tribal governments, Superfund requires the U.S. Environmental Protection Agency (EPA) to deal with abandoned, accidentally spilled, or illegally dumped **hazardous wastes** from the past, primarily from businesses and industry. Other types of pollution are handled by other environmental laws.

The Superfund program has a process for reporting and keeping track of potentially contaminated sites. Since the early 1980s when the law took effect, more than 37,000 hazardous waste sites have been reported. EPA must investigate each of the sites to determine the seriousness of the **contamination**. Only the most serious sites are cleaned up using Superfund authority; approximately four percent of reported sites are being cleaned up under Superfund. Sites not handled by the Superfund Program will be cleaned up by state governments or under other laws, or will require no cleanup because they pose no danger to people or the environment.



## Activity 2

It is important to keep in mind that the Superfund Program deals only with abandoned, accidentally spilled, or illegally dumped hazardous substances. A number of other major environmental laws—such as the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Clean Air Act, the Toxic Substances Control Act, and the Safe Drinking Water Act—were enacted to deal with other types of pollution.

To help prepare your students for this activity, use *Warm-Up 6: What is an Aquifer?* You can perform the entire Warm-Up or simply review the major points covered in it.

For more information on hazardous waste sites and cleanups, see the Suggested Reading list found at the end of the Haz-Ed materials. Other Haz-Ed materials that are related to the topic include *Warm-Up 2: EPA's Superfund Program—Overview*.

## Preparation

1. Gather the following materials (*NOTE: You can split the class into 4 groups if desired and have each group do the experiment.*)
  - bottom part of a clear, plastic two-liter soda bottle
  - pump mechanism from a liquid soap dispenser
  - small piece of nylon fabric to cover the end of the pump tube
  - tape
  - resealable plastic sandwich bag with 2 cups of small pebbles or aquarium gravel (white or light-colored)
  - resealable bag with 2 cups of clean sand (white sand is best)
  - large coffee filter (round with a flat bottom, not cone-shaped)
  - clean spray bottle, the type spray window cleaner comes in
  - bottle of red food coloring
  - clear measuring cup (2-cup size)
  - copies for each student of:
    - Fact Flash 1: Hazardous Substances and Hazardous Wastes*
    - Fact Flash 2: The Superfund Cleanup Program*
    - Fact Flash 5: Groundwater*
  - copies for each student of the following maps from *Fact Flash 3: Flowing Railroad Hazardous Waste Site*
    - Map 1, Flowing Railroad Site
    - Map 2, Flowing Railroad Site Area
    - Map 3, Diked Sludge Pond, Cross-Section



Activity 2



2. Read Fact Flashes 1, 2, 3 and 5 to prepare your lecture.
3. Distribute Fact Flashes 1 and 2 and assign students to read them as homework.

## Procedure

### Class #1

1. Review the main ideas from Fact Flashes 1 and 2.
2. Distribute Map 1, *Flowing Railroad Site* (from *Fact Flash 3: Flowing Railroad Hazardous Waste Site*). This is an overhead view of a fictional site showing where past industrial activities are thought to have taken place. Describe past site activities to the students, using the information in Fact Flash 3.
3. Distribute Map 2, *Flowing Railroad Site Area* (from Fact Flash 3). This is an overhead view of the towns, rivers, and some activities in the surrounding area. Describe the area to students using information from Fact Flash 3.
4. Ask students how they think contaminants might spread from the site. Possible answers include:
  - The wind can blow contaminant vapors.
  - The wind can blow small soil particles to which contaminants are attached.
  - Contaminants can be washed into the Flowing River by rainfall running off the site.
  - Liquid contaminants can flow down through the soil to the groundwater due to gravity.
  - Contaminants can be washed down through the soil to the groundwater by rainfall soaking into the soil.
  - Groundwater moving underground can spread contaminants in the aquifer.
  - Contaminated groundwater can move that uses the Flowing River.
  - Excavation or other activities that disturb the soil on the site can move contaminants.
5. Ask students how animals or plants may be exposed to contaminants from the site. Possible answers include:
  - The wind can blow contaminants to tree leaves, grasses, or crops.
  - Animals can eat contaminated plants.



### Activity 2

- Fish and aquatic plants can be exposed to contaminants washed into the Flowing River.
  - Farmland crops could be exposed to contaminants through the irrigation system that uses water from the Flowing River.
6. Ask students how people in Ruralville and Utopia may be exposed to contaminants from the site. Possible answers include:
- Eating contaminated crops
  - Eating contaminated fish from the Flowing River
  - Utopia residents drinking contaminated water from their municipal wells
  - Ruralville residents drinking contaminated water from the Flowing River
  - Children playing on the site
  - Fishermen crossing the site to get to the Flowing River
  - Ruralville residents breathing air containing contaminated dust blown off the site
  - Ruralville and Utopia residents taking showers with contaminated water.
7. Ask students what factors would affect the amount of exposure from site contamination. Possible answers include:
- Amount of contamination originally released at the site
  - Amount of dispersion of the contaminants
  - Amount of physical, chemical, and biological transformation of the contaminants into harmless compounds
  - Frequency of contact with contaminated water, soil, plants, and animals.
8. Explain to students that in a follow-up class, they will look more closely at how groundwater at the Flowing Railroad hazardous waste site may have been contaminated.
9. Distribute *Fact Flash 5: Groundwater* and assign students to read it prior to the next class.

### Class #2

1. Distribute Map 3, *Diked Sludge Pond, Cross-Section* (from *Fact Flash 3*). Briefly review with students the main points in *Fact Flash 5: Groundwater*, assigned for reading after the first class.
2. Explain that groundwater contamination is a major concern in the Superfund Program, and it is difficult to visualize how contaminants move underground. Therefore, the class is going to construct a small groundwater model to explore how groundwater and contaminants move in an aquifer.

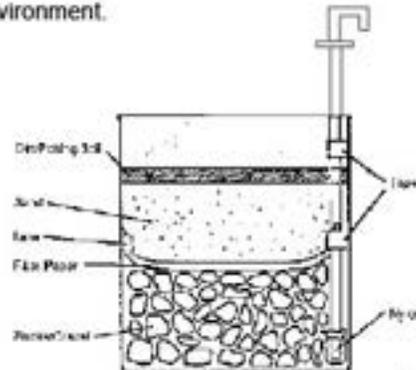


Activity 2



3. Construct a miniature model of a groundwater environment. Choose 2 or 3 students to build the groundwater model at the front of the class. (If you have enough supplies, divide the class into 4 groups and have each group construct its own model.) Use the illustration shown on the next page as a guide.

- Tape the pump mechanism, with the nylon fabric attached, to the inside of the container so that the nylon-covered end of the tube almost touches the bottom of the container.
- Fill the container about one-third full with the pebbles or gravel.
- Spread out the coffee filter and, if necessary, cut the paper to make a circle with a diameter larger than the diameter of the inside of the container. Place the filter paper on top of the pebbles and tape it to the sides of the container.
- Fill the rest of the container with sand. The filter paper will prevent the sand from falling down into the gravel and filling the spaces between gravel particles.



Your groundwater model is now ready for conducting experiments. Have students perform the following steps.

4. Spray water on the sand with the spray bottle, until the sand is saturated. The water will filter down through the sand and into the gravel. Keep spraying until the **water table** (the top of the portion of the ground that is completely saturated with water) is in the sand. Keep track of the amount of water that the container can hold at your selected water table level.
5. Push down on the pump mechanism and slowly draw a little water from the gravel through the tube and out of the pump. Make sure the pump empties into the measuring cup. Explain that the pump mechanism creates a vacuum to draw out the water. This is essentially the same method used to pump groundwater from **aquifers** (underground rock materials that are capable of storing and transmitting water in useful amounts).
6. Spray more water on the sand until you reach your original water level. Then 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 of the container. Explain to the students that the food coloring represents a hazardous waste, such as gasoline, that dissolves in water.

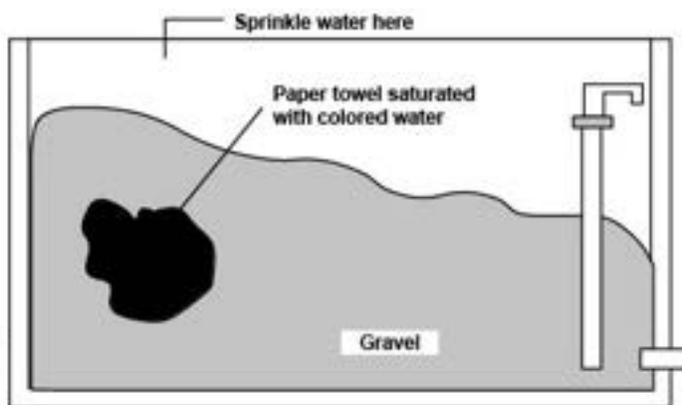


Activity 2

7. Make it rain on your aquifer model by pumping the spray bottle 5 times.
8. Continue pumping water from the container into the measuring cup. The water in the cup will eventually have a reddish hue. Keep track of how much water you have to pump from your groundwater model. Discuss with the students how the pollutant at the surface level has contaminated the groundwater. This is similar to rainwater carrying contaminants underground and into an aquifer. Can the students make any observations about how the pollutant moves downward through the sand from the drop placed by the wall of the container?
9. Ask students to guess how much clean water will have to be sprayed onto the sand to remove all of the food coloring. Continue adding water to the sand and removing water with the pump until the students believe your groundwater has been cleaned up. How much water did it take to clean the aquifer? Was this close to what the students guessed?

*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 food 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.*



10. 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**



Activity 2



**(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.

11. Ask students how your small groundwater model represents contamination at a Superfund site. Answers could include:
  - Contaminants on the ground surface can be washed into groundwater by rainwater.
  - Contaminants in groundwater can be removed by pumping out contaminated groundwater; however, the amount of water needed to clean contaminants from groundwater is far greater than the amount of contamination added.
  
12. Ask students what is different between your experimental groundwater model and a real Superfund site. The following points could be made:
  - A Superfund site can have thousands of gallons of contaminants in the groundwater as opposed to a few ounces.
  - The subsurface at a Superfund site is far more complex than your groundwater model.
  - The water in your model is contained, but at a real Superfund site it almost always is flowing slowly in one direction. Flowing groundwater at a Superfund site can carry contaminants miles from where the contaminants were spilled on the surface. This can make it very difficult to locate a contaminant source once contaminated groundwater is detected.
  
13. 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 was flowing north toward Utopia or south away from Utopia? *(The answer is that residents would be in greater danger if the groundwater was 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.)*

### Extensions (Optional)

- 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.



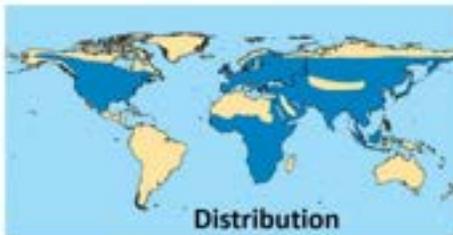
**Activity 2**

- Consider inviting an EPA or state Superfund employee involved in overseeing hazardous waste cleanup projects to discuss a real Superfund site in your state and what made it a Superfund site.
- As an extra credit project, advanced students could use a computer model to predict the movement of contaminants in groundwater under various conditions. Check your local telephone directory for the nearest EPA or United States Geological Survey (USGS) office and contact them about obtaining a copy of the groundwater models they use on a personal computer disk.

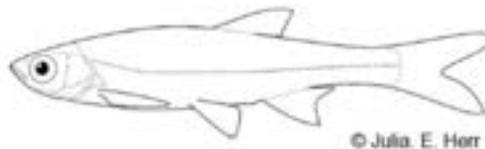


# Minnow (Cyprinidae)

Note:  
They are not baby fish!



What distinguishes a cyprinid from  
all other fishes?



© Julia. E. Herr



- Single dorsal fin without true spines
- Toothless mouth with thin lips
- Pharyngeal arch with 1-3 rows of teeth, each row with a maximum of 8 teeth

