ENGINEERS WITHOUT BORDERS USA

CLEAN WATER CURRICULUM

This project was made possible with the generous support of the United Engineering Foundation

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Teacher's Background

Lesson Plans

CLEAN WATER CURRICULUM

Project Overview

This curriculum is built around the **Project #2: *Clean Water***. The project challenged students at the University of Massachusetts, Amherst (UMass) and the community of Namawanga Village, Kenya, to develop a self-sufficient water supply for several thousand people in the rural farming village of the Namawanga area in western Kenya.

The project's student engineering team included Christina, Mollie, Julie, Tom, Mary, Elsbeth, Chris, and Matt. Project mentors included John Tobiason, professor of civil and environmental engineering, and professional engineers Eric Lehan and David Bakuli.

The UMass students took their first trip to the Kenyan village in March of 2006. During the trip, four students spent one week testing water and learning the geographical layout of the village. The ultimate goal for the student engineers working on the project was to provide a permanent clean water source for the community.

The group worked to improve the existing spring boxes by protecting them from surface runoff and animal waste. The team installed fencing around water recharge areas for the existing spring boxes to limit livestock contaminants in the area. Together with the local community, however, the group would like to drill between one and three wells that would ensure a clean, reliable source of drinking water for years to come.

Sustainability is an important aspect of all EWB-USA projects. By designing low-cost, easy-to-maintain solutions to local problems, engineers empower communities for the long haul. In the case of this project, UMass students are working with Kenyan stakeholders to develop the most affordable, sustainable solution to ensure potable drinking water for all.

Curriculum Connections

MATH:

- Estimation (how much water is used in a day)
- Measurement (scale modeling, etc.)
- Time measurement and calculation
- Budgeting and basic economics
- Graphing

SCIENCE:

- Geology (aquifers, ground water)
- Environmental Science (water testing, water purification)
- Engineering (mechanical, civil)
- Biology (waterborne disease)

SOCIAL STUDIES/HISTORY:

- Focus on African and Kenyan geography/climate/clean water awareness
- Comparative anthropology (Kenyan v. American customs, daily life, etc.)
- Working in groups and team-building (cooperation among and between very different groups, cultures)
- Stakeholder perspectives
- Public outreach campaigns

SCIENCE

Assessment

Middle School

In this activity, students will test local water sources. Water testing was an essential part of the EWB-USA team's work in Kenya. While people in most of the United States have water piped into their homes after it has been treated, people in Kenya draw their water from untreated sources. Untreated water can be dangerous, because it may contain bacteria or other contaminants. How clean is your local water?

Materials:

- Access to an untreated water source (pond, lake, creek, river)
- Clear containers with caps (for water collection)
- Clipboards
- Thermometers
- pH paper
- Copies of the EPA's online publication "What Do Scientists Measure?" (www.epa.gov/owow/monitoring/nationswaters/whatdo.pdf)

Procedure:

1. Tell the class that they will be going to a local pond, lake, creek, or river to assess the water quality. You'll begin by simply observing the water; then, you'll collect a sample to test on-site.
2. Break the class into four groups. Pass out the publication "What Do Scientists Measure?" and give each group a clipboard. Give each group a clear container, a thermometer, and a strip of pH paper.
3. At the site, have each group do its own "five senses" observation. Have each group record:
    - **Smells:** Does the water have an odor? Can you describe it?
    - **Appearance:** Is the water oily? Foamy? Is it clear or muddy? Is there litter in or near the water?
    - **Surroundings:** Are there trees overhanging the water so that the water is shaded? Is grass cut down to the edge of the water? Are the banks of the body of water built up? What are potential sources of contamination?
    - **Life:** Can you see or hear any animals in or near the water? Record and sketch what you see.
4. Have each group measure the temperature of the water. Try to have different groups measure the temperature of the water at different sites, with some being sunnier than others. Have students record the location of the water they're testing (e.g., "the area we tested was shallow and there was no tree cover," etc.) Next, have students lower the thermometer a few inches below the water surface and wait for three minutes before taking a reading.
    - **Explain:** Temperature affects the biological activity and growth of aquatic organisms. Most healthy creeks should be at about 18 degrees Celsius (about 65 degrees Fahrenheit). To a point, the higher the water temperature, the greater the biological activity.
5. Have each group collect a water sample and test the pH.
    - **Explain:** Stream water that's healthy for aquatic life should be at about a 6.5 – 8.5 level. pH lower than 7 is acidic and higher is alkaline. Pollution can change pH level. Acidic or alkaline water is harmful to stream life - and to human beings, as well. (For more information about pH value and its significance to water quality, visit: http://ga.water.usgs.gov/edu/phdiagram.html.)

6. Back in the classroom, have students compare and contrast their observations. Are all the observations the same? What are the differences? Based on the information they've collected, is the water quality good or poor? Would you use the water in your local lake, stream or creek to drink, brush your teeth, and bathe in? Why or why not?
7. Find out more about water quality. Investigate how minerals, salts, bacteria, fecal matter (and other contaminants) affect water quality. (For more information about water quality, visit http://ga.water.usgs.gov/edu/earthgwquality.html.)

Extensions: Using a local map, find any power plants or factories along the waterways. Do these factories pump polluted water into the waterways? Where would the water be cleanest or most polluted? If you were drawing drinking water from this waterway, how far would you have to go to find the cleanest water?

High School

Expand the activity by using a more sophisticated testing technique and testing for dissolved oxygen and water turbidity. (Low cost, high quality water testing kits are available at www.worldwatermonitoringday.org/Test_Kits/Kits_Main.html.)

Bring a sample of water back to the lab to test it for salinity by connecting a battery to a lightbulb and running two wires from the battery into a beaker containing the water sample. If the light lights up, salt has dissolved in the water releasing free electrons and conducting the current. Saline water is not potable, and is harmful to both land plants and animals.

Elementary School

Simplify the activity by printing and exploring the USGS Water Cycle Placemat available at www.ga.water.usgs.gov/edu/watercycleplacemat.html. Visit your local municipality's website, and find out what happens to your water when it goes down the drain. How is your wastewater treated? If possible, visit your local water source.

Design

Middle School

Clean water is critical for survival. In this activity, students will learn about major waterborne illnesses most prevalent in Kenya and build models to design different methods of mitigation - resource protection and water filtration.

Materials:

For each of four groups:

- 2-liter soda bottle cut in half
- Paper towels
- Gravel, sand and cotton balls (to make a filter)
- Water

Online Resources:

www.who.int/countries/ken/en/
www.who.int/water_sanitation_health/diseases/en/

Procedure:

1. Split the class into four groups, and provide each group with materials. Each group will be making and experimenting with a simple water filter.
   - **Explain:** While water treatment plants clean most of the water we drink in the United States, much simpler treatment systems can make a huge difference. For instance, in countries like Kenya, simple filtering systems and boiling can have a very positive impact on public health.
2. Have students put the top half of the soda bottle upside-down (like a funnel) inside the bottom half. The top half will hold the filter; the bottom half will hold the filtered water.
3. Brainstorm with the class to create a container of dirty water that represents real-world pollution. Options include oil, soap, bits of plastic, metal, etc.
4. Have students select from the materials you've provided, and layer them in the filter in the way they think will be most effective to filter out the pollutants you've added. Layer the filter materials inside the top half of the bottle. Ask students to predict which material might remove which pollutants from the dirty water and record their predictions.
5. Have each group pour the dirty water through the filter. What does the filtered water look like? Which group's water was cleanest? Why? Have students record their findings.
6. Have each group take their filter apart and look at the different layers. Can you tell which pollutant each filter material removed from the water? Which filter was most effective? Can students think of a way to improve on their filter?
7. Based on findings, have students reconfigure and retest their filters. Can they improve on their original design?

High School

Expand the activity with statistical analysis from the World Health Organization. Help students recognize that fecal matter, in the water system, is a major source of disease. Students will focus on designing a water treatment system or process that can be implemented at a low cost and without the need for electricity (why must grazing cattle be kept away from a spring box or borehole? How can a natural filtering system be used to lessen the chance of contamination? Can boiling water be implemented as a way to treat drinking water? Can a spring box system include water treatment?) Have students design what they feel is a low-cost, sustainable set of standards for managing water pollution and ensuring water purification.

Elementary School

Simplify the activity by discussing how a well or spring box may provide water, but how do you get the water from the source to the people who need it? Provide students with a wide range of containers, and challenge groups to carry water from one location to another without spilling. Then have students pour the water into a smaller container. Which shape and size of container worked best for transportation, and why? As an extension, grow several different "crops" in the classroom, keeping careful track of water use. If desired, tie a plastic bag around some of the leaves of one plant to notice transpiration (water expelled from the plant's leaves). Based on findings, which plants would do best in a setting where water is scarce? Why?

Implementation

Middle School

Spring boxes collect and protect water from a natural spring. Boreholes, though, rely on the existence of groundwater in an aquifer. In this activity, students will learn what an aquifer is and build a model aquifer.

Materials:

- Copies of the EPA handout: "Groundwater" www.epa.gov/superfund/students/clas_act/haz-ed/ff_05.htm or www.epa.gov/superfund/students/clas_act/haz-ed/ff05a.pdf
- Sand
- Gravel
- Soil
- Water
- Large clear plastic cups
- Graduated cylinders
- Plastic spoons
- Permanent markers
- Measuring cups
- Food coloring
- Sprinkling can
- Handout: Topographical Map (High School only)

Online Resources:
www.epa.gov/OW/kids.html
www.epa.gov/teachers/water.htm
www.epa.gov/owow/monitoring/nationswaters
www.epa.gov/owow/monitoring/nationswaters/whatdo.pdf

Procedure:

1. Distribute EPA Groundwater handout, and review it with the class.
   - **Explain:** Spring boxes and boreholes built in Kenya tap into the aquifer underground, so it's important to understand what an aquifer is and how it functions before drilling or digging. An aquifer is an area in which water is naturally stored under the surface of the land.
2. Let the students know that they will be constructing a model aquifer.
3. Break the class into small groups, and give each group their supplies. Have each group start by placing ½ cup of gravel in a cup, and then adding water. Ask groups to observe what happens to the water. They will notice that the water filters through the gravel, and is stored at the bottom of the cup.

Questions:

- How much more water do you think this aquifer can hold before it begins to flood (the water comes over the top of the gravel)? Record answers and have students test their estimates.
- How could this aquifer be constructed so that it holds more water? Allow students to take sand and soil to add to their aquifer, recording quantities used. How much water can each group's aquifer hold without flooding? Which type of aquifer holds the most and least water?
- Discuss the issue of fecal pollution with students. How could fecal matter make its way into the groundwater? Have students place a drop of food coloring on the top of the aquifer, and then add "rain" by pouring water from a sprinkling can. How long does it take for the colored water to make its way through the aquifer to the very bottom?
- Discuss the issue of drilling a well for the Namawanga community. Based on what they now know about aquifers, how would EWB-USA students determine how deep the well would need to be? How might EWB-USA students design a well that could make water easily available?

High School

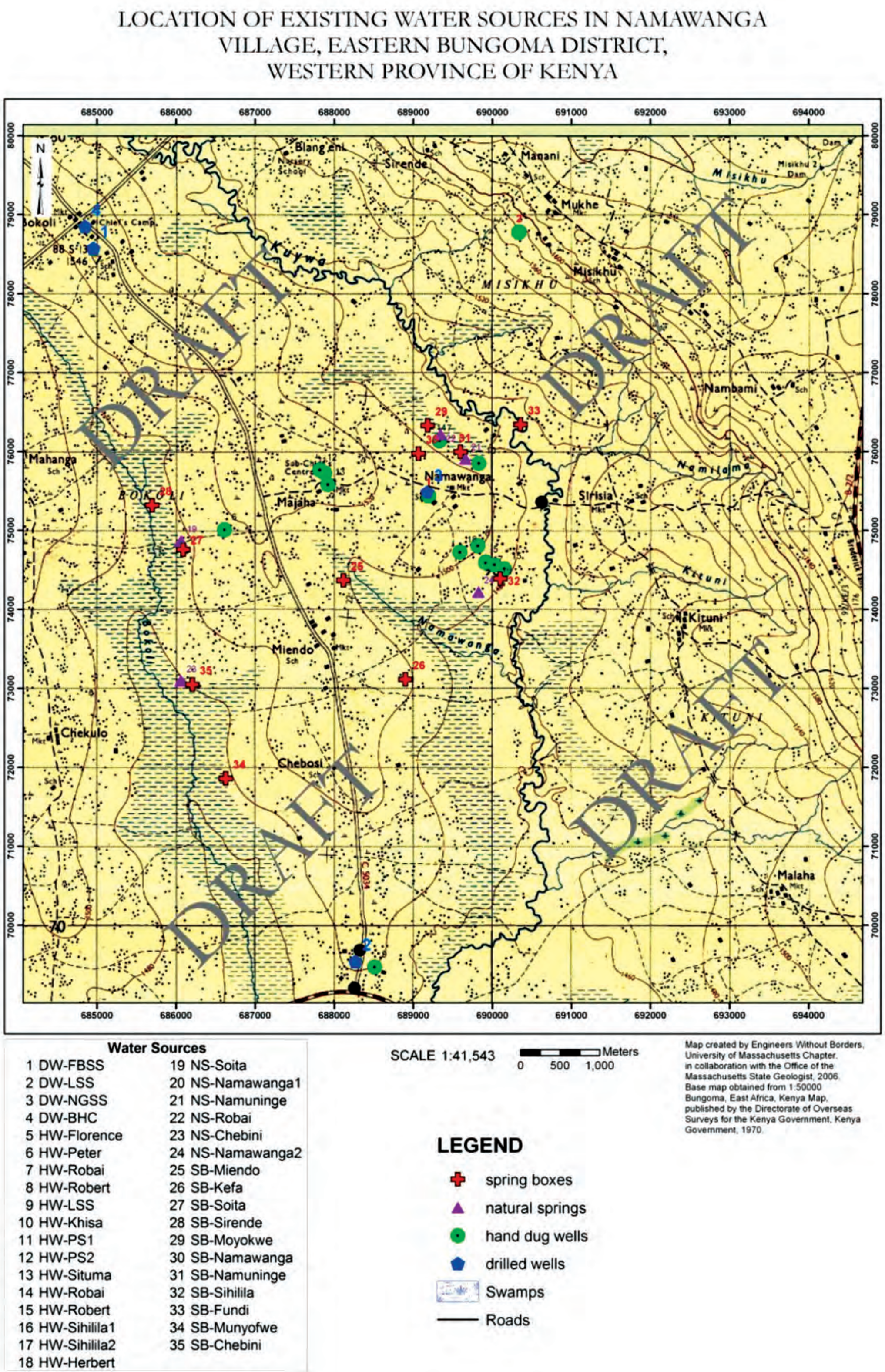
Expand the activity by having students literally model or map the aquifer tapped by the Kenyan community in Namawanga Village. The topographical map handout, along with a description of the hydrological features of the Kenyan Rift Valley ((http://www.fao.org/nr/water/aquastat/countries/kenya/index.stm) provide a starting place for students as they research the geology of the area.

- **Explain:** In general, Kenyan aquifers are made up of sedimentary rocks, which cover approximately 55% of the surface area of Kenya. The yields in these aquifers range from 8 cubic meters/hr to 3 cubic meters/hr. Students may want to calculate how many gallons of water are contained in a cubic meter of water, and, based on that figure, calculate how many gallons of water could be produced from a borehole well in the course of a day.

Elementary School

Simplify the activity by having students build their own aquifer in a cup, but rather than experimenting with various soils, assign specific soil mixes to each group. Have each group add water to their aquifer, measuring carefully. Then compare to see which type of aquifer holds the most water.

Handout #1: Topographical Map



MATH

Assessment

In Namawanga, Kenya, families spend up to five hours per day collecting water for drinking, washing and cooking. EWB-USA is working to make sure that the water they collect is clean and safe, and they hope to drill a well that will make water more accessible.

Middle School

How much water do we need? In this activity, students will measure the quantity of water (in gallons and liters) used in their homes each day by keeping a water log and learning to read their water meter. How much does your water cost? What is the cost of water for taking a shower? Compare/contrast to Kenyan water use.

Materials:

- Water meter handout for each student: www.nwwater.com/index.cfm/nodeID/efdac63f-5436-48dd-b3ee-217059d2af88/fuseaction/showcontent.page
- Water use handout for each student: www.ciese.org/curriculum/drainproj/personalwateruse.pdf
- Poster paper, markers, and general arts and crafts supplies

Procedure:

1. Tell the students that they will be conducting an assessment of their own water use.
    - **Explain:** EWB-USA students in Kenya had to begin their work by assessing how water is accessed in Namawanga. Most of the time, families spend up to five hours per day collecting and carrying containers of water from a distance to fill their needs.
2. Ask students how their water use habits might change if they had to carry water rather than simply turn on the tap.
3. Distribute handouts. Give students the following assignment:
    - Find the water meter in your home, and take a reading. Take a reading each day for a week.
    - Calculate your own water use. Each time you turn on the tap, make a note on your handout.
    - Calculate water use by other family members by multiplying your water use by the number of people in your family.
    - Add additional water use not related to your personal needs by observing and asking how often the dishwasher, laundry, sprinkler and other appliances are used each day and each week.
    - Fill a container with water (1 to 5 gallons depending on students) and have them carry it some distance (e.g., around the school, their block) to gain appreciation.
4. At the end of one week, have students bring back their completed handouts. Collect the numbers for each type of water use, and the daily and weekly water meter readings.
5. Break students into groups and give the students the price per thousand gallons of water (based on local fees).
6. Ask each group to develop a way to visually express the information they've gathered. Possibilities include posters with pie graphs, Venn diagrams and charts, three-dimensional presentations, PowerPoint presentations, etc. Each group should show:
    - Total quantity of water used during the week
    - Average quantity of water used per student per week
    - Average quantity of water used per family per week

- Relative quantity of water used for each activity (toilets, baths, etc.)
- Relationship between estimated water use and meter readings
- Total cost of water used over the course of the week
- Difference between the amount of water used by a Kenyan family per week (about 46 liters or 12 gallons) and the amount of water used by a typical class member's family per week

7. Have each group present their unique style of presentation. As a class, select a favorite presentation, and display that presentation publically for the entire school.

Extension: Review and discuss relative water use around the world, using data provided by the United Nations Development Program on Data360.org: www.data360.org/dsg.aspx?Data_Set_Group_Id=757.

High School

Expand the activity by having students interview school administrators to find out how much water the school uses per day, week, or year. If possible, interview town officials to find out how much the local community uses. As an extension, have students investigate water reduction technologies and techniques including low-flow toilets and shower heads, automatic sinks, timed sprinkler systems, etc. To what extent are these technologies presently in place in their school and community? How much water could be saved through consistent use of these water-saving techniques?

Elementary School

Simplify the activity by discussing that according to the USGS, the average American uses between 80 and 100 gallons of water each day (about 340 liters). How much is that? Have students collect and bring in clean liter and gallon bottles until they've collected 90 gallon jugs and either 340 liter containers or 170 2-liter containers (or both). Work as a class to build a "wall" or "walls" of containers to represent the quantity of water used per person per day. How high, long, and deep is your wall? Research the annual consumption of water and the amount of fresh water available on each continent. Is there a disparity? What can you do with the water you collected?

Design

Middle School

Spring boxes make it possible for communities in developing countries to collect water easily from a natural source. However, when livestock graze nearby, their waste pollutes the water with potentially deadly bacteria. To keep livestock away from spring boxes, EWB-USA engineers design barriers. In this activity, students measure out the perimeter of a spring box fence, select a material to build with (combining strength, durability, and low cost), and budget the cost of materials.

Materials:

- Tape measures, or string and ruler
- Masking tape
- Computer with Internet access

Procedure:

1. Break students into groups and tell them they must select, measure, and budget for a spring box fence that is strong enough and inexpensive enough to keep cattle out and last at least a few years. The fence must also be big enough to surround the area immediately around the spring box – about a 10-meter radius. They should also have a plan for making it possible to repair the fence locally.

   Explain: In Kenya, EWB-USA students built fences of wood, metal, and barbed wire to keep livestock (mainly cattle) away from spring boxes. This is very important, because cattle manure can pollute water with dangerous microbes. In their report, though, the students noted that local people would not have access to these supplies if they needed to repair the fences. Instead, local people would need to use wood - which is less expensive and easier to find.

2. Provide each group with a tape measure or string and ruler, masking tape, and access to an Internet-connected computer. Using these materials, they should:

   - Estimate the perimeter and area of a spring box enclosure (in feet and meters).
   - Decide upon an appropriate fence design and material (Metal/barbed wire? Split rail? Stockade?).
   - Develop a budget to build the fence (including fencing material, hardware, and equipment).

   Hints for teachers to share with students:

   - Don't forget you'll need a gate so that people can get in and out.
   - Remember to consider height as well as width of fencing.
   - It might be less expensive to make the length of each side of your fence coincide with the price of off-the-shelf materials.
   - When you look for prices, check at least two websites and compare.

3. Have students share their plans with one another. How did they make their decisions regarding size, material, and cost? How did they solve the sustainability question?

High School

Expand the activity by having the students, in addition to designing, budgeting, and modeling a fence, also plan for footings. How deep must the team dig? How much concrete or other material is required to ensure a solid footing? How many footings are needed? What supplies are needed beyond the actual fencing material? To further enrich this activity, teachers may ask each group to design its fence on the basis of a site which includes hills and/or dips in the land.

Elementary School
Simplify the activity by breaking students into groups, and providing each group with a ruler and box of craft sticks. Based on a small-scale model, have students calculate how many craft sticks will be needed to complete the fence. Students should begin by measuring the width and length of a craft stick, estimate amounts needed, and then actually calculate the number of sticks needed. If desired, students may build a model of the fence to see if their estimates, calculations and actual experience match up.

Implementation

Middle School
What does it cost to build a spring box? In this activity, students will imagine that their community has no water delivery infrastructure and that they are part of a team of students that has just implemented a spring box at a nearby creek. Students will also calculate the cost of building a spring box.

Materials:

Handouts

- Handout #2: Spring Box example (all students)
- Handouts #3, #4, #5: Building Material Cost & Tool Handout (select age appropriate handout - elementary, middle, and high school)

Procedure:

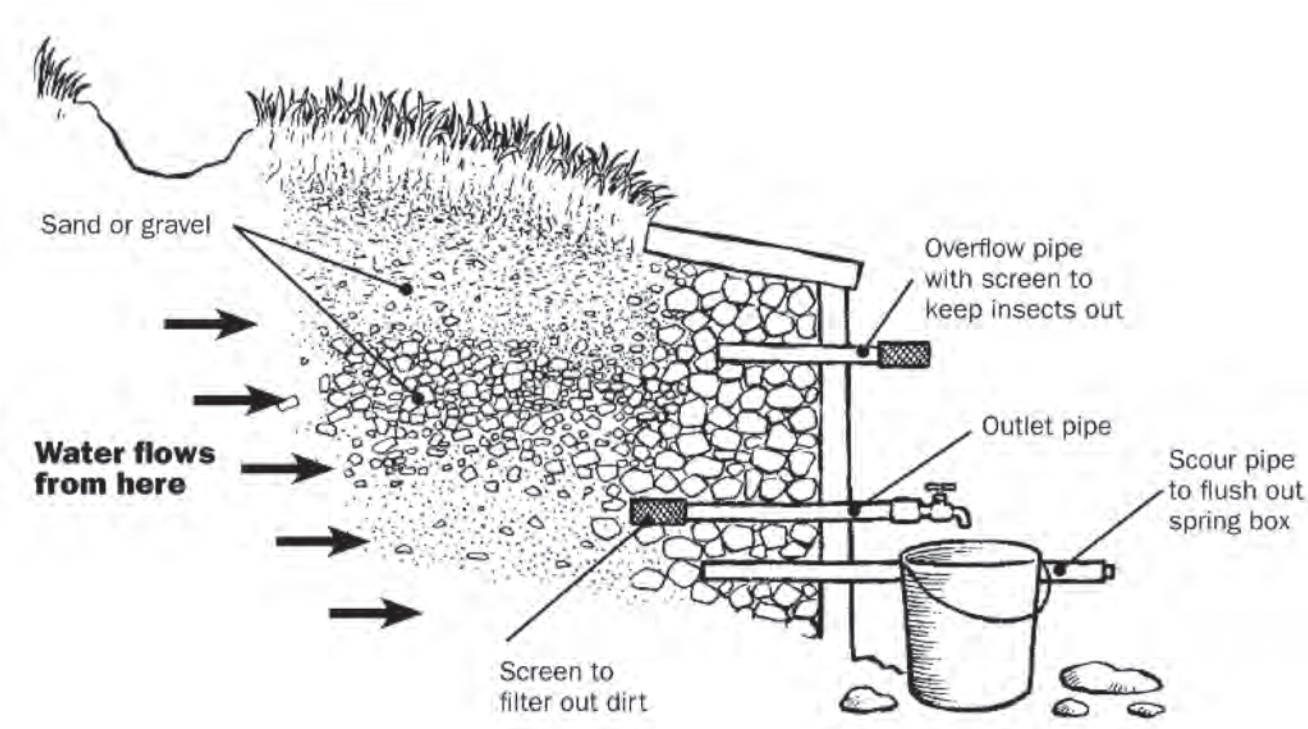
1. Distribute Handouts #2 & 3 (or 4 or 5). Handout #2 provides the number of building material units required, their cost per unit, and the tools to build a spring box. Their task is to calculate an individual total for each line item without the use of a calculator and then the project implementation cost of the spring box.
2. Next, students will search out the cost of some of the tools that were used for the project, and calculate the total cost of the tools. If students will be using the Internet, they can search retail sites.
3. Have students refer to Handout #3 (or 4 or 5). One side of the concrete spring box was reinforced with 14 one-meter lengths of rebar. The rebar was sold in 20′ sections. How many sections of rebar would have been purchased to reinforce the side of the spring box? Three sections were purchased.
4. Have the students consider how they might design it differently to reduce cost or make installation easier.

High School
Expand the activity by having the students work in groups to research the best prices utilizing the Internet or contacting/visiting a store. If students will be using the Internet, they can search retail sites which allow students to compare and contrast prices for materials at different retailers. After calculating line-item totals and a grand total of materials, the students may compare prices.

As an extension, older students can calculate a cost for implementing the spring box in Kenya (including travel costs) - with material purchased in Nairobi (visit http://nil1949.com/index.htm; select items and request prices). Include conversions from Kenya Shillings (http://coinmill.com/KES_calculator.html).

Elementary School
Simplify the activity by having the students determine the total cost of materials that was spent to implement the spring box.

Handout #2: Spring Box example



Handout #3: Building Material Cost - Middle School

Upper Spring Box	Unit	Unit Cost	Units	Total Cost
3″ PVC	per 20 meters	$15.00	0.0648	
3″ Galvanized Steel	per 20 meters	$65.00	1.8382	
1″ PVC	per 20 meters	$3.95	0.1026	
1″ Galvanized Steel	per 20 meters	$1.68	3.72	
1″ Galvanized Steel T-Section	per item	$4.82	1	
1″ Galvanized Steel Elbow	per item	$3.71	4	
3″ Galvanized Steel Elbow	per item	$15.56	1	
1″ Gate Valve	per item	$16.88	1	
Y-Filter	per item	$18.00	1	
Rebar	per 100 lbs	$37.37	1.656	
Cement	per 100 lbs	$6.84	26.4	
Concrete aggregate (50/50 mix)	per cubic meter	$35.53	1.344	
Concrete sand (50/50 mix)	per cubic meter	$36.84	1.344	
Gravel	per cubic meter	$35.53	0.6534	
Fastening wire	per lbs	$0.66	3	
4″ nails	per lbs	$0.66	3	
Steel lid with hinges	per assembly	$5.00	1	
Padlock	per item	$5.92	1	
Grand Total				

- Shovels – 2
- Tape Measure – 2
- Saw- 1
- Carpenters square (to make square edge) – 1
- Wheelbarrow- 1
- Adjustable wrench -1
- Screwdriver -1
- Trowel -2
- Hammer -1
- Buckets – 2

Handout #4: Building Material Cost - High School

Upper Spring Box	**Unit**	**Unit Cost**	**Units**	**Total Cost**
3″ PVC	per 20 meters		0.0648	
3″ Galvanized Steel	per 20 meters		1.8382	
1″ PVC	per 20 meters		0.1026	
1″ Galvanized Steel	per 20 meters		3.72	
1″ Galvanized Steel T-Section	per item		1	
1″ Galvanized Steel Elbow	per item		4	
3″ Galvanized Steel Elbow	per item		1	
1″ Gate Valve	per item		1	
Y-Filter	per item		1	
Rebar	per 100 lbs		1.656	
Cement	per 100 lbs		26.4	
Concrete aggregate (50/50 mix)	per cubic meter		1.344	
Concrete sand (50/50 mix)	per cubic meter		1.344	
Gravel	per cubic meter		0.6534	
Fastening wire	per lbs		3	
4″ nails	per lbs		3	
Steel lid with hinges	per assembly		1	
Padlock	per item		1	
Grand Total				

- Shovels – 2
- Tape Measure – 2
- Saw- 1
- Carpenters square (to make square edge) – 1
- Wheelbarrow- 1
- Adjustable wrench -1
- Screwdriver -1
- Trowel -2
- Hammer -1
- Buckets – 2

Handout #5: Building Material Cost - Elementary School

Upper Spring Box	**Unit**	**Unit Cost**	**Units**	**Total Cost**
3″ PVC	per 20 meters	$15.00	0.0648	$0.97
3″ Galvanized Steel	per 20 meters	$65.00	1.8382	$119.48
1″ PVC	per 20 meters	$3.95	0.1026	$0.41
1″ Galvanized Steel	per 20 meters	$1.68	3.72	$6.25
1″ Galvanized Steel T-Section	per item	$4.82	1	$4.82
1″ Galvanized Steel Elbow	per item	$3.71	4	$14.84
3″ Galvanized Steel Elbow	per item	$15.56	1	$15.56
1″ Gate Valve	per item	$16.88	1	$16.88
Y-Filter	per item	$18.00	1	$18.00
Rebar	per 100 lbs	$37.37	1.656	$61.88
Cement	per 100 lbs	$6.84	26.4	$180.58
Concrete aggregate (50/50 mix)	per cubic meter	$35.53	1.344	$47.75
Concrete sand (50/50 mix)	per cubic meter	$36.84	1.344	$49.51
Gravel	per cubic meter	$35.53	0.6534	$23.22
Fastening wire	per lbs	$0.66	3	$1.98
4″ nails	per lbs	$0.66	3	$1.98
Steel lid with hinges	per assembly	$5.00	1	$5.00
Padlock	per item	$5.92	1	$5.92
Grand Total				

- Shovels – 2
- Tape Measure – 2
- Saw- 1
- Carpenters square (to make square edge) – 1
- Wheelbarrow- 1
- Adjustable wrench -1
- Screwdriver -1
- Trowel -2
- Hammer -1
- Buckets – 2

SOCIAL STUDIES/HISTORY

Assessment

Middle School

In this activity, students will learn the basic facts about Kenya through mapping, research and reporting and also learn about the Namawanga community.

Materials:

- Maps:
  - Large world map
  - Africa/Kenyan map: www.lib.utexas.edu/maps/africa/kenya_pol88.jpg (Elementary School only)
  - Africa outline map: www.nationalgeographic.com/xpeditions/atlas/index.html?Parent=africa&Rootmap=nicara&Mode=b
  - Kenya outline map: www.nationalgeographic.com/xpeditions/atlas/index.html?Parent=africa&Rootmap=kenya&Mode=b &SubMode=w
- CIA World Factbook article on Kenya: www.cia.gov/library/publications/the-world-factbook/geos/ke.html
- Computer with Internet and PowerPoint software (optional)
- Scissors

Online Resources:

www.peacecorps.gov/wws/educators/enrichment/africa/countries/kenya/index.html
www.cia.gov/library/publications/the-world-factbook/geos/ke.htm www.timeforkids.com/TFK/specials/goplaces/0,12405,182117,00.html

Procedure:

1. Present the class with a large scale map of the world, and ask for volunteers to locate Africa and Kenya. Ask students what they know about Africa and Kenya, and write down their answers on the board. Provide each student with a Kenyan map outline. Have students fill in the Kenyan map outline, major cities/towns and geographic features such as rivers, the rift valley, etc.
2. Break students up into four groups. Ask students to imagine that they will be joining an EWB-USA team project in Kenya. Prior to leaving the USA, they will need to learn all they can about conditions in Kenya - ranging from weather to politics to culture.
3. Assign each group a topic to research and report on. Students may use books, the Internet or encyclopedias to seek out information, but they must be sure their information is current. Topics to assign include: climate and geography, culture, economics, and political conditions.
4. Have students work together to gather information about their topic. They may present their findings in the form of a PowerPoint presentation, a poster, or a written report - but all groups should use the same format.
5. Have each team report on its findings to the group at large. Encourage the class to ask questions from the point of view of an EWB-USA member about to leave for Kenya (i.e., questions should be practical and appropriate).
6. Once all teams have made their reports, consolidate all reports into a single presentation, flip book or report.

High School
Expand the activity by having students complete the same activities as the middle school students, and also utilizing the CIA World Factbook website and the Peace Corps "Water in Africa" site as it relates to Kenya: www.peacecorps.gov/wws/educators/enrichment/africa/countries/kenya/index.html.

Elementary School
Simplify the activity by discussing the location of Africa using a large classroom map, and have a volunteer point out Kenya. Have students find Kenya on the African outline map and color it in (map URL available in the materials list above). Break students into groups, and have each group research a topic related to Kenya (e.g., animal life, weather, family life, kids in Kenya).

Design

Middle School
Clean water is critical to survival, but few people really understand that water that LOOKS clean may, in fact, be deadly. Students will research how pollution affects Namawanga Village water and compare that to pollution that threatens your own municipal water supply. Students will design a school awareness campaign that will address the following: what are the issues students should know about? What are some ways in which students and their families can take action to ensure a clean and plentiful water supply in your area?

Materials:
- Copies for each student of the "Hygiene" chapter of the downloadable UNICEF booklet entitled "Facts for Life" (the entire booklet is downloadable at www.unicef.org/publications/files/pub_ffl_en.pdf)
- Access to the Internet
- Information about water access and treatment in your area
- Glass of water from the tap labeled "A"; glass of water from a clear but untreated source (stream, pond, etc.) labeled "B"

Online Resources:
www.unicef.org/wes/index_documents.html
www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf
www.nccwep.org/outreach/television.php

Procedure:
Before starting this activity, contact your local treatment plant and arrange for a class visit to the plant. If this is not possible, request a visit from a water treatment representative who can discuss local water treatment and issues with your class.

1. Read the UNICEF materials together, and discuss the implications of the instructions. How do people in Kenya usually find water? Where does the water come from? What are some of the major sources of contamination, and what problems does the contamination cause? Why don't people know that their water is contaminated?
2. Ask students to come up to your desks in small groups to examine the two glasses of water. Ask: Do both cups of water seem to be clean? Do they look clean? Smell clean? How are they different? Do they think both glasses are filled with potable (drinkable) water? Explain that the water in glass A, which looks clean, really IS clean, whereas the water in glass B, which also looks clean, is untreated - and thus likely to contain contaminants. The fact that water looks and smells clean doesn't mean it's uncontaminated!
3. Prepare students for a visit to the water treatment plant by explaining that the water they drink is treated in a water treatment plant. Together, brainstorm a list of questions to ask - in particular, questions regarding threats to local water quality, and actions that can be taken by the community to ensure that local water is safe to drink.

4. Following the field trip, gather ideas from the class for raising public awareness of the importance of clean water. Together, implement a school-wide clean water awareness campaign, featuring posters, presentations, and/or other methods your class has developed. Include statistics and information, some of which can be found in the UNICEF materials, and some of which are available online at UNICEF, EPA and the Clean Water Education Partnership.

High School

Expand the activity by adding a focus on your local watershed. Using a map, identify your watershed and the possible point source polluters within the watershed. Investigate the impact of point source pollution on your local water, and research possible problem areas. What is being done to mitigate water pollution? If problems are not mitigated, what are the possible hazards your community faces relative to problems with water quality? How can those problems be resolved?

Elementary School

A similar activity can be undertaken with younger children, but rather than reading and summarizing the UNICEF document, simply explain concerns with water safety and hygiene. Following a visit to the water treatment plant, have students design water safety awareness posters for the school.

Implementation

Middle School

In order to implement a civil engineering project in any community, the community members must agree on where, when and how the project will be completed. This isn't always easy, since different people have different priorities, needs and expectations. In this lesson, students will learn what a stakeholder is, and will research the concerns of different water-related stakeholders in their own community.

Materials:

- Access to the Internet
- Large poster board
- Markers

Procedure:

1. Explain to students that a stakeholder is any person or organization that has an interest in a project or plan. For example, imagine a family living in a rental apartment. They're thinking of buying a dog. Who might the stakeholders be in this decision-making process? A main stakeholder within the family is the individual who will be responsible for walking, feeding and picking up after the dog. In addition to the family, stakeholders would include the landlord (who might be worried about damage to his property), neighbors (who might be concerned about the noise), etc.
2. Ask students who they think the stakeholders would be in a decision to create a year-round school year in the United States. Write answers on the board. Be sure to encourage students to think “outside the box,” to include (for example) businesses like summer camps that cater to vacationing students; real estate agencies that rent summer homes to families; and so forth. Help students to see that “stakeholders” can be a large and diverse group.
3. Explain that, in Kenya, EWB-USA student engineers needed to work with many different stakeholders to determine whether, where, how and when spring boxes and boreholes would be implemented. Each stakeholder group had a different concern:
    - Women, the usual water carriers, wanted water to be as close as possible.
    - Landowners wanted to protect their rights to their land.
    - Farmers wanted their animals to be able to graze freely - and therefore opposed too much fencing.
    - Health officials wanted the water to be as clean as possible.

4. Ask students if they can imagine how these different groups might disagree with one another. Solicit at least four areas of potential disagreement (e.g., this well will produce clean water, but the water may be far away; without fencing, spring boxes are polluted by grazing animals; the closest location for a spring box or borehole might be on private property; etc.)
5. Break students into groups, and assign each group a research project. Explain that they may use the Internet to research their project.
6. Where does your local drinking water come from, and what are the issues related to that source? Is the water plentiful? Are there water shortages? Is the water polluted? Where does the pollution come from?
7. Where does your local wastewater go, and what are the issues related to that? If you live near the shore or other waterway, does wastewater pollute the waterways? If you live near a factory, does the factory's wastewater threaten the quality of drinking water?
8. Once your class can identify the source, destination and issues surrounding local drinking water, work as a class to identify the stakeholders involved in making water-related decisions in your community. Identify the roles those individuals play (e.g., homeowners, town officials, fishermen, factory owners, etc.).
9. Together, draw up a large stakeholder "map," showing each type of stakeholder and describing his or her particular point of view on water in your community (e.g., homeowners want clean, plentiful, inexpensive water). Looking at your map, how might local stakeholders disagree?

Extension: Select a water-related topic of local interest, and have groups of students research and represent a point of view in a debate. Can they come to a decision? If possible, invite at least one representative stakeholder to visit your class (or visit that individual in his or her place of work).

High School

Expand the activity by including the extension and having students work in groups to develop one or more recommendations for managing real-life stakeholder differences relative to water use. Recommendations should include any relevant statistics, existing programs, and cost estimates. For example, a plan for a coastal town might include a plan for sewering to mitigate marine pollution - but should also include cost estimates for sewering as well as resources for finding the necessary funds.

Elementary School

Simplify the activity by doing the above steps 1–4 only. Select a topic of school-based interest in which there are at least four to six distinct stakeholders (e.g., students may no longer bring their own lunches to school or the school district will no longer provide bus service for students). Help students to determine who the stakeholders are, and have groups work together to develop 3–5 arguments for their own point of view. Conduct a debate, with the goal of reaching a mutually satisfactory conclusion.