SAMARITAN'S PURSE WATER PROJECTS

Turning on the tap to safe water for communities.

Every 24 seconds, a person in the developing world – usually a child – dies from diseases caused by polluted drinking water. But this heart-breaking issue extends even to developed countries like Canada, where water contaminated by animal waste has been a problem.

Through basic information and challenging activities, these junior high (grade 7-9) science resources are intended to teach students principles around water stewardship and water treatment, while adhering to government education guidelines. Learn about Samaritan's Purse's work helping families get safe water and involve your students in thinking about world water issues and how to solve them.

WATER TREATMENT CASE STUDIES

Source: Samaritan's Purse Canada, www.SamaritansPurse.ca.

Teachers: Resources are available on this website to help you and your students explore solutions to the challenges posed in these six case studies. The resources include a quick overview of the most common water treatment systems used around the world, plus detailed explorations of each system. We recommend reviewing these resources before discussing these case studies.

The case studies can be used in at least three ways:

1. To introduce students to the concept of water stewardship and water treatment methods by providing one story per group or one to two stories for the entire class. You can lead the discussion using points in each case study's 'Things to think about' section.
2. As a method of testing students after they have learned about the basic water treatment methods available.
3. As a starting point for students writing their own case studies and testing each other on potential solutions.

*Of course, you are welcome to find other uses that fit with your curriculum needs.

CASE STUDY #1 – SOLVING THE WATERHOLE WOES

Fatu glances at the setting sun in the African nation of Liberia as she and her friends carefully climb down a steep bank into the waterhole to fetch the last bucket of water for the day.

The laughter of the girls echoes in the tree canopy as they walk the jungle path from the village to their traditional water hole. Shooing the dog away from the water's edge and ignoring the woman who is bathing at the far end, Fatu enters the coffee-with-milk colored water until it is deep enough for her to dip in her blue plastic bucket without touching the bottom.

After filling their buckets, the girls carefully place them on their heads and climb the slippery bank to begin the 30-minute return trip to their village. Fatu has many brothers and sisters, and it's her and her two younger sisters' responsibility to bring enough water for their household of 10 people. The family lives in a traditional mud hut with a thatch roof.

On the way, Fatu and her friends pass by the small, local school and look with wonder and a tinge of envy at the children lucky enough to attend. She imagines what they could be learning, and part of her wishes someone else could fetch the family's water and prepare the food so she could go to school. As she looks longingly, she stops to let the yapping dog following her take a drink of water from her bucket, then she continues home.

Things to think about:

- This open, unprotected water source is probably highly contaminated from animals, people bathing, washing laundry and dishes, and women entering the water to fill their buckets.
- The coffee-with-milk color water suggests there may be high silt content.
- Unless the silt is settled (by letting the bucket sit until the silt sinks to the bottom) the high silt content makes it difficult to properly chlorinate the water.
- High silt also easily clogs a ceramic pot filter, and the flow rate would likely not produce enough safe water for the entire family.
- High silt content also makes it unsuitable for SODIS because sunlight will not be able to penetrate the water sufficiently.
- Using a BioSand filter is a good option in this situation. The family might want to strain the silty water through a cloth first, since this will reduce the amount of maintenance needed on the filter.
- Although there are usually high rainfalls in a jungle, the family's thatch roof would not be appropriate for a rainwater harvesting system. Beyond not having an appropriate roof, the system would require a large amount of start-up funds, which Fatu and her family do not appear to have.

> **Potential questions:** What is the best way for Fatu's family to solve their water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #2 – THE MODERN, BIG-CITY WATER CHALLENGE

José lives with his wife, Maria, in a small apartment in a densely populated neighborhood in Manila, the capital of the Philippines. He works as a teacher and she is a social worker. Together, they live in a small one-bedroom apartment on the third floor of a stone building.

The breeze through the open windows brings some relief from the stifling heat, but also adds the fumes and noise of the busy traffic on the street below. They get their water from a tap in their tiny kitchen. The stone counter beside the sink also holds the electric hotplate they use for cooking.

Like many cities in developing countries, Manila finds it difficult to keep up with the rapidly increasing demand for water. So many people are moving to the city that the water supply system is overloaded, and regular maintenance is a challenge.

Sometimes, water lines break or develop leaks that suck dirt into the distribution system. While their water appears clear from the tap, it seems that every few months, José, Maria, or their neighbors experience medium to severe stomach pain.

Things to think about:

- While water from the tap may *look* clean, the quality is unreliable and may at times be contaminated.
- This seems to be a modern, educated, middle class couple with jobs and some purchasing power.
- If they live together in this tiny apartment, José and Maria's drinking water needs may be relatively modest. There is no need to treat large quantities of water for them.
- Chlorinating their water is an option. Their level of education would probably enable them to learn to dose their water appropriately. However, they may find the taste unacceptable.
- They may choose to boil their drinking water and then store it. However, boiled water tends to taste "flat." Aerating it, perhaps by stirring and letting the boiled water stand overnight, can improve the taste. They could also improve the taste by putting a drop of lemon or lime in each glass of water.
- If they could afford it, José and Maria might buy a ceramic pot filter. There are period replacement costs, but they would have many years of safe water.

> **Potential questions:** What is the best way for José and his wife to solve their water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #3 – A BIG OR SMALL SOLUTION TO A CAMPUS WATER PROBLEM?

Charlie is a third-year student at a government-run training institute in the African nation of Zambia, where he stays with his classmates in a dormitory on the premises. The institute runs on a shoestring budget and isn't able to buy expensive water treatment systems.

The water on campus is pumped from a nearby river through a barrel filled with sand. That barrel removes silt and debris from the water before storing it in a small water tower. While the barrel removes silt and debris, the sand is too coarse and the flow rate is too fast to remove bacteria.

Water from the tank flows by gravity to a communal point from which staff and students get their drinking water. The distribution site is a cement wall with taps. Below the taps, a series of sinks enable students to wash and do laundry.

For bathing, they carry buckets of water from the distribution site into a bath shelter for a splash bath from the pail. Each dorm contains a covered red plastic bucket that is filled at the distribution site to provide drinking water.

An aid group came to Charlie's village when he was younger, and he remembers a lesson he learned from them about the importance of pre-treating the water by letting the silt settle. He and his friends at the dorm continue this practice, but they notice that even when silt settles to the bottom of the bucket, someone in the dorm is usually sick with some sort of stomach pain.

Things to think about:

- The rapid sand filter removes silt and debris as well as parasites from the water. However, it does not remove bacteria or viruses.
- If the water is fairly clear with little organic matter, chlorination could be the best solution, especially if it is done at the central distribution point.
- The institute probably has staff capable of dosing the chlorine correctly.
- The red drinking water buckets could be at risk of re-contamination, especially if students use cups to dip water from the bucket. Dosing the chlorine directly to the red buckets may reduce this risk.
- There may be a challenge in achieving community acceptance of the value of safe water. While some are taking an extra step toward drinkable water, others may not be, and that's negating the efforts of Charlie and his friends.

> **Potential questions:** What is the best way for the training institute to solve its water problem? Is there a way for Charlie and his dorm to solve the problem on their own? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #4 – MAKING WATER SAFE AFTER A DISASTER

Chiraz has just returned to his home in Bangladesh. Several weeks earlier, he and his family had to flee the area when a big storm inundated large parts of the region where he lived. The sight of the bloated, decaying bodies of drowned people and cattle remains burned in his memory.

As Chiraz looks over his tiny flooded yard, he notices the chicken coop has disappeared and the fish pond he shares with his neighbors is filled with mud and water. The garden is washed away and the rice in his paddy behind the house is covered under silt.

The yard and his house are coated with clay deposited by the storm tide. The wells in town are contaminated and it will take weeks before they are cleaned and repaired. Some drinking water is trucked in by relief organizations, but delivery is unreliable with sometimes days or a week between deliveries. At such times, the only water available is silt-laden from the river.

Things to think about:

- Water in the river may contain high loads of bacteria and/or viruses, especially if it has contained decaying bodies of people and animals. This is an extremely dangerous situation that can give rise to very serious disease outbreaks and more deaths.
- Disasters like this often attract non-government organizations and other external assistance. These organizations may have access to special flocculation-chlorination packets (e.g. PUR) that can be distributed so people can treat their water.
- Hopefully, this is a temporary situation until the well is cleaned, repaired, and “shock” chlorinated.
- Chiraz will likely have incurred losses to his livelihood and may not have much money to buy treatment materials. He will probably need to rely on assistance from others.
- Chiraz will need to learn how to add flocculent, stir, wait for the chemicals to work, and then decant or strain the water through a cloth to make it ready for drinking.
- Until flocculation-chlorination packets become available, Chiraz can dip water from the river, let it settle or filter it through a cloth and boil the clear water. The storm will likely have felled trees and created debris that could be used as fire wood.
- The water may be too silty to use with a ceramic filter, which would plug quickly. However, if Chiraz can let the silt settle, he could use the decanted (clear) water in a ceramic filter.
- A BioSand Filter may not be the best solution because it would take time to construct, install, and wait for the biological layer to become active.

> **Potential questions:** What is the best way for Chiraz to solve his family’s water problem? Are there any solutions beyond treating their water? Which water treatment solution is best? Why? If that method isn’t available, is there a second-best treatment solution? Why don’t the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #5 – SEARCHING FOR A MOVEABLE SOLUTION

Mariama lives with her family in a large leather tent that is typical for the nomadic tribe to which they belong in the African nation of Niger. Mariama's people herd cattle throughout the arid pastoral belt separating the Sahel from the Sahara desert.

Outside, her brother, Abdul, is watering the goats and sheep. He uses a bucket made from a truck tire inner tube to haul water from the same open well the family uses for its drinking water.

Abdul is short for his age and tends to drag the bucket through the manure-strewn mud as he empties it in the water troughs. By dipping the dirty bucket back into the water, he introduces bacteria from the manure into the well.

The well is deep and the water is cool and known for its good taste. Mariama's family is using this well while remaining in this area, until the area has been grazed down to the point where the family will move on to other pastures.

Things to think about:

- Even though this region experiences intense sunlight, the SODIS treatment might be too cumbersome to maintain. It would require many bottles to provide the family with drinking water, and those bottles would need to be carefully maintained so they remain in direct sunlight. There is also the danger of the bottles being damaged by the cattle.
- Certainly, the nomadic lifestyle isn't suitable for heavy BioSand Filters because they would be too difficult to carry from place to place. Once installed, the filters should not be moved to avoid damaging the biological layer.
- In this desert environment, wood is difficult to find. This makes it expensive to boil enough water.
- Mariama's people enjoy daily tea ceremonies. The tea is made on tiny charcoal burners, just large enough to hold the tiny teapot. This provides them with some of their daily liquid intake. Moreover, Mariama's people seem to drink remarkably little, considering the harsh, hot environment in which they live.
- A ceramic filter (possibly from locally made clay pots) is one option for Mariama's family. These filters are portable, although they are also prone to breaking. However, local pottery is readily available in the region.
- The region where Mariama's people live is too remote to be able to rely on a regular supply of chlorine or flocculation-disinfection packets or other commercially available materials. They may travel for months before entering a town.

Potential questions: What is the best way for Mariama and her family to solve their water problem? Is there a viable method for the entire tribe to which they belong? Are there any solutions beyond treating their water? Which water treatment method is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well? Would there be a situation or place in Canada where the best treatment solution could be used?

CASE STUDY #6 – WELL, IT SURE *LOOKS* CLEAN AND CLEAR . . .

With a sigh, Bill lowers his backpack to the ground, awed by the scenery around him. The sight of the little mountain lake in front of him made the arduous climb well worth it. It is day two of the week-long trek for Bill and his friend through the back trails of the Rockies.

With dismay, Bill picks up bits of paper a previous camper must have left at the campground at the water's edge. The lake was close enough to civilization to attract hikers throughout the year. As Bill and his friend moves deeper into the back country, there will be fewer signs of humanity.

The beaver dam at the far end of the lake reminds Bill that even in these pristine settings, the supposedly clear and clean wilderness water is polluted. He had heard many a tale of hikers returning with the dreaded "Beaver Fever" – a reference to a type of diarrhea (Giardia Lamblia) that can be transmitted by beavers. The name is not fair to the beaver because the spread of Giardia Lamblia into the back country is in large part due to poor sanitary practices of *human* visitors.

At the end of the day's hike, Bill and his friend surveys everything they brought to treat water from the lake: plastic bottles, a cooking pot, a travel-sized ceramic filter, and some chlorine tablets.

Maybe they didn't need *everything* they brought, but in Bill's mind, better safe than sorry. After all, his favorite band was performing in town the day they were supposed to return from the hike and Bill wasn't going to get sick and miss the concert.

Things to think about:

- Even though the setting may look pristine, its accessibility to human visitors increases the risk of pollution from people (or their pets) relieving themselves in unsanitary ways (e.g. no latrines, open defecation rather than burying their feces).
- The water may look clean and clear, but it can still contain bacteria and parasites.
- Giardia Lamblia is transmitted by digesting the tiny cysts that may lead to diarrhea.
- Camping and hiking equipment stores sell micro filters that can filter out the cysts and make water safe.
- SODIS bottles could work if there was sufficient sunlight, but would be difficult to use while hiking. As well, SODIS, would not kill the Giardia cysts.
- Adding chlorine to the water could kill bacteria, but is unlikely to kill the Giardia cysts. The levels required to kill Giardia would make the water undrinkable.
- A BioSand Filter might fit in a large, full-length backpack, but imagine taking one on a hike?!
- The best option in this case (if you don't have a micro filter) might be to boil the water for five minutes to kill the cysts. Note, however, that you'd need to boil for longer because at high altitudes water boils at a lower temperature.

Potential questions: What is the best way for Bill to solve his water problem? Are there any solutions beyond treating the water? Which water treatment solution is best? Why? If that method isn't available, is there a second-best treatment solution? Why don't the other treatment methods work as well?