Chapter 7: Drinking Water [1]

Water is a unique compound (Figure 7.1). It is a molecule formed by one oxygen and two hydrogen atoms. The hydrogen atoms arrange themselves at an angle of 105ºs to each other. The asymmetrical arrangement of the water molecule gives water some unique features. The water molecule has a slight positive charge created by the asymmetrical hydrogen atoms and a slight negative charge on the oxygen side of the atom. This feature of water makes it a universal solvent. When water freezes the molecules realign themselves into hexagons due to their electrical charge. This is why ice is less dense than water. If ice were not less dense than water, ice would sink to the bottom of the oceans and the oceans would become solid ice.

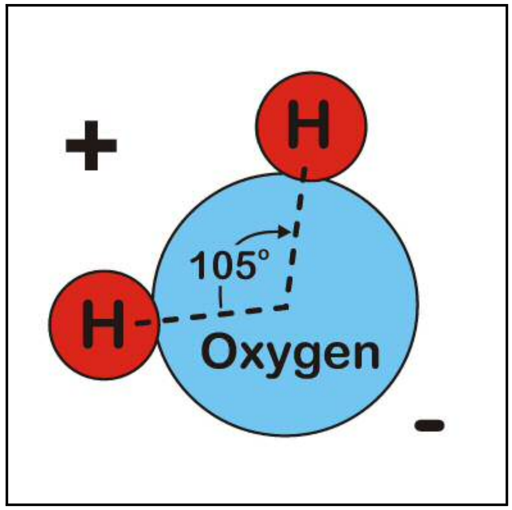

Figure 7.1: H_20 - Because of its asymmetrical bonding, the water molecule has many unique attributes. Source: author – [file:\WA-FreezingWater.cdr]

The adult human body is roughly 50% to 65% water. It averages around 57% to 60% water. Jokingly, it is said that the human body is a bubble of water swimming through a sea of air. Fish are a bubble of water swimming through a sea of water. Water is necessary for life. Deprived of water, people can survive three to five days, sometimes a week. In this respect, water is more important than food.

When viewed from outer space, Earth is the blue planet. It is the planet of water. Approximately, 70% of the earth's surface is covered with water. Most of it is sea water which is not potable. Only 2.5% of the world's total water is freshwater. However, only 1% of the freshwater is available with the majority of freshwater being locked up in glaciers and icecaps. Although Earth is the planet of water, very little of the water is available and potable for human consumption. This chapter focuses on obtaining potable drinking water in order to survive.

Without water, most people will live for several days. Without food, most people can live for several weeks. Contaminated water can make a person severely ill or even kill them. It is important to have a source of potable water for surviving the unexpected emergency. This chapter provides methods with which to obtain potable water.

Sources of Contamination

The EPA lists six sources of freshwater contamination. In general, there are five freshwater sources of contamination. These are aesthetic, biological, organic, inorganic, disinfectant and by-products and radionuclides. Each source of contamination is discussed below.

---

[1] This chapter was written by Robert B. Kauffman who is solely responsible for its content. This chapter is copyrighted © Robert B. Kauffman, 2015.

Copyright © 2016 Robert B. Kauffman

Aesthetic – This category includes offensive taste and odors from either unnatural or natural sources. It includes particulate matter such as sand, mud, or other sediment. Sulfur water from a well is drinkable but has a bad taste and odor. Unless, there are other contaminants present, this water is drinkable. Sediments can be filtered or settled out of the water. Chemicals can be added to sulfur water to make it more palatable. The addition of iodine to the water neutralizes the sulfur in sulfur water.

Biological – Pathogens are micro-organisms including bacteria (E. coli, Salmonella, Legionella, Shigella, etc.), viruses (e.g. Hepatitis, etc.) and parasites (e.g. Giardia, tapeworms, etc.). Typically, bacteria ranges from one to ten microns in length and 0.2 to 1 micron in width (Bacteria and Virus Issues, 2016). Roughly 100 times smaller than bacteria, virus range from 0.004 to one micron in size. Protozoan cysts such as Giardia are typically 2 microns to 50 microns in size and can typically be removed with fine filtration.

Organic and Inorganic Compounds – Organic compounds are compounds composed of carbon. In general, organic compounds refer to organisms that are or were alive. Dead or rotting animals are a source of organic compounds in the water. Organic compounds can also include other carbon based chemicals.

Inorganic compounds refer to all other chemical compounds that were not alive and/or non-carbon based substances. These include pesticides, herbicides and chemicals of all sources. Household products include cleaners, gasoline, herbicides, pesticides, charcoal lighter, paints, paint cleaners, etc.

Disinfectants and by-products – These are by-products of sewage treatment plants. Generally, they are not our focus.

Radionuclides – This is a specialized group of contaminants associated with radioactive fallout from a nuclear conflict or meltdown of a nuclear reactor.

Purification Strategies

In general, there are three strategies used to obtain drinkable water. These are *avoid the contamination, remove it*, or *kill it*. Storage of potable water or selecting a site without contamination are examples of avoiding contamination. Filtering or distilling water are examples of removing contamination. Boiling water, iodine, or UV lamps are examples of killing the contamination. The next section discusses sources of contamination. Not all methods of purification work on all types of contaminated water. For example UV lamps are effective in killing pathogens but are ineffective against organic or inorganic compounds.

Generally, there are six methods of water purification (Figure 7.2). These are discussed in more depth in the following sections. In addition, water storage is discussed although technically it is not a water purification method. Regardless, it is a strategy for obtaining or having potable water. Disinfectants and by-products was not included because these sources of pollution are usually associated with sewage treatment plants.

Copyright © 2016 Robert B. Kauffman

Figure 7.2: Summary Table of Purification Methods		
Purification:	**Eliminates:**	**Doesn't Affect:**
1. Boiling	Pathogens	Organic and Inorganic, Radionuclides
2. Filtering	Pathogens	Organic and Inorganic, Radionuclides
3. Chemical	Pathogens	Organic and Inorganic, Radionuclides
4. Distilling	Pathogens, Organic and Inorganic, Radionuclides	na
5. Reverse Osmosis	Pathogens, Organic and Inorganic, Radionuclides	na
6. UV Light	Pathogens, Organic	Inorganic, Radionuclides

Water Storage – Storing water is a strategy of avoidance. Tap water is treated water. Depending on circumstances, the shelf life of water can be indefinitely. Bradley (2011, p.93) recommends storing water in FDA-approved DOT #34 opaque containers. Storing water out of sunlight reduces the likelihood of algae and bacteria growth. The opaque container reduces the likelihood of algae and bacteria growth also. Store away from pesticides, gasoline, paints and other solvents. Pre-treat water with a water stabilizer which is normally stabilized sodium hypochlorite (Figure 7.3). Most experts recommend rotating or replacing the water every six months.

A counter viewpoint is that prudently stored water will last indefinitely. Tap water is treated water. Non-contaminated water sealed in a container will remain uncontaminated for as long as the container remains unopened and sealed.

Stored water will last most people through most short-term crisis situations. It is helpful to examine the type of disasters presented in the *Surviving the Unexpected Emergency Model*. For example, if the reader's home is prone to flooding, stored water should be stored above the expected flood levels. To store the water in the basement where the stored water can become contaminated by flood waters is to compromise the stored water. If there is any doubt, purify the water.

For planning processes, a rule-of-thumb is a gallon of water per person per day (Figure 7.4). A gallon of water weighs roughly eight pounds. Two liter soda bottles can be used for water storage. Two two-liter soda bottles equals a gallon of water. Divide the number of bottles by two and the number of days of water is calculated for one person.

Common storage containers include recycled two-liter soda bottles, commercially purchased water bottles (see Figure 7.5), five and six gallon camping water containers (Figure 7.5), five gallon emergency containers (Figure 7.6), and barrels (Figure 7.7). Emergency containers will be discussed in a later section in this chapter.

Figure 7.3: Stabilizer – Water preserver is a stabilized source of sodium hypochlorite. Source: internet – [file:\WaterTreatment[40].jpg].

Copyright © 2016 Robert B. Kauffman

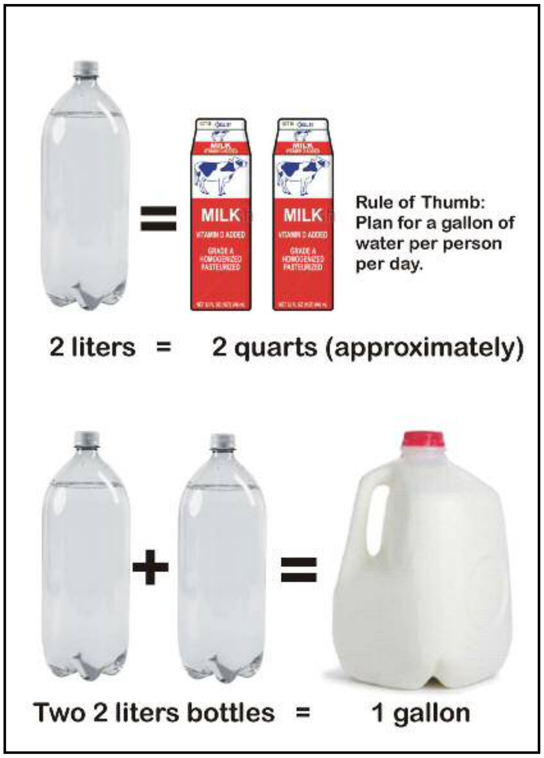

Figure 7.4: Two Liter Containers – Two two-liter soda bottles equals a gallon of water. A gallon of water weights roughly eight pounds. Plan on a gallon of water per person per day. Source: author – [file:\WA-LiterBottles.cdr].

Figure 7.7: Five Gallon Emergency Containers – Commercially purchased five-gallon containers provide convenient stacked storage. Remember, each full container weights 40 pounds. Source: internet – [file:\FiveGallonWaterContainers.jpg]

Figure 7.5: Commercially Purchased Water Bottles – For short-term situations, liter bottles of water are a practical storage method. Source: internet – [file:\StoredWaterBottles.jpg]

Figure 7.6: Five and Six Gallon Camping Jugs – Five and six gallon water containers line the canoes on a eleven day backcountry trip in the brackish water of the Everglades. Source: author – [file:\DSC_0056.jpg]

Figure 7.8: Barrels – Polyethylene barrels provide high volume water storage. Remember, a 55 gallon drum of water weighs 440 pounds. Source: internet – [file:\WaterStorageBarrels.jpg]

Copyright © 2016 Robert B. Kauffman

Boiling – Boiling water kills all pathogens forms of pollution (Figure 7.9). As a rule, bring the water to a "*rolling boil*" for one minute. After the water reaches a rolling boil for one minute, all pathogens are normally killed. Boiling water doesn't remove particulate matter. Nor does it remove organic and inorganic pollution or radionuclides.

Figure 7.9: Boiled Water – Bring water to a rolling boil for one minute. All pathogens will be destroyed. Source: internet – [file:\BoilingWater.jpg]

After reaching a rolling boil, allow the water to cool naturally. The container of water can be placed in a stream or lake to augment its cooling. If the water tastes flat, shake it. This will aerate the water. A disadvantage of boiling water is that it is energy consumptive. It takes a lot of energy to boil a small amount of water. The campfire pictured provides large amounts of inexpensive energy.

Filtration (Figure 7.10) – Filters use paper, ceramic, or other substances to filter out unwanted particulate and pathogens from contaminated water. The pump pictured in Figure 7.10 is a typical camping pump filter that pumps the water through a 0.2 micron ceramic filter. Used alone, the pump will protect against bacteria and protozoa cysts such as Giardia. It will not provide protection against viruses. Also, filtration is ineffective against organic and inorganic and radionuclides contaminations.

Figure 7.10: Water Filter – The hand pump pumps the unfiltered water through a ceramic filter. Source: author – [file:\WA-Pump03.jpg]

Often the literature differentiates between filtration and purification. Filtration is a strategy of removing the contamination. Generally, purification focuses on killing the contamination. The two methods often complement each other and are used in concert with the other.

Also, when choosing a site for filtration, choose a site that will most likely be free of contamination (i.e. avoidance). Water taken out of the center of a lake is less likely to be contaminated than water from a stream. Muddy or dirty water will require more frequent cleaning of clogged filters also.

Chemical Disinfectant (Figure 7.11 and Figure 7.12) – The purpose of chemical purification is to kill contaminants in the water. On the periodic table, generally, one of the halogens or salt producing elements is used. There are five halogens: fluorine (F), chlorine (CL), bromine (Br), and iodine (I), and astatine (At). Most commonly used halogens are chlorine and iodine. Bromine has seen some use in

Copyright © 2016 Robert B. Kauffman

purifying swimming pool water.

Chlorine is effective against most diarrheal producing diseases. Against, bacteria such as E. coli, it is highly effective (The Safe Water System – Chlorine, 2012). Against viruses such as Hepatitis A, the use of chlorine is rated as moderately effective. In contrast, protozoa such as Giardia are much more resistant (i.e. highly) to chlorine. In the case of protozoa such as Giardia, consider using a complementing strategy to obtain potable water. First, select water that is unlikely to contain the cyst. Next, use good filtration in case the cyst might be present. Then finish off purification with the use of a chemical disinfectant. Respectively, these complementing strategies are ones of avoidance, removal, and killing the Giardia cyst.

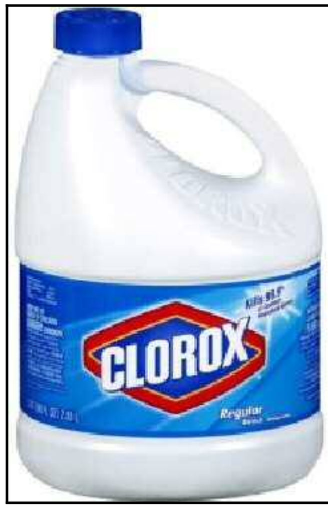

Figure 7.11: Clorex ® – Clorex is chlorine bleach and can be use to purify water.
<cl>Source: internet – [file:\ClorexBottle[38].jpg]

Figure 7.12: Iodine – The bottle contains iodine crystals. The bottle is filled with water. The iodine is water soluble. The water is poured into the container of water. Source: author – [file:\WA-Iodine03[92].jpg].

If using chlorine bleach add eight drops or 1/8 tsp per gallon of water. Double the amount of drops for cloudy or turbid water (i.e. 16 drops or 1/4 tsp per gallon of water). Letting the water sit for 30 minutes prior to drinking it will allow sufficient time for the bleach to work. If there is any doubt, allow 60 minutes or one hour.

<u>Distillation</u> – Distillation is the process of heating water (Figure 7.13). The water vapor is cooled and condenses back into a liquid. Distillation is a good method for filtering out organic and inorganic substances. A disadvantage is that it is a slow process. For those familiar with whisky stills, it is the same distillation process.

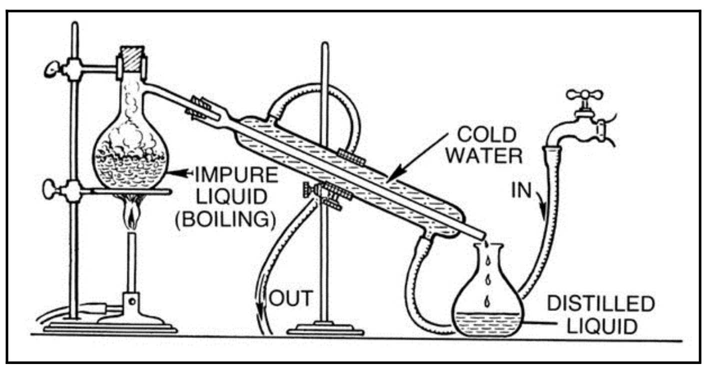

Figure 7.13: Distillation – The liquid is boiled and the steam is condensed back into water as it cools leaving the pollutants behind. It is a slow but effective process. Source: internet – [file:\Distillation[85].jpg].

<u>Reverse Osmosis</u> – Osmosis is the process of equalizing concentrations on both sides of a semipermeable membrane where the molecules of a solvent pass through the membrane from a less concentrated or dense solution into the more concentrated or dense solution. This is the problem with drinking sea water. The denser saltwater in the intestines draws freshwater out of the body and through the semipermeable membrane of the intestine to dilute or make less dense the saltwater in the intestines. This osmotic process can lead to dehydration and death.

Copyright © 2016 Robert B. Kauffman

Reverse osmosis is the process of forcing a more concentrated solution through a semipermeable membrane into the less concentrated solution. The process is useful to remove virtually all impurities from the water. Also, it can be used to remove radionuclides. The downside of the process is that it consumes large amounts of water to produce small amounts of water.

Figure 7.14: UV Light – UV light is a short wave length light that disrupts pathogens, bacteria, and viruses. Source: author – [file:\WA-UVlight01.jpg]

UV Light (Figure 7.14) – Ultra violet light kills micro-organisms including pathogens, bacteria and viruses. The short-wave length light disrupts the cell functions. It is not affective against organic and inorganic or radionuclides contaminations. For UV filtration to work effectively, the water needs to be exposed to the UV light for a sufficient amount of time. Turbidity decreases the effectiveness of UV radiation and increases the time required to expose water to UV radiation. Typically, the UV radiation is emitted from a florescent light bulb. The bulb requires electricity. Camping versions require batteries to use.

Disaster/Environment Influence

When considering the method of water purification or storage, consider the types of disaster or crisis situations most likely encountered. Two examples are provided to illustrate this consideration.

Water Contamination from Flooding (Figure 7.15) – Floods introduce numerous sources of contamination to the water. Flooding could be due to hurricanes or rivers flooding. Petrol chemicals from cars create inorganic contamination. Raw sewage from septic systems and centralized sewage systems create organic contamination. Trash, chemicals, insecticides, etc. stored in garages create inorganic pollution. All forms of water contamination other than radionuclides contamination can easily be present during floods. As a general rule, water storage is a good strategy and the water needs to be stored in a location above the flooding waters.


Figure 7.15: Water Contamination with Flooding – Floods introduce numerous sources of pollution. Petrol chemicals from cars. Raw sewage from septic systems or centralized sewage systems. Trash, chemicals, insecticides, etc. stored in garages. Source: internet – [file:\Flood01[54].jpg]

Giardia (Figure 7.16) – Although Giardia is a protozoan associated with beavers, it can be transmitted to humans through contact with feces where the cyst lies dormant in the soil or on surface of foods that have come in contact with the cyst. It is associated with beavers because the cyst is excreted by the beavers into streams where the seemingly crystal clear drinking

Copyright © 2016 Robert B. Kauffman

water becomes contaminated with the cyst.

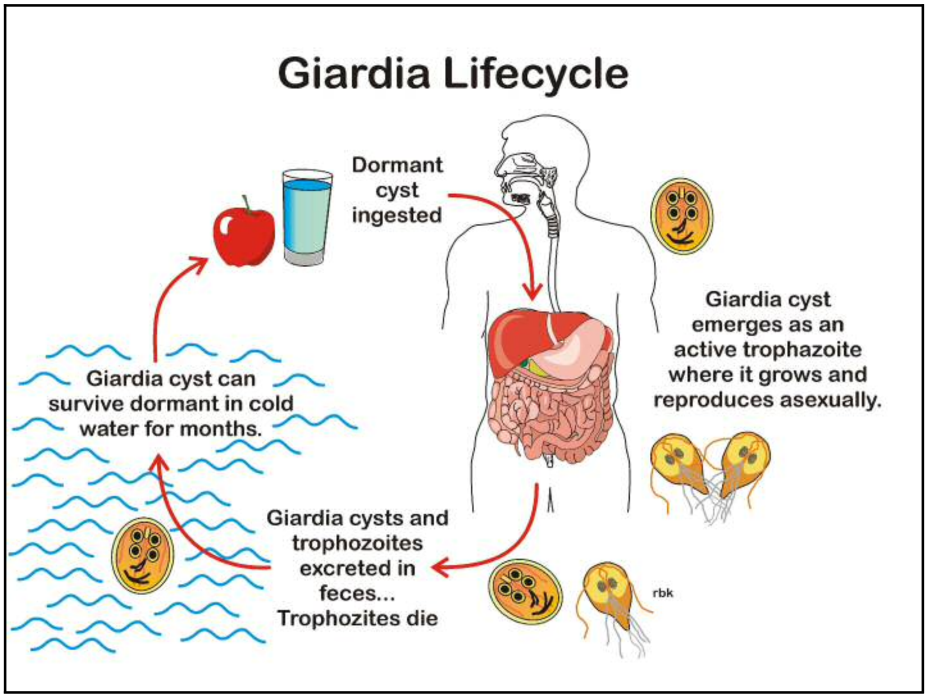

Figure 7.16: Life Cycle of Giardia – Although Giardia is usually associated with beavers and drinking water, the protozoan can also be transmitted through the soil and other means. Source: author – [file:\WA-Giardia.jpg].

Normally, Giardia is a recreational illness associated with backcountry use and beavers (Figure 7.17). Although a one micron filter is recommend, the two micron filters used in most backcountry filters and pump filters will suffice (see Figure 7.9). Consider supplementing filtering with chemical or UV purification also. Also, more vigilance is needed when there are signs of beaver habitat. Again, water taken from the middle of a lake is less likely to be contaminated than water taken from a stream where beaver sticks are found floating next to the shore (i.e. beavers eat the bark off the sticks for food.).

When human or infected animal's feces is used for fertilizer, the dormant cyst can be transmitted through the soil or through foods coming in contact with the cyst bearing soil. Although this tends to be a third world concern, it can occur in this country where feces are used as fertilizer. In these situations, food and hands require proper washing.

Figure 7.17: Beaver Habitat – For backcountry users, Giardia is usually associated with beavers and drinking unfiltered and purified water. Source: author – [file:\Beaver-002[gd].jpg]

Emergency Water Storage

This section investigates sources of tapping into water sources in the house prior to a crisis situation. The main problem with most of these methods is making the decision to use them prior to the pending crisis. If people wait until the emergency crisis and the water becoming contaminated, it is of little avail to fill a bathtub with potable water.

Copyright © 2016 Robert B. Kauffman

Five Gallon Buckets – Having several five-gallon bucket available can be used to quickly store water in case of an emergency. One five-gallon bucket is enough water for one person for five days. Remember, it will weigh roughly 40 pounds.

Bathtub – The standard bathtub can hold between 35 to 50 gallons of water. Soaking tubs can hold between 60 to 80 gallons of water. Filling an unlined bathtub has three disadvantages. First, the bathtub may not be sanitary. Second, most drain plugs are not perfect seals and will slowly drain over a short period of time. Third, the bathtub does not normally fill past the overflow drain.

Figure 7.18: Bathtub Liner – The bathtub liner uses the bathtub as the structural form for the liner. The liner is really a bag that is filled with water in time of crisis. Source: internet – [file:\BathtubLiner[40].jpg].

There are commercially available bathtub liners or bags that use the bathtub to provide structural support for the liner or bag (Figure 7.18). In addition, the bag may come with a hand pump or siphon to withdraw the stored water. As with most of these emergency devices, the issue is when to use the bag in time of a crisis. Also, a false alarm can be problematic since the bag may not be designed to easily drain the water if it is not needed.

Figure 7.19: Drain Faucet – The drain faucet on a hot water heater. Note that it threaded to couple a garden hose to it for draining purposes. Source: internet – [file:\DrainFaucet[40].jpg].

Water Heaters – Most homes have a water heater that stores up to 40 gallons of potable water. Initially, it may be hot water, but it is drinkable water. Be sure to turn the water heater off. All water heaters have a faucet to drain the water heater. The faucet contains threads that allow a garden hose to be connected to the water heater for draining purposes (Figure 7.19). If needed trim a short length of garden hose to facilitate draining. Also, if the water coming into the house could be contaminated, turn off the main water line coming into the house.

Toilets (Figure 7.20) – The tank of the toilet contains what is usually potable water. Today, it is more of a novelty source than a practical source of water. Older toilets contained three and one half, five, or even seven gallons of water. Although today's toilets flush with 1.6 gallons of water, they hold more in the tank than 1.6 gallons but less than what they used to hold. Remember, the water in the toilet bowl is contaminated and should not be used. Also, some experts suggest that the water in the tank should be used with caution because it can contain mold and other contaminants. If there are any questions, purify the water.

Figure 7.20: Toilets – Depending on the age of the toilet, the tank may contain three to five gallons of potable water. Some experts suggest treating the water regardless. Source: internet – [file:\WA-Toilets.cdr].

Copyright © 2016 Robert B. Kauffman

Water Pipes – Depending on the size of the house and the amount of water pipes, the water pipes in a house can easily contain up to 2.5 gallons of water. Again, turn off the water main coming into the house if there is potential water contamination of the water supply. Drain both the cold water and hot water pipes into bottles as needed or until drained. A sink in the basement with a faucet can easily do this. To facilitate quicker draining open a sink faucet on the second floor.

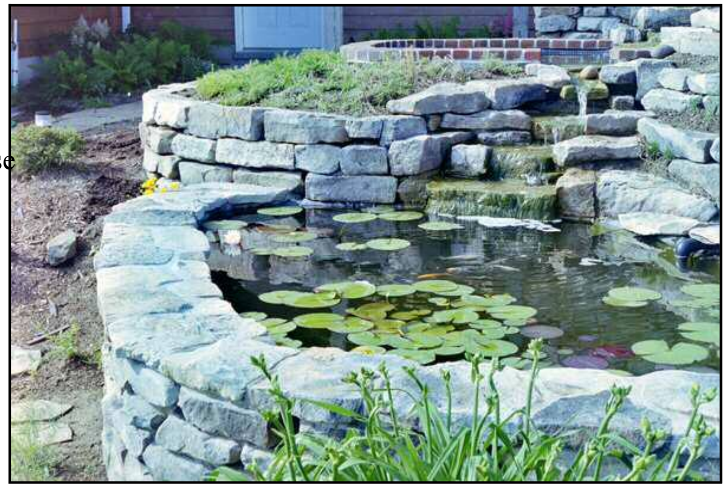

Figure 7.21: Ponds – Ponds can provide a source of water. Treat it as non-potable water. Source: author – [file:\DSC_0122[20].jpg].

Waterbeds – A king sized waterbed holds roughly 235 gallons of water. A queen sized waterbed holds roughly 196 gallons. Treat the water as if it is untreated.

Swimming Pools – If the pool is properly treated and filtered, its water can be considered potable. If the pumps have stopped or if the pool has become inoperative, consider the water as untreated. A child's inflatable pool can be used to store water also.

Ponds (Figure 7.21) – Consider the water as untreated and purify it using the same methods that would be used for treating water from streams or other natural sources.

Cisterns (Figure 7.22) – A cistern is used to collect rain water and to store if for some time of use. The surface of a roof multiplies and concentrates water collection. In normal sustainability situations, water from cisterns is used to water plants and used for non-potable water situations. However, in times of emergency crisis, water stored in a cistern can be use for consumption if it is purified.

Figure 7.22: Cisterns – Cisterns are used to store water. Often they collect water from the roof of a building. Source: author – [file:\WA-Toilets.cdr].

Dew Collection – In the morning, dew can be collected using a towel or rag. Wipe the dew until the rag is saturated. Wring out the rag into a container. Repeat the process. Bradley (2011) notes that this can be a relative efficient method to collect water. Treat the water collected as untreated water.

Copyright © 2016 Robert B. Kauffman

Solar Stills (Figure 7.23) – Using the sun as the heating source, solar stills utilize the greenhouse effect and the distillation process to purify water. The solar radiation passes through the polyethylene and heats whatever water bearing material is present in the still. The water condenses on the polyethylene and drips into the cup or container. The hose is useful because once the seal is broken, the still needs to be reestablished.

Bradley (2011) is not a fan of the process. It works better in theory than practice. This author last attempted to use a solar still numerous years ago as a Boy Scout. It requires full sunlight and semi-specialized equipment to work. As noted, it works better in theory than practice.

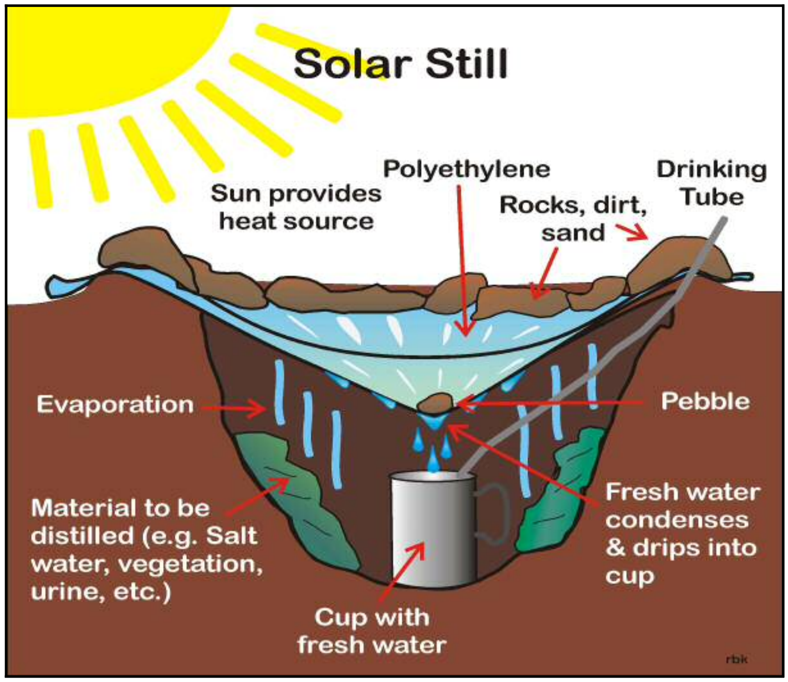

Figure 7.23: Solar Stills – Solar Still can work under the right conditions. They need the materials pictured to create the still. Source: author – [file:\WA-SolarStill.cdr].

Barrier Analysis

Chapter 4 introduced the concept of Barrier Analysis (Figure 7.24). Conceptually, barrier analysis is a straightforward process. The hazard which create the accident and energy transfer is identified and possible barriers are placed between the hazard and the target to prevent or reduce the likelihood of the accident occurring. The barriers are less than perfect or there are limitations to their effectiveness.

From an organizational perspective, this chapter is divided into four sections. Sources of contamination and the influence of disasters constitute the hazard, harmful agent, or adverse environmental condition that can lead to the energy transfer. The purification strategies and emergency water sources constitute barriers to contaminated drinking water. They are less than adequate (LTA).

Figure 7.24 is the working table that identifies barrier analysis for an activity or program. In this case, the activity was chosen for drinking water during a flood. Other relevant disasters could be chosen also and a working table applied to them. Second, the energy flow (hazard) harmful agent, adverse environmental condition is identified. In this case sources of contamination were limited to flood situations. It was divided into pathogens and organic and inorganic contamination. If desired, pathogens could have been subdivided into viruses, bacteria and protozoa. This would allow for a more exacting analysis of potential barriers. Also, it results in redundancy since water storage can be used as a barrier for viruses, bacteria, and protozoa protection. Next, the target is identified in the second column which in this case is an unchanging prepper. Fourth, the barriers and controls are identified in the third column to separate the energy from the target. In the last two columns of the table, the table identifies how the barrier works and the limitations of the barrier or how it is less than adequate.

Copyright © 2016 Robert B. Kauffman

The working table serves as a "Cliff Notes" for the chapter or a summary table of the chapter. Also, it serves to focus specific remedies toward identified disasters or crisis situations that the prepper has identified using the *Surviving the Unexpected Emergency Model*. The table provides a systematic approach toward protection. However, for most people it provides a way of thinking and toward approaching crisis situations. It asks the question of what can I do to protect myself from the potential injury, damage or loss.

Figure 7.24: Barrier Identification Table
Activity or Program: **Drinking Water – Flooding**

Energy Flow (Hazard) or harmful agent, adverse environmental condition	**Target – Vulnerable person or thing**	**Barrier & Controls to separate energy and target**	**Purpose/ Prevention**	**Limitations**
Pathogens	Preppers	Water Storage	Separates water by space from hazards	Maintenance and storage space requirements need to be above flood waters.
	Preppers	Rolling boil of water for one minute	Kills pathogens in the water	Doesn't affect organic or inorganic contamination which is likely too be present. Stove may not be operable. Campfire maybe impractical.
	Preppers	UV Light	Kills pathogens in the water	Doesn't affect organic or inorganic contamination which is likely too be present. Needs electricity or batteries. Electricity may not be available
	Preppers	Pump water using two micron filter	Separates (filters) pathogens from drinking water	Doesn't affect viruses, organic or inorganic contamination which is likely to be present in flood waters.
Organic and Inorganic Contamination	Preppers	Water Storage	Separates by space the target from the contamination	Maintenance, storage space, water rotation, Specific source of contamination (e.g. flood, tornado, etc)
	Preppers	Distillation	Separates by distillation process contaminate and water	It is a slow process requiring specialized equipment, and a cooling source.
	Preppers	Reverse Osmosis	Separates by reverse osmosis organic and inorganic contamination	It requires large amounts of water which in a crisis situation may not be available.

Source: adapted from Table 2 in NRI MORT User's Manual and Oakley (2003) by Kauffman and Moiseichik (2013)

Copyright © 2016 Robert B. Kauffman

Summary

Water is necessary for life. A rule of thumb is that people need one gallon of water per person per day. Different sources of contamination and strategies of purification were discussed. Storage of water is a simple and effective strategy. Water heaters and toilet tanks can be used as water sources if needed, particularly in short term crisis situations. Water sources can easily be contaminated by the type of disaster present (e.g. flooding). Or it can be unaffected. Determine the most likely crisis situations and this will help to determine the strategy used. Use barrier analysis to help structure prevention strategies.

References

Bacteria and Virus Issues (2016). *Water Quality Association*. https://www.wqa.org/Learn-About-Water/Common-Contaminants/Bacteria-Viruses

Bradley, A., (2011). Handbook to Practical Disaster Preparedness for the Family.

Kauffman, R., (2015). *Surviving the Unexpected Emergency Model*.

The Safe Water System – Chlorine, (2012). CDC 24/7: Saving Lives. Protecting People. *Center for Disease Control and Prevention*. March. http://www.cdc.gov/safewater/effectiveness-on-pathogens.html

Copyright © 2016 Robert B. Kauffman