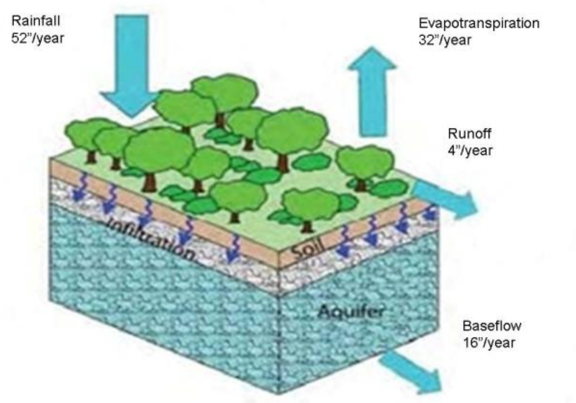
Water Treatment Lab
Environmental Engineering

Background:
Water is vital to our existence. We need it for drinking, cooking, bathing, cleaning, crops, and many other tasks. Early civilizations recognized the need to have easy access to a sufficient quantity of this resource. The earliest treatment methods involved charcoal (the real kind, not the briquettes you throw on a grill), sunlight, boiling, or straining. For a detailed history of drinking water treatment, visit http://esa21.kennesaw.edu/modules/water/drink-water-trt/drink-water-trt-hist-epa.pdf

Unfortunately, water is not always clean enough to use safely. This is becoming an increasingly prevalent problem in both developing and industrialized nations. Some examples of undesirable water components are pathogens (cryptosporidium, giardia), carcinogens (THMs, HAA5s, PFAS), and taste & odor (NOM, H_2S). For more information on drinking water and your health, visit http://esa21.kennesaw.edu/modules/water/drink-water-trt/drinking-water-health-epa.pdf

The natural water cycle allows rainfall to fall on trees, grass, dirt, sand, and infiltrate into ground. This infiltration allows stormwater to be treated by physical (sand, soil, gravel, etc), biological (microbial and plant uptake), and chemical (adsorption and absorption) processes. The natural water cycle allows groundwater tables to be recharged, and when water reaches water bodies, aquifers or drinking water sources, it has already been treated. Urbanization and industry have changed the natural water cycle by not allowing water to infiltrate, but instead runoff to natural water bodies through pipe networks, picking up man-made and natural chemicals (from cars, lawns, agriculture, and industry) and waste along the way. As we add more chemicals into our environment ending up in our water sources, causing algae blooms, erosion, flooding, ecologic changes, and as we add chemicals into the environment, our drinking water becomes more difficult for us to clean.



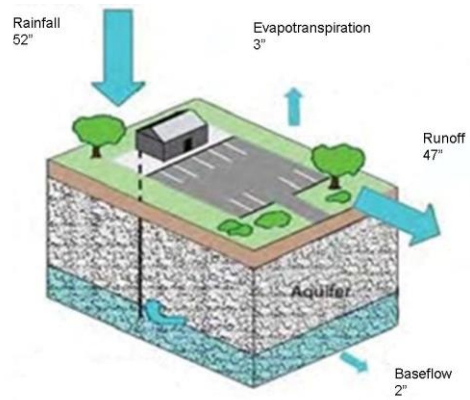


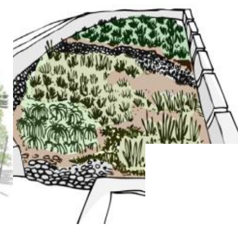
Figure 1. Natural Water Cycle

Figure 2. Urbanized Water Cycle

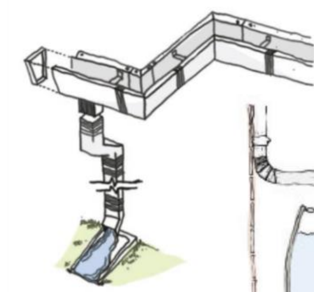
All runoff in the state of Florida (and most of the United States) drains to a natural water body. Some cities, like Philadelphia, have combined sewers where stormwater runoff is treated at a wastewater treatment plant. Although this may sound good, this process further changes the natural hydrology and, in heavy rainfall events when water coming into the plant is too much for the plant to handle, the combined stormwater and wastewater may be discharged into a water body without treatment. In fact, these "combined-sewer-overflows" (CSOs) have resulted in some of the most polluted waterways in America.

Part I: Low Impact Development

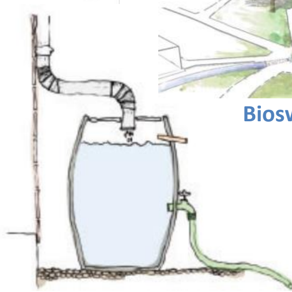
Low impact development and sustainable design are strategies to allow development of homes or businesses with techniques that mimic the natural water cycle by keeping water onsite, reducing the amount of water that is runoff, recharging water tables, and allowing water to be naturally treated by engineering design strategies. These include cisterns, infiltration trenches, raingardens, swales, and filter media that treat nutrients and other chemicals on site prior to water entering our natural systems.



Curb Cuts

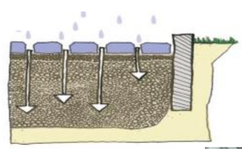


Downspout



Cistern

Bioswale



Pervious Pavement

Swale

Detention/Retention Pond

Check out these Low Impact Development Designs, How does each technique help mimic the water

Disconnection and Green Roofs

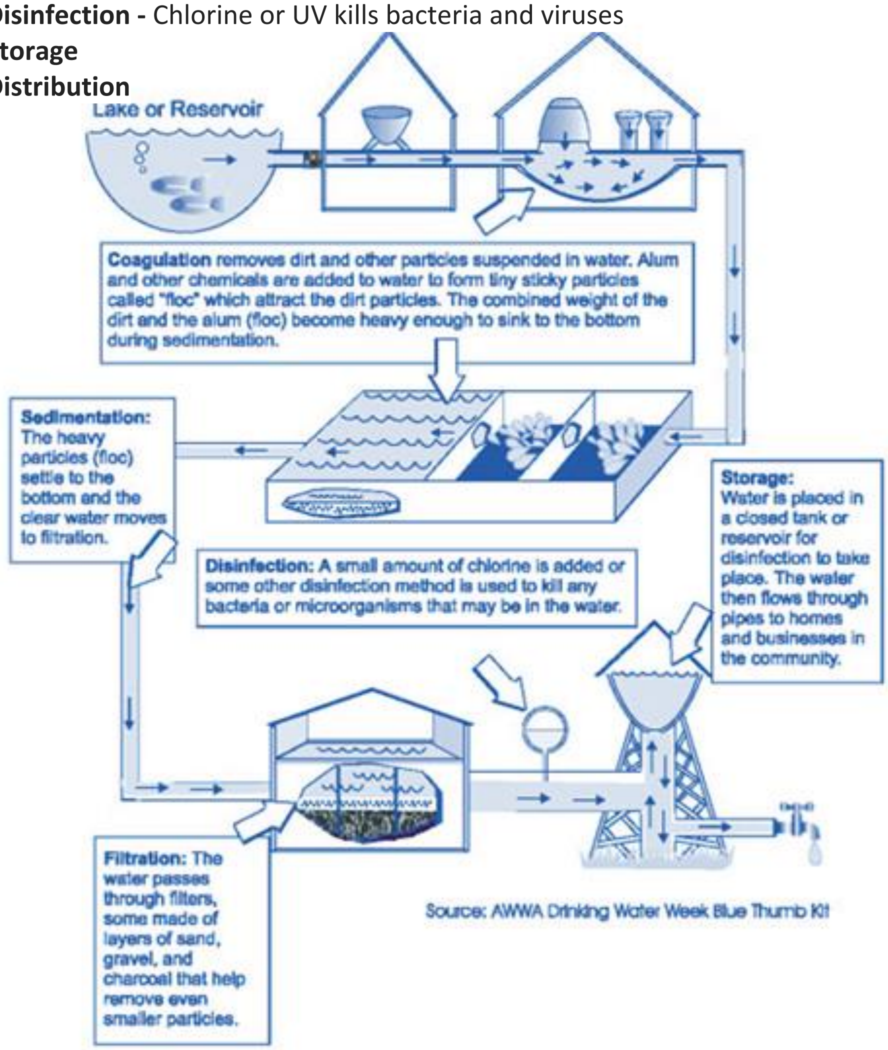
Look up each of these design strategies and decide which 3 you would use around the building you are in right now! Why would you choose these?

When water is pulled from an aquifer in the ground or a water body to be treated for drinking water, it is called "potable" water. The goal of **potable** (drinkable) water treatment is to purify <u>ground</u> and surface water for both safe and enjoyable consumption. The task is to design a system that *chemically, biologically, and physically* converts unacceptable water into potable water.

Part II. Drinking water lab

Steps of Drinking Water Treatment Plant:

1. **Collection** – Collection of Water
2. **Screening and Straining** – Screens to remove trash and debris
3. **Coagulation and Flocculation** – Adding a chemical like alum that will encourage particles to clump together, or "floc"
4. **Sedimentation and Clarification** - Flocs fall to the bottom of the tank for removal
5. **Filtration -** water is filtered to remove any remaining particles and polar chemical compounds (Granular or powdered activated carbon- PAC and GAC (that black stuff in a Brita or Pure water filter), sand, membrane filtration, etc)
6. **Disinfection -** Chlorine or UV kills bacteria and viruses
7. **Storage**
8. **Distribution**



LAB TIME!!!!

Procedure

In this lab, we will be treating contaminated water to observe the steps involved in water purification for human consumption. The goal is to remove impurities from the water. Our results will be measured using a spectrophotometer. This piece of equipment measures the ability of light to pass through a sample. If there are dissolved particles, these particles will block some of the light from passing, reducing the reading on the spectrophotometer. If you don't have a spectrophotometer in your classroom, you can record turbidity (how clear the water is), you can make a secchi disk with cardboard, write a letter on it and determine clarity compared to other groups by the depth at which you can still see the letter on the disk. Keep in mind that this only gives us information on dissolved compounds in our water and should not be used alone to indicate water quality (in other words, don't ask if you can drink the water when we're done- be careful of fingerprints ☺).

We need to remove big particles before removing the small ones. To do this we start with a screen to remove trash, and then a coagulant. In water treatment, coagulation flocculation involves the addition of compounds that promote the clumping of fines into larger floc so that they can be more easily separated from the water. Alum is a coagulant found in your grocery store because it's also used in cooking!

We will be using activated carbon as an adsorbent. GAC (granular activated carbon is charcoal or wood treated by extreme temperatures and pressures to create pores, called "active sites". These active sites increase surface area allowing each particle to uptake more pollutants. GAC is what is found in your Brita or Pure filter.

Materials

2 small cups, one with a ~¼ inch hole on the bottom
Coffee filter
Sand- enough to fill the cup with 1inch (depth) sand
Enough Granular activated Carbon to cover the bottom of the cup (depends on cup size)
Enough alum to cover the area of the top of sand (depends on area of the cup

Coagulant: Alum- a small shaker can be found in your grocery store spice aisle

Adsorbant-
GAC can be found at your local aquarium store

Filtration- sand can be found anywhere, but make sure you wash it well until the water your run through it is clear

Contaminated Water:
Contaminants for 1L:

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10 g clay or cat litter (or dirt)
Methylene Blue dye
1mL 10 µg/mL MIB & Geosmin

A. Contaminated Water:
Shake the capped container of contaminated water. Uncap and describe the turbidity and odor. Pipette contaminated water into a cuvette and obtain a spectrophotometer reading. Do not give the water time to settle!

- Odor:____
- Turbidity: ____
- Spectrophotometer Reading: ______________

B. Aeration: Recap the contaminated water and shake vigorously for 30 seconds. Uncap and pour back and forth between the glass jars four or five times. Describe the odor and turbidity.

- Odor:____
- Turbidity: ____

C. Coagulation/Flocculation: Add the alum to the container, cap, then stir gently by swirling. The alum is a coagulant and will bind with particles suspended in the water. Describe what happens to the water immediately after adding the alum, after 2 minutes, and after 5 minutes (remember to keep swirling!). Pipette a sample of your water into a cuvette and obtain a spectrophotometer reading. Do not give the water time to settle!

- After adding alum:____________________________________
- 2 minutes:____
- 5 minutes: ____
- Spectrophotometer Reading: ______________

D. Sedimentation: Leave the container undisturbed for 10 minutes. Take this time to construct your filter as described in section E below. Record your observations of the water's appearance below. At 10 minutes, pipette a sample of your water into a cuvette and obtain a spectrophotometer reading.

- 2.5 minutes:____
- 5 minutes:____
- 7.5 minutes: ____
- 10 minutes: ____
- Spectrophotometer Reading: ______________

E. Constructing the Filter:

1. Obtain 2 small plastic cups. One should have a hole in the bottom.
2. Place a coffee filter in the cup with the hole in the bottom.
3. Carefully add sand to reach an approximate 1" filter depth. Add GAC if selected.
4. Place the second plastic cup under the cup with the filter.
5. Clean the sand by using the pipette to slowly drip clean tap water through the filter. Discard the effluent. Your single-media filter (dual-media if using GAC) is now ready for use.

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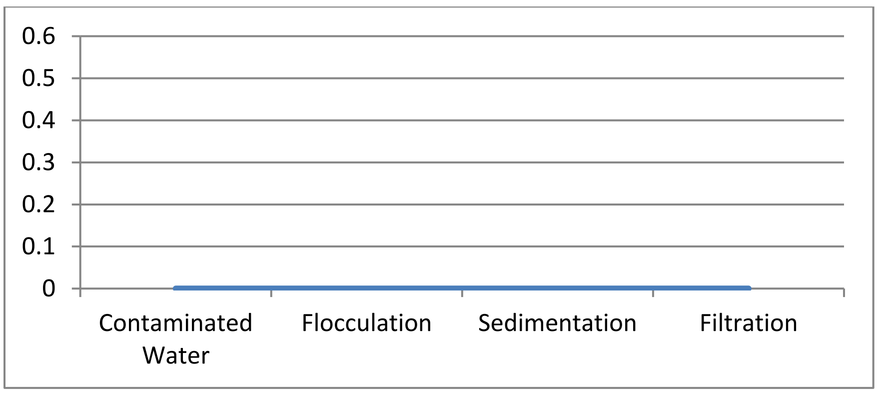
F. Filtration: ***Carefully*** and ***Slowly*** pour off the top 2/3 of the water into the other glass jar. It is very important that you do not disturb the sludge when pouring so take your time! Use a pipette to slowly transfer the water from the jar into the filter apparatus. The water will percolate through the sand and collect in the plastic cup below. Describe the odor and turbidity of the water. Pipette a sample of your water into a cuvette and obtain a spectrophotometer reading.

- Odor:____
- Turbidity: ____
- Spectrophotometer Reading: _____________

G. Disinfection: The final stage of drinking water treatment is disinfection which eliminates any remaining microorganisms. Common disinfectants used are Chlorine, UV, or O_3. This step will not be done in this laboratory exercise as the methods can be dangerous outside of controlled conditions.

If you have a spectrophotometer available, complete the graph below to chart the improvement in water quality based on spectrophotometer readings vs. treatment step.



"Seekers of Science"

Seekers Of Science (S.O.S.) is a comic that is about using real-life science in real-life situations to try and save the world. It stars two real-life scientists, Dr. Tracy Fanara and Tamara Robertson, as they use their skills and those of other scientists around the world to help stop the problems that are put in front of them.

Each issue or arc focuses on a different part of the world of science. From handling pollution to the science of making medicine and so much more. It's our hope that those who read this comic will be inspired by it and want to learn more about what science and more have to offer the world. As well as showing that ANYONE can be part of the STEM (Science, Technology,

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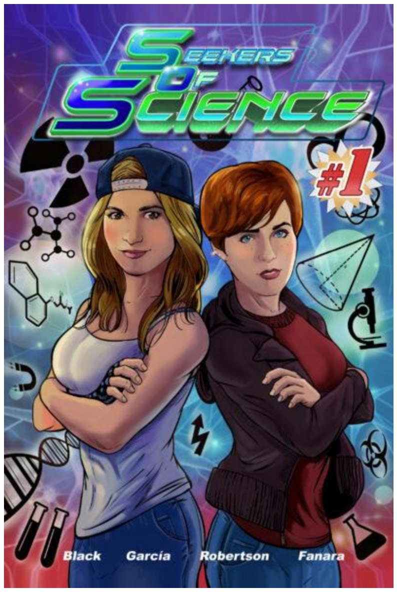
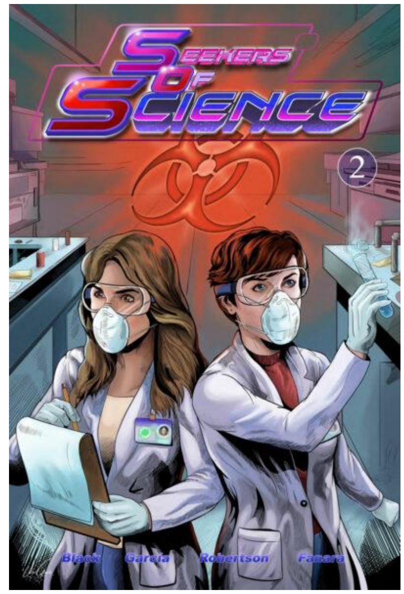
Engineering, and Mathematics) fields. And it's so diverse, that you can find something that speaks to you and your personality.FREE ISSUES





Each attendee of the USA Science Festival will be the recipient of "Seekers of Science" Issue 1 and 2 digitally for FREE by going to:

https://tinyurl.com/SOSComicOutreach

Please share photos of you conducting S.O.S DIY Experiments with us at @sos.comicbook on IG. Find out more about how you can join the "Seekers of Science" team at www.seekersofscience.com

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