


Gravity-Fed Water Systems

The background features abstract geometric shapes. A large light blue triangle points from the top right towards the center. An orange triangle points from the top left towards the center. A teal triangle points from the bottom left towards the center. The text is positioned in the white space between these shapes.

In the developing world,
more than 784 million
people do not have access
to *clean drinking water*.



This causes over 5,000
deaths per day, and *billions*
of dollars in
medical bills and loss in
economic productivity.



What do you think is the
cause of
waterborne disease?



Answer:
chemical and biological
pollutants in
untreated water.

The bottom of the slide features a decorative graphic consisting of three overlapping geometric shapes: a dark blue triangle on the left, a teal triangle in the middle, and a light blue triangle on the right, all pointing towards the bottom-left corner.

Top Five Chemical Pollutants

1. Mercury pollution from gold mining (3.5 million people)
2. Lead pollution from industrial parks (nearly 3 million)
3. Pesticides from agriculture (more than 2.2. million)
4. Lead smelting (just under 2 million)
5. Chromium pollution from leather tanning (more than 1.8 million)



What is a Biological Pollutant?

Human Fecal Matter
(aka poop)!



Parasite

An organism (microscopic and macroscopic) that lives on a persons' nutrients. In the case of waterborne illness, common parasites are Round worm (below), Hook Worm (below), Guinea Worm, Cryptosporidiosis, and Giardiasis.



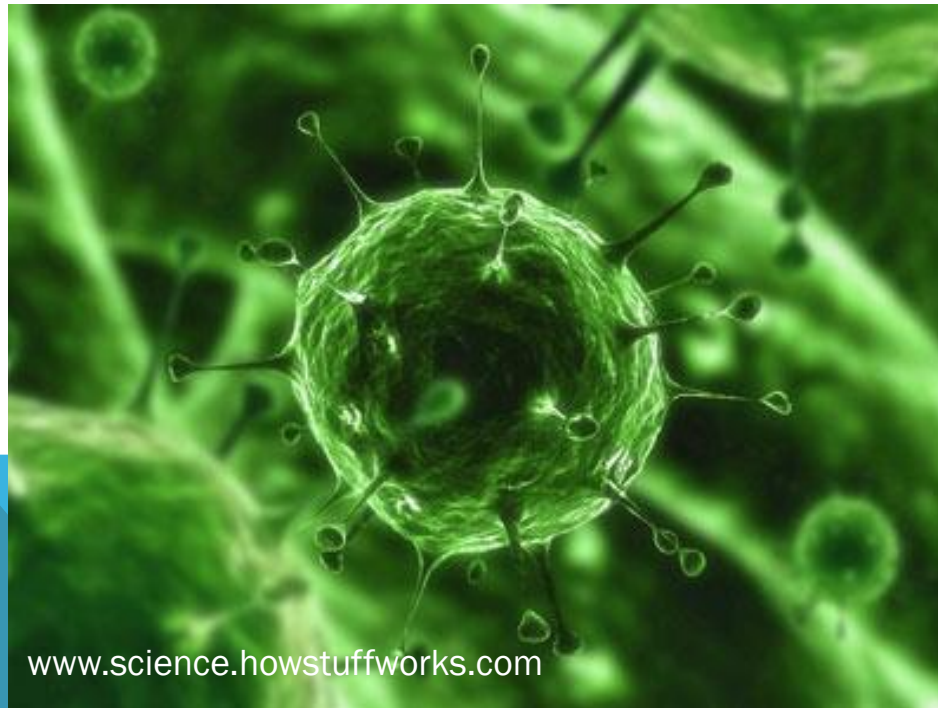
Bacteria

Microscopic single-celled organism that can either be highly infectious, or beneficial to the human body. In the case of waterborne illness, a harmful virus is E-coli (below).



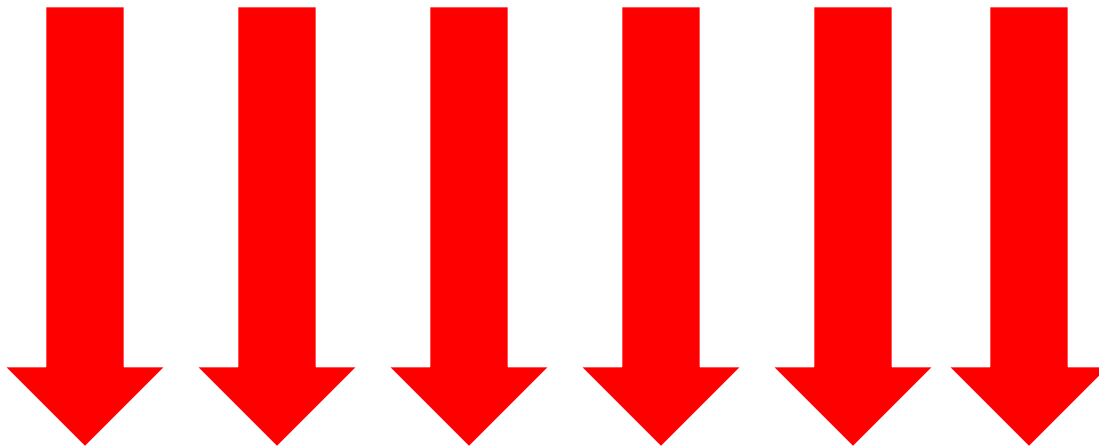
Viruses

A very small organism that causes a disease to spread throughout the body. An example of a virus is Rotovirus (the stomach flu), or influenza.

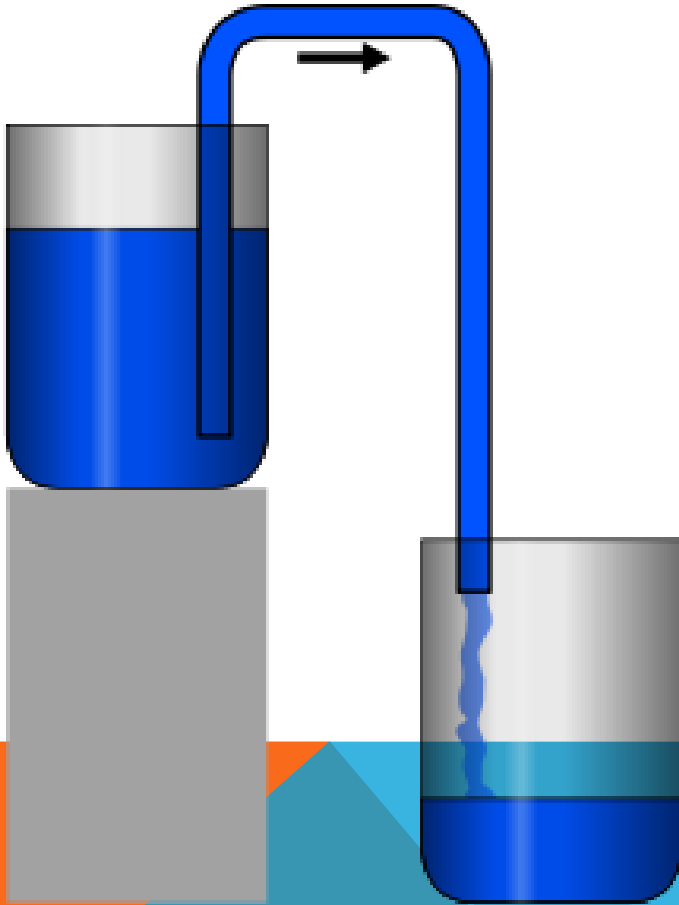


www.science.howstuffworks.com

Gravity is one useful way to get clean water to people.



A gravity-fed water system is....

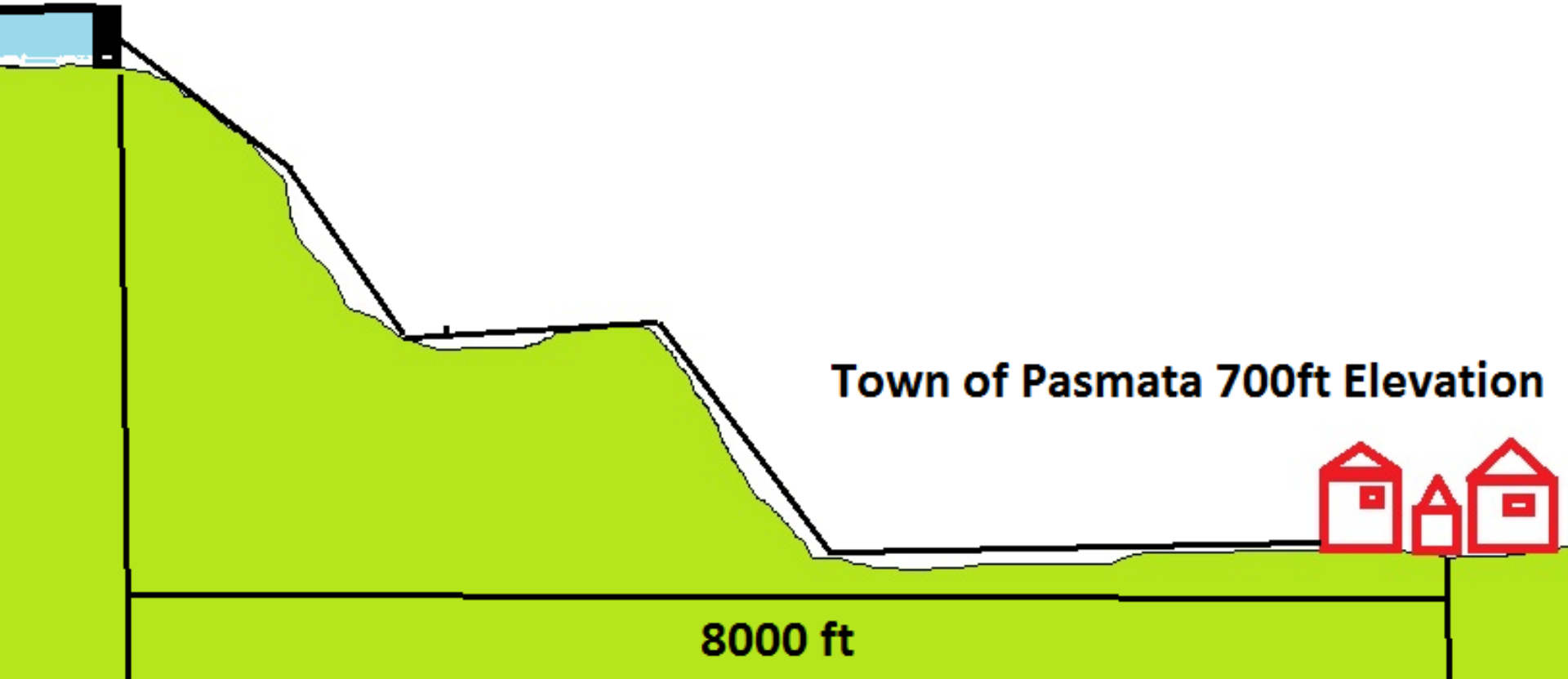


...one which distributes water by the power of gravity. No pumps. No added energy. Just energy that exists through the position of the water with respect to a lower point.

- Potential Energy – energy by relative position.
- Kinetic Energy – energy in motion.
- Zero energy – by pumps or added energy.

In developing world situations, this could be bringing water from a high point in the mountains, to lower point where there is a village....for example, Pasmata, Peru.

Source 750 ft Elevation

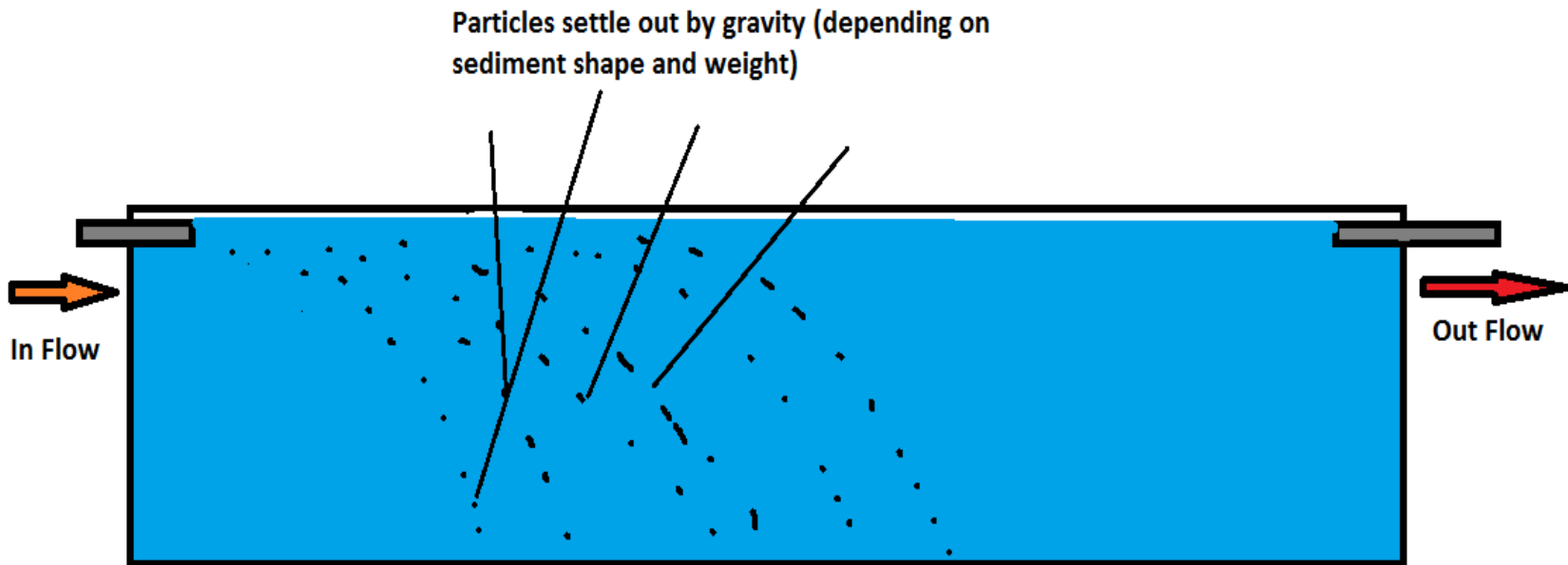


Typical gravity fed systems have a series (one after another in a line), of treatment processes. These are....

- **Sedimentation:** Water from streams or ground water typically has sediments (dirt particles), that can either clog up pipes, or carry water borne illness. This is taken out through sedimentation: settling (removing) of particles by gravity.
- **Filtration:** Many times these sediments are too small to remove through sedimentation (settling of particles out of the water). So they need to be removed by a filter.
- **Chlorination:** Most filters cannot remove every type of “bug”, and therefore need help by disinfection. The adding of as little as 2mg/l (ppm) of chlorine has shown to kill more than 99.99% of bacteria and viruses.

Sedimentation

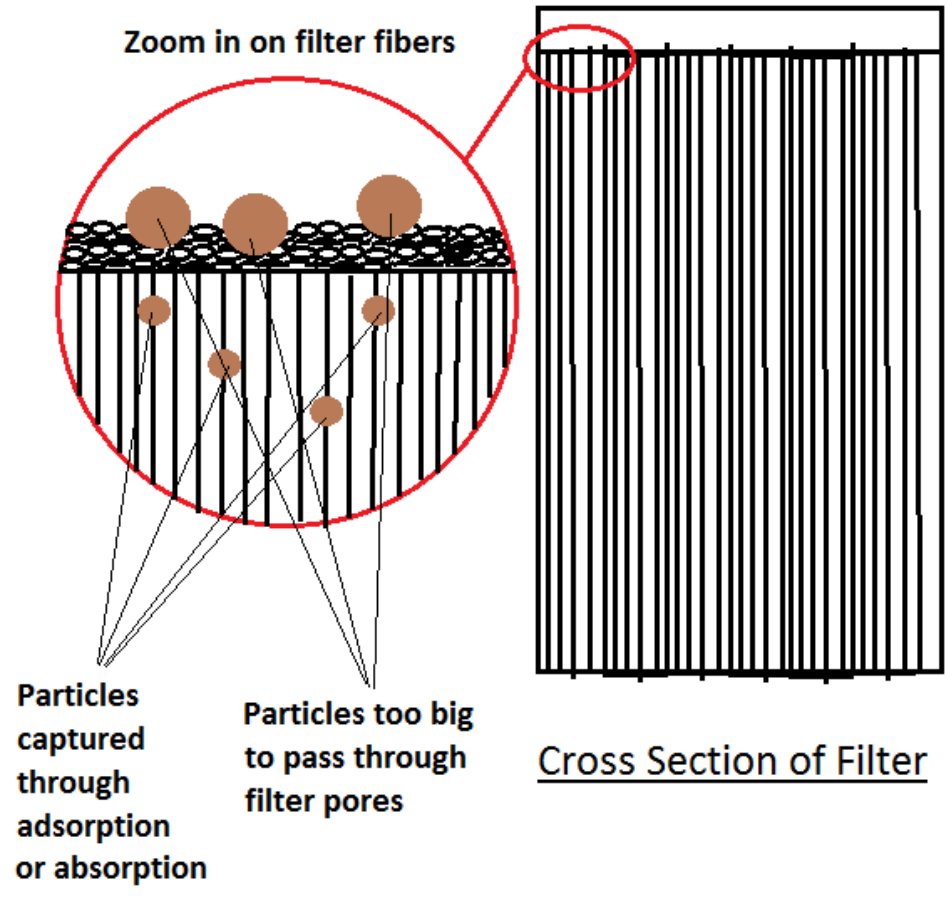
- Removes through gravity pulling down the sediments,
- Pipe on bottom cleans out settled sediments, effectively removing them.
- Settling of large particles is faster than slow particles (bowling ball vs. a grain of sand).
- Time it takes to settle the particles must be considered. If tank is too small, sediments will not have time to settle out and will be pushed through the system.



Elevation View of Sedimentation Tank

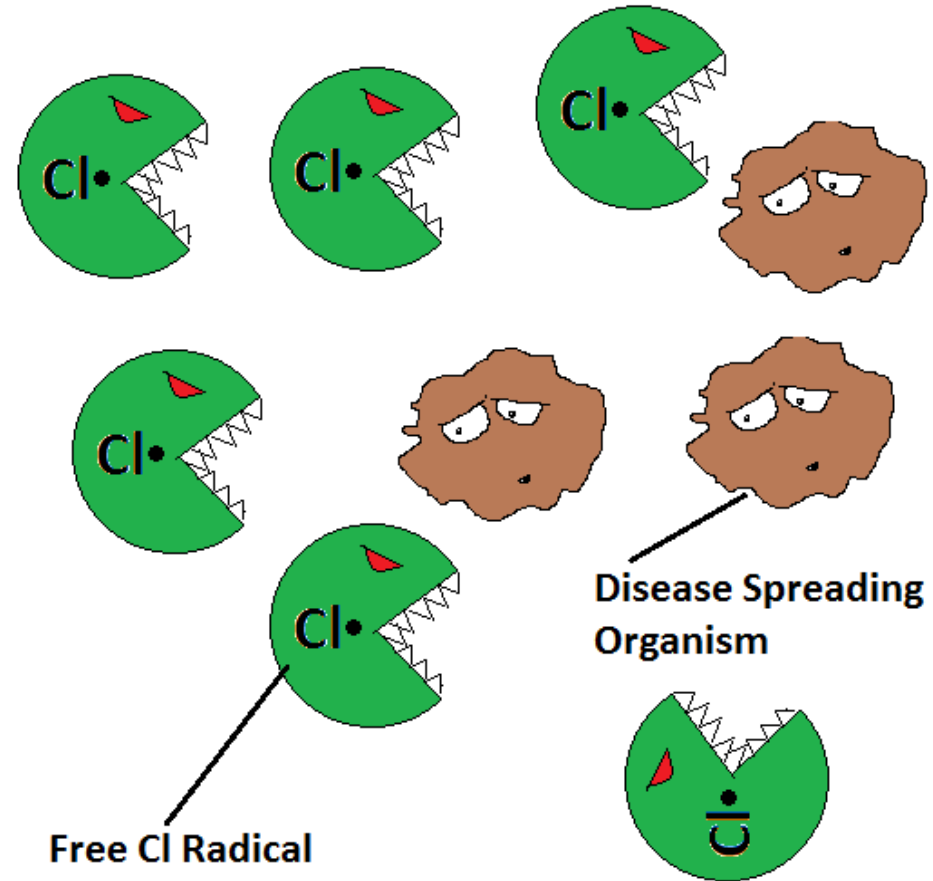
Filtration

- Removes by pore size: the holes of the filter too small to let stuff pass.
- Removes by adsorption: stuff sticks to filter material (sand, rock, carbon; e.g., Brita ® Filter).
- Removes by absorption: stuff sticks to outside of filter material.

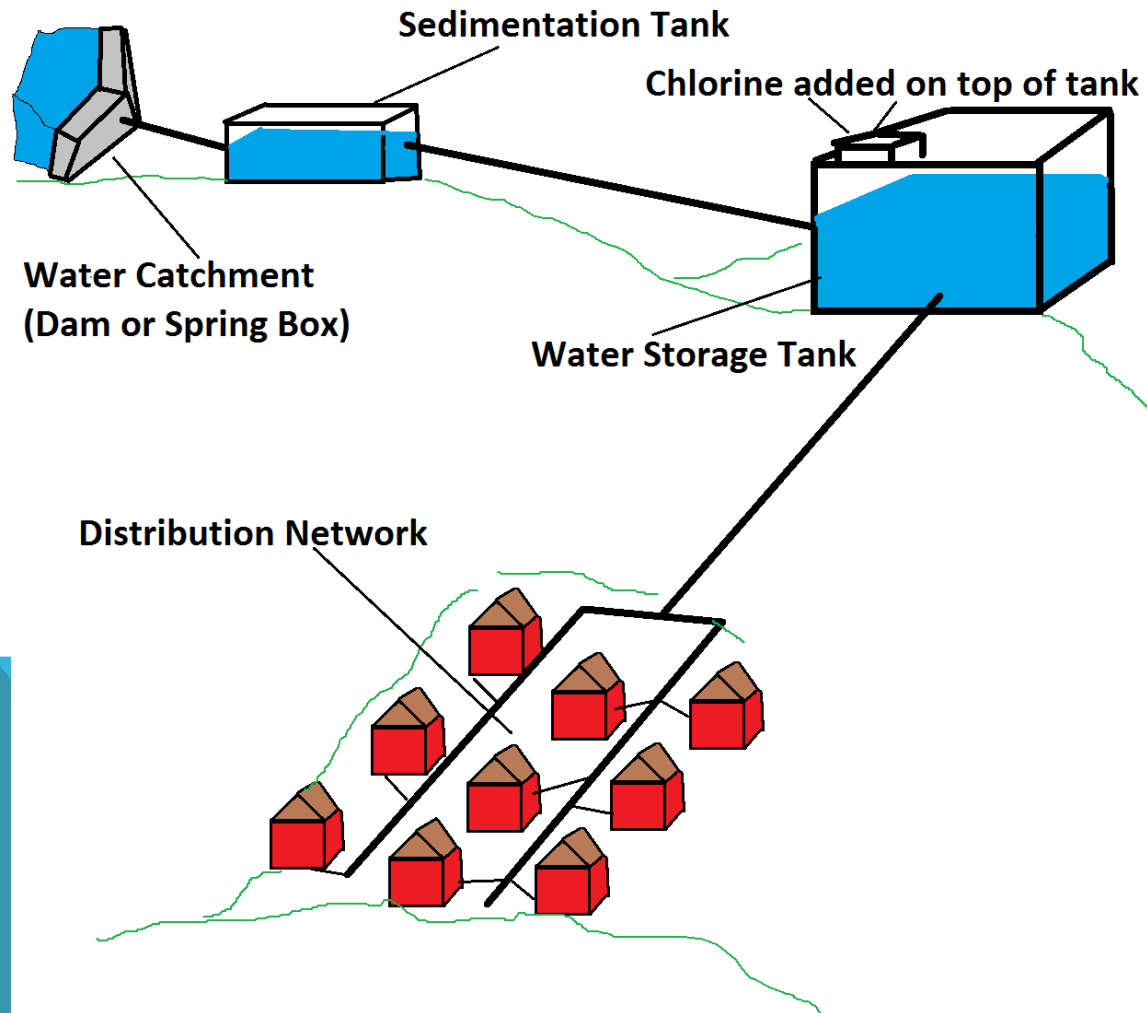


Disinfection

- Chlorine sends out free Cl radicals that go out and “eat” or “blow up” the organisms!



Gravity fed system with all its processes

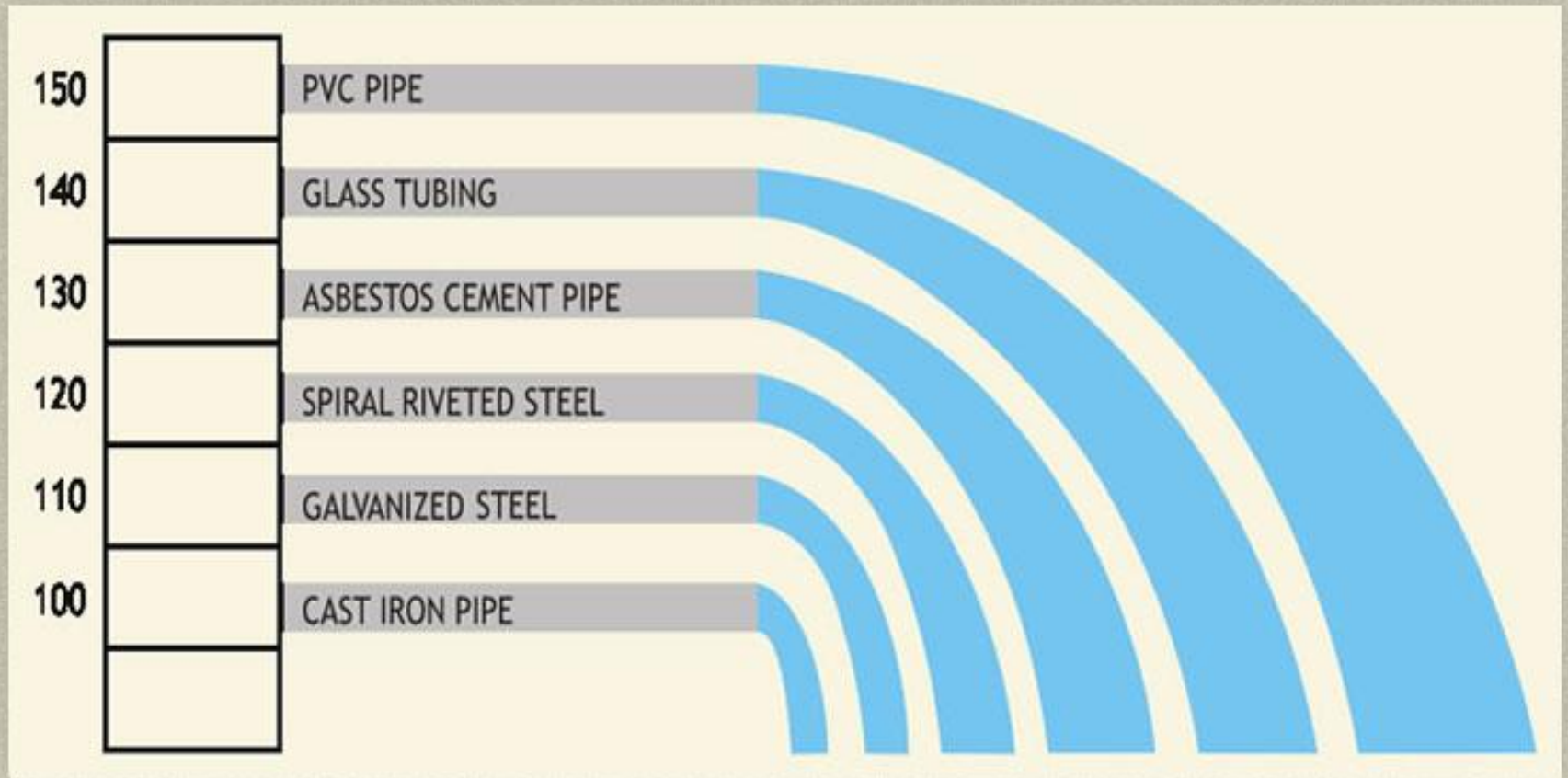


Hydraulic Design

Things we need:

- What is the water demand of the community? How much water does the system need to pipe now, and for 20yrs in the future?
- Topographical Information – is there enough elevation change to pump water by gravity?
- Elevation of source, tank and town?
- Pipes, Valves, Fittings
- What type of pipes will be used (PVC, metal, concrete, etc.)?
- What size of pipes will be used?
- What will be the frictional losses in the pipes ?
- Major Loss: friction in the pipe
- Minor Loss: friction from components (valves, gauges, etc.)

Frictional loss for pipes

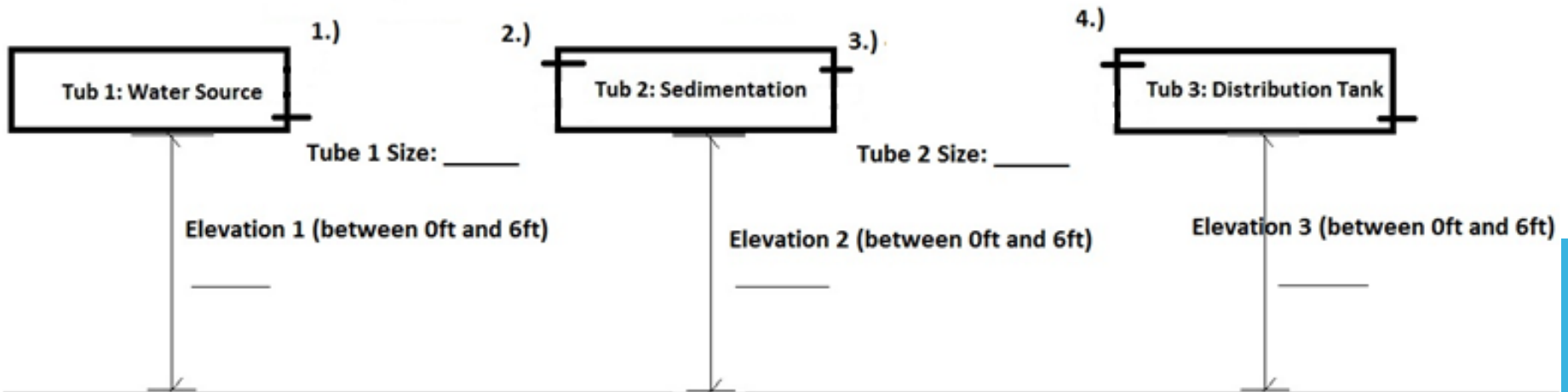


Sedimentation Tank Design

- Position of the pipes in tanks.
- Size of the tank (why is this important?).
- Size of sediments that are in the water (i.e., silt, sand), where small particles settle slower than large particles.
- How many sediments are in the water (turbidity)?
 - Turbidity is measured in NTU's, where higher numbers mean higher cloudiness. Clean water would be NTU between 1 and 5, dirty water (chocolate milk) would be +500

Today's Activity :

Build a model gravity-fed water system with sedimentation



Turbidity (NTU)

Water Samples:

