Pumped Water Storage

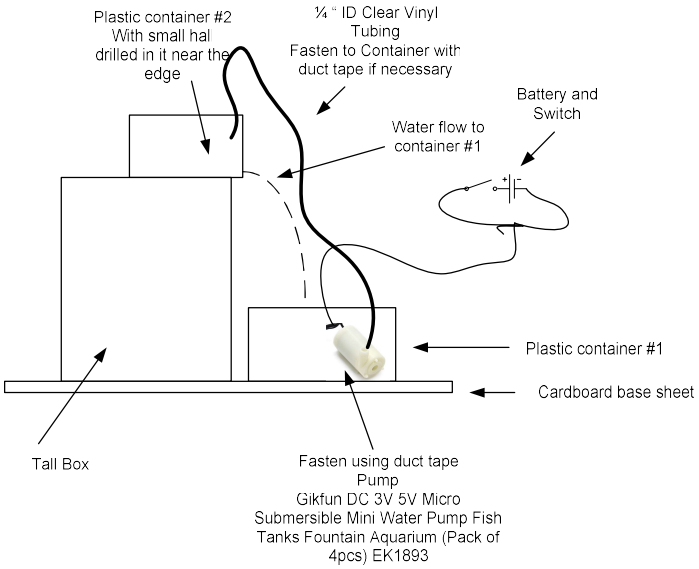
General

This is a proof of concept exercise. You will build not very pretty version of a moving part to use in your city model. This is called a Proof of Concept or POC. It gives you experience in working with the materials and thinking about a story to go along with the moving parts.
You have water bottles that you a fill up with water (use only water) at the soda machine to use in with your part. DO NOT drink from the water bottles, they are not that clean.
You are responsible for cleaning up spills. There are sponges and paper towels along with a bucket on the floor near your table.
When you are finished, make sure your table is dry.
If your cardboard structures are wet, do not try to take them home. Dispose of them here. You will build something much better for your own Future City.

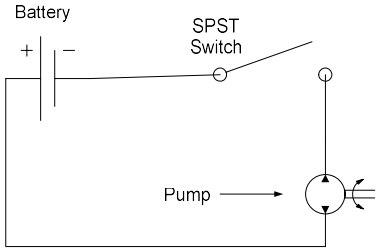
All the parts and tools you need are in your team's brown bag or on the table. Before starting read all of the instructions.

Build the structure

a. Using double sided tape and/or other tape unfold and assemble the box in your kit so that it is a sturdy structure
b. Use duct tape to fasten the box to the large piece of cardboard that will serve as the base of the structure. It should not extend more than halfway across the length of the base piece. See the demo at the front of the room if you are unsure of how to do that. Make sure it will not fall over if holding an unbalanced load or tapped from the side.



2. **Assemble the electric circuit**
   a. Attach the two red wires with clips to the on/off switch
   b. Use a wire nut to connect the black wires
   c. Insert AAA batteries into the battery holder. If the pump motor starts, turn it off
   d. Briefly test the circuit by turning the switch on then off. DO NOT LET THE PUMP MOTOR RUN WHEN NOT IN WATER. Running the pump dry for extended periods will damage it.



3. **Assemble basins and Install pump-tube in structure**
   a. Use duct tape to fasten container #2 (the one with the hole in it) to the top of the tall box. Confirm that it is solidly anchored, you do not want it to fall over when it is full of water
   b. Do not fasten the lower container to the base. It is likely you will have to slide it around.
   c. Use duct tape to fasten the pump to the bottom of the large container.
   d. Attach the clear vinyl tubing to the pump. Make sure it is pushed in as far as it can go onto the pump fitting.
   e. Place the large container with the pump as indicated in the diagram above so that it will catch the water draining from the upper container.

f. Place the free end of the tubing in the upper container
g. Make sure you have paper towels and sponges at hand.
h. Put the open end of the vinyl tube into the large container. Use duct tape to hold in place if necessary. Note tubing become more flexible when warmed.

4. Add water and test
   a. Cut several small pieces of duct tape. Use one to seal the hole in the top basin. Make sure it has a free end to grasp and remove it. (Let it extend past the bottom of the container, or fold over one end about 1/8 inch, so it sticks to itself and will be graspable).
   b. Use the water bottle on your table to fill the large basin approximately ¾ full.
   c. Turn on the pump and be prepared to move the large container to catch water as the top container fills.
   d. If water does not start pumping turn the motor off and then on again. You may nave to hold the free end of the tube lower than the pipe to get the water flowing through the pump.
   e. When the top container is about half full remove the duct tape sealing the drain hole.
   f. Turn off the pump before the top container fills.
   g. Seal the bottom hole before the flow gets so slow it dribbles down the side of the container.
5. Other things to try
   a. Seal and unseal the drain (duct tape will work a couple of more times when wet, best to dry around the drain hole before resealing with duct tape.
   b. Time how long it takes to fill top container.
   c. Time how long it takes to drain the top container, with and without the pump going.
   d. Use different shaped containers with various sized drain holes.
   e. When you get back to your school consider adding a solenoid to control the outflow from the top container. This one is available on Amazon.com

      https://www.amazon.com/Vdc-Normally-Closed-Solenoid-Valve/dp/B007D1U64E/

      It and other similar ones can be found on American Science & Surplus
      https://www.sciplus.com/s/?q=solenoid+valve

   f. Discuss how having a separate water storage could make the water supply more resilient, especially in climates that have wet and dry seasons.
   g. You can build a more complicated water storage system using multiple containers, pumps and solenoids.
   h. Get more tubing so the primary supply and upper basin can be separated further in your model city.
   i. Discuss the real strategies that some of these configurations could represent?

Parts List and Receipt for Parts

Description	Unit Cost	Qty	Cost
Pump	$3.00	1	$3.00
Tubing ¼" ID $^3/_8$" OD 1'	$0.30	2	$0.59
Large Container	$0.83	1	$0.83
Battery Holder	$0.75	1	$0.75
AAA Batteries	$0.40	2	$0.79
Total			$5.96

You will need to include the cost of these materials if used in your model