



Students build a pipeline using tubes for pipes to make a delivery and collection system model that mimics the journey water takes from river to river in the man-made water cycle.

### Charting the Course:

This activity is a good Icebreaker to use as a discussion on water and wastewater services provided by local governments and the process behind treating water for our use. Use it to introduce *What's Your Standard, River to River* and Project WET's *Urban Waters*. It also provides a visual background for *Piped on Water*.

### Objectives

Students will:

- 🌊 Explain the water supply and wastewater collection system provided by local governments
- 🌊 Identify reasons for cleaning water from a source before and after we use it

### Materials

- Paper towel tubes of various lengths, labeled (you will need 13 tubes/set)
- Markers, 2 colors (or colored paper labels) for tubes
- *Marbles or small balls (1/2")*

#### For each team

- Set of infrastructure placement cards, cut apart
- *Just Pipe Up!* Chart
- Infrastructure definitions

### Making Connections

Students may be aware of their water source but they may not know that water must be pumped and stored at various locations as it flows through pipes to treatment plants. They will get a sense of the infrastructure and processes in water delivery and wastewater collection.

### Background

In most Georgia cities a river is the source of drinking water and is the lifeblood of the metropolitan area. Water is pumped out of the river for us to use but must first be treated. After treatment, water is pumped to homes, schools, and businesses. When water is used and goes down the drain it is called wastewater. Wastewater flows mostly by gravity through sewer pipes to the

wastewater treatment plant and back to the river.

In the larger Georgia cities there are over 2,000 miles of sewer lines for wastewater. Ninety percent are **Separated Sanitary/Stormwater Systems** and the remaining 10% are **Combined Sewer Lines**. A separate sewer line collects wastewater in one pipe and stormwater in another pipe. A combined sewer pipe carries both wastewater and stormwater in the same pipe (*see pg. 10*).

Georgia's metropolitan areas have grown dramatically over the past decade adding pressure to the watersheds and river basins that supply water. The cities are also limited in how much water they can withdraw daily from the river. Cost is another factor in limiting the water that is used and cleaned.

**Wastewater** from homes, schools, and businesses travels in a wastewater pipe collection. Along the way it might encounter a pumping station before it flows to the **wastewater treatment facility**. The first stage of treatment at the wastewater treatment facility is **primary treatment** where most of the solids are screened out through the physical processes of screening, skimming, and settling. Next the water goes through the sedimentation process where suspended solids drift to the bottom of the tank. Grease and oil rise to the surface and are skimmed off. Sedimentation is the end of the primary process of wastewater treatment.

During **secondary treatment**, biological processes are used to clean the water. During the activated sludge process, wastewater and microorganisms are mixed in a tank where air is added (aeration and agitation). The microorganisms in turn eat the organic pollutants in the water. A second round of sedimentation occurs followed by disinfection through the use of chlorine or ultra violet lights.



**Advanced treatment** is a higher degree of treatment through filtration. The water is filtered through sand and crushed stone to remove any small particles. When the filters become clogged with solids they are backwashed and then the collected solids are reprocessed in the plant. Some innovative counties are using constructed wetlands areas to do this final step in the process, benefiting wildlife and utilizing natural processes to do the filtration.

### Preparation

Prior to the activity ask students and parents to save their paper towel and tissue rolls and collect enough to make two pipelines, or 26 tubes. Use different colored markers or labels to indicate drinking water delivery pipes (1–8) and wastewater collection pipes (8–13). Label the tubes/pipes in the correct order (see below) repeating the last station so that each tube can make a match with the next infrastructure stop. The first tube has **River** at one end and **Raw Pumping Station** at the other end. The next tube should be labeled **Raw Pumping Station** and **Raw Water Reservoir**. Continue labeling tubes using the chart below.

Label the opposite ends of each tube in a set as follows:

tube	Drinking Water BLUE	
1	River	Raw Pumping Station
2	Raw Pumping Station	Raw Water Reservoir
3	Raw Water Reservoir	Water Treatment Plant
4	Water Treatment Plant	Clear Wells
5	Clear Wells	Pumping Station
6	Pumping Station	Storage Tanks
7	Storage Tanks	Homes, Schools and Businesses
8	Homes, Schools and Businesses	Wastewater Pump Station
	Wastewater BROWN	
9	Wastewater Pump Station	Wastewater Treatment Plant
10	Wastewater Treatment Plant	Primary Wastewater Treatment
11	Primary Wastewater Treatment	Secondary Wastewater Treatment
12	Secondary Wastewater Treatment	Advanced Wastewater Treatment
13	Advanced Wastewater Treatment	River

### Procedure

#### Warm Up

Divide students into teams and give each team a set of **Infrastructure Placement Cards** (pg. 34) that trace the flow of water from the river to their homes and back to the river.

1. Give each team 5 minutes to arrange the cards showing the actual process it takes to clean the water we use.
2. Ask each team to explain their design to the class. Have them describe what the water moves in and what is needed to keep it moving. Each team will present their design to the class. Discuss how the topography of land influences the need at some point for pumping water and at other points for gravity to do the work. (*Generally, water is under pressure when it moves to drinking water treatment and is moving mostly by gravity to wastewater treatment.*)
3. Hand a **Pipe It Up! Chart** (pg. 34) to each team and ask them to place their infrastructure cards on the correct answers on the **Just Pipe Up! Chart**. Collect the charts before starting the activity below.

#### Activity

1. Students are now ready to build the actual pipeline using the knowledge they have about the drinking water and wastewater pipe systems. They will sequence the pipes in order by holding together the pipes end to end.
2. Hand out the tubes randomly (one tube per student). If you have more than 13 students you will need 2 sets of pipes or tubes.
3. Ask students to find their match and hold the tubes together to form a pipeline. Tell them there are many community members who need to get their water and are quite anxious for this project to be completed.
4. When the pipeline is complete tell the students that you are going to see what kind of condition the water delivery and collection system is in. Place a marble or two in the end of the pipeline to see if the marble can pass all the way to the other end of the pipeline system. If the marble falls through it opens discussion about pipes that crack or break and the need for people in careers that will keep pipes, stations, and the delivery and collection system in good repair. If there is a break, discuss where it is and how that break could affect the health of people and animals. Students may have to use gravity to get the marble through the pipe. Or they may



need to push it through the tube (as with a pumping station).

5. Students bring their tubes back to their seats. Pass out the **infrastructure definition** page (pg. 32) and ask students to read aloud the definition of the section of pipe they hold beginning at the River and discuss what happens at their section of man-made water cycle.

6. For the tube that says **Clear Wells and Pumping Station** discuss what a Clear Well is and why a Pumping Station might be needed at that point in the man-made water cycle.

### Wrap Up

Leave one pipeline connected and in view for all the teams to see. Ask student to list the reasons behind the use of this system to clean our water before and after we use it. Why do we need this system in the urban watershed? Does a natural watershed use the same system? Discuss what contaminates might be in the river before we treat it and where they might come from.

Sing the **Just Pipe Up! song** and let the students use the song to prepare for the assessment.



**Check out these related Engineering activities on [teachengineering.org](http://teachengineering.org):**

- ✓ Do as the Romans: Construct an Aqueduct!
- ✓ Tippy Tap Plus Piping

### Assessment

Give a complete set of infrastructure cards to students working in teams of three and four. Ask them to sequence the infrastructure for the man-made water cycle by ordering the cards from river to river. Remind them that they should begin and end with the river. Each team’s list should be ordered as in the activity. Use the Just Pipe Up! Chart as your answer key.

### Extension

Students can take each step in the process and identify it as physical or chemical.



### References

City of Atlanta Department of Watershed Management, [www.cleanwateratlanta.org](http://www.cleanwateratlanta.org)

The ancient Romans constructed over 200 aqueducts in order to bring water from distant sources into their cities and towns, supplying public baths, latrines, fountains, and private households. Wastewater was removed by complex sewage systems and released into nearby bodies of water.





## INFRASTRUCTURE DEFINITIONS

Provide these definitions to students to read when they have completed the pipe puzzle.

**River** – the river is the source of most of Georgia’s drinking water

**Raw Water Pumping Station** – a place where raw water (untreated) is pumped to the raw water reservoir

**Raw Water Reservoir** – a place where raw water is held before drinking water treatment

**Water Treatment Plant** – drinking water treatment is primarily a chemical treatment. Water goes through coagulation, sedimentation, filtration, and disinfection

**Clear Wells** – a place where water is held after drinking water treatment

**Pumping Station** – a place where water is put under pressure and pumped to a storage tank before delivery to homes, schools, and businesses

**Storage Tanks** – a storage area for treated water prior to delivery to homes, schools, and businesses

**Homes, Schools, Businesses** – water users who create wastewater

**Wastewater Pump Station** – a place where wastewater is pumped to the wastewater treatment facility

**Wastewater Treatment Plant** – a wastewater treatment facility that cleans the water through physical and biological processes prior to return of the water to the river

**Primary Wastewater Treatment** – physical process of screening where most of the solids are removed through skimming and settling

**Secondary Wastewater Treatment** – biological processes in secondary treatment include the use of microorganisms that eat the pollutants after air is added to the treatment process

**Advanced Wastewater Treatment** – a higher degree of treatment through filtration. Water is moved through layers of sand and crushed stone to remove any remaining small material or pollutants

**River** – the treated wastewater is returned to the River clean so that the water is safe for aquatic animals and downstream water users





## **JUST PIPE UP, SONG**

(to the tune of Jingle Bells)

Add hand motions as appropriate.

**Just pipe it up, pipe it up!  
That's all you have to do,  
If you want a drink of water  
And to wash your dishes too.**

**Just go to the river  
And put your pipe right in.  
Pump that RAW WATER;  
To the PUMPING STATION.**

**On to the RAW WATER RESERVOIR  
To water treatment it goes,  
On to the Clear Wells and Pump  
Then STORE it before it flows.**

**To our HOMES and our SCHOOLS  
And all our BUSINESSES too.  
Everyone gets clean water.  
Yippee Yip Yahoo!**

**We brush our teeth, and the water we use  
To the sewer system it goes,  
To the Wastewater Pump Station,  
To Wastewater Treatment it flows.**

**There's PRIMARY TREATMENT,  
SECONDARY TREATMENT  
ADVANCED TREATMENT too.  
Everyone likes clean water  
Including fish and beavers too!**

**Now back to the RIVER  
The water's all sparkling clean,  
But it took a lot of work so  
Help keep your river pristine!**





## JUST PIPE UP! CHART

Duplicate and cut apart to use as **Student Infrastructure Placement Cards**.

Make another uncut copy per team to use as an answer key.

RIVER
RAW WATER PUMPING STATION
RAW WATER RESERVOIR
WATER TREATMENT PLANT
CLEAR WELLS
PUMPING STATION
STORAGE TANKS
HOMES, SCHOOLS, BUSINESSES
WASTEWATER PUMP STATION
WASTEWATER TREATMENT PLANT
PRIMARY WASTEWATER TREATMENT
SECONDARY WASTEWATER TREATMENT
ADVANCED WASTEWATER TREATMENT
RIVER