

In Western Australia temperatures are rising, rainfall decreasing, and population increasing. New sources of water are desperately needed. Currently, drinking water comes from surface water (dams), groundwater (bores) and desalination plants, but other sources are required.

Usually we use water once then it goes to a wastewater treatment plant before being pumped into the ocean. A more efficient way to use that wastewater would be to recycle it after use. One way is to replenish groundwater. In the groundwater replenishment process wastewater passes through a treatment plant, to create secondary treated wastewater. Then it undergoes further treatment to make it drinking water quality, known as potable water. This potable water is pumped into a confined aquifer. It remains in groundwater for decades before it's drawn up by bores, treated again, and added to our drinking water supply.

The Water Corporation launched the Groundwater Replenishment Trial in 2009.

The trial, co-funded by the Federal Government, had three aims:

- to develop health and environmental policy and regulations;
- to demonstrate the treatment process is possible and water produced meets health and environmental standards; and
- to raise community awareness about groundwater replenishment.

In this trial, treated wastewater was pumped into a confined aquifer. The trial lasting three years was successful. Treated water consistently met required quality guidelines, so plans are underway to construct Australia's first groundwater replenishment scheme. Potentially, groundwater replenishment could add 28 gigalitres (28 000 000 000 L) of water to Perth's drinking water supply by 2022. This is equivalent to 10% of current supply.

The Water Corporation uses an advanced water treatment process that has three steps:

1. ultra filtration,
2. reverse osmosis; and
3. ultraviolet (UV) disinfection.

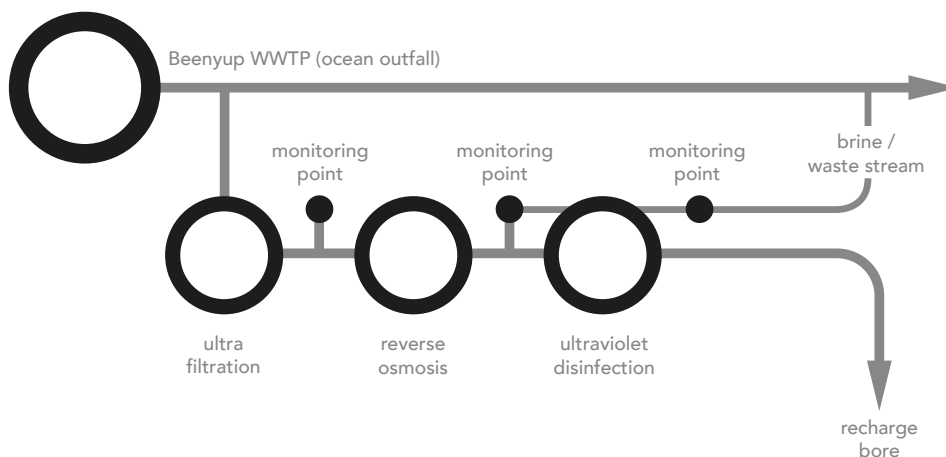


Figure 1: Water Corporation's advanced water treatment process

In this experiment you'll simulate these three processes to create recycled water. Wastewater treated by the Water Corporation still contains small traces of chemicals and micro-organisms before it's either pumped out to the ocean or pumped through the advanced water treatment process. The Water Corporation's equipment is much stronger than equipment you'll use, so wastewater treated by their process will be much cleaner than yours. Your experiment is only a simulation.

**SAFETY NOTE: DO NOT DRINK THE WATER THAT YOU TREAT**

**Step 1: ultra-filtration**

In the Water Corporation’s advanced treatment process, ultra-filtration separates large molecules and dissolved materials larger than 0.1 micrometer (0.0001 mm).

In your process you’ll use filter paper to filter out large particles from your sample.

Equipment	Method
<ul style="list-style-type: none"><li>• 100 mL grey water (e g from a washing machine or dishwasher)</li><li>• 2 x 250 mL beaker</li><li>• filter funnel</li><li>• stand</li><li>• filter paper</li></ul>	<ul style="list-style-type: none"><li>• Pour approximately 100 mL of grey water into a beaker. Keep 5 mL of your grey water aside for later testing.</li><li>• Set up filter paper, funnel and stand, with an empty beaker underneath to collect water.</li><li>• Filter grey water.</li></ul>

**Questions**

1. How did the water change in appearance after it was filtered?  
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2. What did residue in the filter paper look like?  
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3. How did your process differ from that used by Water Corporation?  
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## Step 2: reverse osmosis

The Water Corporation’s advanced water treatment process uses a large amount of pressure to push filtered non-potable water through tubes containing membranes. The membranes have tiny pores, 100 times smaller than those in ultra filtration. Water molecules pass through the membrane but other dissolved particles are left behind.

You’ll simulate this process by passing filtered water through a membrane, called dialysis tubing. Gravity, rather than applied pressure, will push water through the tubing.

### Equipment

- approximately 50 mL water from Step 1
- 30 cm dialysis tubing
- 250 mL beaker
- plastic wrap
- rubber band

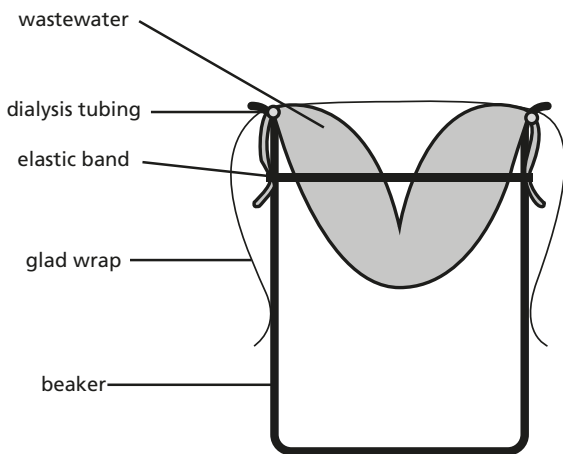


Figure 2: experimental setup

### Method

- Tie one end of dialysis tubing in a knot.
- Open other end carefully (you’ll need to wet tubing with clean water, preferably distilled) and pour in approximately 50 mL of water from Step 1 to fill dialysis tubing to about 5 cm from top.
- Tie top end of dialysis tubing in a knot.
- Suspend tubing in beaker so there’s some pressure, on water, from sides of the beaker. Use an elastic band to hold tubing in place. Cover beaker with plastic wrap, as shown in Figure 2.
- Water will slowly drip into bottom of the beaker. This takes some time to begin and may need to be left overnight.

## Questions

4. Has the appearance of your water changed after passing through the dialysis tubing? Explain why you would or wouldn’t expect to see a difference.

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5. Why is this process so slow? Suggest how it could be made faster.

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6. Treating water using reverse osmosis at the treatment plant is expensive. Why is this?

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### Step 3: ultra-violet disinfection

The Water Corporation's advanced treatment process uses UV light to disinfect treated water to kill any traces of micro-organisms small enough to pass through the membrane. Ultra-violet lights used by the Water Corporation are so strong there's no chance any bacteria will escape them, however lights you'll use are much weaker.

#### Equipment

- water from Step 2
- UV light
- petri dish

#### Method

- Pour 5 mL of your treated water from Step 2 into the petri dish.
- Leave it under a UV light for 10 minutes.
- **DO NOT LOOK DIRECTLY AT THE UV LIGHT.**

### Step 4: Testing the treatment process

You now have 3 samples that have gone through different stages of treatment:

- no treatment: 'untreated water'
- filtration and osmosis: 'treated water, no UV'
- filtration, reverse osmosis and UV radiation: 'treated water'

To measure effectiveness of treatments you'll test bacteria levels in each sample by attempting to grow bacteria using agar plates.

#### Equipment

- 3 agar plates
- inoculation loop
- 3 samples of non-potable water
- bunsen burner
- waterproof tape
- 3 clip lock plastic bags

#### Method

- Heat inoculation loop in flame of a bunsen burner.
- Let it air cool for 15 seconds, without blowing on it.
- Dip hoop into your sample of 'treated water' then wipe across the surface of your agar plate by smearing 3 lines in one direction, then turning the plate 90° and smear another 3 lines crossways. You should spread water across the surface of the agar, not dig into the gel.
- Shut lid on the plate. Use tape to seal the lid on.
- Seal agar plate inside clip lock bag and label it 'treated water'.
- Repeat above process with 'treated water, no UV' sample and 'untreated water' sample.
- Place agar plates upside down in a warm dark place (bacteria grow best at about 32°C) for a few days to allow bacteria to develop. They'll begin to appear after about 2 days.
- Observe results.
- **DO NOT OPEN THE PLASTIC BAG.**
- Dispose of the whole bag, including the plate.

**Questions**

7. How do your fully treated and no treatment agar plates compare in appearance?

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8. How do results compare between untreated water and water that only underwent filtration and reverse osmosis? Explain why this is.

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9. Was UV treatment successful in killing bacteria? Explain how you can tell.

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**After the process**

Once you've completed your treatment process, consider the following questions:

10. Was your treatment successful? Explain.

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11. How could your treatment process have been improved?

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12. Why did the Water Corporation do a trial of the process before building the whole scheme?

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13. Why does the Water Corporation use such a rigorous process to treat water?

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