
WASTEWISE
Schools Program
SCIENCE
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SCIENCE: TEST THE TAP
Background Information for teachers

Curriculum focus

Science: Science Understanding (Biological sciences, Earth and space sciences) and Science Inquiry Skills.

See list of curriculum links at the end of the science activity instructions for more information.

Aim: **Students carry out scientific investigations to evaluate and compare the taste and quality of bottled and tap water. They research the impacts of plastic on our oceans and food chains and communicate their findings.**

Summary of activities:

There are six activities in this unit.

1. Taste and odour test on tap and bottled water
2. Testing the tap (physical and chemical properties)
3. Researching the source of bottled water (homework)
4. The science of plastics in our ocean
5. Taking action with *Take 3*
6. Conclusion and communication.

Suitable for: Year 7 (possibly Year 8).

Duration: Approximately five lessons plus homework.

Background information

In this set of activities, students conduct a range of scientific investigations to compare the properties of tap and bottled water. We have extended the unit of work to include research into plastics in our ocean (how they move and how they accumulate in the food chain). Using the scientific tests we would like students to conclude that there is no significant difference between tap and bottled water. Taking into consideration their research into the environmental impacts of plastic, we hope that they conclude that tap water is a more sustainable choice. In some cases, students may prefer the taste of bottled water or perceive a difference in a quality that hasn't been tested (such as fluoride). You might like to challenge these students by doing an additional test with filtered tap water. Be prepared for some debate and discussion on taste, quality, environmental impacts and ethical decisions.

Table 1 on page 66 provides an outline of the Australian drinking water guidelines and potential health risks for each of the variables we suggest your students test.

The Waste Wise team trialled this investigation with the Intermediate Home Drinking Water Test Kit from www.testkits.com.au. The Waste Wise team has a number of free kits available for schools to use. Please contact the Waste Wise team for the kit at wastewise@der.wa.gov.au.

For more information and statistics on bottled water in Australia please see the bottled water background information in the introduction to this guide.

Cross-curriculum links

This guide is designed to be used as a cross-curriculum unit with many subject areas looking at the topic of bottled water from different angles. This creates opportunities for sharing across subject areas and year levels. You could invite:

- an English class to share taste tests results for additional analysis or invite an English class to present persuasive speeches to highlight why tap water is a better choice
- invite a maths class to share their results on the cost and distance travelled by bottled water
- a geography class to share what happens when plastic ends up in the ocean (inquiry question 6).

You might also like to share the investigation results online, in the newsletter or at an assembly.

Table 1. Water quality variables

WATER PROPERTIES AND CONTAMINANTS		
Property/ Contaminant	**Potential risk**	**Australian drinking water standard** mg/L unless otherwise specified
pH	Extreme pH levels (less than 4 and greater than 11) may adversely affect health although there is insufficient data to set a health guideline. Low pH can be corrosive while higher pH can cause scale problems in the pipes and taste issues.	Insufficient data to set a guideline for health Suggested pH 6.5–8.5 to prevent corrosion of pipes
Hardness (as CaCO3)	Primarily caused by calcium and magnesium salts. Water that is too soft can be corrosive. Hard water can increase scaling problems. Hard water can also create problems with soaps and detergents (it is difficult to lather).	Soft: 0 – 60 mg/L Good quality: 60 – 200 mg/L Hard: 200 – 500 mg/L Very hard: more than 500 mg/L
Iron	Iron occurs naturally in water in small amounts. High concentrations can stain laundry and fittings. Iron bacteria can cause blockages, taste and odour issues and corrosion.	Insufficient data to set health guideline Ideally less than 0.3 mg/L (for taste)
Copper	Copper in water may come from erosion of natural deposits or from corrosion of copper pipes and fittings by salt or low pH water. High concentrations may cause ill effects in some people and stain water blue/green.	2 mg/L (for health)
Free chlorine	Chlorine is widely used as a disinfectant. It is added to water to control and kill microbes (such as bacteria). May irritate the eyes and nose or cause stomach upset. Can cause odour issues for some people (generally if greater than 0.6mg/L).	5 mg/L
Nitrate and nitrite	Occur naturally. Water containing fertilisers and sewage are sources of nitrate/nitrite. Infants (below the age of six months) are most at risk from becoming ill from drinking water contaminated with nitrate/nitrite. Nitrate is rapidly oxidised to nitrate.	50 mg-NO3/L (as nitrate) 3 mg-NO3/L (as nitrite)
Bacteria	Bacteria occur in sewage and natural water and may indicate that water has been contaminated with animal or human waste (faeces). Sickness from bacteria can cause diarrhoea, cramps, nausea, headaches and can even be fatal.	0

Information and guidelines in the table were sourced from the Australian Drinking Water Guidelines (2011, updated 2013) available on the National Health and Medical Research website www.nhmrc.gov.au/guidelines/publications/eh52.

SCIENCE: TEST THE TAP
Activity Instructions

Activity 1. Taste and odour test on tap and bottled water

For this activity you will need:

- a projector
- speakers
- access to the internet
- bottled water at room temperature
- tap water at room temperature (preferably let it sit overnight to release the chlorine)
- clean cups for taste testing
- labels and pens for marking cups (i.e. Sample A, Sample B).

1. Watch this fun clip about buying bottled air (one minute) www.banthebottle.net/video/buying-bottled-water-is-like-buying-air-it-doesnt-make-sense.
2. Ask students for their reactions to the idea of selling air. Is it different from selling water? What do they think? Are we being duped (tricked)?
3. Ask students 'Do you think you can tell the difference between tap and bottled water in terms of taste or smell?'
4. Ask students to make a prediction. Which type of water students will students prefer the taste and smell of?
5. As a class, discuss how to design and conduct a test for odour and taste of bottled and tap water to determine which the class prefers?
6. In small groups, ask students to conduct the odour and taste test using bottled and tap water. Students might like to use Table 2 to record the results for their investigation.

7. Perform the investigation and compile the class results. Did these match your predictions?
8. Watch a short film clip on a taste test done in New York City. http://abcnews.go.com/WNT/video/bottled-water-tap-water-difference-21202028. How do those results compare with yours? Are you surprised?

Table 2. Taste test data

Record your observations in the table below for the two different samples of water. How do they smell? How do they taste?

Water Sample	Odour	Taste	Other observations
Sample A			
Sample B			
Which sample do you prefer? Sample A or Sample B?			
Why?			
Which sample was the tap water? Was it the one you preferred?			
Compile the data from the entire class. Which sample was preferred overall?			
Are you surprised by the results?			

Activity 2. Testing the tap (physical and chemical properties)

In this investigation students will be required to conduct a range of scientific investigations to see if there is a difference in composition between tap and bottled water.

For this activity you will need:

- Bottled water at room temperature
- Tap water at room temperature, preferably water that has been sitting overnight
- Glassware or plastic containers (two per group)
- Copies of Table 1 (page 66) with the information and guidelines for each property (one copy per group)
- Water testing materials. The Waste Wise team trialled this investigation with the Intermediate Home Drinking Water Test Kit from www.testkits.com.au. The Waste Wise team has a number of free kits available for schools to use. Please contact the Waste Wise team for your kit at wastewise@der.wa.gov.au.

Waste Wise used a home drinking water test kit to conduct the bottled water and tap water comparison.

1. Many people have a perception that bottled water is cleaner or purer and is better for them than tap water. Do your students think this? Ask students to brainstorm what they think of when they think of bottled water compared to tap water.
2. Divide students into small groups. Each group will test one property or one contaminant in the tap and bottled water.
   a. pH
   b. hardness
   c. iron
   d. copper
   e. free chlorine
   f. nitrate and nitrate
   g. bacteria (note: the results of this test will be available in 48 hours and might be best done as a demonstration by the teacher).
3. Ask students to design and then conduct an investigation to test bottled and tap water for their assigned variable. You might like to scaffold this for them by asking them to create a table similar to the one we provided in Table 3. Please provide Table 1 (page 66) to each group so that they can read about the property or contaminant they are testing.

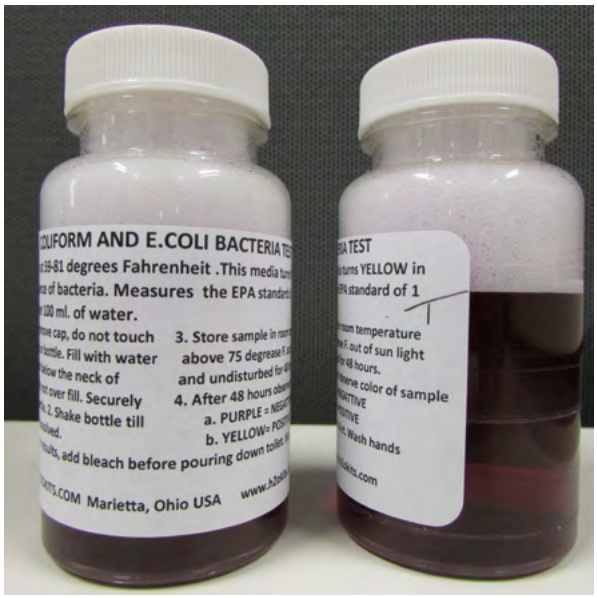
4. When each group has their test results, have a jigsaw activity to share the results and information about the property or contaminant tested. Record the class results in Table 4 (page 72) and discuss:

   a. Is there a difference in the composition of tap and bottled water?

   b. Do you think some brands of bottled water come from the tap? Don't give them the answer. The students will research this question in the next activity.

The Waste Wise team conducted this activity and found the following:

	Tap water	Bottled water	Comments
pH	8 (alkalinity 180)	6.5 (alkalinity 0)	Both within safe drinking water guidelines
Hardness	0	0	No colour change for either strip
Iron	0	0	No colour change for either strip
Free chlorine	0	0	No colour change for either strip
Nitrate and nitrite	0	0	No colour change for either strip
Copper	0	0	No colour change for either strip
Bacteria	0	0	Solution turned purple and remained purple (it turns yellow if bacteria are present)



Neither sample contained any bacteria. The solution turns yellow if bacteria are present.

Test strips are used for most tests and are easy for students to use.

Table 3. Water sample recording sheet for individual variable

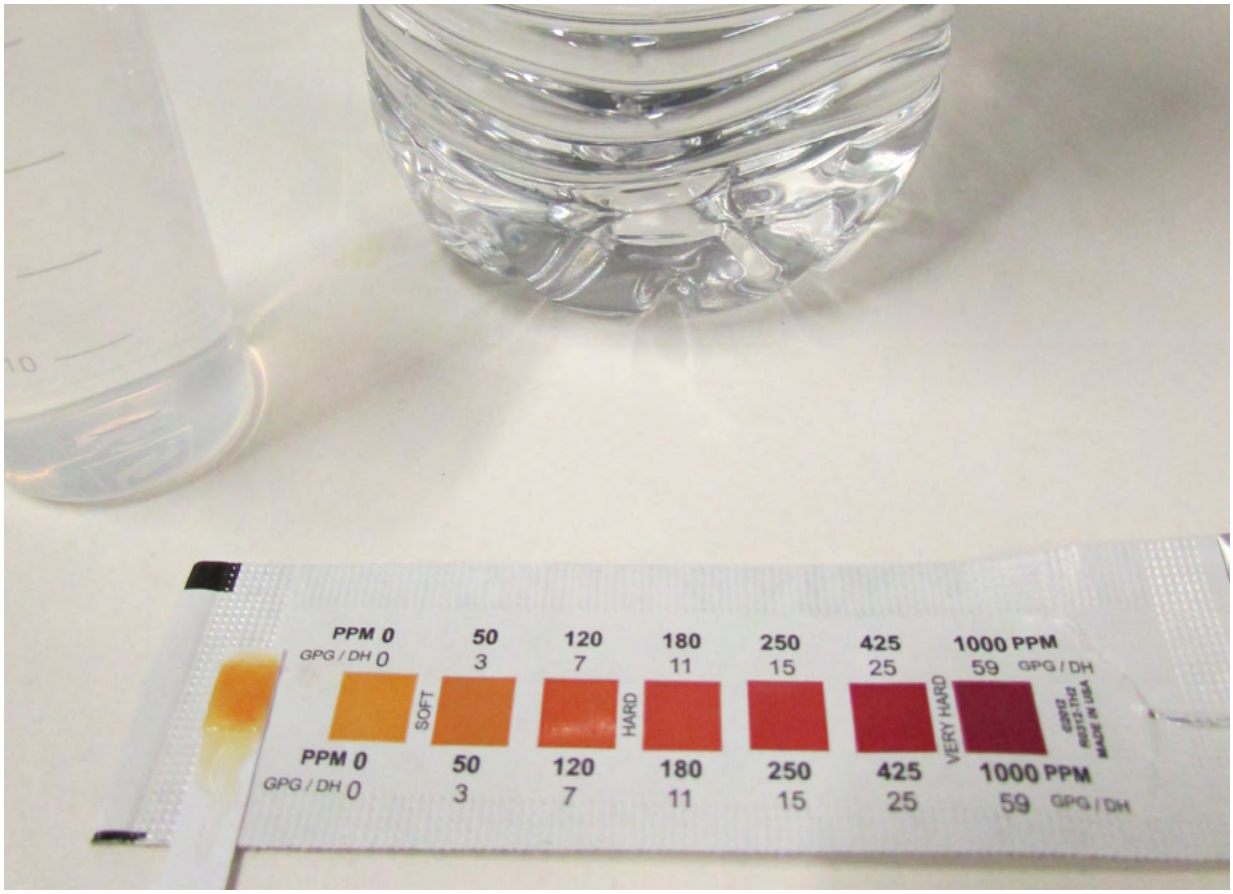
Use this table to plan your group's water quality test and record the results.

Testing for (tick one):			
☐ pH	☐ Hardness	☐ Iron	
☐ Free chlorine	☐ Nitrate/Nitrite	☐ Copper	☐ Bacteria
Aim:			
Hypothesis or prediction:			
Materials:			
Method:			
Results and observations:			
Discussion (be sure to include any sources of error):			
Conclusion:			

Table 4. Water sample recording sheet for class results

Use this table to record the class results

Variable	Who is conducting the test?	RESULTS		Comments
		Tap water	Bottled water	
pH				
Hardness				
Iron				
Free chlorine				
Nitrate / Nitrite				
Copper				
Bacteria				



Activity 3. Researching the source of bottled water (homework activity)

In this activity, students research different brands to discover where the water in bottled water is sourced.

1. Ask students to choose a brand of bottled water (or assign them a brand from the list in the table below). Ask them to find out where the water comes from. Is it from a spring? Is it artesian? Or is it from municipal sources (the tap)?
   You may need to give students a week to do this activity as some students will need to contact the company to find out the answers.
2. Discuss the results with the class. Do some brands of bottled water come from the tap? Do you feel duped (tricked) by bottled water companies?

Waste Wise conducted this investigation with brands from a local supermarket and found this:

Brand	Type of water source	Source of water or location of bottling
Fiji	Artesian	Yaqura, Fiji
Deep Spring	Spring	Not supplied
Aqua Pura	Purified (tap water)	Salisbury South, SA
Mount Franklin	Spring	Bottled in Kewdale, Perth. Water sourced within two hours drive.
Evian	Spring	Evian-Les-Bains, France
Thank You Water	Spring	Mt Tamborine, QLD
Frantelle	Spring	Bottled in Welshpool, Perth (sourced from springs in WA, NSW or VIC)
Snowy Mountain	Spring	Daylesford, VIC
Woolworths Select	Spring	Gingin, WA
Pump	Purified (spring)	Bottled in Kewdale, Perth. Water sourced within two hours drive.
Yaru	Spring	Mount Warning, NSW
Coles brand	Spring	Not supplied
Coolridge	Spring	Bottled in Welshpool, Perth (sourced from springs in WA, NSW or VIC)
Pureau	Purified (Sydney water, tap)	Sydney
Waiwera	Artesian	Auckland, New Zealand

**We used the brands' labels, websites and emails to companies to gather this data.*

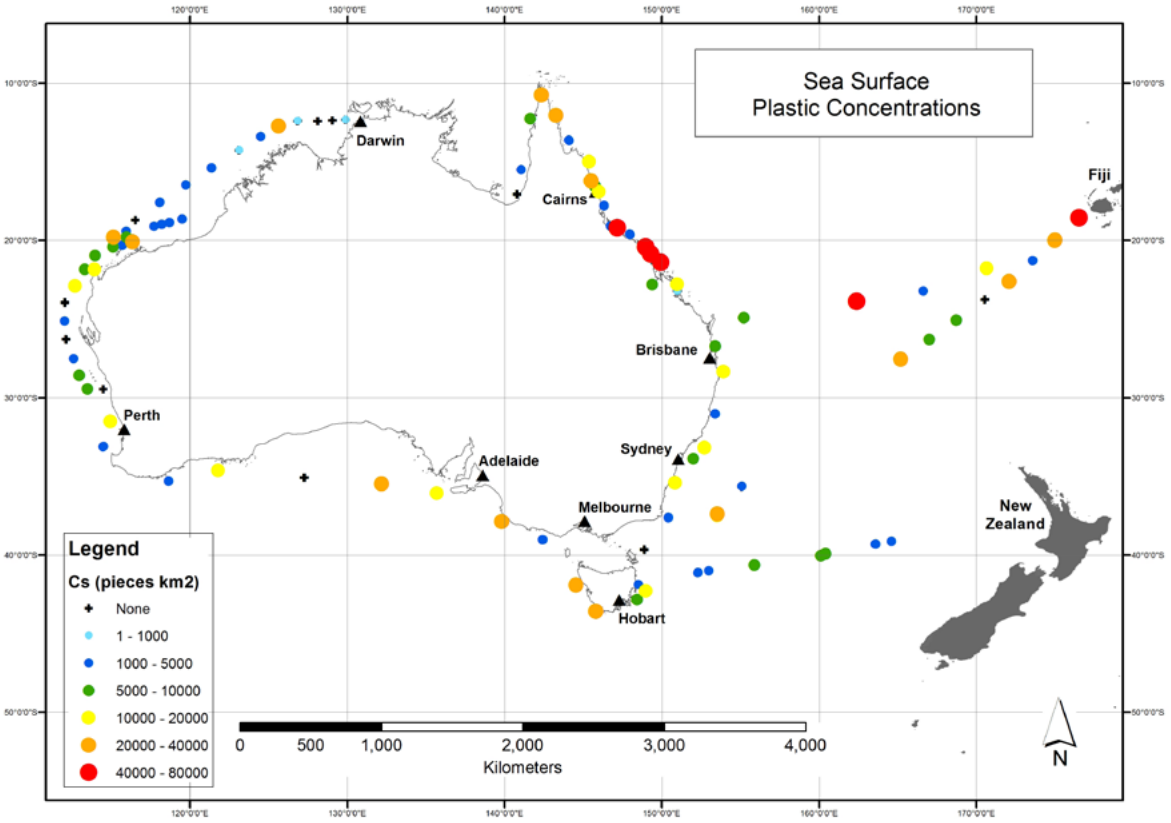
Activity 4. The science of plastics in our ocean

In this activity, students will research how plastics move in our ocean and how plastics impact upon the food chain.

For this activity you will need:

- a projector
- speakers
- access to the internet
- computers for student research.

1. Watch the Seven news clip on plastic in our oceans www.youtube.com/watch?v=os7OuSxP-JA.
2. Discuss with students 'How does this make you feel about plastic?'
3. Watch the video clip on how science is used to chart the garbage patches (3.5 minute0s) www.youtube.com/watch?v=M4UK9Yt6A-s.
4. Give students a chance to look at the website and experiment with how plastics can move through the ocean over time www.adrift.org.au.
5. Watch the clip on the journey to the ocean www.youtube.com/watch?v=vh6MDuxYing.
6. Ask students to research and answer the following questions (they could do this in groups of three or four).
   a. Where do plastics come from? Are plastics a renewable resource?
   b. When was plastic first developed? When did it become widely used? What properties make plastic beneficial for things like food storage?
   c. Science may have provided plastic as a solution to food storage and packaging but it has impacted upon society. What happens to plastic once it enters the ocean?
   d. How has science helped us to understand the way plastic moves in the ocean?
   e. How are plastics in our ocean harmful to marine life?
   f. Draw a food chain to show how plastic accumulates in larger sea life (and even humans).



A map showing the concentrations of plastic found in Australian waters. Image from www.csiro.au.

Extension:

Students could choose a topic to conduct further research such as:

a) How did people shop before the widespread use of plastic? Could we go back to shopping in this way? Have some people already gone back to shopping in this way?

b) How much plastic waste do Australians now produce each year?

c) What percentage of plastics ends up in landfill and what happens to the plastic that is there?

d) What percentage of plastics is recycled and where are they recycled?

CSIRO researcher Denise Hardesty inspects debris on North Stradbroke Island. Image from www.csiro.au.

Activity 5. Taking action with *Take 3*

In this activity, students brainstorm ideas for reducing their use of plastics.

For this activity you will need:

- a projector
- speakers
- access to the internet.

1. Watch the short clip from *Take 3* (two minutes) www.youtube.com/watch?v=bLPXgVCwkXI.
2. Ask students to brainstorm actions we could take to reduce our use of plastic (such as bringing your own bottle, using containers instead of cling wrap) and to reduce plastics getting in our oceans.

Packing a waste free lunch is easy. The students from Dawesville Catholic Primary School do it every day.

Activity 6. Conclusion and communication

1. Ask students to review all of the data from the activities and discuss.
    a. Did the class prefer tap or bottled water in terms of taste and odour?
    b. Was there a difference in water quality between tap and bottled water?
    c. Do you think tap or bottled water is a more sustainable choice? Why?
    d. Is bottled or tap water a more ethical choice?
    e. Which will you choose to drink in the future? Why?
    f. What action could you encourage others to take to reduce the use and impact of plastic?
2. Ask students to compile their findings and present them. Students may choose to communicate their findings by choosing one of the following:
    - a newsletter article
    - a poster advertising tap water
    - a slideshow presentation
    - a film clip
    - a comic strip
    - a debate.

A selection of these final products can then be shared with the entire school through publication in the school newsletter, hanging advertisements around school, sharing a slideshow or film clip at an assembly etc.

Student leadership

Inspired students might like to participate in, or organise, an event to encourage other students to join them in giving up plastic bottles for a day, a week or month. The details of this campaign are outlined in the student leadership section of this document.

Useful websites and further resources

National Geographic article on Great Pacific Garbage Patch

http://education.nationalgeographic.com.au/education/encyclopedia/great-pacific-garbage-patch/?ar_a=1

SCIENCE: CURRICULUM LINKS

Year 7:

SCIENCE UNDERSTANDING	**Science Understanding; Biological sciences** Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions (ACSSU112).	Activity 4
	Science Understanding; Earth and space sciences Some of Earth's resources are renewable, but others are non-renewable (ACSSU116).	Activity 4
SCIENCE AS A HUMAN ENDEAVOUR	**Science as a Human Endeavour; Nature and development of science** Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world (ACSHE119).	Activity 4
	Science as a Human Endeavour; Use and influence of science Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120).	Activity 4, 5
SCIENCE INQUIRY SKILLS	**Science Inquiry Skills; Questioning and predicting** Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124).	Activity 1, 2
	Science Inquiry Skills; Planning and conducting Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125).	Activity 1, 2
	In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (ACSIS126).	Activity 1, 2
	Science Inquiry Skills; Processing and analysing data and information Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS130).	Activity 1, 2, 6
	Science Inquiry Skills; Evaluating Use scientific knowledge and findings from investigations to evaluate claims (ACSIS132).	Activity 1, 2, 6
	Science Inquiry Skills; Communicating Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate (ACSIS133).	Activity 6

Year 8:

Science as a Human Endeavour and Science Inquiry Skills as outlined in the Year 7 table above.