# Increased nutrients in the waterway (Years 5 and 6)

Lesson plan

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| Victorian Curriculum F–10[[1]](#footnote-1) links:  **Levels 5 and 6**  **Science**  **Science Understanding**  **Science as a Human Endeavour**  Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people’s lives  **Biological sciences**  The growth and survival of living things are affected by the physical conditions of their environment  **Geography**  **Geographical Knowledge**  **Factors that shape places and influence interconnections**  Influence of people, including the influence of Aboriginal and Torres Strait Islander peoples, on the environmental characteristics of Australian places |

## Introduction

### This series of lessons explores the effects of extra nutrients entering a waterway via the stormwater system. Students make links between common household products and similar products used in industry that contain phosphates and/or nitrates and consider how these can contribute to reduced water quality. Students assess their own behaviours and promote positive action to address water quality issues.

### Activity 1: The phosphate cycle

### Students explore how plants grow, the phosphorus cycle and the role that nutrients such as phosphate play in helping plants to grow. They learn how phosphates enter our waterways.

### Activity 2: Phosphates in a wetland

Students draw a model of a wetland and demonstrate the effect of excess phosphate levels on the ecosystem.

### Activity 3: Testing phosphates

Students measure the phosphate levels in some water samples and discuss the effects that increased nutrients could have on the waterway.

## Activity 1: The phosphate cycle

Students explore how plants grow, the phosphorus cycle and the role that nutrients such as phosphate play in helping plants to grow. They learn how phosphates enter our waterways.

### Equipment

### Photosynthesis image (Figure 1)

### Phosphate cycle image (Figure 2)

‘No-Phosphate’ washing detergent packaging

Interactive whiteboard or data projector

Activity steps

1. Encourage students to connect with freshwater environments by asking them to share their experiences in rivers and creeks they have visited.
2. Ask students to identify some living things they have seen or know live in waterways e.g. platypus, frogs, plants, insects.
3. Ask students what some of the living things need to survive in their environment.
4. Discuss what plants need to grow and thrive. Refer to Figure 1:

* The green leaves are like a factory. They use the sun’s energy, oxygen and water to make their own food in the form of sugars. In the process, carbon dioxide and water is released.
* The roots draw up water and nutrients in the soil such as nitrates, phosphates and potassium, as well as a host of other trace elements.



Figure 1 How plants grow

1. Show students a packet of fertiliser and describe how plants use it to help them grow. Use the example of fruit or vegetable crops that bear higher quality fruit or have a higher yield. Explain that on a larger scale, for example in agriculture, excess fertiliser can enter the waterway from direct run-off or via drains and stormwater.
2. Discuss a home example such as: after rain excess fertiliser that has been used to fertilise the lawn runs down the drain into the stormwater system. Explain that stormwater ends up in waterways.
3. Display some packaging such as laundry powder, detergent or soap that contains phosphates e.g. in the form of sodium phosphate. Like the excess fertiliser, these phosphates can also enter the waterway through stormwater from grey water or car washing.
4. Explain that phosphate levels are an indication of water quality and can be tested and will be what we will investigate today.

**Phosphate cycle**

1. Explain that phosphate is a nutrient which occurs naturally in freshwater environments. Describe the phosphate cycle and make the comparison between similar cycles such as the water cycle. Using Figure 2, explain the phosphate cycle to students.
2. The phosphorus cycle in terrestrial and aquatic environments:

* Phosphorus is a naturally occurring element originating from minerals in rocks and is essential for animals and plant life.
* In natural circumstances, phosphorus usually enters a waterway from the weathering of rocks (inorganic phosphorus) and the decomposition of plant and animal materials (organic phosphorus).
* Phosphorus is usually found in waterways as a form of phosphate.
* Phosphate can also be added to soil by a vegetable grower, which can run-off into the waterway.
* Phosphate in the soil is also used by plants and then eaten by cows. The cow manure enters the waterway or goes back into the soil, adding phosphate to the soil or water.
* People and animals also consume phosphate in meat and vegetables; this may end up in sewage treatment or if consumed by animals, in waterways.
* Recycling of phosphorus (as phosphate) is slow because no biologically important form of phosphorus is gaseous. Phosphate that becomes part of marine sediments may take millions of years to solidify into rock, uplift as mountains and erode again to become available to living things.



Figure 2 The phosphate cycle

1. Use the analogy that, in the same way that we recycle our aluminium cans, plastic and paper to make new products, phosphate travels through a cycle in the environment.

## **Activity 2: Phosphates in a wetland**

Students draw a model of a wetland and demonstrate the effect of excess phosphate levels on the ecosystem.

### Equipment

Whiteboard

### Activity steps

1. Explain we are going to investigate what happens when phosphates enter a waterway, in this case, a wetland.
2. Draw the outline of a wetland on the whiteboard. Ask students to identify living and non-living things that belong in the wetland and ask them to draw these on the whiteboard eg. plants, animals and items such as rocks.
3. Demonstrate a balanced amount of phosphate in the water which occurs naturally by drawing dots to represent the phosphate level.
4. Draw a stormwater drain and show water flowing into the wetland which contains extra phosphate (add more dots). Demonstrate the effects of this by adding algae and other plants to cover the wetland.
5. Ask students if they have seen ponds or fish tanks, with lots of algae in them.
6. Explain that the increased plant growth can lead to a lack of oxygen as the plants start to die, which can stress or kill animals (including waterbugs) and other plants in the wetland. This process is called eutrophication.
7. Explain that is why we measure phosphate levels in our waterways.

## Activity 3: Testing phosphates

Students measure the phosphate levels in some water samples and discuss the effects that increased nutrients could have on the waterway.

### Equipment

### For each group:

### Phosphate test kit

### Phosphate test instruction card

### Beakers/water bottles

### Three water samples e.g. creek, wetland, tap water, creek with added phosphate

### Gloves and safety glasses

### Small amount of fertiliser containing phosphate e.g. Osmocote

### Interactive whiteboard or data projector

### Activity steps

1. Explain that today students will measure phosphate levels in three samples of water. Describe where each sample came from.
2. Explain that when we carry out an experiment like this one, we would first make a prediction about what are findings will be. Ask what they would predict we will find in this experiment?
3. Discuss the safe use of chemicals in the classroom.
4. Demonstrate to students how to carry out a safe test for phosphates.
   1. Use beakers or water bottles to fill tubes up to the line
   2. Phosphate tablets will be distributed by the teacher (wearing gloves and eye glasses)
   3. Once a tablet is added to their tube, they will need to shake the tube for 3-4 minutes to dissolve the tablet
   4. Once dissolved, we need to wait 6 minutes for the test to work
   5. After 6 minutes we will use the colour charts to determine the level of phosphate in the water in parts per million (ppm).
5. Discuss that scientific testing must be accurate to achieve repeatable results and that, as scientists, the students are responsible for the accuracy of the tests.
6. Ask students to follow test steps in order on their phosphate colour charts. You may like to pair students up and have a few pairs test one of the different samples each.
7. Collate results on the board for each of the samples and note the median result.
8. Show the Melbourne Water’s Water Quality Guidelines to assess the phosphate levels and discuss findings with the class. (See attachment)
9. Recap on the activity be asking the class what effects the increased nutrients could have on the waterway.
10. Ask students what they can do at home to reduce the amount of phosphate entering the freshwater system.

**Teacher background**

**Improving the water quality of our waterways**

* Increased nutrients affect water quality.
* Dog poo enters waterways via stormwater. Pick up dog poo when walking your dog.
* Wash cars on the grass verge to limit detergents running down the gutter.
* Purchase low or no-phosphate laundry power (especially in septic tank areas or where grey water is reused).
* Make sure litter goes in the bin as it can enter waterways via stormwater.
* If you like to see a range of animals around your local waterway, do your bit to limit water pollution. Look after the small macro-invertebrates and you are looking after the larger animals.
* Make others in your family and community aware of the actions that contribute to reduced water quality.

**Key messages**

Pollution from run-off and stormwater can harm out waterways. Waterways support a diverse range of plant and animal life, including native fish, frogs and platypus. They are worth looking after.

Everyone can help to protect waterways by picking up after their dog, putting litter in the bin and carefully using fertilisers in the garden.

**What is phosphorus?[[2]](#footnote-2)**

Phosphorus is a naturally occurring element originating from minerals in rocks and is essential for animal and plant life. In natural circumstances, phosphorus usually enters waterways from the weathering of rocks (inorganic phosphorus) and the decomposition of plant and animal material (organic phosphorus).

Although phosphorus is one of many nutrients required by plants and animals, in freshwater systems it is often the nutrient limiting plant growth (i.e. it is the nutrient in shortest supply). This places a special importance on the monitoring and management of phosphorus. Phosphorus is rarely found in its elemental form (P). It usually occurs in waterways as a form of phosphate (PO43-).

This test measures Reactive Phosphorus (RP)—any form of phosphorus that reacts with reagents in a colorimetric test without prior filtering or digestion (acid and heating). This method is also known as ‘total reactive phosphorus’ and is largely a measure of orthophosphates. However, the procedure isn’t 100 per cent accurate and so results will include a small fraction of some other forms of organic and inorganic phosphorus that are easily broken down in water.

**Why monitor phosphorus?**

Phosphorus is often the limiting nutrient in freshwater systems. This means that increased concentrations of phosphorus provide increased opportunity for growth of algae and other plants. If phosphorus concentrations are high enough, they can contribute to algal blooms and infestations of aquatic macrophytes. Excessive algal and macrophyte growth can lead to smothering of habitat, clogging of waterways and overnight ‘oxygen troughs’. Oxygen troughs occur when plants respire during the night (consuming oxygen) but are not photosynthesising (and therefore not producing oxygen). Under normal circumstances, a cycle of oxygen peaks during the day and troughs during the night. However, in eutrophic waters this cycle becomes exaggerated, with oxygen concentrations reaching very high levels during the mid-afternoon and then dropping to very low levels just before sunrise. Levels can be low enough to severely stress, or even kill, the fauna of the stream.

At the end of an algal bloom, when the plant material is decaying (oxidising), the micro-organisms that break down the plant material consume large amounts of oxygen during the process, also adding oxygen stress to the ecosystem.

**Sources**

Natural sources of phosphorus in waterways include: inorganic phosphates dissolved from weathered rocks; organic material from plants that have taken up the inorganic phosphate; organic material from animals (including wastes and decaying tissues); and remineralised phosphate that has been converted by bacteria from organic particulate phosphorus into dissolved inorganic phosphate.

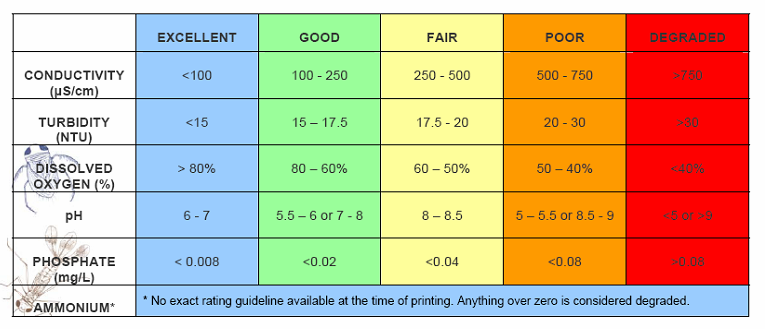
Human derived or accelerated inputs of phosphorus to waterways can include those associated with eroded soil that is deposited as sediment (including particles with phosphate fertiliser attached), discharges from sewage treatment plants, stormwater runoff, discharges from intensive agriculture/dairying, stock access to streams and poor land management.

**Natural Variations**

Phosphorus concentrations can vary over time in relation to seasonal phenomena and episodic events. For example, higher flows (whether seasonal or episodic) are typically associated with increased inputs of suspended particulate matter, which carry attached TP. If storms follow bushfires within a catchment, extremely high levels of TP may be measured, associated with ash deposition and massive sediment inputs.

**Attachment 1**

Water Quality Guidelines



1. Creative Commons Licence Victorian Curriculum and Assessment Authority (VCAA) <<http://victoriancurriculum.vcaa.vic.edu.au/>> Accessed 14 August 2016. [↑](#footnote-ref-1)
2. Extracted from: <<http://www.vic.waterwatch.org.au/monitoring-and-data/1011/>> [↑](#footnote-ref-2)