# WAI - WAI NOT!

## Science activities to support the use of SOPI in schools

Ministry for Primary Industries
Manatū Ahu Matua

# CONTENTS

# CONNECTIONS TO THE NEW ZEALAND CURRICULUM

## CURRICULUM PRINCIPLES

The learning activities in this resource have been developed to support these curriculum principles of The New Zealand Curriculum.

**Learning to learn:** Encourages students to reflect on their own learning processes and learn how to learn.

**Community engagement:** Enables students to connect to wider aspects of their lives, their families, whānau, and communities.

**Coherence:** Provides identified links across the learning areas of science, technology, social sciences, and mathematics and statistics to support students to make connections within and across learning areas.

**Future focus:** Encourages students to look to the future by exploring such significant future-focused issues as sustainability, enterprise, and globalisation.

## ACHIEVEMENT OBJECTIVES

The learning activities in this resource support these science achievement objectives of The New Zealand Curriculum:

### Level 4

#### Nature of Science

Investigating in science
Students will:

- build on prior experiences, working together to share and examine their own and others' knowledge.
- ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.

Participating and contributing
Students will use their growing science knowledge when considering issues of concern to them.

#### Planet Earth and Beyond

Earth systems
Students will develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources.

Interacting systems
Students will investigate the water cycle and its effect on climate, landforms and life.

#### Material World

Properties and changes of matter
Students will group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials.

Chemistry and society
Students will relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

### Level 5

#### Nature of Science

Understanding about science
Students will understand that scientists' investigations are informed by current scientific theories and aim to collect evidence that will be interpreted through processes of logical argument.

Communicating in science
Students will use a wider range of science vocabulary, symbols, and conventions.

Participating and contributing
Students will develop an understanding of socio-scientific issues by gathering relevant scientific information in order to draw evidence-based conclusions and to take action where appropriate.

#### Planet Earth and Beyond

Earth systems
Students will investigate the composition, structure, and features of the geosphere, hydrosphere, and atmosphere.



#### Material World

Properties and changes of matter
Students will investigate the chemical and physical properties of different groups of substances, for example, acids and bases, fuels, and metals.

Chemistry and society
Students will link the properties of different groups of substances to the way they are used in society or occur in nature.

#### Living World

Life processes
Students will identify the key structural features and functions involved in the life processes of plants and animals.

## KEY COMPETENCIES

These learning activities provide opportunities for:

**Participating and contributing**

- become actively involved in communities
- contribute as a member of groups
- participate in new contexts
- contribute to the quality and sustainability of social, physical and economic environments.

**Relating to others**

- listen actively
- recognise different points of view
- negotiate and share ideas
- cooperate and work effectively with others
- develop new approaches, ideas, and ways of thinking.

**Thinking**

- develop curiosity and ask questions
- actively seek, use, and create knowledge
- make sense of information, experiences, and ideas
- develop understanding and shape actions.

**Managing self**

- become self-motivated
- become enterprising, resourceful and resilient
- establish goals, make plans and manage projects
- develop strategies for meeting challenges.

## KEY UNDERSTANDINGS

- The productive and efficient use of water and the care and protection of its quality has a significant effect on New Zealand's economy.
- Water is a finite resource that is constantly being recycled.
- We all have a responsibility to protect the quality of our limited water supplies.
- The quality and quantity of water is affected by human activities.
- Precision technology can ensure that we manage water supplies more efficiently.

# TEACHING AND LEARNING PLAN

## INTRODUCTION

Water is essential to all life and New Zealand is very lucky in that we have ample supplies of water. We are surrounded by ocean and most of our towns and cities are not far from the sea, which supports aquaculture, salt production, and fishing and recreation.

We also have a large number of freshwater sources such as rivers, lakes, and aquifers, and our climate provides a good level of rainfall to replace and maintain our fresh water supplies, that is used for drinking water, industrial uses and the irrigation of land.

Levels of rainfall can have an impact on production levels in the primary industries. Many of us take our water sources for granted and think little about where it comes from before we turn on a tap, and where it goes once we have used it.

These science activities have been developed to be taught over several sessions and the indicative timeframe for each is 1–2 hours. The activities can be covered in any order and with any number of students. They can also be taught as individual activities.



## ACTIVITY 1:

# WHERE DOES IT ALL COME FROM?

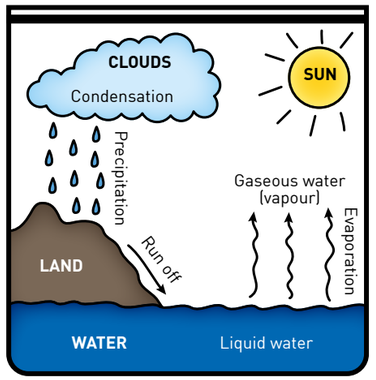
This activity provides opportunities for students to develop a fundamental understanding of the importance of water. Students investigate their water sources and how water is treated once they have used it. This activity scaffolds their understanding so that they can extend their knowledge to the role water plays in the primary industries and their roles in ensuring its quality.

1. We live on the only planet in our solar system that has water, as far as we know. Approximately 71% of our planet is covered in water, which is why Earth is known as the blue planet. Of this water, most of it is salt water in oceans, but water can appear in several different forms – gaseous water or water vapour in the atmosphere; liquid water (fresh and salt) in groundwater, rivers and lakes; and solid water as snow and ice. After carrying out their own research, students can produce an infographic to show the estimated proportions of the different forms of water on planet Earth.

2. The water cycle shows how the Earth's limited water supply is constantly changing form as it is recycled between land, sky, and sea. Students should review their prior knowledge by making a water cycle model related to their local context. They will need to use the following terms:

   Absorption; a body of water; clouds; condensation; evaporation; liquid water; precipitation; run-off; transpiration; the Sun; water vapour.

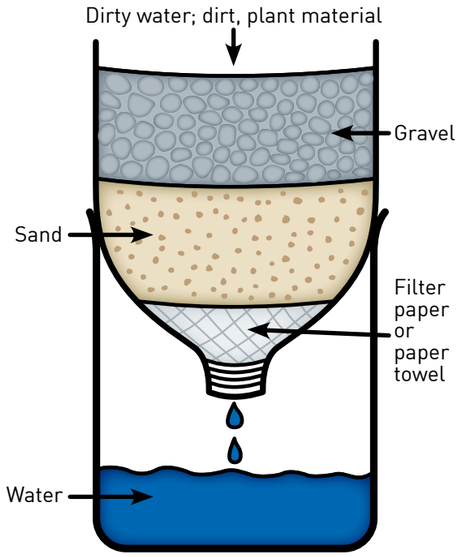
   One example of such a model could be constructed using sealed ziplock bags and blue dyed water. Students can use permanent markers to draw the water cycle on the outside of the bags that are then taped to a sunny window so that they can see the water cycle in action.



To increase engagement **Edpuzzle** could be used to add in questions during a video, such as this **video** which is listed in the resources section. Or students could generate a series of questions to create a **Kahoots** quiz. Kahoots also have premade quizzes that could be used.

3. The water cycle influences our weather and climate. Have the students investigate the difference in meaning between the terms 'weather' and 'climate'. Students can consider climate change and climatic conditions. How has our climate changed over the past 100 years? Look at temperature changes.

4. As a precursor to investigating wastewater treatment, students could explore how they could improve water quality by making a water filter out of a plastic drink bottle cut in half to model how dirty water can be treated. They should not assume that the end product is suitable for drinking!




5. Most households around New Zealand, other than those that have their own wells or rainwater tanks, do not rely on water straight from the source. Water is often processed in some way before it is distributed for consumption. Most of the water that is used domestically is poured down drains and consumers think no more about it. Students can investigate and present a report about water treatment in their local area. Where does their water supply come from and what is done to it to ensure it is safe to use. Once used, what happens to it? Does it go straight into a river, stream or the sea, or is it processed in some way first? Contact your local council and arrange a visit to a water treatment plant where students can see how water is processed before and after use.

Using the information they have discovered about water use and water treatment, students can carry out a survey to discover how 'water-wise' their community is. What action could they take as a result of this survey?



## RESOURCES

- **SOPI 2016**
- **SOPI reports 2010–2015**
- Science Learning Hub – **Water**; **Building a Water Cycle** – activity; **Construct an aquifer model** – activity; **Disinfecting wastewater** – interactive activity
- **The Pond NZ** – keyword search: 'water', 'water cycle', 'water treatment'
- Te Ara Encyclopedia of New Zealand – **Water Resources**; **The Hydrological Cycle**
- Nasa Space Place: **How much water is on Earth?** – short video and infographic
- Youtube videos: **The Water Cycle** [6.46 mins] **Water Cycle Rap** [2.46 mins] **Where does your sewage go?** [2.54 mins]
- Ministry of Health – **Drinking Water**
- Regional water treatment processes – **Hamilton City Council**; Watercare Auckland; **Christchurch**; **Wellington Water**
- Regional wastewater treatment processes – **Christchurch**; **Watercare Auckland**; **Napier**; **Waimakariri**
- Radio New Zealand podcast: **The world is running out of water** – panel discussion [2 mins]
- National Library – **Water** links
- **Water Island** – online game
- ABC: **Catchment Detox** – online game

## ACTIVITY 2:

# WAI? WHAT'S IT FOR?

"New Zealand is blessed with a lot of fresh water, with 145 million litres available per person per year." (SOPI 2016).

That is a lot of water so what is it used for? This activity provides students with opportunities to think about what they use water for and to then consider its use in local primary industry contexts. They investigate how plants including trees, fit into the water cycle, as well as how water is used by primary industries that are either directly or indirectly dependent on plants. Plants, like all living things, depend on a reliable quality water supply and a range of minerals or nutrients dissolved in the water. Our primary producers use different irrigation methods to meet the needs of plants. Plants also play a vital part in the water cycle and can influence our climate, soil and water quality, and the sustainability of our water supplies.

1. Before starting this activity, students discuss what they and their families use water for. They can do this in a whole class discussion, a think-pair-share activity or a bus-stop activity. What about 'hidden' water? How would this change over a year? How much of their water use is essential and how much water is wasted? What actions could they take or encourage others to take to conserve water? They could expand their focus to consider water use in their local context (school, neighbourhood), regionally, or nationally.

2. The primary industries are major users of water in production and processing. After viewing **this video** as a starter activity, students use the most recent **SOPI publication** to collaboratively brainstorm how the key primary industries in their local area use water. They can then contact these industries for more information about their water use.

3. Students investigate the **transport of water** in plants, using coloured water and pale leaves or flowers. Using a microscope, they can observe the coloured structures within a plant, draw them and, using a scientific diagram as a guide, name and describe the plant structures that are responsible for the transportation of water around the plant. They can present their diagrams as a poster or digitally, using an app such as Google Drawings or **Thinglink**.

4. Students create a mind map or poster to show the links and connections between these terms:

   dissolved nutrients; evaporation; heat from the Sun; leaves; osmosis; photosynthesis; root hairs; stoma; transpiration; transpiration stream; water; wind; xylem.



They can then add in the processes used in a local primary industry (e.g. irrigation storage), showing their relationship to the natural water cycle.

**Extension activity:**

Plants take in water through their root hairs and lose water through stomata in their leaves. Students can use leaves and Vaseline™ to carry out an **investigation** into the parts or side of a leaf from where plants lose the most water **http://www.sicm.org.uk/tuition/biologypdf/10%20Transpiration.pdf**

- How much water do plants lose?

Students carry out an investigation into water loss in plants due to transpiration. This can be done by measuring either the volume of water lost, using a traditional bubble **potometer** or calculating weight loss using a **flask potometer**. The investigation could be taken further by investigating how different conditions – light intensity, temperature, movement of air, and humidity – affect the rate of water loss. Have the students consider the implications of such water loss for our primary industries (or a selected local industry). Relate these findings to the demand for irrigation on farms across New Zealand.

## RESOURCES

- SOPI 2016 report and December update
- SOPI reports 2010–2015
- Ministry for Primary Industries: Stock Water Reticulation Study – video
- What is the importance of water?
- Transport of water in plants
- Science Learning Hub: The evaporation and transpiration; water quality
- The Pond, NZ: Keyword search – 'water uses', 'transpiration', 'stomata', 'minerals for plant growth'
- Science in the Primary Industries
- NIWA: Kaitiaki Tools
- Water Use in New Zealand
- Freshwater Use in New Zealand: New Zealand Parliament
- World Vision: Water Matters
- Transpiration Experiments
- Simple transpiration investigation set up – Youtube
- DairyNZ: Rosie's Education – Just add water; Exploring and participating in local responses to water quality issues; The nitrogen cycle; Testing stream health and resilience by measuring water quality indicators
- Rural News: Canterbury irrigation scheme benefiting region already



## ACTIVITY 3:

# GETTING TECHNICAL

"The Government is continuing to support the primary sector through investing in irrigation and water storage. The productive use of our land and water is a key feature of New Zealand's primary sector economy. The Ministry for Primary Industries (MPI) undertakes a wide range of initiatives to improve the productivity of our land and soils and ensure these resources are managed sustainably … However, we can improve the way we manage this resource and increase productivity of the water we use. MPI supports a range of projects across the country that seek to best utilise water in order to boost production and get the most out of our lands and soils. MPI is also committed to improving and maintaining the quality of New Zealand's waterways so that they remain available to future generations." (SOPI 2016).

Many of our primary producers rely on irrigation rather than rainfall to maximise the growth of the plants and animals required for their industry. Many processors of primary produce have high water needs as part of their processing systems. Technologies have been developed to ensure that the appropriate amount of water reaches the right locations at the right time. In this activity students investigate the use of precision technology to manage water use.

1. Students contact a local primary producer or processor with the purpose of developing a case study focusing on an aspect of water use. This could be done as a collaborative project where individuals or groups of students investigate different aspects and then pool their information to create a 'water profile' of the industry they are studying.

   Starter questions may include:
   - What is their source of water?
   - What do they use water for?
   - How much water do they use – weekly, annually?
   - How do their usage patterns change over a year?
   - How is the amount of water regulated?
   - What technology is involved?
   - What processes are undertaken to reduce the impact of wastewater on the environment?

2. Students use existing case studies to find out measures that are being taken by those working in our primary industries to manage water use and to take care of the quality of water.

3. Precision technologies give primary producers the technology to be more accurate and less wasteful in managing their water resources. For example, this technology can measure precise amounts of water and deliver it to specific areas of land at specific times.

Using a 'brain dump' strategy, have the students generate a list of questions about the term 'precision production'. They can then use their questions to guide an investigation into the use of precision technology in a range of primary industries. Questions they need to cover include:

- What is 'precision technology'?
- Why were precision technologies developed?
- What are some scientific or technological developments that make precision technologies possible?

Arrange to interview or visit a primary producer or processor who uses precision technology to manage water use.

Students can create a PMI chart on the concept of precision production. They can use their findings to make supported recommendations to a producer or local body about management strategies that support sustainable practices.

## RESOURCES

- SOPI 2016
- SOPI reports 2010–2015
- Ministry for Primary Industries: dairy farm case studies; benefits of irrigation to the economy; sustainable farming fund; keyword search for 'irrigation' will result in a number of useful resources
- Ministry for Primary Industries: Meet some of our primary industry champions; Meet Craige – Arable Farmer and Primary Industry Champion – YouTube
- Precision agriculture for more accurate farming: Rob's Country (NZ) – Youtube
- National Geographic: What Happens When Farming Goes High-Tech?; What is precision agriculture? (Australia); From drone to tractor (USA); Drones, scanners and GPS (USA)
- Five technologies changing agriculture
- Precision Agriculture Association NZ
- AgriOptics Variable Rate Irrigation – Greenvale Pastures
- Radio New Zealand podcast: Craige and Roz Mackenzie – The Ballance Farm Environment Award Winners
- Agrioptics NZ
- BNZ – Agrioptics
- Te Ara Encyclopedia: Water resources



# ACTIVITY 4:
# THERE'S SOMETHING IN THE WATER

"MPI is committed to improving and maintaining the quality of New Zealand's waterways so that they remain available to future generations." (SOPI 2016, p.17).

Water is rarely pure as it often contains dissolved gases, minerals, nutrients, sediments and other materials from the catchment area surrounding the source of the water, all of which can alter its quality. Some of these additions are natural and some result from human activities. Water can also have variations in the levels of pH, and plants and aquatic animals may require different pH levels for optimal growth and survival. In this activity students investigate the chemicals that could or should be in the water and the quality of water that is desired. They also examine how human activity affects the quality of our water.

Students can place themselves on a continuum indicating the extent to which they agree with the statement 'The quality of our waterways is being reduced.'

### Focus questions

Questions such as these can guide students in their research and discussion on this topic.

- What impact do human activities, urban and rural, have on our waterways?
- What happens to excess water, chemicals and nutrients that are not used?
- What types of nutrients do livestock put on pastures?
- How does increased nutrient loading on pastures due to livestock effluent affect waterways?
- How can we minimise the impact of human and livestock activities on waterways?
- What do the terms 'leaching' and 'run-off' mean?
- What is 'eutrophication'?
- How do these processes affect local waterways?

1. In groups of 3-4, students can analyse a number of water samples collected from a range of waterways by:
   - commenting on the clarity of each water sample
   - filtering each sample to find any insoluble sediments
   - testing each sample for pH levels
   - evaporating the remainder of each sample to separate out the once-soluble substances in the water.

2. Further analysis of the water samples is a complex process. However, students can use water testing kits, which are readily available for purchase online, or from local garden centres or pet stores for testing aquarium water. These test for nitrate and phosphate levels and a number of other substances.
3. Students can visit or interview a representative from an organisation that tests water quality. They can explore the **LAWA website** to discover what they can find out about a local waterway.
4. They can then produce and share a scientific report outlining the results of their tests. They can use Google Maps to indicate the sources of their water samples and to explore the local environments to check for nearby environmental features or industries that could be contributing to the water content.
5. Students can explore how local primary industries (producers and/or processors) address water use and quality issues by inviting industry representatives to talk to the class or by visiting local industries and producers.
6. Students can work collaboratively to investigate how water quality is measured and what is considered to be an acceptable standard of water quality in New Zealand. They can also investigate who is legally and ethically responsible for water quality and explore measures that encourage responsible and sustainable water use, for example the **National Policy Statement for Freshwater Management**.

7. Many primary industries rely on fertilisers to enhance plant growth. Most of these fertilisers provide large quantities of nitrates and phosphates. Fertilisers cannot be too soluble or they are quickly removed from the soil and leach into waterways. Nor can they be too insoluble as they are then inaccessible for plants to absorb for growth. Students can compare the solubility of different substances and create a table of those that are soluble and those that aren't. They should include some substances, such as fertilisers, that are in common use in the primary industries. Using solubility rules they can then predict the solubility of some named substances. They may choose to create a screencast of their investigation so that they can explain their process and results and the implications of their results. They can add this to a digital portfolio of their work, or present it to an audience.
8. Students can investigate innovations being developed in New Zealand to address water pollution. Examples are **Clearview Innovations** or **Pioneering to Precision**



**Extension activities:**

1. Students can investigate factors that affect the rate of solubility of a substance in water and consider how their findings could be applied to specific primary industries to ensure more precise and sustainable use of fertilisers for crops. They can read about the work on precision delivery systems that is being carried out at **Ravensdown** and **Ballance Agri-Nutrients** as part of the MPI **Primary Growth Partnership**.
2. Different minerals or nutrients are needed for different aspects of plant growth. Producers add these nutrients as fertilisers – both chemical and organic – to the soil to achieve optimum growth. Most chemical fertilisers are sold with a NPK rating. Students can collect images from a range of commonly used fertilisers and use these to create an infographic explaining what the acronym 'NPK' represents and why it is needed by plants. They can investigate other minerals that are important to plant growth and explain why primary producers cannot rely solely on natural processes for plant growth.
3. Students can grow plants such as duckweed (*Lemna*) or radish seedlings in a range of different nutrient solutions, chemical and organic, and in **nutrient deficient solutions**.

   They can then calculate the rate of growth of the plants (by recording changes in the total leaf area over time) to comment on the effects of different nutrients on plant growth. They can then relate their findings to a primary industry context.

4. Students can research the effects of human activities on waterways and ways we can reduce their negative effects. This video is useful – **the effects of water on erosion**.
5. Students can present recommendations on ways to maintain water quality, or reduce the impact of human activities, or improve water quality, supported by scientific evidence. Their presentations could take the form of letters, videos, posters, infographics or slide shows.

## RESOURCES

- SOPI 2016
- Ministry for the Environment: Environmental reporting on fresh water
- Land, Air, Water Aotearoa (LAWA)
- Statistics New Zealand: Environmental indicators – freshwater; River water quality trends – nitrogen
- Ministry for Primary Industries: Protection and response – fresh water
- Ministry for Primary Industries: The Canterbury waterway rehabilitation experiment [2.17 mins] YouTube
- Science Learning Hub – Farming and Environmental Pollution – Managing nutrients
- NIWA: What do we measure?; Water quality tools; How clean are our rivers?; Nutrient overloading; Farm practices and stream health; River water quality trends: nitrogen
- Te Ara Encyclopedia: Water Quality
- Water quality in New Zealand: Understanding the science
- Stuff: 5 January 2017: Our freshwater health crisis – preventive medicine urgently needed
- NZ Farmer: 17 January 2017: Dairy NZ's grass-fed policy could be adding to our nitrate woes
- Timaru Herald: 26 January 2017: Farming's image suffers as pollution sickens the waterways
- NZ Herald: 15 March 2017: Whanganui River given legal status of a person under unique Treaty of Waitangi settlement
- DairyNZ: Rosie's Education – Just add water; Exploring and participating in local responses to water quality issues; The Nitrogen cycle; Testing stream health and resilience by measuring water quality indicators
- CAREX Canterbury Waterways Rehabilitation Experiment
- LAWA: https://www.lawa.org.nz/explore-data