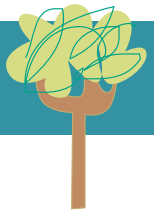
SECTION TWO:

The water cycle

This section includes activities based around the natural water cycle and how water changes state and moves around the environment.



Section 2: The water cycle

The purpose of this section is to help students to:

- Understand how water changes state (solid – liquid – gas)
- Understand that water moves around the planet in a cycle
- Explore how water moves around a natural catchment compared to an urban catchment

Overarching concepts for Section Two:

- Water naturally moves around the planet in a cycle, changing state as it goes
- Our changes to the natural landscape affect how water moves around a catchment

Section 2: The water cycle

Learning experiences – Section Two

Learning experiences	Learning intentions Students will . . .	Curriculum links (Achievement objectives)	Content
1. The natural water cycle	• Understand that water moves around the planet in a cycle • Investigate water movement in a terrarium and relate this to water movement in the environment	**Science:** **Level 3 and 4** ***Planet Earth and Beyond:*** *Interacting systems* Investigate the water cycle and its effect on climate, landforms and life ***Nature of Science:*** *Investigating in science* Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations	Students set up a terrarium experiment to see the water cycle in action. They observe water changing state from liquid to gas (water vapour) and back again
2. Changes in the movement of water	• Investigate how urban landscapes can alter the pathways of water • Recognise that water behaves differently on permeable and impermeable surfaces	**Science:** **Level 3 and 4** ***Planet Earth and Beyond:*** *Interacting systems* Investigate the water cycle and its effect on climate, landforms and life	Students examine water movement in natural and urban catchments. They investigate how water interacts with both impermeable and permeable surfaces

2:1 The natural water cycle – teacher notes

Curriculum links

Science: Level 3 and 4
Planet Earth and Beyond:
Interacting systems:
Investigate the water cycle and its effect on climate, landforms and life

Nature of Science:
Investigating in science:
Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations

Education for sustainability concepts

Interdependence/ Whanaungatanga:
Everything and everyone in our world is connected

Background knowledge

Water changing state

Water is the only substance on earth that is found naturally as a solid (e.g. ice, snow, hail), liquid (e.g. water, rain) and a gas (e.g. water vapour, steam, fog, mist).

The natural water cycle

Water moves around the planet in a repeating cycle, **changing state** between a liquid, a gas and a solid.

In the water cycle, the sun heats up liquid water on the earth and causes it to become water vapour ***(evaporation)***. The water vapour then rises in the air and, when it hits cold air higher up, it condenses into clouds ***(condensation)***. When the clouds become too heavy, it falls to the earth as rain/hail/snow ***(precipitation)***.

Water movement in the water cycle

When water reaches the earth as precipitation it can:

1. **Evaporate** directly from the ground/ocean/a water body
2. **Run-off** to collect in water systems such as wetlands, lakes, creeks, streams, rivers or estuaries (making its way through these systems to the ocean where, over time, it will evaporate as the sun heats it)
3. **Soak** into the ground

From there follow a number of pathways. It can:

- be taken up by plants and trees, which eventually release it out into the atmosphere as water vapour ***(transpiration)***
- filter through the ground into the groundwater system
- filter down into giant, underground, rock 'sponges' called **aquifers**. Water from aquifers re-enters water systems through springs or seepage into the ocean or by filtering back into waterways

Water can also become solid ice or glaciers or end up in a thermal boiling pool. The options are almost endless!

The cycle continues as water evaporates and then precipitates back to earth.

2:1 The natural water cycle – learning experience

Learning experience

- Share learning intentions and success criteria
- With the students, make a terrarium using listed resources. Explain that you will use the terrarium to show how water changes state and moves in the water cycle. *(Students could construct a terrarium as a homework activity if preferred)*
- Place soil in a vase **or** large jar. Plant several seedlings in soil and water generously so that soil is wet to touch. Place plastic wrap on top of vase/container and secure with a rubber band to prevent any moisture escaping
- Set aside terrarium while you discuss students' predictions. Ask students what they understand by 'the water cycle'. Explain that water moves in a cycle around the earth, changing state as it goes. Ask what students understand by 'changing state' *(see teacher notes – the natural water cycle)*
- Display the poster *'The water cycle'*. Discuss the stages of the water cycle on the poster; evaporation, precipitation, transpiration, condensation. Explain each process. Ask if students can find evidence of any of these stages of the water cycle in the terrarium. *Students should be able to see evaporation as water vapour in or on the side of the container and condensation hanging as water droplets on plastic wrap after about 20 minutes. Precipitation is sometimes visible as water droplets very slowly making their way down the side of the container, or on leaves. After a few hours there should be large water droplets hanging from the plastic wrap and 'precipitation' will be more frequent and easier to observe*
- A few days later, if we take off the plastic wrap and feel the soil would it still be wet? *Yes it would, because water in the terrarium is moving around in a cycle; changing state, but not escaping, as it does on earth*
- Ask students to draw a diagram of the terrarium, labelling the states of water that they can see and where the processes of condensation, evaporation, precipitation and transpiration are occurring. Record observations over several days
- For a simple review of the water cycle and the associated vocabulary see: http://www.epa.gov/ogwdw/kids/flash/flash_watercycle.html
- For an animation about the water cycle, transpiration and run-off see: http://www.youtube.com/watch?v=LBtOZAo2sr4

As an extension, read Connected, Part 2, 2002: An interview with a glass of water. Find words to describe water as a solid, a liquid and a gas in the article.

Learning intentions

Students will:
Understand that water moves around the planet in a cycle

Investigate water movement in a terrarium and relate this to water movement in the environment

Success criteria

Students can:
Explain how water moves in the water cycle

Describe the movement of water in a terrarium and relate this to water movement in the environment

Resources

Clear container, e.g. jar/vase
Plastic wrap
Soil
Spray bottle/watering can
Several small plants
Rubber band
Poster The water cycle

Example of a terrarium

Reflection questions

- Where do the processes of precipitation, evaporation, transpiration and condensation happen outside the terrarium? *(see teacher notes for examples)*

Vocabulary

- state
- terrarium
- condensation
- evaporation
- precipitation
- transpiration

2:2 Changes in the movement of water – teacher notes

Background knowledge

Pathways of water

In a natural catchment covered with trees and vegetation, water will fall onto trees, plants or soil and be absorbed by them. Large amounts of water will seep into the ground in a natural environment *(infiltration)*, and be absorbed by plants. The majority of water in a natural, vegetated catchment passes through the groundwater system.

Impermeable surfaces

Impermeable surfaces will not let water through them. Many surfaces in urban environments are impermeable e.g. concrete, buildings and roads.

Permeable surfaces

Soil, bush and grassed surfaces are permeable, letting water through them so that it can enter groundwater and aquifers.

Run-off

Run-off can be defined as rain that is not absorbed by the ground. Run-off flows overland into our rivers, streams and beaches.

Water movement in poster *'Water movement in natural/urban catchments'*

An equal amount of rain falls in the urban and natural catchment in the poster. The sizes of the arrows are based on proportions of each of the processes. In the urban catchment, there are a lot of impermeable surfaces, so rain is mostly directed into the stormwater system or flows overland as run-off *(red arrows)*.

In the natural catchment, much of the rain is taken up by vegetation and released into the atmosphere by transpiration *(pink arrows)*. The remainder runs off into streams and rivers or filters into aquifers and groundwater *(infiltration – purple arrows)*.

Is more run-off a problem in urban catchments?

Large amounts of run-off can cause flooding and erosion. Less infiltration can cause a depletion of groundwater supplies. Run-off flows down our driveways, footpaths, roads and carparks into drains, taking debris and chemicals into drains, streams and rivers and out to sea.

For more activities relating to the water cycle and water movement in a catchment see: http://www.sciencelearn.org.nz/Contexts/H2O-On-the-Go/

Curriculum links

Science: Level 3 and 4
Planet Earth and Beyond:
Interacting systems:
Investigate the water cycle and its effect on climate, landforms and life

Other curriculum links: L 3 and 4
Science: *Nature of Science:*
Investigating in science

Education for sustainability concepts

Interdependence/ Whanaungatanga:
Everything and everyone in our world is connected

Sustainability/Hauora:
The choices we make today affect the choices we can make in the future

Answers to BLM 2a

1. a) precipitation b) transpiration c) infiltration d) run-off
2. More run-off, less transpiration, less infiltration, less water to groundwater
3. More impermeable surfaces, less trees, less permeable surfaces

2:2 Changes in the movement of water – learning experience

Learning intentions

Students will:
Investigate how urban landscapes can alter the pathways of water

Recognise that water behaves differently on permeable and impermeable surfaces

Success criteria

Students can:
Identify differences in the movement of water in urban catchments compared to natural catchments and give reasons for the differences

Describe how water behaves on impermeable and permeable surfaces

Resources

Poster The water cycle

Poster Water movement in natural/urban catchments

BLM 2a Water movement

Container of water

Learning experience

- Share the learning intentions and success criteria
- Revise the concepts and vocabulary introduced in the previous activity. Discuss the concept of a catchment
- Ask students what would happen to rain if the catchment in the poster *'The water cycle'* was covered with houses and concrete. *(Rain would not soak into the ground)*
- Introduce the word 'impermeable' and discuss the difference between permeable and impermeable surfaces *(see teacher notes)*
- Take a container of water onto a permeable surface (e.g. grass) and an impermeable surface (e.g. courts) in your school grounds. Tip water onto each surface and observe results. Discuss why water behaves differently on these two surfaces
- Ask students to look at the two versions of water movement in a catchment shown on the poster *'Water movement in natural/urban catchments'*/BLM 2a. Explain what run-off and infiltration are *(see teacher notes)*
- In pairs, ask them to describe the differences they see between the two sides of the poster/BLM 2a *(one has lots of permeable surfaces (natural catchment), the other has lots of buildings/impermeable surfaces (urban catchment)*
- Explain that the different arrows show the different pathways water can take when it rains. Encourage the students to notice that there is the same amount of rain falling on both catchments
- Ask 'Where does the largest amount of water go in the natural catchment?' *(pink arrows) transpiration from plants*
- Where are the pink *(transpiration)* arrows in the urban catchment? These arrows are very small; Why is this? *(There are not many trees, therefore not much transpiration)*
- Point out the aquifer in the natural catchment in the poster and explain how the water in a natural catchment filters down into the groundwater or aquifers *(infiltration – see teacher notes)* and then out to sea

- Why do you think the red run-off arrows are so much larger in the urban catchment? *There are a lot more hard (impermeable) surfaces in an urban catchment than a natural catchment. The water can't soak into the ground as much and a lot more of it runs off. To avoid flooding, we use stormwater drains to collect the water and direct it through underground pipes straight into streams and out to the sea*
- Ask the students to complete BLM 2a
- Use the poster *'Water movement in a natural/urban catchment'* as an answer sheet. Discuss their answers *(see teacher notes)*

As an extension, find examples of impermeable surfaces in your school and observe water falling on them and how it is directed into drains

Reflection questions

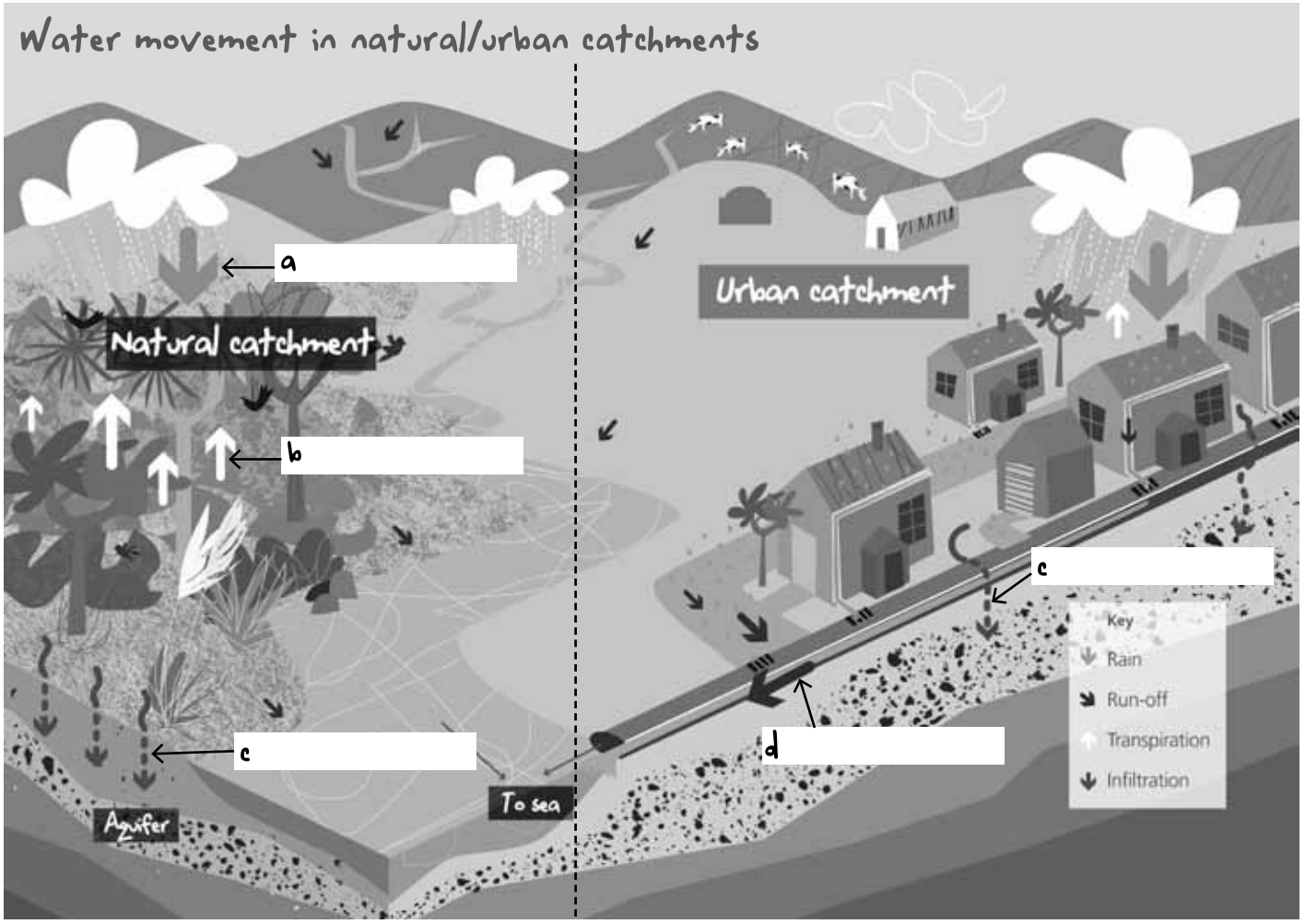
- Why is so much run-off a problem in the urban catchment? *Large amounts of run-off in urban catchments can be a problem because water collects pollutants from* ***impermeable*** *surfaces such as roads and roofs and transfers them directly to streams rather than filtering them out as they pass through the ground. Excess run-off also reduces the flow of water to groundwater*
- How could we minimise problems with run-off in urban landscapes? *Limit the amount of impermeable surfaces and use permeable surfaces wherever possible*

Vocabulary

- catchment (Greater Wellington's *Take Action for Water* educational resource has several activities that explore this concept in detail)
- urban
- run-off
- infiltration
- permeable
- impermeable

BLM 2a: Water movement

1. Place the following words in the appropriate boxes to describe the processes shown:
   run-off, transpiration, infiltration, precipitation (one appears twice)



2. How does water move differently in an urban catchment?

3. What causes these differences?

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