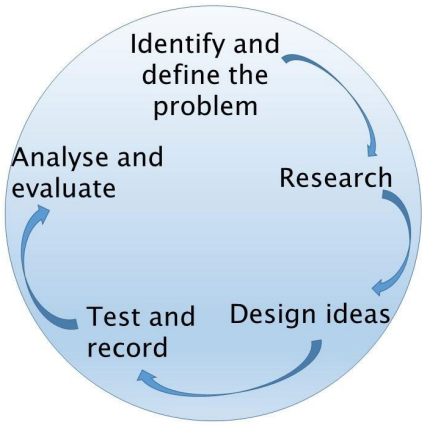
Flooding – Student Workbook

The Challenge

Floods can be damaging to property. For people looking to build in areas surrounding waterways it is vital that they understand which areas are most likely to be flooded so to assist them in making decisions about where and how to build.

Your job is to investigate factors that lead to flooding and design defences against flooding for an area surrounding a river. The end result 'hazard map' should show areas where flooding is most likely to happen and give some suggested solutions to reduce the impact of these floods.



Background Information

Flooding occurs when increased water in a river channel can no longer be contained within that channel. This can happen when there has been long periods of rain or a sudden, large, downpour. It has been predicted that as global climate changes storms and cyclones will become more frequent. This could lead to more flash floods, as rivers struggle to cope with sudden increases in volume of water.

Floodplains are often built on as they are flat areas of land which may be easier to work on. They are often very picturesque, which also makes them desirable. However, they are areas most at risk of flooding.

A simple way of reducing the damage caused by flooding is to restrict building near high-risk areas. There are also natural and engineered methods of preventing flooding where buildings do exist. These include building levees and deepening channels. Both can be expensive and can cause flooding downstream. Flooding can lead to the destruction of houses, crops and farmland. Areas next to a river can become boggy and plants can be flattened. Local governments may try to minimise these impacts by developing hazard maps to identify areas prone to flooding then engaging engineers to come up with solutions for problem areas.

Flooding – Student Workbook

Background Research

Visit the Department of Fire and Emergency Services' (DFES) website and use the information found here, particularly in the video, 'Dangers of Floodwaters', to answer the following questions:
(https://www.dfes.wa.gov.au/safetyinformation/flood/Pages/default.aspx)

1. What is the most common type of flooding in Australia known as?

   _____

2. How many deaths have been related to floods in a ten-year period?

   _____

3. What three simple steps can you take to keep safe around floodwaters?

   _____

   _____

   _____

4. List some of the dangers of floodwaters.

   _____

   _____

5. DFES recommends that people use a range of sources of information in an emergency. List three here.

_____

_____

_____

6. List three ways you can prepare for a flood.

_____

_____

_____

7. List five items that you need in your emergency kit.

_____

_____

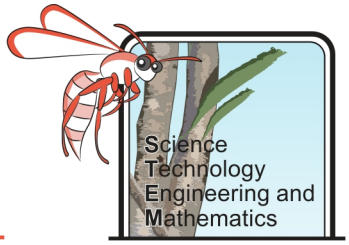
_____

_____

_____

8. What should you do with pets during a flood?

_____



9. List some household tips that can help you prepare for a flood and protect your property.

_____

_____

_____

10. Jot down three tips for returning home after a flood.

_____

_____

_____

11. What should you do with food that has been exposed to floodwater?

_____

12. What should you do with mattresses that have been soaked with floodwater?

_____

13. How do you access the DFES public information line?

_____

Testing Soils

Background

The type of soil in an area can be a major factor in determining whether it is prone to flooding or not. Some soils do not allow water to soak into them readily, causing it to wash away (or flood). Others allow water to soak in quickly, causing it to move downwards into underground water stores (so are less likely to flood). Others soak up water readily and hold it, these soils are said to have a high water-holding capacity (these soils can become very waterlogged after a lot of rain).

Objective

To examine a range of soils to see how they respond to the addition of water.

Equipment

- 3 beakers
- 1 funnel
- Graduated cylinder (or other equipment that can measure mL of water collected)
- 6 sheets of filter paper
- 3 soil samples
- Retort stand with boss head and clamp (or similar)
- A cup/scoop
- Stopwatch

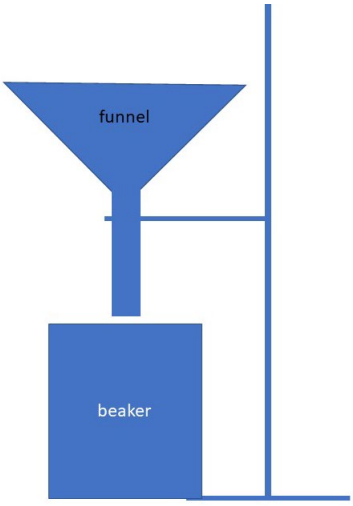


Figure 1. Equipment set-up

Hypothesis

Write your prediction for what will happen when water is added to each of the three soil types provided.

Flooding – Student Workbook

Method

1. Line the funnel with filter paper and position above an empty beaker using the clamp and stand.
2. Fill the funnel with one type of dry soil (to about two thirds).
3. Measure 100 mL of water into another beaker and pour this over the soil (remember to start your stopwatch as soon as you begin pouring and to pour slowly, ensuring that that the water does not overflow).
4. Observe your experiment for 1 minute. Swap the beaker below for an empty one and measure how much water you collected in the first beaker, recording your results in the table provided.
5. Dispose of the wet soil, filter paper and water as directed by your teacher.
6. Repeat steps 1-5 for each soil type, recording your results.
   Once you have completed your investigation with dry soils your teacher will add water to each of the soils sample tubs (to saturate them). Repeat steps 1-5 for each soil type again. Note the results into your table.

Results and Analysis

Create a table to record your results in.

Flooding – Student Workbook

1. Which soil held the most water when dry (had the smallest volume collected in the empty beaker below)?

_____

2. Which soil held the most water when wet (had the smallest volume collected in the empty beaker below)?

_____

3. Which soil is most likely to become waterlogged? Explain your answer.

_____

_____

4. Which soil is most likely to allow water to pass through into underground water stores? Explain your answer.

_____

_____

5. Did any of the soils you were working with take a long time to soak up the water added (you would have seen water sitting above the soil in the funnel)?

_____

6. Which soil type is most likely to contribute to flooding? Explain your answer.

_____

_____

Evaluation

1. Was this a fair test?

_____

2. What could you do to improve this test?

_____

_____

The Effect of Vegetation on Flooding

Background

Vegetation around a waterway may decrease the chances of flooding and reduce the negative consequences (like movement of soils).

Objective

To investigate what impact vegetation has on the likelihood and consequences of flooding.

Hypothesis

Write your prediction for what will happen to soil on a slope that is rained on compared to soil with plants in it, on a slope.

_____

_____

_____

Equipment

- 1 half drain pipe or similar
- 1 plastic tray
- 1 cup
- Potting soil
- Small established plant in soil
- Measuring beaker
- Duct tape
- A number of books (blocks or similar)

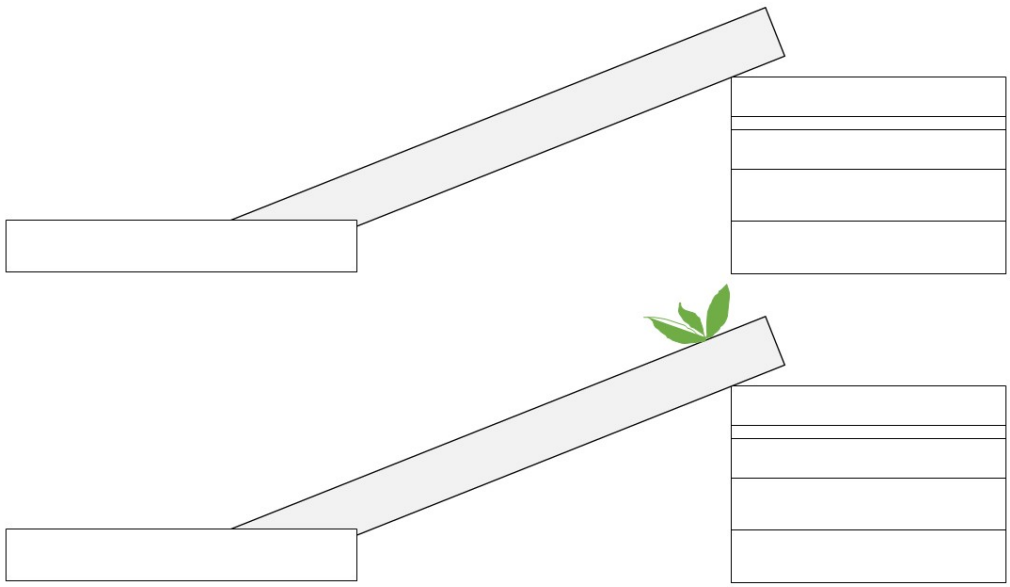


Figure 2. Top - drain pipe resting on books with just soil at the top. Bottom - drain pipe with plant at the top of it.

Method

1. Tape one end of the drain pipe into the centre of the plastic tray.
2. Raise the other end of the pipe up and place it on a stack of books, to produce a slope.
3. Put one cup of soil at the top of the drain pipe.
4. Collect 500ml of water in the measuring beaker.
5. Slowly pour the water on top of the soil and observe what happens, recording your observations.
6. Empty out the soil and wash up your equipment.
7. Repeat steps 1-5 this time with the plant in the soil at the top of the slope.

Results and Analysis

1. What happened to the soil without the plant in it?

_____

_____

2. What happened to the soil with the plant in it?

_____

_____

3. Explain what you think caused any differences in the trials.

_____

_____

4. Is a vegetated area or a non-vegetated area more likely to flood?

_____

_____

5. What would you recommend should be done for an area that is at risk of flooding?

_____

_____

Evaluation

1. Was this a fair test?

_____

2. What could you do to improve this test?

_____

_____

Extension

Green Infrastructure (GI) relies on designs which use natural systems to manage stormwater runoff. One method of GI is green roofs which are rooftops that are planted with native vegetation over a waterproof layer. Discuss how green roofs could help prevent flooding.

_____

_____

_____

_____

_____

_____

Permeable Pavement

Background

When there is heavy rain in built up areas flash flooding can occur, as the water runs off concrete surface. One method of reducing the amount of storm water run-off is by creating a permeable pavement. This allows the rain water to pass through it into the soil below. A normal pavement is made of sand, cement, aggregate and water. To make it permeable the mixture for the pavement must be changed, by removing one of the usual ingredients. A **permeable** pavement needs to be **porous** enough to allow water to pass through it but also strong enough to allow people to walk over it. The perfect mix should not be too wet or it won't drain well, or too chunky as then it will break easily.

What do the following terms mean?

a) Porous

_____

_____

b) Permeable

_____

_____

Objective

To investigate the best mix of materials to create a permeable pavement.

Equipment

- Plastic table cover
- 1 container of coarse aggregate e.g. limestone, pebble or granite
- 1 container of sand
- 1 container of Portland cement
- Water
- Measuring scoop (the one from washing powder is a good size)
- 3 plastic cups
- 3 stirring sticks
- 2 x measuring beakers

- Filter, retort stand, boss head and clamp
- 3 x filter paper
- Stopwatch
- Gloves
- Safety glasses

Method

1. Put the plastic table cover on your desk to protect it.
2. Put on your gloves and safety glasses.
3. Decide which ingredient you will eliminate from your first batch (aggregate/sand/ cement).
4. Beginning with small quantities of each material, mix them in a plastic cup making a note of how much of each material you have added in the table below. Slowly add water to make it stick together.
5. Create another two batches eliminating a different ingredient each time.

	Aggregate (number of scoops)	**Sand (number of scoops)**	**Cement (number of scoops)**	**Did the mix stick together?**
Mix 1				
Mix 2				
Mix 3				

6. Allow the mixes to dry overnight.
7. Make a hole in the bottom of each plastic cup and use a clamp and stand to hold them above a measuring beaker or jug.
8. Pour 100mL of water over the top, starting your timer immediately.
9. Stop the timer when all of the water passes through (or at two minutes if the water doesn't pass through).
10. Repeat steps 7-9 for mixes two and three to calculate the infiltration rate for each.

Flooding – Student Workbook

Results and Analysis

	Volume of water collected (ml)	Time to drain through (s)	Infiltration rate (ml/s)
Mix 1			
Mix 2			
Mix 3			

1. Which mixture had the highest infiltration rate (allowed the water to pass through the fastest)?

   _____

2. Which mix was the least permeable (allowed the least water to pass through)?

   _____

3. Which mix would be best to use in pavements to prevent flash flooding? Explain your answer.

   _____

   _____

Evaluation

1. Was this a fair test?

   _____

2. What could you do to improve this test?

   _____

   _____

Modelling Rivers

Objective

To investigate areas of likely flooding through modelling river features.

Equipment

- 1 large plastic tub
- 1 disposable aluminium baking tray with one of the short edges cut off
- Modelling clay/playdough
- Measuring jug or beaker
- Wooden block/book
- Scissors
- Spoon/modelling tool

Method

1. Mark on figures 3 and 4 where you think flooding will occur.
2. Fill the aluminium tray with modelling clay/playdough.
3. Create your first river model by scooping out the clay. Make one section of the river much narrower than the rest of the river.

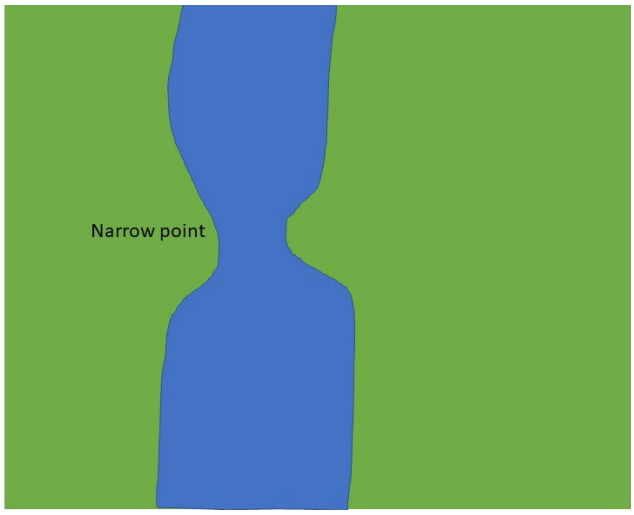


Figure 3. Carved out river with a narrow section

4. Place the river model into the plastic tray and raise one end using the wooden block so the cut off end of the aluminium tray is at the bottom end of the river.
5. Using the measuring jug, pour water down the river and note where the water goes over the banks.
6. Remould your river so that you now have a large meander.

Figure 4. Model river with a meander

7. Repeat steps 3 and 4.
8. Remould your river again so that you now have a straight river, but with one section that is much shallower than the rest.
9. Repeat steps 3 and 4.

Results and Analysis

Draw diagrams to show where the flooding occurred in each scenario.

River with narrow section

River with meander

River with shallow section

Flooding – Student Workbook

Discussion

Why do you think that flooding happens in particular areas?

What could be done to the river to try and prevent flooding from happening in these areas?

Levees Investigation

Objective

Design, test and evaluate model levees and compare their effectiveness.

Research

1. What is a levee? (we suggested drawing a diagram)

_____

_____

2. What is the purpose of a levee?

_____

_____

3. How does a natural levee form?

_____

_____

_____

Equipment

- Sandwich bag
- Popsicle sticks
- Gravel
- Sand
- Cardboard
- Duct tape
- Plastic container
- Cup/beaker
- Sand

Method

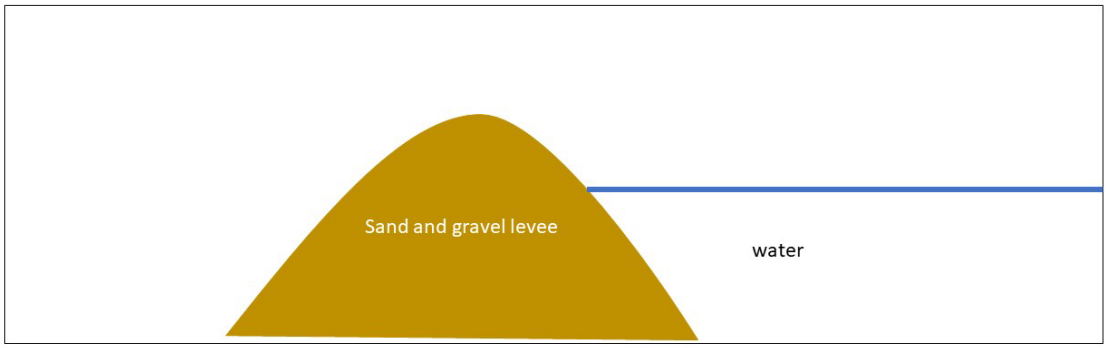


Figure 5. First build a levee with sand and gravel and test how well it holds back water.

1. Using only sand and gravel construct a levee in the middle of the plastic container, separating the container in two.
2. Pour water into one side of the plastic container and observe how well your levee prevents water from passing through to the other side.
3. Clear out the sand and gravel.
4. Now use the remaining equipment to create a levee in the plastic container, so that this divides the container in two and take a photo of your levee.
5. Test how well it holds up when water is poured into one side of the container.
6. Evaluate your levee, make improvements and then test it again (don't forget to take a photo).

Results and Analysis

1. Stick in photos of your levee designs and label them. Use your photos to discuss the pros and cons of each design.

	Pros	Cons
Sand and gravel		
Design 2		
Design 3		

2. Which design was most effective at containing the water?

_____

_____

3. Could this design be used on a much bigger scale?

_____

_____

4. Are levees effective at containing water?

_____

_____

Discussion

In some places in the world they can't afford to pay for man made levees, what might be the problem with only using sand and gravel as a levee?

_____

_____

Flooding – Student Workbook

Designing Defences

Objective

To research different flood management techniques and design flood defences for a local river.

Method

1. Using the map below, or a map of another river local to you, highlight areas you think flooding is most likely to occur and **explain why**.

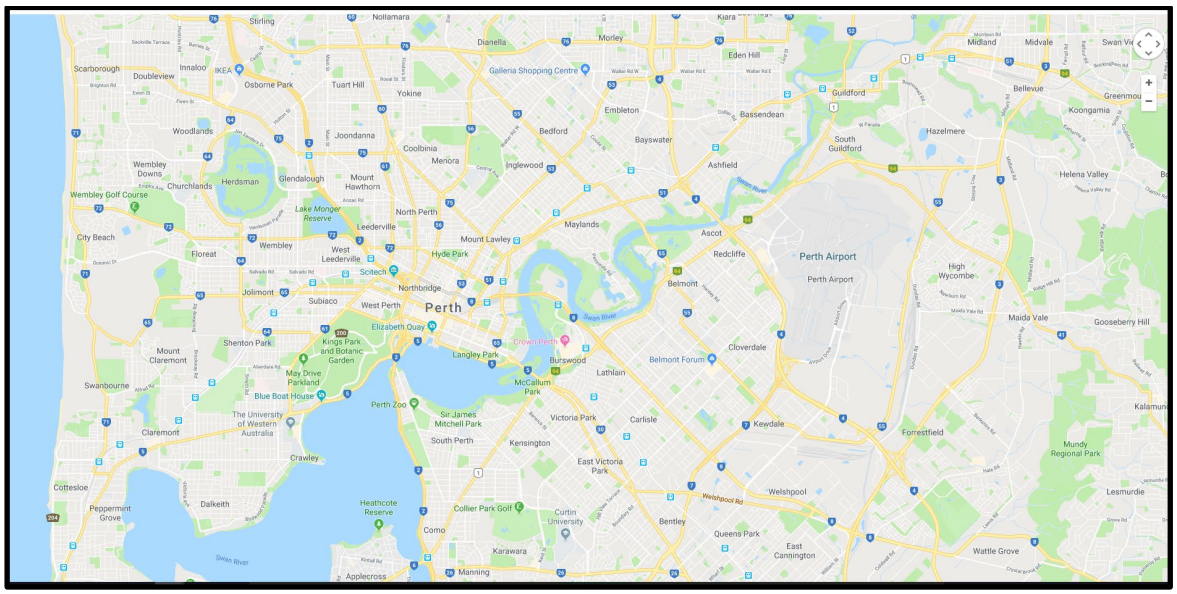


Figure 6. Map of the Swan river through Perth.

Explanation

_____

_____

2. Research different types of flood prevention.

Method of flood prevention	How it works
Revegetation	
Levees/ embankments	
Dams	
River deepening/ straightening	
Other	

3. Mark numbers on your map where you think different flood prevention techniques should be used.
4. Explain why you have chosen each river management technique and how you think it would prevent flooding.

Discussion

What other information would you like to find out about the area? Explain why would it help you decide which flood prevention techniques to put in place.