# Investigating flow rates (Years 7 and 8)

Micro-organisms at work—at the sewage treatment plant

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| Victorian Curriculum F–10[[1]](#footnote-1) links:  **Levels 7 and 8**  **Science**  **Science Understanding**  **Science as a Human Endeavour**  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 |

Melbourne Water’s sewerage system is big—really big! They remove and treat most of Melbourne’s sewage via a network of over 400 kilometres of sewers, nine pumping stations and two treatment plants.

Students gain an understanding of how gravity and pumping is used to carry sewage through pipes to the Eastern or Western Treatment Plants. They investigate flow rates by posing scientific questions and designing their own scientific investigations to answer them.

### Duration

One double-period session

### Equipment

For each group:

One copy of **Student worksheet: Investigating flow rates**

plastic tubing of different diameters: 5 mm, 8 mm and 12 mm;

1L and 2L soft drink plastic bottles

one bucket

graduated measuring jug

measuring device such as a stop watch

a low-melt glue gun to seal joins of tubing to plastic bottle

### Preparation

Teacher requires access to a cordless drill or similar to make a hole in the plastic bottle to fit the tubing. Ensure that all safety requirements are followed.

### Activity steps

1. Explain that the sewerage system uses a combination of gravity and pumping to deliver sewage to the treatment plant. Gravity is the main force used to move the sewage in the sewer pipes but at different points along the pipes pumping stations may be needed to raise the sewage to a level where gravity can again take over.
2. In one sewerage system the sewage is raised 16.5 m from its lowest point at one pumping station; it flows downhill and is then raised 27.5 m at the next pumping station Enable students to get a sense of the height by comparing them to the heights of structures or trees in the school grounds. Using a fish tank pump and plastic tubing, demonstrate a pump in operation and relate this to the way that a sewerage system moves water uphill from a lower container to a higher container. Measure in seconds the time it raise 1 L of water by one metre. Calculate the flow rate in litres/second.
3. Discuss how the water flows once it has been raised to its highest point.
4. Pose the question: What factors affect how fast water flows through pipes?
5. Introduce an investigation of flow rates when moving water from a storage container to another container through tubing. Use a variables grid (Table 5) to brainstorm the aspects of the investigation that can change.

Table 5 Variables grid for flow rate investigation

|  |  |  |
| --- | --- | --- |
| shape of storage container holding the water | quantity of water in the storage container | diameter of the tube |
| length of the tube | position of the tube on the storage container | inclination of the tube |
| flow rate |  |  |

1. Identify the variable to be measured (flow rate in litres/second).
2. Explain that to ensure a fair test they should change one variable and keep all others the same. Use an example of changing the diameter of the tube, keeping all other variables the same and measuring any change in flow rate litres/second.
3. Encourage students to come up with their own questions to investigate such as:

* Does the inclination of the tube affect flow rate?
* Does the diameter of the tube affect flow rate?
* Does the quantity of water affect the flow rate?
* Does the shape of the container affect flow rate?

1. Guide students to turn their question into a hypothesis by making it an ‘If, then’ statement. As an example, if a question is ‘Does the diameter of the tube affect flow rate’, then the hypothesis would look something like: ‘If the diameter of the tube affects flow rate, then the flow rate should be faster for a tube with a larger diameter than that of a smaller diameter’.
2. Provide students with Student worksheet: flow rate to design their investigation and record their results.
3. Provide assistance to make holes in the plastic bottles to fit the plastic tubing.
4. Supervise the use of the low-melt glue gun to seal the joins to prevent leakage.
5. Discuss each group’s investigation and results. Develop generalisations from the evidence gathered, for example, pipes of a larger diameter enable sewage to flow faster than pipes of a smaller diameter under the same pressure. Students could develop questions about flow rate and the diameter of pipes used around the treatment plant.

### Extension activities

Students research Bernoulli’s Principle, the Venturi effect and the effect of pipe dimensions on flow rates.

Research the location of the treatment plant. Use topographic maps or Google Earth to compare the elevation with that of central Melbourne. Pose the question: Why do you think the elevation of the sewage treatment plant was a consideration when the site was chosen?

### Teacher background

In a container of water, all the water pushes downwards causing pressure on the water at the bottom. A greater quantity of water will cause a greater quantity of pressure pushing downwards; less water will result in less pressure.

### Western Treatment Plant

A system of pipes, sewers and drains built underground carry sewage from homes and factories to the sewage treatment plant. At the Western Treatment Plant a combination of gravity and pumping is used to move the sewage to the treatment plant. For most of the way it flows downwards but two pumping stations are used to pump the sewage upwards. The Brooklyn pumping station, which can pump 17,600 L of sewage a second, raises the sewage 16.5 m to the head of the trunk sewer, from where it runs downwards towards Hoppers Crossing. Another pumping station pumps the sewage 27.5 m upwards and from there it runs down to Werribee.

**Eastern Treatment Plant**

A system of pipes, sewers and drains built underground carry sewage from homes and factories to the sewage treatment plant. The Eastern Treatment Plant has many small pumping stations that move sewage along and transfer it between systems within the plant. The pumps raise the sewage 17 metres from below ground to the highest point at the treatment plant.

Generally the Eastern Treatment Plant is lower in elevation than the locations which are the source of the sewage, however some suburbs near the Eastern Treatment Plant are at the same or a slightly lower elevation.

## Student worksheet: Investigating flow rates

### Introduction

A system of pipes, sewers and drains built underground carries sewage from homes and factories to the sewage treatment plant. A combination of gravity and pumping is used to move the sewage to the treatment plant. For most of the way it flows downhill through these pipes.

Consider the questions: What factors affect how fast water flows through the pipes?

Does the inclination of a pipe affect the flow? What about the diameter of the pipe, does that make a difference?

Use a plastic soft drink bottle and plastic tubing as a starting point to design your own investigation.

Ensure you design a fair test by only changing one variable.

### Materials and equipment

plastic tubing of different diameters: 5 mm, 8 mm and 12 mm

1 L and 2 L plastic soft drink bottles, and a bucket

graduated measuring jug

timing device such as a stopwatch

a low-melt glue gun to seal joins of tubing to plastic bottle.

### Hypothesis

My question to investigate:

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Turn this into a hypothesis:

If \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### Controls

List the variables that may change in your investigation in the grid below:

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| --- | --- | --- |
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|  |  |  |
|  |  |  |

Variable being measured is

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Variable being changed is

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Variables kept the same are

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### Procedure

Draw a labelled diagram of your investigation.

### Observation and results

Create a table for your results.

### Conclusion

Explain your findings based on your evidence.

1. Creative Commons Licence Victorian Curriculum and Assessment Authority (VCAA) <<http://victoriancurriculum.vcaa.vic.edu.au/>> Accessed 14 August 2016. [↑](#footnote-ref-1)