



**Scottish
Water**

Always serving Scotland

Pipe networks

Third and fourth level

Description of module

The provision of clean water and the disposal of waste are looked at here, along with the pipe networks that support the processes. Environmental, social and economic impacts are key themes and are explored through a variety of activities.

Main experiences and outcomes

Literacy and English

I can independently select ideas and relevant information for different purposes, organise essential information or ideas and any supporting detail in a logical order, and use suitable vocabulary to communicate effectively with my audience.

LIT 3-06a / LIT 4-06a

When I engage with others I can make a relevant contribution, ensure that everyone has an opportunity to contribute and encourage them to take account of others' points of view or alternative solutions.

I can respond in ways appropriate to my role, exploring and expanding on contributions to effect on, clarify or adapt thinking.

LIT 4-02a

As I listen or watch, I can:

- clearly state the purpose and main concerns of a text and make inferences from key statements
- compare and contrast different types of text gather, link and use information from different sources and use this for different purposes.

LIT 4-04a

When listening and talking with others for different purposes, I can:

- communicate detailed information, ideas or opinions
- explain processes, concepts or ideas with some relevant supporting detail
- sum up ideas, issues, findings or conclusions.

LIT 4-09a

Social studies

I can discuss the sustainability of key natural resources and analyse the possible implications for human activity.

SOC 4-08a

I can develop my understanding of the interaction between humans and the environment by describing and assessing the impact of human activity on an area.

SOC 4-10a

I can explain the development of the main features of an urban area in Scotland or elsewhere and can evaluate the implications for the society concerned.

SOC 4-10b

Having studied an economic activity, I can explain its development and assess the impact of change within its locality and beyond.

SOC 4-10c

I can identify internal and external factors influencing planning and decision making and can assess how these decisions contribute to the success or failure of businesses.

SOC 4-22b

Technologies

I can examine a range of materials, processes or designs in my local community to consider and discuss their environmental, social and economic impact, discussing the possible lifetime cost to the environment in Scotland or beyond.

TCH 4-02a

I can use ICT effectively in different learning contexts across the curriculum to access, select and present relevant information in a range of tasks.

TCH 4-03b



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Activity 1

Learning intention

- Depending on previous knowledge, pupils either revise what they already know about pipe networks, or gain an introductory overview of the subject

Success criterion

- Pupils are able to contribute to the quiz activity

Suggestions for teachers

This activity is optional: if pupils have already completed some of Scottish Water's education modules, they may already know enough to carry on to the next activity after this.

1 Using resource sheets

Divide pupils into groups of four and give out resource sheets 1 – 4 to each group so that each pupil has a different one. (If groups of 3 are needed, one pupil could have resource sheet 1 & 2, as these are rather easier). Give 5 minutes for pupils to read them, allowing them to highlight key words and phrases.

2 Quiz

Hand out the quiz sheet to each pupil (resource sheet 5). It is structured so that every pupil should be able to contribute three answers. One member of each group could act as quizzer, and the pupils work through the questions together in their groups; answers may be oral or written according to the preference of the teacher. The quizzer could take in the resource sheets before the questions are asked, and give them out again at the end so that pupils can amend their answers as necessary.

3 Working together

When the above has finished, pupils could work together to make up another question to ask the rest of the class later. It can be as hard as they like, but the information must be in the text they have read.

4 Taking turns

As a plenary, the class could work together, with the teacher asking the questions from the quiz, and then each group could ask its own question in turn.





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Activity 2

Learning intentions

- To enable pupils to have a better understanding of the environmental impact assessment process
- To help pupils understand the environmental, economic and social factors that need to be balanced

Success criterion

- Pupils are able to justify their choices in terms of environmental, economic and social impacts

Suggestions for teachers

1 Background knowledge

Pupils need some background knowledge; resource sheet 6 is a simple summary on building a pipe network. This is probably best discussed as a class. A useful group activity following that could be to ask pupils to list ideas on the impacts of setting up a new pipe network, done under the three headings: Environmental, Economic and Social.

2 Paper exercise

Resource sheets 7 and 8 could be displayed or given out to pupils; it presents a challenge for groups to design a pipe network and present their choices to the rest of the class, who will be in the role of the (possibly sceptical) island community. If teachers wish to increase the role-playing element, resource sheet 9 has a list of questions that members of the island community could ask at the simulated consultation meeting.

3 Pipe network game

Divide into small groups and give each a copy of the map (resource sheet 7) - the larger the better - and the Island Pipe Network Challenge (resource sheet 8). Discuss the task as described on resource sheet 8. Spend some time discussing the map with the pupils: where the woods, houses, loch, roads and sea are located.

4 Preparation

The groups prepare their plan by drawing the pipe network on the map (suggest groups draw on in pencil first, then black felt for clean water and orange for waste water), as well as the water treatment works and waste water treatment works.





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Activity 2 continued

5 Explanatory notes

Pupils write short explanatory notes on the map, such as; “pipe goes round the road so we don’t have to dig it up.”

6 Presentation preparation

The groups prepare a presentation for the rest of the class and must be able to justify their plan. If you like, one pupil could prepare each of the bullet points (design, route, impact and actions) to make sure everyone is involved.

7 Presentation and class assessment

Pupils give the presentation to the rest of the class.

Pupils peer assess by going round the maps in groups, each group having 5 minutes in front of each map before writing ‘two stars and a wish’ on Post It notes, and then moving on to the next. These comments are meant to be helpful, so that the pupils can make changes to the plan, to improve it later – a vital piece of formative assessment thinking.

Pupils look at all of the Post It assessments stuck on their map and agree amongst themselves how they might improve the plans. They then stick up their final plans for display.

8 Assessment

The designs produced could form part of the assessment. Another could be if the pupils added to their lists under the headings of Environmental, Economic and Social to show the increase in their awareness of the issues.

9 Extension

As an extension, or alternative to the hypothetical island in the exercises above, an area including the pupils' school could be chosen, and the same design brief given: to place a clean water works, a waste water treatment works and pipe systems for the clean and waste water. This alternative would increase pupils' engagement by making it more relevant.





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Activity 3

Learning intention

- To enable pupils to have a better understanding of the water treatment processes

Success criterion

- Pupils can produce annotated diagrams of each stage of the process

Suggestions for teachers

1 Summary

Resource sheet 10 can be used to talk through the processes involved in purifying water and making it safe for drinking.

More information can be found on the Scottish Water website:
www.scottishwater.co.uk/education

If teachers provide pupils with a copy of resource sheet 10 and work through the water treatment process, pupils will be well prepared for the next learning activities.

2 Detailed description

A more visual, and detailed description is given at:
www.youtube.com/watch?v=9z14I51ISwg

Because it is quite detailed, it is recommended that pupils are given plenty of time to assimilate it by seeing it more than once. Resource sheet 11 is a pro forma recording sheet on which pupils can make brief notes. The video clip - about three and a half minutes long - could be shown once, and pupils asked to make sketches of the process, pausing the video in order to do this. On the next showing, pupils could make brief notes to accompany the sketches.

3 Class or homework

A neat copy of these notes could be produced, either in class or as homework. A flow diagram or a story would be effective ways of displaying the information.

4 More depth

If more depth is required, the pupils could be divided into five groups:

- Raw water
- Screening
- Clarification
- Filtration
- Disinfection
- pH correction

and asked to research each of the processes, presenting the information to the rest of the class on a whiteboard or flipchart.



Pipe networks

Resource sheet 1

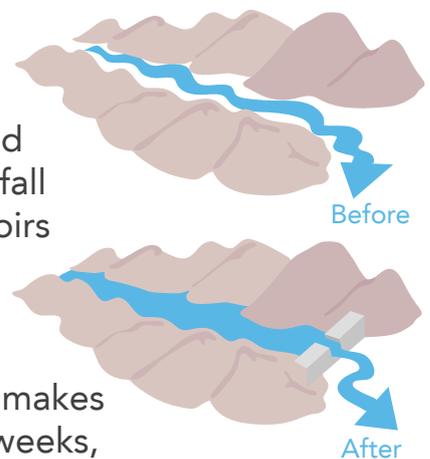
How is water collected for us to use?

1 It is easy to turn on the tap to get clean water, but a lot of things have to happen to allow us to do that.

First of all, water has to be taken away from its natural cycle.

Most of the water used today is collected and stored in man-made or natural lochs called reservoirs. Rainfall is highest in hilly areas, so this is where most reservoirs are.

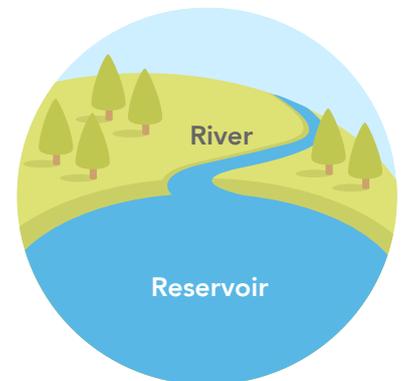
Reservoirs are made by building a dam across the upper part of the river. The water then collects and makes a huge loch. So, even if it does not rain for several weeks, there will still be water available.



2 The dam has to be made of very strong, thick concrete to hold back the huge amount of water behind it. The amount of water flowing through the dam is controlled by opening and closing valves.

The Scottish Environment Protection Agency (SEPA) set minimum compensation flow rates from the dam to protect the environment such as fish, wildlife and plants downstream.

The water in the reservoir needs to be cleaned before it is ready for us to drink. The river has carried lots of bits of grit and dirt down with the water. Some of this grit and dirt will sink to the bottom of the reservoir as silt. This happens because the water in the reservoir is deep and still. The rest is removed at the water treatment works which makes the water clean and safe to drink.





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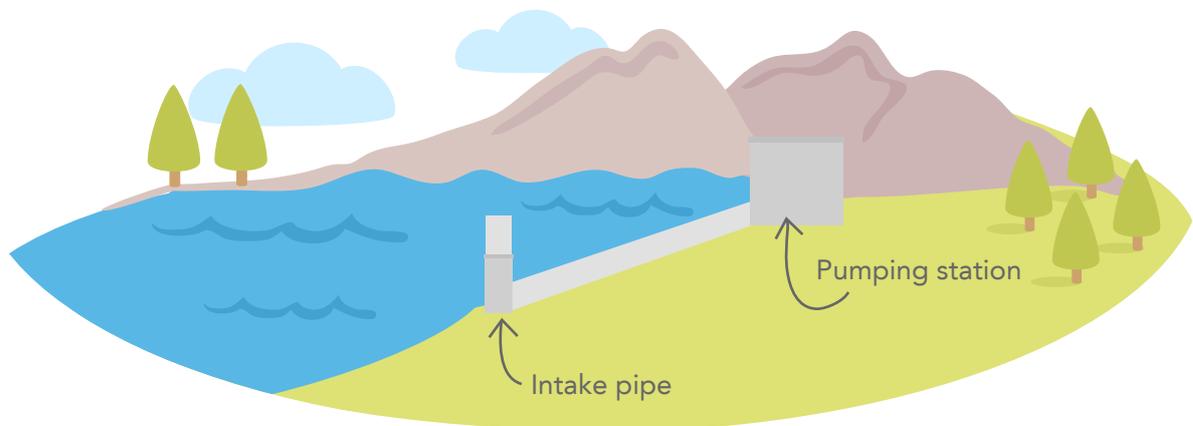
Pipe networks

Resource sheet 2

How is water collected for us to use?

1

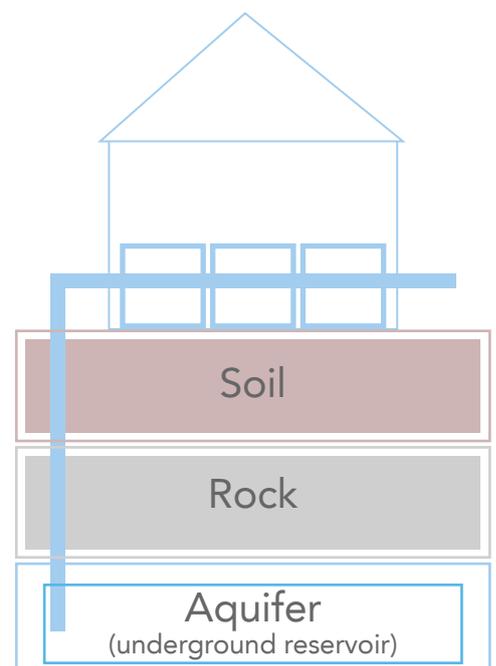
Sometimes we take water from natural lochs like Loch Lomond.



Sometimes a reservoir forms naturally underground. Rainwater soaks into the ground and through the rock below. It happens where there are rocks like chalk and limestone. They soak up a lot of water. They are a bit like underground sponges. The water then collects in a space between layers of rock. We call this an aquifer.

2

We collect water from the aquifer by drilling boreholes in the rock. The water is then pumped out. Wherever we get it from, all water must go to the water treatment works to be made safe and clean before it is piped to our taps. When clean water leaves the water treatment works it travels through large pipes called water mains which are buried underground. There is a water main under the road near your house and the water in your tap comes through a water supply pipe from that water main.





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Resource sheet 3

The water pipe network

- 1 Water is delivered to homes through the **water mains** network by pressure.
- 2 Scottish Water get this pressure either by using gravity or pumping the water through the network. Scottish Water normally put their large storage tanks at high level so the water can flow downhill. This saves energy and keeps the cost of delivering the water through the network of pipes to the taps in your home down.
- 3 Drinking water enters your home through a pipe called the **water supply pipe**. This pipe is controlled with a **stop cock** and **water meter** (if you have one) which is found at the end of the **communication pipe**.
- 4 The **water main** is laid below ground to make sure that it is not damaged by frost.
- 5 The **communication pipe** takes the water from the **main pipe** to your home.
- 6 Where the **water supply pipe** enters your home, usually in the kitchen, it is fitted with a **stop valve** which controls the water coming in from the **water main**.

The diagram below shows which of the pipes around a home Scottish Water and the homeowner are responsible for.



Water and waste pipes	Responsibility
① — The water supply pipe	Homeowner
② × Stop valve	Homeowner
③ — Private drain	Homeowner
④ ● Stopcock/meter	Scottish Water
⑤ — The communication pipe	Scottish Water
⑥ — The water main	Scottish Water
⑦ — Sewer	Scottish Water

Pipe networks

Resource sheet 4

The waste water pipe network

Waste water is anything which flows through a sewer including bath water, industrial waste and toilet waste. Rain water from the roads, roofs and gardens is known as surface water.

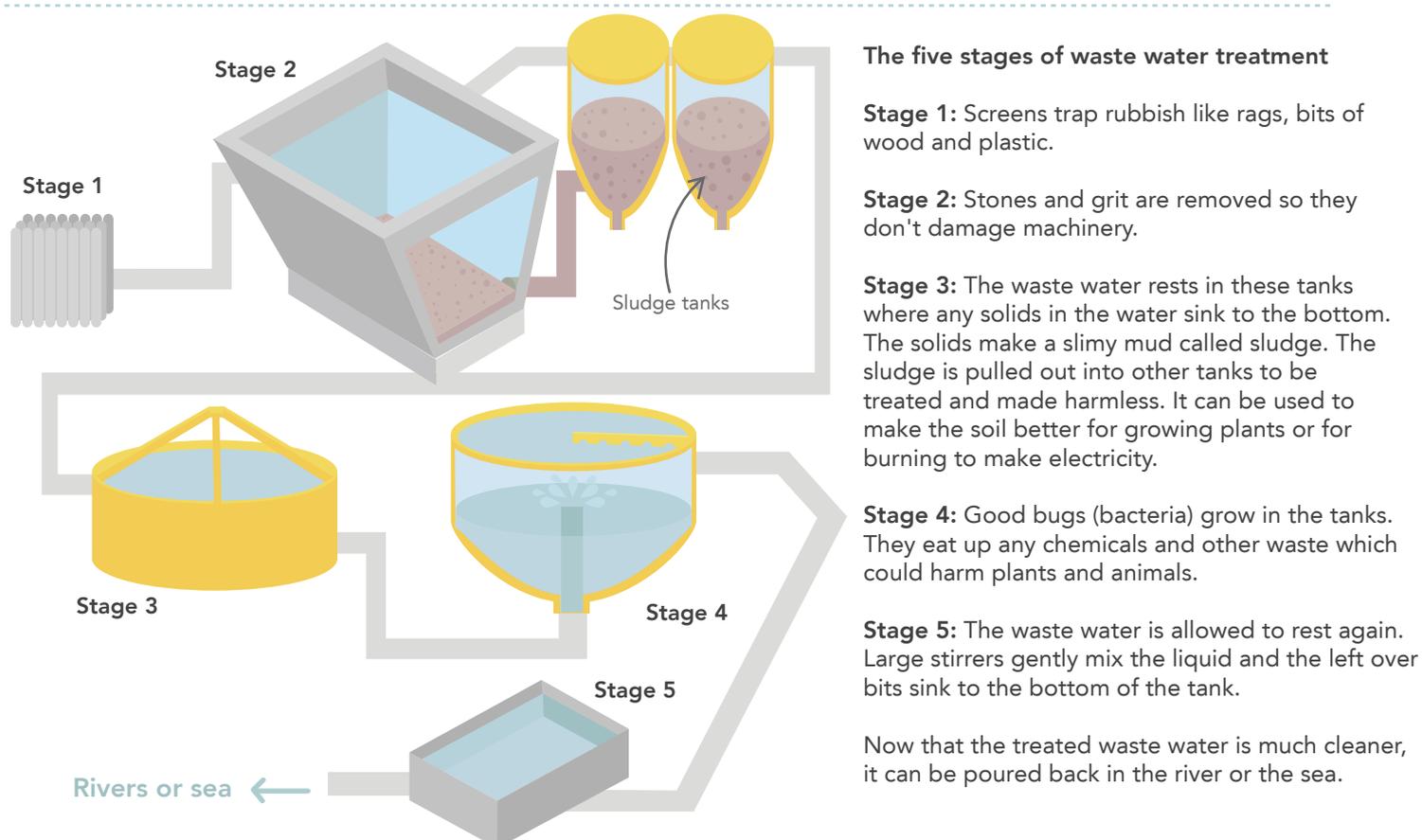
The more clean water we use, the more dirty water we produce.

So that the natural environment can be protected and to control the possible spread of waterborne diseases, waste water is treated by Scottish Water before it is returned to the environment.

From your home, the dirty water flushed down the toilet, wash hand basin and kitchen sink all goes into the private drain.

This private drain carries the water through to the public sewer which takes it to the waste water treatment works.

Underneath every road and street there is a network of sewers, pipes and pumps that carry waste water to where it can be treated and returned to the environment. Sewers vary in diameter.





Pipe networks

Resource sheet 5

Pipe networks quiz

- 1 Which areas have the highest rainfall in Britain?
- 2 What are the natural or man-made lochs called, that collect and store our water?
- 3 What is silt?
- 4 Some kinds of rock can soak up a lot of water. Name two of them.
- 5 What is an aquifer?
- 6 What does a water treatment works do?
- 7 Why are large storage tanks at a high level?
- 8 Why is the communication pipe buried underground?
- 9 Pipes coming into a house usually divide into two. One goes to the kitchen sink. Where does the other one go?
- 10 What is waste water made up of?
- 11 What diameter are sewers?
- 12 Why does Scottish Water treat waste water before it is returned to the environment?



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Resource sheet 6

Building a pipe network

Before providing a new pipe network to extend the water supply an environmental impact assessment will take place. For example, cutting down woodland to lay pipes can destroy the land's natural defence against flooding and digging up environmentally important areas like marshes can destroy the homes of birds and animals.



The environmental impact assessment is very important and must be carried out before permission will be given to build the pipe network.

- Step 1** Scottish Water will think very carefully about the route of any pipe network and try to choose the best route that will cause least harm to the environment.
- Step 2** The proposed route will be mapped out and the impact on the environment described.
- Step 3** Discussions take place with a number of public bodies for example, Scottish Natural Heritage (SNH) and the Scottish Environment Protection Agency (SEPA). Local communities affected by the development are also part of the discussions.
- Step 4** All the information collected is put into a document called an Environmental Statement which becomes part of the planning application. This Environmental Statement includes details of any steps that will be taken to reduce the impact of the building of the pipe network on the environment. Sometimes it is impossible to prevent environmental damage but it may be possible to reduce it or create alternative habitats for wildlife and birds.
- Step 5** The design of the pipe network is discussed by the Local Authority who have the final decision whether to allow it to be built on the proposed site.



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Resource sheet 7

Island map



Key



Houses



Loch



Roads



Pipes



Sea



Woods



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Resource sheet 8

The pipe networks challenge

An environmental impact assessment

The villagers on the island need a steady supply of fresh water from a clean water pipe network to use for example for drinking, cooking, washing-up and washing clothes. They also need a good waste water pipe network to carry waste water from their homes, schools and workplaces to the waste water treatment works where the waste water can be treated to make it safe before it is released back into a river or the sea.

Before the pipe networks can be built, an environmental impact assessment will have to be carried out.

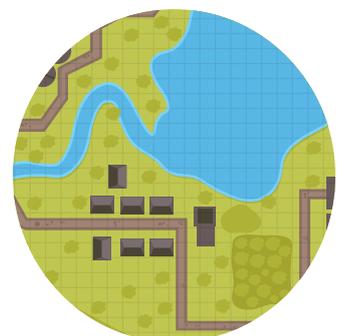
- 1 Look at the map of the island and decide the following:
 - The location of the water treatment works.
 - The location of the waste water treatment works.
 - The route that the water pipe network and the waste water pipe network will take.

- 2 Carry out and produce an Environmental Impact Assessment of your plan.

This should include:

- The proposed design of the pipe networks.
- Why you have selected that route.
- The impact that your chosen route will have on the environment.
- Any actions that you are prepared to take to reduce the impact on the environment.

- 3 You will be asked to present your ideas and assessment to the class who will be in the role of the island community. You will have 10 minutes to present your plan. Following this presentation and discussion you may make any amendments before it is given to a panel of pupils who will be acting as the Local Authority. They will have the final decision as to whether you can build the pipe networks as you have planned.



Good luck!



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Resource sheet 9

Local residents' questions



I run a fish factory, so I use lots of water. I'm really in favour of a better water supply.



What about the tourists? They'll be put off by all these great big diggers all over the place!



The pipes will be going right through my fields. I want compensation for that!



I run a bed and breakfast house. I hope some of the workers come and stay at my place whilst they're here.



I'm worried in case the water and waste water treatment works look really ugly and spoil our beautiful countryside.



I'm a mum with three small children. I'm worried in case they wander off and fall into these deep holes, or get knocked over by the construction vehicles.



Will any permanent jobs be created at the water and waste water treatment works?



I'm a farmer, so I'd be very pleased if the waste water treatment works could produce some cheap fertilizer for my crops. Is that possible?



We've had droughts here recently. Will the new works mean that we are less likely to have a hosepipe ban in future?



Will your new pipes have to go under a road? If so, how will you keep disruption to a minimum? I'm concerned in case my customers can't get to my shop every day.



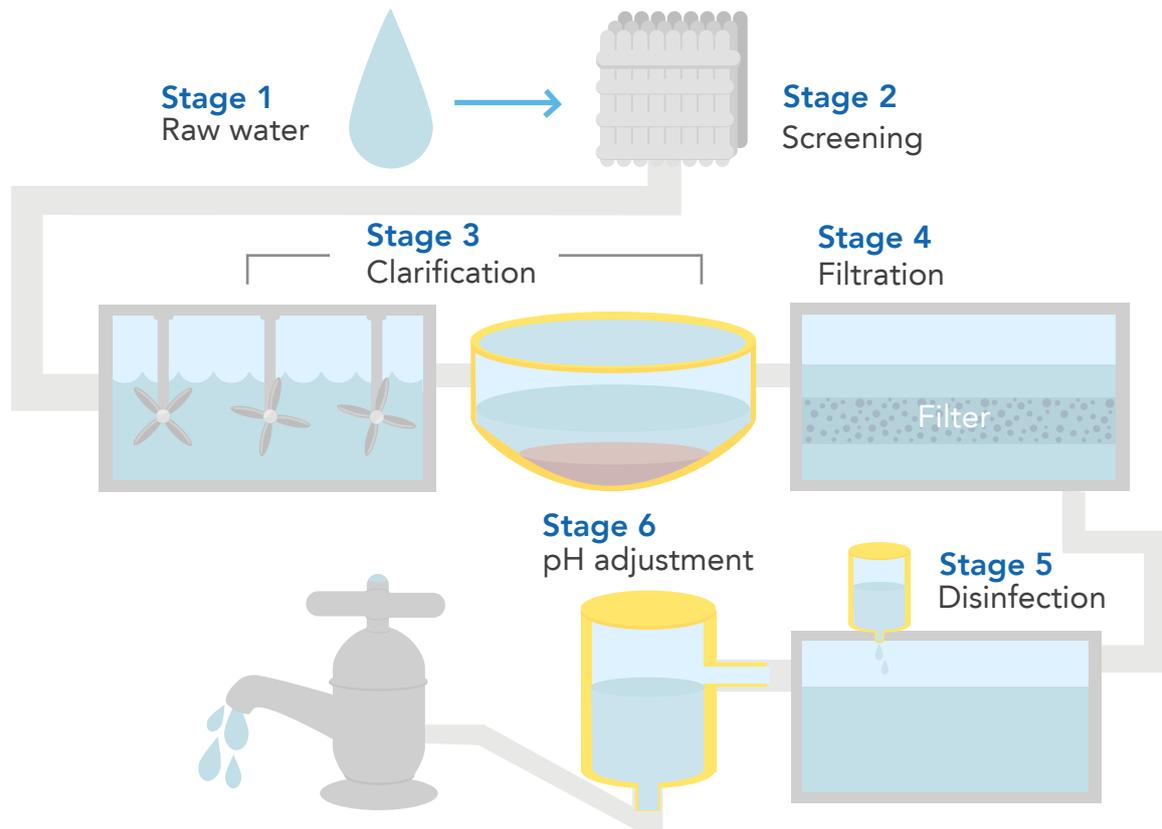
I work at the local hospital. Can you guarantee that the new water supply will be absolutely fresh and clean?



Pipe networks

Resource sheet 10

Typical example of the water treatment process



Stage 1: Surface water is stored in reservoirs to provide a continuous supply to meet demand throughout the year.

Stage 2: Water is passed through mesh screens to remove debris, such as leaves, weeds and sticks.

Stage 3: Impurities in the water are removed.

Clarification includes:

- coagulation and flocculation
- sedimentation

Stage 4: Any impurities still left from the clarification stage are removed through filtration.

Stage 5: Disinfection is vital to ensure that water-borne diseases are eliminated, and that the drinking water that we supply to you meets the water supply regulations.

Stage 6: pH is a scientific term used to describe the acidity or alkalinity of a substance. We need to control the pH level of drinking water. If water is too acidic it may corrode metal pipes, and if it is too alkaline it may cause deposits to form inside the pipes.

The water is now safe to drink and use in our homes, schools and businesses.



Pipe networks

Resource sheet 11

Water treatment process

Screening

Clarification

Filtration

Disinfection

pH Correction