Unit 25: Water Quality

Delivery guidance

Water is essential for all life on the planet, whether plant, animal or human. Learners will be aware that access to water depends on the hydrological (water) cycle, in which water is constantly coming into contact with the air and the earth. As a consequence, the water we use in our everyday life is never pure: biological, chemical and physical materials are dissolved in it and/or carried by the flow. Issues with water quality can cause serious problems, so it is essential to monitor and control this quality. Conservation officers, environmental research technicians, environmental protection officers and others will apply many of the principles covered in this unit as part of their everyday role.

Learners will study what is in our rivers, seas and drinking water, and how it has come to be there, either through the natural hydrological cycle or as a consequence of human activity. They will learn about the water footprint as a marker to gauge the water requirement for different activities and processes. They will consider the influences of factors such as pollution, eutrophication, acidification etc. on water quality and the aquatic habitat. They will have opportunities to participate in practical activities, involving water analysis in the field and in industry, recording results, interpreting data and suggesting improvements to an area of water. Learners will explore the measures that can be taken to reduce the impact of human activity on water quality and make efficient use of water through effective conservation and control.

Use online and other resources to investigate policies and strategies in different areas which seek to conserve and control water usage and improve water quality. Make use of any contacts who are involved in areas such as environmental science, water analysis, water purification and waste water control. Where possible, give learners the opportunity to visit appropriate establishments (for example, those involved in water conservation and control, water analysis, water treatment and waste water management).

Approaching the unit

From other units, learners may have some appreciation of the importance of water to all living things on the planet, and the impact of shortages of water and/or water of poor quality. In *Unit 2*, they will have learned that the properties of water are very unusual for a molecule of its size. In this unit, learners will further explore the structure and bonding of water and the reasons for its anomalous behaviour. They will also investigate the distribution of water around our planet by the hydrological cycle (better known as the water cycle) and consider the effects of different factors on different processes within the cycle. They should understand how biological, chemical and physical factors influence water quality and aquatic species and realise that water can contain chemical substances, physical matter and biological material such as microorganisms. Learners will understand the need to monitor water quality to ensure effective water conservation and consumption control.

Learning aim A is primarily concerned with three main areas: the structure, properties and uses of water; the hydrological cycle; and the water footprint. Learners will revisit some ideas from *Unit 2* in relation to bonding in the water molecule, its structure and its ability to form hydrogen bonds. They will understand that the latter property gives rise to many of the anomalous properties of water, such as its high boiling point, high specific heat capacity and ability to dissolve numerous substances. Learners will further explore how these properties lead to a wide range of uses and applications.

Learners will look at the water cycle, the processes involved and how these processes vary according to different climatic conditions and terrain. They will then consider the impact on the water cycle of human activity, such as the burning of fossil fuels and deforestation. Learners will also explore the concept of the water footprint and assess its effectiveness as a measure of the use of water in a range of activities and processes.

Learning aim B looks at the factors – physical, chemical and biological – which can influence water quality and affect aquatic species. From other units and learning aim A, learners will understand that water can contain soluble substances, particulate matter and biological material such as microorganisms. From their knowledge of the water cycle, they will realise that this is due to various factors such as soil composition, plant/animal life and human activity. There are opportunities for practical activities involving water quality analysis, using a variety of biological, chemical and physical tests. These activities could form part of the learner's investigation into the composition of naturally-occurring substances and what constitutes good water quality, in terms of potability and acceptability for marine and freshwater habitats. This can extend to investigation of potential pollutants and the impact of biological organisms, organic and inorganic chemicals and physical effects on water supplies and on aquatic and marine environments. Learners will understand the effects of acidity caused by increased levels of carbonic acid (e.g. on coral reefs) and the impact of eutrophication (due to intensive farming methods) on different ecosystems.

Learning aim C is concerned with monitoring and reporting on water quality. There is a focus on practical activity, as learners must carry out sampling and testing in the field, over a period of time, as well as laboratory analysis of samples. They should be able to explain the principles behind and significance of biological tests (e.g. for populations of species), chemical tests (e.g. dissolved oxygen and pH) and physical tests (e.g. temperature and turbidity). They should also demonstrate the use of quantitative wet techniques (e.g. titration) and instrumentation techniques (e.g. spectroscopy or gas chromatography) to investigate water quality. A visit to an industrial or university laboratory may be beneficial. Learners must comply fully with health and safety requirements for sampling, testing and laboratory analysis. They must report their findings in a scientific format including: title, abstract, introduction, method, results, accuracy, discussion, conclusions, evaluation, references and bibliography.

Learning aim D focuses on methods of water treatment and strategies to control and conserve. Learners will understand from the previous learning aims (and perhaps from other units) that water can contain biological, chemical and physical matter. To render it potable and safe for human consumption and use, water must go through treatment processes such as screening, filtration, pH correction and sanitisation. Learners should understand that there will be variations according to the terrain (e.g. hard or soft water areas), climatic conditions, water source (e.g. marine or freshwater) and local policies that seek to enhance health (e.g. addition of fluorine). They should appreciate that, once the water has been used, it is likely to contain more biological, chemical and physical matter than before, presenting a greater risk to the environment. Before it can be discharged into the water cycle (via waterways etc.), it must be treated again. Learners should understand why sewage discharged from households, businesses and industrial premises needs treatment that involves removal of debris and sediment, oxidation to facilitate microbial decomposition of organic matter, and removal of toxic chemicals e.g. nitrates and phosphates. Finally, learners should have opportunities to explore a range of measures designed to control and minimise the use of water. If possible, invite a visiting speaker from the local authority or relevant government department who is involved in promoting water conservation and can provide information and details about policy and regulations.

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Understand the properties and uses of water	**A1** Structure, properties and use of water **A2** The hydrological cycle **A3** The water footprint	A report that reviews a wide range of uses and applications of water, with explanation of its unique properties. The report should include an explanation of the hydrological cycle for the global distribution and recycling of water, with an assessment of the different factors that affect the balance of the processes involved. The report should also cover the use and evaluation of the water footprint concept for a range of products and users.
B Understand how biological, chemical and physical factors influence water quality and aquatic species	**B1** Factors affecting water quality **B2** Water content **B3** Pollutants **B4** Acidification **B5** Eutrophication	A report on the presence and impact of substances and microorganisms in water sources, with a comparison of typical water content from different sources. The report should include a discussion of how water quality of a river changes as it travels from source to mouth, and the impact of significant processes of acidification and eutrophication. The report should also evaluate the impact of a range of factors on two different species of aquatic life.
C Investigate basic water quality of an aquatic habitat	**C1** Measuring and reporting on water quality	A report explaining biological, chemical and physical tests, and indicators of water quality. Learners' diaries, risk assessments, photographs and results of practical work carried out for the investigation of water quality for an aquatic habitat over a specified period of time. A report on the investigation, following a scientific format, giving conclusions and suggestions for improvements to the water quality of the aquatic habitat. An evaluation of the methods and techniques used, considering alternative approaches and other similar studies.
D Understand the principles of water treatment and conservation	**D1** Water treatment **D2** Sewage treatment **D3** Water conservation and consumption control	A report explaining different methods of treatment, conservation, consumption and management of water resources, and their evaluation for different purposes.

Assessment guidance

This unit is internally assessed via a number of independent tasks. Learners must produce individual evidence that is both original and can be authenticated.

Relevant sources of research information may include government and international statistics, regulations surrounding water quality, and online information relating to monitoring of water quality and policies aimed at conservation and consumption control.

For learning aim A, learners should produce a report that:

- reviews a wide range of uses and applications of water, including life processes as well as commercial applications
- explains the unique properties of water, in particular the bond polarity which gives rise to hydrogen bonding and the unusual physical properties of water compared with other molecules of similar size and mass
- explains the hydrological cycle in terms of the global distribution and recycling of water, with an assessment of the different factors (e.g. climate, geology, topography, population and demographics) that affect the balance of processes involved
- describes the use and evaluation of the water footprint concept for a range of products and users, drawing comparisons.

For learning aim B, learners must produce a report on the presence of physical, chemical and biological substances in water sources. This should include a comparison of typical water content from different sources, looking at differences in dissolved substances and microorganisms in marine water (oceans and seas), freshwater (rivers) and water that has been treated for human purposes (i.e. drinking and washing). The report should include a discussion of changes in water quality of a river from source to mouth. It should also examine the impact of acidification and eutrophication; learners can use independently-researched case studies as evidence for the causes of acidification and eutrophication and to illustrate the impact of these processes on local communities and livelihoods. They can also use case studies to evaluate the impact of a range of factors on two different species of aquatic life.

For learning aim C, learners must produce a portfolio explaining biological, chemical and physical tests, and indicators of water quality. This should include learners' diaries, risk assessments, photographs and results of practical work carried out to investigate the water quality of an aquatic habitat over a specified period of time. The investigation should be reported in a scientific format: the report must include title, abstract, introduction, method, results, accuracy, discussion, conclusions, evaluation, references and bibliography. The introduction should review the methods used, in terms of their significance in monitoring water quality. The report must include conclusions and suggestions for improvements to the water quality of the aquatic habitat, as well as an evaluation of the methods and techniques used, considering other similar studies and suggesting alternative approaches.

For learning aim D, learners must produce a report explaining different methods of treatment, conservation, consumption and management of water resources, evaluating these methods for different purposes. This could include recollections from visits to water treatment facilities and sewage treatment plants as well as information from other sources. Learners should discuss the need for water conservation and give details of methods that can be used by individuals, organisations and local authorities to conserve and control the consumption of water. (Ideally, this evidence will be supported by learners' own experiences.) The report should evaluate the use of water treatment and conservation methods for different purposes, considering domestic, industrial and commercial uses as well as the influence of factors such as climate, terrain and the main water source.

Getting started

This gives you a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 25: Water Quality

Introduction

From chemistry-based units such as *Unit 2*, learners will understand the unique properties of water and be able to relate these properties to bonding and structure. From their knowledge of biology, they will realise that all life depends on water and appreciate the consequences if it is not available or contains harmful substances. If they have completed *Unit 24*, they will have had opportunities to explore the effects of pollution on aquatic environments and water supplies, and will appreciate the need for water treatment before and after use. In this unit, these ideas will be explored in greater depth and learners will carry out practical investigations of water quality (e.g. carrying out field studies and sampling aquatic environments). They will look in more detail at the principles behind water treatment processes and measures which seek to conserve and control the consumption of water.

A visit to an organisation involved in monitoring water quality, water treatment or water conservation would be helpful. This would also give learners an idea of the range of employment opportunities in this area and of current developments in terms of managing water supplies and ensuring a clean aquatic environment.

Learning aim A: Understand the properties and uses of water

For learning aim A, the teaching focuses on three main areas: the structure, properties and uses of water; the hydrological cycle; and the water footprint. Use activities such as quizzes or question and answer sessions to gauge current knowledge and understanding, then adapt delivery methods accordingly. If possible, arrange for a visiting speaker from an organisation or government department that is involved with monitoring levels of water pollution in the environment, monitoring the effectiveness of water treatment and purification processes, and/or assessing the water footprint of processes and organisations.

A1

- Recap the water molecule in terms of its bonding, structure and intermolecular attractions (e.g. hydrogen bonding) and relate this to its properties. This could involve an activity such as a quiz or question and answer exercise to gauge prior knowledge. Ask learners to compare the properties of water (e.g. boiling point, specific heat capacity, solubility and chemical reactivity) with those of other substances of similar molecular weight, considering both organic and inorganic substances. This could involve a 'mix and match' or 'linking lines' exercise.
- Remind learners that, while most substances become more dense when going from the liquid to the solid state, ice becomes less dense due to the hydrogen bonding. If possible, give a practical demonstration comparing the volume of water in its liquid and solid state with that of some other substances, e.g. candle wax.
- Ask learners to relate the uses and applications of water with its chemical and physical properties, e.g. its relatively high latent heat of vaporisation makes it an ideal cooling agent. You could present this as a 'linking lines' activity, where learners link properties with applications.

A2

- Learners are likely to have encountered the water cycle elsewhere, so they should be able to describe the processes involved. They could perhaps carry out some independent research and produce a poster/leaflet about the impact of different climatic conditions on the water cycle.

- Then ask learners to identify critical points in the cycle where climate conditions (e.g. tropical, tundra etc.) and human activity (e.g. building, industrial discharge) can lead to problems such as flooding, contamination of water supplies and pollution. Learners could colour-code these critical points using amber for natural factors and red for human ones, or rank each factor from 1–3 in terms of risk.

A3

- Learners should understand the concept of a water footprint and define it as a measure of the amount of water used to produce a product; they should know this is used to assess the dependence and security of water supplies, for reduction and management of water use. It might be useful to show a video on this topic.
- Learners should be able to describe the components of the water footprint, in terms of green, blue and grey. Ask them to identify processes that could be assigned to each component. Then ask learners to work in groups to find information and data on the water footprint of a range of operations and processes. Groups should share their findings with the class through discussion or presentations.
- Ask learners to carry out independent research into how the water footprint can be calculated for products, companies, individuals and nations. They should also research factors that affect the water footprint, such as access to and availability of water, geology, topography, climate, population and demographics.

Learning aim B: Understand how biological, chemical and physical factors influence water quality and aquatic species

For learning aim B, the focus is on the factors (physical, chemical and biological) which can influence water quality and affect aquatic species. Use activities such as quizzes or question and answer sessions to gauge current knowledge and understanding, and adapt your delivery methods accordingly. There should be opportunities for practical activities involving water quality analysis, including a variety of biological, chemical and physical tests; this will also be a major part of learning aim C. If possible, arrange for a visiting speaker from a government department or organisation that is involved in environmental monitoring and protection.

B1

- Having studied the water cycle in learning aim A, learners will know how different climate conditions, as well as human activity, can affect water supplies and aquatic habitats. In this learning aim, they will explore in more depth factors such as location, surface features, soil, climate and seasons, flora/fauna and human activity such as agriculture, deforestation, construction, industry and so on. Learners can carry out research, make notes and participate in a class discussion or presentation.

B2

- Allow learners to access information, through online research or by contacting a government department, about the regulations and requirements for potable drinking water, marine water and freshwater, in terms of levels of naturally-occurring substances, total dissolved solids (TDS) and salinity.
- There is scope for practical activities, including tests for anions and cations, silica and gases such as oxygen and carbon dioxide.
- Give a presentation about the advantages and disadvantages of substances present in water, e.g. the nutritional value of calcium versus the negative effects of hard water.

B3

- Teaching will focus on the presence of pollutants and problems for water quality when materials are in excess. Having studied the water cycle, learners should be able to identify point

and non-point sources of pollutants (e.g. pipes leading to water from buildings and run-off from fields or roads).

- Learners should understand that pollutants can lead to an increase in biological species, organic chemicals, inorganic chemicals and physical debris in waterways and rivers, which may contaminate the water supply.
- Ask learners to research processes or sources of pollution which could lead to pathogenic bacteria, viruses, protozoa, helminths, fungi and algae entering the water cycle. Then lead a class discussion to identify organisations and establishments where some water treatment may be required at source, before the water enters the main sewage system.
- Give a presentation about organic chemical materials in water. Explain that this can pose problems regarding biodegradability and highlight the problems associated with plastics in particular.
- Ask learners to research case studies which highlight the problem of plastic build-up in oceans – e.g. the 'plastic whale' found on a Norwegian coast with plastic waste in its stomach.
- Next, ask learners to research the problems attributed to the accumulation of pesticides (e.g. DDT) and insecticides (e.g. organo-phosphates).
- Finally, ask learners to work in groups to pinpoint areas where there is a high risk of plastics and organic chemicals entering the water cycle, either directly or by diffusing into it.
- Give a presentation to introduce inorganic chemical materials in water and explain how nitrates and phosphates, iron and heavy metal ions, acids, cyanide, sulphide and fluoride ions are likely to be discharged into waterways. Ask learners to research and discuss the potential effects for humans, animal and plant life and ecosystems in general. Lead a discussion to pinpoint areas where there is a high risk of these chemicals entering the water cycle directly or diffusing into it.
- Ensure learners understand that physical contaminants in water can be wide ranging. While many solids may not dissolve in water, some can form suspensions which accompany the flow of water. This is also true of liquids which are not miscible with water. Allow learners to look at water samples under the microscope to identify suspended solids and oil droplets.
- Give a presentation about, or ask learners to research, the implications of physical contaminants for light penetration, photosynthesis, and other factors that can affect aquatic flora and fauna. Learners should understand that physical effects – such as an increase in temperature, colour changes, or changes in flow rate (e.g. brought about by diversion etc.) – can also have adverse impacts.

B4

- Give a presentation about the effects of acidification and how an increase in the levels of carbonic acid (due to the absorption of more carbon dioxide) will affect the environment. Ask learners to research case studies where increased acidification has resulted in the conversion of insoluble calcium carbonate to soluble calcium hydrogencarbonate, causing problems for coral reefs, reef fish, food webs, fisheries and the livelihoods of indigenous people.

B5

- Give a presentation about eutrophication. Learners should understand that eutrophication caused by the run-off from fertilisers containing nitrates and phosphates can cause excessive growth of phytoplankton and algae. This leads to changes in aquatic ecosystems arising from a reduction in photosynthesis, oxygen depletion, increased toxicity and pH imbalances.
- Ask learners to research case studies where eutrophication is believed to have affected aquatic environments such as rivers or lakes.

Learning aim C – Investigate basic water quality of an aquatic habitat

Learning aim C is concerned with investigating the water quality of an aquatic habitat. Learners will be required to undertake sampling, carry out tests on the spot and use laboratory methods and equipment. Some of the tests may be familiar to learners from other units but they must have opportunities to acquire the skills needed to carry out the investigation for the assessment activity. Learners are also required to plan the activities and safety requirements. The practical work could be done in conjunction with a government department or organisation that is involved in monitoring water quality. However, learners must work independently to carry out their own practical work in relation to assessment. In addition to the practical investigations, there can be activities such as presentations, discussion and research.

C1

- Begin by asking learners to produce a plan of their monitoring activity, identifying the following:
    - The aquatic environment they are going to look at.
    - Sampling procedures – Learners should discuss the merits of judgemental, random, stratified, grid, cluster and grab sampling and identify which would be most appropriate for the task in hand. You may wish to show a video on sampling methods to help with this section.
    - Biological testing methods that could be used to gather information about populations – e.g. measurements of luminescence and tests for the presence of microorganisms.
    - Chemical testing methods – Chemical tests are usually carried out in the laboratory, but some can be performed in the field, e.g. pH. Chemical tests can include ammonium, nitrate, sulphate, hardness and salinity. Tests for organic compounds such as DDT will involve instrumentation techniques such as GC or HPLS, but some use volumetric analysis, e.g. for Ca^{2+} or Fe^{2+}.
    - Physical testing methods – Physical tests are better conducted in the field and can include water quantity, flow, temperature, turbidity and TDS. Satellite imaging can be used to assess surface and topographical features.
    - Laboratory methods they will use.
    - A risk assessment – Learners should identify safety considerations relating to the nature of the environment, PPE to be worn, and hazards relating to the use of chemicals and equipment. They should also assess any potential damage that the monitoring activity might cause to the locality.
- Learners may be familiar with some of the tests to be used; where this is not the case, they should conduct further research.
- Once learners have carried out their monitoring of water quality, they must analyse their results, draw conclusions and make recommendations.
- Learners should present their evidence in the form of a scientific report, including title, abstract, introduction, method, results, accuracy, discussion, conclusions, evaluation, references and bibliography. They could initially produce a 'practice' report on practical activities they have carried out, to prepare for the assessed investigation.

Learning aim D: Understand the principles of water treatment and conservation

Learning aim D is primarily concerned with the treatment of water before and after use and measures that seek to conserve water and control consumption. Learners should be able to describe in detail the processes involved in the treatment of water before it enters the municipal water supply, and those involved in the treatment of sewage before waste water is discharged into the environment. Delivery methods can include activities such as presentations, discussions, group

or paired activities, watching videos, reviewing newspaper and journal articles, and independent research. If possible, arrange for learners to visit a water purification facility and/or a sewage treatment plant or invite a visiting speaker from a government department or organisation that is involved in water monitoring and conservation.

D1

- Begin by asking learners to research the regulations and requirements for water supplies in a range of countries. Then lead a class discussion to draw comparisons and identify differences in approach, making links with factors such as climate, terrain and the water source.
- Learners should understand that water intended for human consumption must be potable and free from anything that is detrimental to health. They should also be aware that water used for certain industrial operations (e.g. cooling or steam generation) does not need to be potable. As a result, it may be used directly from waterways or marine sources, or treated in a limited way to ensure it is suitable for use with the plant and equipment.
- Give a presentation explaining the key water treatment processes in more detail. Show a video on water purification processes or, if possible, arrange for learners to visit a water purification plant. Learners should be able to describe and explain processes including screening/straining, settling, oxidising, flocculation, filtration, pH and disinfection.
- Ask learners to research requirements for additional or supplementary treatment processes, for example:
    - Some areas have high proportions of certain inorganic substances (especially if the water has been sourced from an Artesian well) which can only be removed by techniques such as ion exchange or reverse osmosis.
    - If the water supply is obtained from seawater, desalination will be required.
- Discuss contingency plans to be used if hazardous substances enter water systems, e.g. through industrial accidents which cause acute pollution. Ask learners to research case studies about any such incidents in their own area or elsewhere and to identify what measures were put in place to minimise risks to human health.

D2

- Give a presentation to introduce sewage treatment. Learners will know that, after it has been used, water must return to the water cycle via the environment. This waste water may contain large amounts of human waste as well as waste and effluent from other sources; therefore, it must be treated before it is returned to the environment. Show a video about sewage treatment or, if possible, arrange for learners to visit a treatment plant in their own locality. Learners should be able to describe and explain the processes involved in sewage treatment, including primary (removal of solid matter), secondary (aerobic treatment to encourage microbial growth) and tertiary (chemical treatment to sanitise) treatment.

D3

- Give a brief presentation about water availability. Learners should understand that water shortages can occur even in areas with high rainfall. Most of the water used for domestic, commercial and industrial purposes is provided through the municipal supply and subject to treatment, so this can be a finite source over a given period of time. The situation is more critical in areas with less rain and, in some circumstances, humans and animals may turn to contaminated sources which pose a serious risk to health. Climate change also has implications for the availability of fresh water in many areas.
- Lead a class discussion, guiding learners to explore the need for strategies aimed at conserving water and controlling water consumption.
- Ask learners to investigate policies and strategies in their local area for water conservation.

- If possible, arrange for learners to visit a local government department responsible for water, speak to an officer and obtain information about regulations and advice on promoting water conservation strategies.
- Then ask learners to research the policies being implemented in other areas and to access information from private organisations on strategies they have in place for water conservation. For example:
    - learners could contact construction companies and find out whether new-build houses are likely to have better insulation of piping, shorter toilet flushes or more taps that turn themselves off
    - learners could contact cleansing departments and organisations to find out about waterless cleaning methods or procedures for minimising run-off.
- Ask learners to produce a poster or leaflet which illustrates the measures they would put in place to reduce the amount of water they use.
- Ask learners to keep a diary of their water usage for a week and to measure or estimate the amount of water they use each day. On the first day, they should measure more or less their normal usage but on subsequent days, they could try to implement the control measures described in their poster or leaflet. At the end of the week, they should assess the extent to which they managed to reduce their water usage each day and identify which measures appear to be most effective.

Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit links to:

- Unit 1: Principles and Applications of Biology I
- Unit 2: Principles and Applications of Chemistry I
- Unit 5: Principles and Applications of Biology II
- Unit 6: Principles and Applications of Chemistry II
- Unit 13: Biological Molecules and Metabolic Pathways
- Unit 15: Diseases and Infection
- Unit 19: Microbiology and Microbiological Techniques

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC International Level 3 in Applied Science. Check the Pearson website at http://qualifications.pearson.com/endorsed-resources for more information as titles achieve endorsement.

- Binnie, C., Kimber, M. and Thomas, H., *Basic Water Treatment*, 6th edition, ice publishing, 2017, ISBN 978-0-727-76334-1) – An accessible and practical guide to all aspects of potable water quality and treatment.
- Ekström, K. (ed.), *Waste Management and Sustainable Consumption: Reflections on consumer waste*, Routledge, 2015, ISBN 978-1-138-79726-0 – Examines the social and cultural views of waste, shedding new light on the topic by emphasising the consumer perspective throughout.
- Harrison, R. (ed.), *An Introduction to Pollution Science*, RSC Publishing, 2005, ISBN 978-0-854-04829-8 – Covers topics including pollution in the atmosphere, the world's water, and soil and land contamination.
- World Health Organisation (WHO)*, Guidelines for Drinking-water Quality*, 4th edition, WHO, 2017, ISBN 978-9-241-54995-0 – WHO guidelines for drinking water quality.

Journals

The following technical journals require high-level reading skills and an ability to use and understand technical terms. They contain the latest news and research into related topics.

- *Journal of Water and Health*
- *Nature*
- *New Scientist*
- *Scientific American*

The Guardian newspaper's science section is also a useful source of relevant news articles.

Videos

You may wish to search YouTube for the following titles:

- The Water Cycle
- What is a water footprint and Why it is important? | Waterpedia
- Water Pollution Documentary
- How Do Water Treatment Plants Work?
- How Do Wastewater Treatment Plants Work?

Websites

- Environmental Protection – This website provides information about different aspects of environmental protection.
- Friends of the Earth – This website considers various issues related to the environment.
- Websites of local and national wildlife organisations – These sites will explain how water quality can affect systems and habitats.
- WaterWeb – This website is a useful directory of other water-related sites

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling students to access them through the school/college intranet.