

Unit 16: Understanding Water Quality

Unit code	Y/600/9638
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit aims to introduce learners to skills and knowledge associated with water quality and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

Almost every living thing on our planet needs water to survive and to humans water is vital. Issues with water quality can cause serious problems for humans – from fisheries to crop production, water pollution can cause devastation. As a result, monitoring and controlling water quality is essential.

The focus of this unit is on monitoring water for the aquatic habitat, with the emphasis on animals and plants rather than on farming or crop production.

In this unit learners will begin to understand the importance of managing water quality and the measures that can be taken to reduce the impact of human activity on water quality. Learners will be able to apply this knowledge to industry, for example to fisheries management. Water treatments will be covered to show learners possible solutions to poor water quality so that an aquatic habitat could be improved to establish a potentially successful ecosystem in the body of water.

The unit enables learners to practise the water quality analysis skills which are used in the field and in industry, including measuring a variety of factors, recording results, interpreting data and suggesting improvements to an area of water. The practical element of the unit should help learners to appreciate the impact of physical, chemical and biological factors on the aquatic habitat.

● Learning outcomes

On completion of this unit a learner should:

- 1 Understand the factors, physical, chemical and biological, which influence water quality and aquatic species
- 2 Be able to measure basic water quality factors
- 3 Be able to record and interpret water quality data
- 4 Understand the principles of water treatment.

Unit content

1 Understand the factors, physical, chemical and biological, which influence water quality and aquatic species

Physical factors: the hydrological cycle; physical factors eg influence of human activity, geographical features, surface topographical features

Chemical factors: eg alkalinity, ammonia, carbon dioxide, chlorine, nitrates and nitrites, dissolved oxygen, pH, phosphates, temperature, turbidity, suspended solids, hardness (temporary and permanent)

Biological factors: eg health of aquatic organisms, biological oxygen demand, micro-organisms, flora and fauna present in ecosystem

2 Be able to measure basic water quality factors

Measuring basic water quality factors: physical factors eg water quantity, flow (meters), temperature (probes), turbidity (light meter), geographical features (satellite pictures), surface topographical features; chemical factors (by use of test kits and other appropriate methods) eg dissolved oxygen, pH, ammonia, nitrite, nitrate, hardness, chlorine, salinity; biological factors (by use of test kits, probes, kick sampling, nets, indicator species) eg biochemical oxygen demand; basic biological sampling methods eg for invertebrates, vertebrates, macrophytes, algae, microbiological testing; safe practice in water sampling

3 Be able to record and interpret water quality data

Water quality data: use of water quality data to evaluate the quality of the environment for aquatic species; record keeping eg weather conditions, disease treatments, husbandry factors; biological indicators commonly used to assess water quality, environmental quality standards (set by the Environment Agency) and the River Invertebrate Prediction and Classification System (RIVPACS); toxicity required to fail safety checks; relevant current legislation eg Environment Act 1995; guidelines and codes of practice relating to water quality and aquatic species health

4 Understand the principles of water treatment

Methods of water treatment: commonly used water treatment methods eg aeration, ion exchange, sedimentation, biological filtration, solids removal, activated sludge techniques, UV treatment, ozonisation; nitrogen and phosphorous removal; algal control eg via bacteria; sequence of treatment; advantages and disadvantages of each method; relevant current legislation and codes of practice in place to satisfy water quality demands eg Environment Act 1995 and methods used

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 explain the hydrological cycle		
P2 explain how the physical environment can change water quality	M1 explain how biological, chemical and physical factors can affect the life cycle of two named species of aquatic animal or plant	D1 evaluate biological sampling techniques used in water sampling
P3 explain how an aquatic habitat's flora and fauna changes when water quality changes		
P4 determine the basic water quality of a given aquatic habitat [CT1; TW1]	M2 describe the health and safety considerations when sampling different aquatic habitats	
P5 carry out basic biological sampling for a given aquatic habitat [EP3; CT1, 2, 3]		
P6 carry out a water quality survey on an aquatic habitat for a given period [CT1, 2, 3]		
P7 produce a report on the water quality of a given aquatic habitat [RL5, 6]	M3 compare data collected to known data for other locations	D2 explain the use of biological indicator species in given situations.
P8 discuss the methods of water treatment commonly used to meet specified objectives [IE1, 2, 3]		
P9 assess water treatment methods commonly used to meet specified objectives [IE4, 6]	M4 discuss advantages and disadvantages of water treatment methods commonly used in industry.	
P10 explain how commonly used water treatment methods satisfy current legislation.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical and written assessments, and visits to suitable aquatic habitats. It may involve developing links with industry for site visits and with guest expert speakers who can talk about locations where water monitoring and treatment are used.

The unit can be delivered using a wide range of techniques, including lectures, discussions, seminar presentations, supervised practicals and research using the internet and/or library resources. Delivery should stimulate, motivate, educate and enthuse learners.

Any site visits should be checked for suitability and a risk assessment of activities carried out. Charities that run reserves will often support visits and provide expert guidance about the specific location as well as sometimes being able to design sessions and practical work. For example, learners may have the opportunity to use data logging equipment and a variety of probes or kick sampling for small invertebrates. Observation records and/or witness statements must be provided as evidence of this and to confirm learner achievement. Guidance on the use of observation records and witness statements is provided on the Edexcel website (www.edexcel.com).

Guest speakers can be used to provide background information on legal requirements and the health and safety issues to consider when recording and checking water quality, for example safe levels of chemicals, invertebrate sampling and government quality requirements.

Samples can be collected from a variety of sources and analysis completed in the classroom. The use of data logging equipment could be linked to a series of science-based lectures where, if in a centre environment, science specialists may be able to help.

Whichever delivery methods are used, it is essential that tutors stress the importance of animal welfare, sound environmental management and the need to manage the resource using legal methods.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and assessment
Introduction and overview of the unit.
Assignment 1: Learning the Ropes (P1, P2, P3, M1, D1)
Introduction to water quality factors assignment.
Research into physical, chemical and biological factors that affect water quality.
Supervised practicals, guest speakers, site visits.
Assignment 2: Guiding Visitors (P4, P5, P6, M2)
Introduction to water quality measurement assignment.
Investigation of water measurement/sampling techniques.
Guided site visits, supervised practical work.
Assignment 3: Surprise Inspection! (P7, P8, M3, D2)
Introduction to water interpretation assignment.

Topic and suggested assignments/activities and assessment

Investigation of water data recording and interpretation techniques.

Supervised practical sessions, site visits, internet research and guest speakers.

Assignment 4: A Possible Threat (P9, P10, M4)

Introduction to the water treatment assignment.

Guest speakers, site visits, demonstrations, supervised practical work, internet research, library research, demonstrations and lectures.

Research and fieldwork into methods of treating water, relevant legislation and codes of practice.

Review of learning and assessment.

Assessment

For P1, learners need to explain the hydrological cycle. Evidence can take the form of a presentation, ICT-based presentation, leaflet or information booklet.

P2 requires learners to explain how physical factors can change water quality. This can be assessed through a question and answer interview session with supporting witness statements, a presentation or a guidance booklet, for example for the Environment Agency.

For P3, learners need to explain the impact of water quality on flora and fauna. For this learners could study two species in detail using internet research and library resources. Evidence could be a research project followed by a presentation or a role-play scenario involving a body of water where species are threatened and learners are reporting back to colleagues on the risks involved.

P4, P5 and P6 involve carrying out water quality tests on an aquatic habitat. This would be assessed best by using photographic evidence, results tables and data, witness statements if site visits are carried out and a learner diary.

P7 can be linked to work carried out for P4, P5 and P6. Learners could produce a report on water quality for either a site they have previously studied or another site. The report can be in writing or via a verbal presentation but must include all the information stated in the *Unit content* for learning outcome 3.

P8 requires learners to discuss commonly used water treatment methods. Evidence can take the form of a discussion, presentation, leaflet, guide for an employer or site owner, or new employee handbook.

For P9, learners need to assess commonly used water treatment methods. Learners could produce a summary booklet of available treatments, a web page providing guidance on the treatments, a blog of a landowner who has had to carry out treatments or a key for landowners to follow using a series of questions to determine which treatment would be best for their situation.

For P10, learners need to explain how commonly used water treatment methods meet the requirements of current legislation. Evidence can take the form of a leaflet, presentation, web page, or a role play of a court case where a body of water has been polluted.

For M1, learners need to explain how the life cycle of two named species of aquatic animal or plant can be affected by biological, chemical and physical factors. Evidence could take the form of a letter to the government about the specific area and species involved, a speech by an environmental charity, a web page calling for action to be taken in relation to a local area or planning a project that school children could carry out to tidy up an area after a problem has occurred and to save certain species.

M2 requires learners to describe the health and safety considerations when sampling different aquatic habitats. Evidence can take the form of a discussion, presentation, leaflet, guide for an employer or site owner, or new employee handbook.

For M3, learners need to compare data they have collected with that from another source. Evidence can be in the form of a written or verbal presentation using tables, graphs, charts, or other suitable formats.

For M4, learners need to discuss advantages and disadvantages of water treatment methods commonly used in industry. Again, an ICT-based presentation, guide to landowners, charity booklet or government guide would all be suitable evidence.

For D1, learners need to evaluate biological sampling techniques used in water sampling. Evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software) or a project.

D2 requires learners to explain the use of biological indicator species in given situations. Evidence could take the form of notes from a site visit about species observed, presentation, booklet, guide for landowners or a web page.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Learning the Ropes	You are a recently qualified ecologist and have taken a job at a local charity working in one of their managed centres. You must find out about the techniques used at the site and how the water quality is maintained.	Leaflet. Written notes.
P4, P5, P6, M2	Guiding Visitors	A group of secondary school children has arranged to visit the site and you will be acting as their expert for the day. Practise and then demonstrate the different methods that can be used to test water quality.	Witness statements. Learner diary. Photographs. Observation records.
P7, P8, M3, D2	Surprise Inspection!	Your boss tells you that the government will be sending people to check the records for the site to make sure everything is in order. You must collect data and put it into a form that people can easily understand.	Tables. Graphs. Charts. Report. Photographs.
P9, P10, M4	A Possible Threat	Some local fishermen have reported problems near to your site and they suspect that pollution might be present and harming fish stocks. You are concerned that the problems may spread to your area of water. You decide to help and support the local community trying to clear up the area and suggest which treatments may be suitable.	Report. Presentations. Practical notes.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Land-based sector suite. This unit has particular links with the following units in the BTEC Land-based suite and the BTEC Environmental Sustainability suite:

Level 2	Level 3
Introduction to Environmental Studies	Understanding Fishery Management
	Understand Ecological Concepts and Application
	Practical Chemical Analysis
	Scientific Practical Techniques

Essential resources

Access to an aquatic habitat is essential so that learners can experience the environments where water quality testing is carried out on a regular basis. Habitats that support small invertebrates would be preferable.

The equipment required will include the normal safety gear used in laboratories and in the field, a range of dissolved oxygen meters, thermometers and chemical test kits, water sampling equipment, basic water flow measurement equipment, record keeping equipment and a calculator.

Tutors delivering this unit should be experienced in analysing water and evaluating the results in relation to the effects on aquatic life.

Employer engagement and vocational contexts

Learners would benefit from having access to a working environment. This can be achieved by creating links with local businesses or charitable organisations which can benefit from taking on learners. Local authorities can be a useful source of information, as can business education alliances. Charitable organisations can often provide guest speakers to give lectures and demonstrations.

Indicative reading for learners

Textbooks

Andrews C, Carrington N and Exell A – *The Interpet Manual of Fish Health, Second Edition* (Interpet Publishing, 2002) ISBN 9781842860670

Barnes R and Mann K – *Fundamentals of Aquatic Ecology, Second Edition* (Blackwell Science, 1991) ISBN 9780632029839

Bromage N and Shepherd C – *Intensive Fish Farming* (Blackwell Science, 1992) ISBN 9780632034673

Ertueth K and Mirza I – *Water Quality: Physical, Chemical and Biological Characteristics* (Nova Science Publishers, 2010) ISBN 9781607416333

Jacoby J and Welch E – *Pollutant Effects in Freshwater, Third Edition* (Taylor & Francis, 2006) ISBN 9780415429900

Li Y and Migliaccio K – *Water Quality Concepts, Sampling, and Analyses* (Taylor & Francis, 2010) ISBN 9781420092660

Miller P and Nicholls J – *A Handguide to the Fishes of Britain and Europe* (Treasure Press, 1986)
ISBN 9781850511144

Templeton R – *Freshwater Fisheries Management, Second Edition* (Blackwell Science, 1995)
ISBN 9780852382097

Websites

Centre for Ecology and Hydrology – Natural Environment Research Council	www.ceh.ac.uk
Centre for Environment, Fisheries and Aquaculture Science	www.cefas.co.uk
Chartered Institution of Water and Environmental Management	www.ciwem.org
Department for Environment, Food and Rural Affairs	www.defra.gov.uk
Environment Agency	www.environment-agency.gov.uk
Freshwater Biological Association	www.fba.org.uk
FreshwaterLife	new.freshwaterlife.org
Health and Safety Executive	www.hse.gov.uk
Institute of Fisheries Management	www.ifm.org.uk
Lantra Sector Skills Council for the environmental and land-based industries	www.lantra.co.uk
Natural England	www.naturalengland.org.uk

Journals

Fish Biology

Hydrological Sciences

Water and Environment

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	discussing different water treatment methods assessing water treatment methods
Creative thinkers	determining the basic water quality of a given habitat carrying out biological sampling for an aquatic habitat carrying out a water quality survey
Reflective learners	producing a report on the water quality of a given habitat
Team workers	working as a team to collect water quality data
Effective participators	carrying out biological sampling for an aquatic habitat

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Creative thinkers	applying techniques studied to the working environment suggesting improvements to techniques used in the field
Reflective learners	suggesting improvements to techniques and sites
Team workers	practising water sampling techniques

● Functional skills – Level 2

Skill	When learners are ...
ICT – using ICT	
Select, interact with and use ICT systems safely and securely for a complex task in non-routine and unfamiliar contexts	carrying out internet research writing presentations
ICT – finding and selecting information	
Select information from a variety of sources to meet requirements of a complex task	carrying out internet research on legislation, researching water quality at different locations comparing data
ICT – developing, presenting and communicating information	
Enter, develop and refine information using appropriate software to meet requirements of a complex task	presenting written work and data
Combine and present information in ways that are fit for purpose and audience	analysing and displaying data producing presentations
Mathematics – representing	
Understand routine and non-routine problems in familiar and unfamiliar contexts and situations	using calculations in water analysis
Identify the situation or problems and identify the mathematical methods needed to solve them	using formulae to estimate population size
Choose from a range of mathematics to find solutions	analysing data
Mathematics – analysing	
Apply a range of mathematics to find solutions	analysing data
Use appropriate checking procedures and evaluate their effectiveness at each stage	checking data
Mathematics – interpreting	
Interpret and communicate solutions to multistage practical problems in familiar and unfamiliar contexts and situations	analysing data
Draw conclusions and provide mathematical justifications	using formulae

Skill	When learners are ...
English – Speaking, Listening and Communication	
Make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	contributing to video, blogs and group presentations
English – Reading	
Select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	reading information as part of internet and library research
English – Writing	
Write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	completing reports, diaries and other assessments