

Unit 30: Public Health Engineering in Civil Engineering

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

To enable mankind to live successfully in communities, care must be taken to prevent the development of disease and ill-health resulting from the inadequate, inefficient and unhealthy disposal of waste. This unit explores the civil engineering aspects of what is commonly known as public health engineering.

Many projects will include elements where a thorough knowledge of public health engineering will be needed. Learners will develop an understanding of the above-ground and below-ground drainage systems that are commonly used to drain liquid waste from buildings. These will be explored in terms of design, installation and maintenance. Learners will also have the opportunity to explore simple on-site treatment methods and techniques.

Historically, solid waste has by preference been buried in landfill sites, but this becoming increasingly less acceptable. Learners will investigate the alternative ways in which solid waste can be disposed of.

The sources of water supplies are also investigated in this unit, and learners will gain knowledge and understanding of how raw water is treated so as to produce water supplies of drinkable quality.

Learning outcomes

On completion of this unit a learner should:

- 1 Understand the different methods of providing below-ground drainage systems in terms of design, installation, testing, materials and maintenance
- 2 Understand the different methods of providing above-ground waste water drainage systems in terms of design, installation, testing, materials and maintenance
- 3 Understand how waste water can be treated on-site for domestic purposes
- 4 Be able to describe the methods used to dispose of solid waste
- 5 Know the sources of drinking water and understand the processes used to produce water of drinkable quality.

Unit content

1 Understand the different methods of providing below-ground drainage systems in terms of design, installation, testing, materials and maintenance

Design and installation requirements for below ground drainage systems: combined systems; totally separate systems; partially separate systems; grey water systems; for eg domestic dwellings, small commercial and industrial buildings, small housing developments, small industrial/commercial trading estates

Details: ventilation of below ground drainage systems; use of open vents and air admittance valves (AAV); limitations on use of AAV; access to below ground drainage systems; rainwater storage and use; grey water storage and use

Calculations: size of drain; depth of flow; self-cleansing velocity and inclination of drains from given data; methods of determining drain/sewer loadings; self-cleansing velocity and inclination of sewers from given data; maximum depth of flow

Materials and installation techniques: common materials used for below ground drainage systems; methods of jointing different below ground drainage materials; bedding of drains; depth of cover; drains passing through building structures

Soundness and performance: tests to below ground drainage systems; alignment tests; mirror and torch tests; obstruction test; rolling ball test; soundness tests; hydraulic and pneumatic tests

Servicing and maintenance: health, safety and welfare; personal hygiene and protective clothing and equipment; tools and equipment required for servicing and maintenance; work sequences and methods of carrying out servicing and maintenance tasks; testing of drains and sewers for toxic or explosive gases

2 Understand the different methods of providing above-ground waste water drainage systems in terms of design, installation, testing, materials and maintenance

Design and installation of: above ground drainage systems suitable for domestic dwellings and small commercial or industrial buildings up to four storeys high

Requirements: single stack system of above ground drainage; modified single stack system; ventilated stack system; single ventilated system; stub stack system

Materials and techniques: common materials; methods of jointing and fixing

Soundness and performance: soundness testing; pneumatic testing; methods of applying tests and test criteria; performance testing for trap seal retention

Servicing and maintenance: health, safety and welfare; personal hygiene and protective clothing and equipment; tools and equipment needed; work sequences and methods of carrying out servicing and maintenance; tasks; checking for toxic or explosive gases in above ground drainage systems

3 Understand how waste water can be treated on-site for domestic purposes

Types of system: septic tanks; package systems

Design requirements: location; design; method of operation; sizing based upon population; provision for sludge and water disposal after treatment; vehicle access; land drains; soakaways

4 Be able to describe the methods used to dispose of solid waste

Principles: refuse chutes; compaction, composting and incineration; sorting, disposal and recycling of solid waste

Requirements and constraints: legal requirements; health, safety and welfare; damage to the environment and cost implications associated with solid waste; disposal by incineration and landfill sites

5 Know the sources of drinking water and understand the processes used to produce water of drinkable quality

Rainfall: water cycle (evaporation, condensation, precipitation); absorption of carbon dioxide, sulphur dioxide and oxides of nitrogen

Hardness: hard and soft water; temporary hardness and permanent hardness; pH values; removal of temporary hardness; removal of permanent hardness by the base-exchange process; hardening of acidic water to prevent corrosion; plumbo-solvency and cupro-solvency; palatability

Sources of supply: eg rivers, streams, shallow wells, deep wells, bore holes, desalination impounding reservoirs; river management; weirs; flood plains

Water purification: properties of potable water supplies, eg colour, turbidity, taste and odour; protection of the gathering grounds; effects of livestock, cultivation, nitrates and landfill; storage, impounding and storage/settlement reservoirs; filtration, slow sand filters, rapid sand filters, micro-straining, sterilisation and chlorination of water supplies

Storage and distribution: service reservoirs; pumping stations; use of water towers or expansion/pressure vessels; diagrammatic layouts of each method highlighting the components for each installation, distribution, water-main grid systems; minimum pressure; methods of isolation; materials and jointing methods used; disinfection

Grading grid

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

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 describe the common below-ground systems for the disposal of foul and surface water from domestic and small commercial or industrial buildings	M1 perform calculations to determine quantity of flow, velocity of flow, depth of flow, pipe size and gradient of below-ground drainage from given data	D1 evaluate the methods of testing, inspection and maintenance of below-ground drainage in relation to health and safety
P2 describe the common above-ground systems for the disposal of waste water from domestic and small commercial or industrial buildings	M2 compare different materials for both below and above-ground drainage systems in terms of installation and maintenance	
P3 describe two methods of on-site treatment of domestic sewage from a small development, including treatment of effluent and disposal of sludge		
P4 describe the methods used to dispose of solid waste	M3 assess methods of solid waste disposal in financial, legal, environmental and health, safety and welfare terms	
P5 identify the sources of drinking water and a treatment process for purification, storage and distribution of water supplies.	M4 explain how potable water can be purified.	D2 evaluate the different methods of water purification for potable water.

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet or library resources and the use of personal or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

Learning outcomes 1 to 3 link together and form a logical, consistent and progressive structure. Learning outcomes 4 and 5 are not linked, either to each other or to any of the first three learning outcomes. This implies three broad areas of delivery, each leading to a separate assessment instrument.

Teaching and learning strategies should be designed to support delivery using a learner-centred approach. This would involve learners investigating areas such as how solid waste is disposed of in their area and relating this to taught theories.

A series of realistic scenarios should be used to show the calculations for the design of simple gravity drainage systems. The scope of these calculations is intended to give learners a basic understanding and should not be seen as a mathematical exercise. Tables and charts should be used wherever possible.

Processes that involve chemical or biological changes should be taught in broad detail and learners should be provided with an overview and a basic understanding of the principles involved. There is no requirement for a detailed understanding of the exact biological and chemical changes involved.

Reference should be made to the Building Regulations and other relevant standards and guidelines wherever necessary in order to support delivery. Learners should be encouraged to see how the theories and practice being taught relate to industry practice and standards.

Wherever possible, links should be formed with industry and site visits arranged. For example visits to water treatment plant, reservoirs and solid waste facilities will help learners relate to the topics covered in this unit. Opportunities for learners to access different materials such as pipes will support delivery. A visit to a local materials supplier may be a means of providing this opportunity.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria may be fully addressed by using four assessments. The first of these would cover P1, P2, M1, M2 and D1, the second would cover P3, the third would cover P4 and M3, and the fourth would cover P5, M4 and D2.

To achieve a pass grade learners must meet the five pass criteria listed in the grading grid.

For P1, learners must describe the common below-ground systems for the disposal of foul and surface water from domestic and small commercial or industrial buildings. This will include separate, combined, partially separate systems and grey water storage and treatment. Learners should describe the materials used including clay, concrete, plastics and iron and must describe how one of these materials is jointed and laid. Learners must show an understanding of the need for access to pipelines and ventilation requirements.

Evidence for P1 could be in the form of a presentation, a report on a real project that has been studied or through verbal questioning based on a case study provided by the tutor. Learners should include sketches or referenced diagrams from texts to illustrate their description, which should be in accordance with relevant standards and legislation.

For P2, learners must describe the common above-ground systems for the disposal of waste water from domestic and small commercial or industrial buildings. This should include single stack, ventilation and access requirements. Examples of suitable evidencing approaches are as for P1. Learners could use sketches or referenced diagrams from texts to illustrate their description, which should be in accordance with relevant standards and legislation.

For P3, learners must describe two methods of on-site treatment of domestic sewage from a small development, including treatment of effluent and disposal of sludge. They should show knowledge of on-site treatment for domestic waste water, and should include septic tanks and basic package plants, and the methods used to treat effluent and dispose of sludge. An understanding of how these are sized, operated and maintained must be demonstrated within the description. Examples of suitable evidencing approaches are as for P1.

For P4, learners must describe the methods used to dispose of solid waste. They should describe how domestic solid waste is dealt with at source and the methods available for its disposal. This should include refuse chutes within buildings, compaction of waste, sorting of waste for recycling, a typical method of collecting recyclable waste, disposal through incineration or landfill and a method of recycling a commonly collected material. Learners must also describe environmental constraints associated with disposal methods and health, safety and welfare issues. Examples of suitable evidencing approaches are as for P1.

For P5, learners must identify the sources of drinking water and a treatment process for purification, storage and distribution of water supplies. This should encompass a number of sources and should not focus solely on the sources near to where the learner is located. A treatment process used for water purification is to be identified in terms of the stages that may be used. This need not be in any more detail than the production of a schematic block diagram. Learners should also identify how water is stored following treatment and distributed to users. Reference should be made to service reservoirs or water towers, pumping stations, supply mains and distribution networks, materials used for pipework and the minimum pressure at which water is supplied to users. Examples of suitable evidencing approaches are as for P1.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must perform calculations to determine quantity of flow, velocity of flow, depth of flow, pipe size and gradient of below-ground drainage from given data. Calculations should make use of available charts and tables and should be in accordance with appropriate standards, guidelines and legislation. Calculations should be substantially correct with only small errors being acceptable. Correct units should always be quoted.

For M2, learners must compare different materials for both below and above-ground drainage systems in terms of installation and maintenance. The comparison should be made in relation to the practical application of different materials used in drainage installations and the maintenance of such installations. Examples of suitable evidencing approaches are as for P1.

For M3, learners must assess methods of solid waste disposal in financial, legal, environmental and health, safety and welfare terms. They should assess the value of different methods of solid waste disposal in terms of costs, legal requirements and environmental and health, safety and welfare issues. Examples of suitable evidencing approaches are as for P1.

For M4, learners must explain how potable water can be purified. They should show an understanding of different processes that may be used to purify water including screening, filtration, micro-straining, sterilisation and chemical treatment and should identify the purpose of each in relation to the treatment of the water. Examples of suitable evidencing approaches are as for P1.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the two distinction grade criteria.

For D1, learners must evaluate the methods of testing, inspection and maintenance of below-ground drainage in relation to health and safety. They should also discuss the suitability of each method through their advantages and disadvantages. Examples of suitable evidencing approaches are as for P1.

For D2, learners must evaluate the different methods of water purification for potable water. This should clearly identify the appropriateness of methods in relation to the properties of the source water and the required properties of the purified water. Examples of suitable evidencing approaches are as for P1.

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

The learning outcomes in this unit are closely linked with, for example, *Unit 29: Construction in Civil Engineering*, which complements it by allowing learners to explore aspects of construction technology in more detail.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

This unit presents opportunities to demonstrate key skills in communication and information and communication technology.

Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

Essential resources

Site visits to solid waste disposal facilities and water treatment installations will add greatly to learners' experience. Where possible, visits to construction sites to view the installation of drainage installations should be undertaken. Such visits may also provide the opportunity for testing, inspection and maintenance to be viewed. If it is not possible to arrange site visits, some elements of drainage may be seen within existing buildings and video or DVD materials should be used.

Samples of pipe materials will help learners to understand the materials used. If the centre delivers craft programmes it may be possible for learners to gain some practical installation, inspection and testing experience.

Copies of drawings and utility records will provide a valuable resource for helping learners to understand the different types of drainage systems and water distribution networks.

Learners will require access to copies of legislation, standards and design charts and tables.

Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for site visits and any practical work.

Indicative reading for learners

Textbooks

Association of Municipal Engineers – *Recycling Household Waste: The Way Ahead* (Thomas Telford, 1991) ISBN 0727716506

Chadderton D – *Building Services Engineering, 5th Edition* (Taylor & Francis, 2007) ISBN 0415413559

Greeno R and Hall F – *Building Services Handbook, 4th Edition* (Butterworth-Heinemann, 2007) ISBN 0750682205

Purcell P – *Design of Water Resource Systems* (Thomas Telford, 2003) ISBN 0727730983

Twort A, Ratnayaka D and Brandt M – *Water Supply, 5th Edition* (Butterworth-Heinemann 2000) ISBN 0340720182

Water Industry, England and Wales – *The Water Supply (Water Fittings) Regulations 1999* (The Stationery Office Books, 1999) ISBN 0110825527

Williams P – *Waste Treatment and Disposal, 2nd Edition* (John Wiley and Sons, 2005) ISBN 0470849134

WRc – *Sewers for Adoption, 5th Edition* (WRc Publications, 2001) ISBN 1898920435

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> describing below ground drainage systems for the disposal of wastewater and surface water; or, comparing materials used for below and above ground drainage installations; or, describing methods of on-site treatment; or, evaluating different methods of purifying potable water; for example. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write two different types of documents, each one giving different information about complex subjects.</p> <p>One document must be at least 1000 words long.</p>
Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> describing below ground drainage systems for the disposal of wastewater and surface water; or, evaluating the methods of testing, inspection and maintenance of below ground drainage; or, identifying the sources of drinking water, a treatment process, the storage and distribution of water supplies; for example. 	<p>ICT3.3 Present combined information such as text with image, text with number, image with number.</p>