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BSI Standards Publication

Greywater systems –

Part 1: Code of practice

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Contents

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Foreword

Publishing information

This part of BS 8525 is published by BSI and came into effect on 30 June 2010. It was prepared by Technical Committee CB/506, *Water reuse*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

BS 8525, *Greywater systems*, will be published in two parts:

- Part 1: *Code of practice;*
- Part 2: *Domestic greywater treatment equipment – Requirements and test methods.*

Use of this document

As a code of practice, this part of BS 8525 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 8525 is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following regulations:

- The Private Water Supplies Regulations 2009 [1];
- The Private Water Supplies (Scotland) Regulations 2006 [2];
- The Private Water Supplies (Wales) Regulations 2010 [3];
- The Private Water Supplies Regulations (Northern Ireland) 2009 [4];
- The Health and Safety at Work etc. Act 1974 [5];
- The Workplace (Health, Safety and Welfare) Regulations 1992 [6];
- The Building Regulations (England and Wales) 2000 [7];
- The Building Standards (Scotland) Regulations 2004 [8];
- The Building Regulations (Northern Ireland) 2000 [9];
- The Confined Spaces Regulations 1997 [10];
- The Work at Height Regulations 2005 [11].

In this document, the following national regulations, which apply to plumbing systems in premises to which a supply of public mains water has been, or is to be, provided, are referred to as the "Water Fittings Regulations [12]":

- The Water Supply (Water Fittings) Regulations 1999, in England & Wales;
- The Water Byelaws 2004 (Scotland), in Scotland;
- The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009, in Northern Ireland.

0 Introduction

0.1 General

On-site collection and use of greywater is an alternative to public mains or private potable water supply for a variety of non-potable water uses in the home, workplace and garden.

As greywater systems become more popular, there is a need for standardization to protect the public and to ensure that reliable systems are designed, installed and maintained.

0.2 Types of greywater systems

Greywater systems vary significantly in their complexity and size, and can be grouped according to the type of filtration or treatment they use, as follows.

a) Direct reuse systems (no treatment)

These systems use simple devices to collect greywater from appliances and deliver it directly to the points of use, with no treatment and minimal, or no, storage, e.g. a greywater diverter valve.

NOTE 1 It is possible to reuse greywater without any treatment, provided that extended storage is not required. As untreated greywater quality deteriorates rapidly, the collected greywater ideally needs to be reused as soon as it has cooled.

NOTE 2 Where no treatment is included in the greywater system, applications are restricted to sub-surface irrigation and non-spray applications.

b) Short retention systems

These systems apply a very basic filtration or treatment technique, such as skimming debris off the surface of the collected greywater and allowing particles to settle to the bottom of the tank. They aim to avoid odour and water quality issues by ensuring that the treated greywater is not stored for an extended period.

c) Basic physical/chemical systems

These systems use a filter to remove debris from the collected greywater prior to storage while chemical disinfectants (e.g. chlorine or bromine) are generally used to stop bacterial growth during storage.

d) Biological systems

These systems use aerobic or anaerobic bacteria to digest any unwanted organic material in the collected greywater. In the case of aerobic treatment, pumps or aquatic plants can be used to aerate the water.

e) Bio-mechanical systems

These systems, the most advanced for domestic greywater reuse, combine biological and physical treatment, e.g. removing organic matter by microbial cultures and solid material by settlement. They encourage bacterial activity by bubbling oxygen through the collected greywater.

f) Hybrid systems

These systems use a mix of the system types detailed in a) to e).

NOTE 3 Greywater systems can also be integrated with rainwater harvesting systems. See Annex A.

1 Scope

This part of BS 8525 gives recommendations on the design, installation, alteration, testing and maintenance of greywater systems utilizing bathroom greywater to supply non-potable water in the UK.

It covers:

a) systems supplying water for domestic water uses (in residential, commercial, industrial or public premises) that do not require potable water quality such as laundry, WC and urinal flushing and garden watering;

b) individual and communal systems.

It applies to retrofitting and new build.

It does not cover:

1) systems supplying water for drinking, food preparation and cooking, dishwashing and personal hygiene;

2) direct reuse systems for external use;

3) product design for specific system components;

4) the reuse of trade effluent.

NOTE Although this British Standard does not give specific recommendations relating to the use of treated greywater for fire suppression or commercial irrigation, these applications are not excluded.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 1427, *Guide to on-site test methods for the analysis of waters*

BS 4800:1989, *Schedule of paint colours for building purposes*

BS 6068-4.12, BS ISO 11371, *Water quality – Part 4: Microbiological methods – Section 4.12: Detection and enumeration of Legionella*

BS 6700:2006+A1:2009, *Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Specification*

BS 7671, *Requirements for electrical installations – IEE Wiring Regulations – Seventeenth edition*

BS 8515:2009, *Rainwater harvesting systems – Code of practice*

BS EN 12050-2, *Wastewater lifting plants for buildings and sites – Principles of construction and testing – Part 2: Lifting plants for faecal-free wastewater*

BS EN 12056-2, *Gravity drainage systems inside buildings – Part 2: Sanitary pipework, layout and calculation*

BS EN 12056-4, *Gravity drainage systems inside buildings – Part 4: Wastewater lifting plants – Layout and calculation*

BS EN 13564 (all parts), *Anti-flooding devices for buildings*

BS EN 60335-2-41, *Household and similar electrical appliances – Safety – Part 2-41: Particular requirements for pumps*

BS EN ISO 7393-2, BS 6068-2.26, *Water quality – Determination of free chlorine and total chlorine – Part 2: Colorimetric method using N,N-diethyl-1,4-phenylenediamine, for routine control purposes*

BS EN ISO 7899-1, BS 6068-4.3, *Water quality – Detection and enumeration of intestinal enterococci – Part 1: Miniaturized method (Most Probable Number) for surface and waste water*

BS EN ISO 7899-2, BS 6068-4.4, *Water quality – Detection and enumeration of intestinal enterococci – Part 2: Membrane filtration method*

BS EN ISO 9308-1, BS 6068-4.14, *Water quality – Detection and enumeration of Escherichia coli and coliform bacteria – Part 1: Membrane filtration method*

BS EN ISO 9308-3, BS 6068-4.10, *Water quality – Detection and enumeration of Escherichia coli and coliform bacteria – Part 3: Miniaturized method (Most Probable Number) for the detection and enumeration of E. coli in surface and waste water*

BS EN ISO 19458, *Water quality – Sampling for microbiological analysis*

BS ISO 5667-5, *Water quality – Sampling – Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems*

Other publications

[N1] WATER REGULATIONS ADVISORY SCHEME. *Information and Guidance Note No. 9-02-05: Marking and Identification of Pipework for Reclaimed (Greywater) Systems*. Newport: WRAS, 1999. [1)]

[N2] ENVIRONMENT AGENCY. *The Microbiology of Drinking Water (2009) – Part 4 – Methods for the isolation and enumeration of coliform bacteria and Escherichia coli (including E.coli O157:H7)*. Blue book 223. Bristol: Environment Agency, 2009. [2)]

[N3] ENVIRONMENT AGENCY. *The Chemical Disinfecting Agents in Waters and Effluents*. Blue book 218. Bristol: Environment Agency, 2008. [2)]

1) Available online at http://www.wras.co.uk.

2) Available online at http://www.environment-agency.gov.uk.

3 Terms and definitions

For the purposes of this part of BS 8525, the following terms and definitions apply.

3.1 air gap
visible, unobstructed and complete physical air break between the lowest level of water discharge and the level of potentially contaminated fluid downstream (critical water level) within a cistern, vessel, fitting or within an appliance

NOTE This definition has been taken from Defra's guidance document on the Water Fittings Regulations [13].

3.2 anti-surcharge valve
valved device, installed directly in the pipework of a drainage system intended to protect buildings from backflows and flooding from drains or foul sewer(s)

3.3 backflow
movement of fluid contrary to its intended direction of flow within an installation

3.4 backflow prevention arrangement
arrangement or device which is intended to prevent contamination of water by backflow

3.5 back-up water supply
supply of potable water, e.g. from the public mains water supply, that can supplement the non-potable supply in times of drought and/or heavy demand

3.6 bathroom greywater
greywater from domestic baths, wash and hand basins, showers and clothes washing machines

3.7 blackwater
domestic wastewater with faecal matter and urine

[BS EN 1085 (modified)]

3.8 break cistern
cistern used to separate two plumbing systems of different pressures, water qualities or flow rates, where the water from one system discharges through an appropriate air gap and into the storage cistern feeding the second system

3.9 calmed inlet
fitting on the end of the drainage pipe feeding the storage tank that minimizes turbulence and slows the water flow into the tank

NOTE The calmed inlet is used to prevent disturbance of any sediments near the base of the tank.

3.10 cistern
fixed container holding water at atmospheric pressure, which is part of a plumbing system

3.11 control unit
unit which automatically controls and monitors the function of the greywater system to facilitate effective operation

3.12 cross-connection
physical hydraulic link or a removable link between separate systems

3.13 dead leg
section of pipework through which no water flows, usually created by closing a valve or terminal fitting

3.14 dip sample
sample of water collected by immersing a sterile container into a body of water

3.15 domestic use
use related to residential or similar dwellings

NOTE Potable domestic use includes water for the kitchen sink, wash and hand basins, bath, shower and dishwasher. Non-potable domestic use includes water for WC flushing, domestic washing machines and garden watering.

In commercial, industrial or public premises, "domestic use" is limited to water used for those applications/appliances described above and excludes, for example, water used for fire fighting, central heating or irrigation systems.

3.16 domestic wastewater
water discharged from kitchens, laundry rooms, bathrooms, toilets and similar facilities

[BS EN 1085]

3.17 greywater
domestic wastewater excluding faecal matter and urine

[BS EN 1085]

*NOTE This British Standard covers systems using bathroom greywater. For ease of reference, where the standard refers to "greywater", this is assumed to be "bathroom greywater". See **3.6**.*

3.18 nominal capacity
dimensional volume of the maximum capacity of water that can be retained within the tank, e.g. up to the overflow

3.19 non-potable water
any water other than potable water

NOTE Non-potable water can also be referred to as "unwholesome" water.

3.20 overflow
pipe or arrangement of fittings that relieves the system of excess water at a predetermined level

3.21 point of use
outlet where water is drawn by the user either directly or by connecting an apparatus

3.22 potable water
water suitable for human consumption that meets the requirements of Section 67 (Standards of Wholesomeness) of the Water Industry Act 1991 [14]

NOTE Potable water can also be referred to as "wholesome" water.

3.23 public mains water
wholesome water supplied by a water undertaker, licensed water supplier, Scottish Water or the undertaker as specified in the Water Industry Act 1991 [14] in England & Wales, the Water (Scotland) Act 1980 [15] in Scotland, or the Water and Sewerage Services (Northern Ireland) Order 2006 [16] in Northern Ireland

3.24 rainwater
water arising from atmospheric precipitation

3.25 soakaway
pit or other drainage arrangement prepared in permeable ground to which surplus surface water is fed and from which it soaks into the ground

[BS EN 1085]

3.26 spillover level
level at which the fluid in a receiving vessel will first spill over or out of the vessel if the inflow of water exceeds the outflow through any outlet and any overflow pipe

3.27 surface water
water from precipitation, which has not seeped into the ground and which is discharged to the drain or foul sewer directly from the ground or from exterior building surfaces

[BS EN 1085 (modified)]

3.28 tank
closed, watertight, vented container for rainwater or greywater, which forms part of a drainage system

NOTE Other definitions of "tank" describe vessels used in water supplies at pressure but these are outside the context of this British Standard.

3.29 warning pipe
pipe in which water flows when the predetermined overflow level is about to be exceeded, giving conspicuous warning of impending overflowing e.g. by visible means or audible alarm

4 Design

4.1 System type and treatment capacity

4.1.1 General

The following factors should be identified in order to determine the type and treatment capacity of the greywater system:

a) demand and yield, based on:
   1) the number and type of intended applications, both present and future;
   2) the volume and usage patterns of these applications;
   3) discharge figures for showers, baths, wash and hand basins and washing machines connected for reuse;
b) water quality guidelines for the intended uses (see Clause **6**);
c) peak capacity treatment rate.

The sizing of integrated greywater and rainwater systems should be in accordance with Annex A.

NOTE 1 Residual disinfectant or byproducts might be present in the treated greywater. Colour could also be present. These systems might not be suitable for laundry use or garden watering. Furthermore, if it is intended that treated greywater is to be used for garden watering, water that has been artificially softened might not be suitable for some plants and soils because of salt carryover in the treated greywater.

NOTE 2 It is noted that treated greywater discharge rates vary depending on the appliances that are in use. For example, a shower can discharge at a rate between 0.1 L/s (or less) and 0.3 L/s, while a full bath typically discharges at between 0.4 L/s and 0.5 L/s. The greywater system needs to manage these varying incoming flow rates.

4.1.2 Calculation method

4.1.2.1 General

The type and capacity of the greywater system should be calculated using one of the following methods:

a) the simplified approach, where the bathroom greywater is to be used for WC flushing and/or laundry within single residential premises (see **4.1.2.3**);

b) the detailed approach, where the bathroom greywater is to be used for WC flushing, laundry, vehicle washing and garden watering in residential, commercial, industrial or public premises (see **4.1.2.4**).

Where a property is intended for a hotel, hall of residence or similar accommodation buildings, or where more than one property is to be supplied by a single greywater system, the detailed approach should be used.

4.1.2.2 Demand and yield hierarchies

It is recommended that demand drives the specification of the greywater system, in order to prevent the collection and treatment of water that cannot be used. The following demand order of preference should be considered for potential non-potable uses:

a) WC flushing;

b) external use – non-spray;

c) laundry use, i.e. washing machine;

d) external use – spray.

Only bathroom greywater should be collected for treatment so that the greywater system can offer the best quality treated water for non-potable uses without having the additional burden of treating the most heavily contaminated greywater, particularly from food waste. The following yield order of preference should be considered for collection and treatment:

1) showers and baths;

2) wash and hand basins;

3) washing machines.

NOTE 1 Where washing machines are both taking water from and feeding water into the greywater system, the system needs to incorporate a suitable treatment process and only utilize suitable greywater.

NOTE 2 It is assumed in this standard that the appliances from which greywater is collected will be used normally. Where it is anticipated that an appliance will be used in an unusual manner, e.g. for the soak disinfection of cotton towel nappies or for hair colouring, further consideration might need to be given to either:

- *the suitability of the appliance for greywater collection; or*
- *the suitability of the treatment process incorporated in the greywater system.*

4.1.2.3 The simplified approach

*COMMENTARY ON **4.1.2.3***
The simplified approach is based on the following assumptions:

a) relatively constant daily demand of 25 litres per person for WC flushing and 15 litres per person for laundry;

b) relatively constant daily supply of bathroom greywater of 50 litres per person.

When calculating the treatment capacity of the greywater system, the average daily yield and demand per person should be taken into account.

NOTE Typical values are given in Table 1.

Table 1 **Typical average daily greywater yield and demand**
Measurements in litres

Occupancy	Yield [A]	Demand		
		WC	Laundry [B]	Other non-potable uses [C]
1 person	50	25	15	10
2 people	100	50	30	20
3 people	150	75	45	30
4 people	200	100	60	40
5 people	250	125	75	50
6 people	300	150	90	60

[A] Yield from showers, baths and/or wash and hand basins.

[B] These figures are based on average daily demand. It is noted that a washing machine will typically use 50 L per cycle.

[C] For example, garden watering.

NOTE These values have been derived from the Communities and Local Government (CLG) Water Efficiency Calculator [17]. An electronic version of the calculator is available at http://www.wrcplc.co.uk/partgcalculator/.

4.1.2.4 The detailed approach

NOTE The detailed approach assumes that the yield and demand are constant and excludes usage peaks.

4.1.2.4.1 Greywater yield

The following equation should be used to determine the greywater yield, Y_G, in litres (L):

$$Y_G = n\left(\sum\left[\left\{SU_s\right\}+\left\{BU_b\right\}+\left\{\left(H_{wb}U_{hwb}\right)+F_{wb}\right\}+\left\{\left(\frac{W}{L}\right)U_{wm}\right\}\right]\right) \quad (1)$$

where:

n is the number of persons

S is the average flow rate from the shower in litres per minute (L/min)

U_s is the typical usage factor for the shower

B is the bath volume to overflow (unoccupied) in litres (L)

U_b is the typical usage factor for the bath

H_{wb} is the mean peak flow rate from taps in litres per minute (L/min)

U_{hwb} is the typical usage factor for the hand wash basins

F_{wb} is the fixed flow from basin taps used for vessel filling

W is the washing machine water consumption per wash cycle (see Commentary) in litres (L)

L is the maximum dry wash load recommended by manufacturers (see Commentary) in kilograms (kg)

U_{wm} is the typical usage factor for the washing machine

NOTE Where premises have an active hygiene flushing programme to minimize poor water quality in the potable cold or hot water system, this run-off may be collected as an additional resource. If this is a regular programme it can be considered for inclusion in the yield calculation.

*COMMENTARY ON **4.1.2.4.1***
The following are some typical values that can be used in equation 1. Where more precise values are not known, these values may be used for estimation purposes.

n: two people in the master bedroom and one additional person in each of the remaining bedrooms

S: 5 L/min for low flow or electric shower; 12 L/min for normal mixer shower; 15 L/min for high flow shower

U_s: 5.60 for a shower only; 4.37 where there is also a bath

B: 120 L to 250 L

U_b: 0.5 for a bath only; 0.11 where there is also a shower

H_{wb}: 5 L/min to 15 L/min

U_{hwb}: 1.58

F_{wb}: 1.58 L per person per day

W: 30 L to 60 L

L: 4 kg to 10 kg

U_{wm}: 2.1

*European Community energy labels for washing machines either for sale or hire are required to display efficiency data based on a standard 60 °C cotton wash. For washing machines, this includes information on water consumption (*W*) and load capacity (*L*) and these values should be used in the equation 1. Where the performance of the washing machine is unknown, the ratio may be assumed to be 8.17 litres per kilogram.*

4.1.2.4.2 Greywater demand (WC flushing and laundry use)

The following equation should be used to determine greywater demand, *C*, in litres (L) where the treated greywater is to be distributed for WC flushing (single-, full- or part-flush cisterns) and laundry use, as relevant.

NOTE Where more than one type of WC is installed, the consumption can be calculated for each WC or it can be assumed that all WCs will be used equally, in which case the standard consumption for each type can be calculated and the results simply averaged.

$$C = n\left(\sum\left[\left\{V_{WC}U_{sf}\right\}+\left\{V_{FWC}U_{Ff}+V_{PWC}U_{Pf}\right\}+\left\{\left(\frac{W}{L}\right)U_{wm}P_{WM}\right\}\right]\right) \quad (2)$$

where:

- n is the number of persons
- V_{WC} is the flush volume for a single-flush WC
- U_{sf} is the usage factor for a single-flush WC
- V_{FWC} is the full-flush volume for a dual-flush WC
- U_{Ff} is the full-flush usage factor for a dual-flush WC
- V_{PWC} is the part-flush volume for a dual-flush WC
- U_{Pf} is the part-flush usage factor for a dual-flush WC
- W is the washing machine water consumption per wash cycle (see Commentary) in litres (L)
- L is the maximum dry wash load recommended by manufacturers (see Commentary) in kilograms (kg)
- U_{wm} is the usage factor for the washing machine
- P_{WM} is the proportion of water consumed by the washing machine to be supplied by non-potable water

*COMMENTARY ON **4.1.2.4.2***
The following are some typical values that can be used in equation 2. Where more precise values are not known, these values may be used for estimation purposes.

n: two people in the master bedroom and one additional person in each of the remaining bedrooms

U_{sf}: 4.42

U_{Ff}: 1.46

U_{Pf}: 2.96

W: 30 L to 60 L

L: 4 kg to 10 kg

u_{wm}: 2.1

P_{WM}: 1

*See also Commentary on **4.1.2.4.1** regarding typical values for washing machine consumption and dry wash loads.*

4.1.2.4.3 Greywater demand (external use, e.g. garden watering)

If the treated greywater is required for external use, demand should be estimated. The value will depend upon a number of factors, e.g. soil type, crop types, shading and topography.

4.1.3 Sizing

Depending on the type of greywater system, the optimum storage capacity for treated greywater should be determined by the following factors:

a) the peak capacity treatment rate;

b) the demand, usage or behaviour patterns.

It is recommended that storage of treated greywater be minimized to that needed for immediate use. As there is generally a ready supply of untreated greywater, storage equal to a single day's use is normally considered sufficient.

NOTE Where an integrated greywater and rainwater system is used, the storage might need to be increased (see also Annex A).

4.2 Collection

NOTE 1 Greywater systems depend significantly on the behaviour of the people using the collection appliances, as well as the quality and volume of water collected.

Depending on the type of system, greywater can be collected in different ways. It should generally be collected in separate wastewater drainage pipework and allowed to flow from collection appliances to the greywater system by gravity or syphonic action.

*NOTE 2 Where this is not practicable, e.g. in single-storey dwellings, pumps need to be considered (see **4.8.2**).*

Collection pipework should be:

a) dedicated to bathroom greywater;

b) sized and laid out in accordance with BS EN 12056-2, such that the generation of foam is minimized. As air entrainment is a major factor in the generation of foam, turbulence and the use of bends should be minimized;

c) identified in accordance with Annex B;

NOTE 3 Useful guidance on the colour coding of pipework is given in WRAS Information and Guidance Note No. 9-02-05 [N1] and the National Joint Utilities Group's NJUG Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus [18].

d) free draining to avoid stagnation.

Collection pipework should prevent contaminated water entering the greywater system from other sources.

It is recommended that hair traps and filters be used to minimize pollutants entering the greywater system, wherever possible.

A bypass should be fitted around the greywater system allowing the collected greywater to flow directly to the foul sewer during periods of maintenance, blockage or system isolation. The bypass should not compromise the drainage system.

4.3 Treatment

*NOTE 1 There are many different methods used to filter/treat collected greywater, which range in complexity and the level of treatment. These are outlined in Clause **0**.*

The intended use of the collected greywater should be considered in order to determine whether filtration/treatment is needed and which method is appropriate, e.g. physical, chemical or biological.

The collected greywater should only be treated to the extent needed to meet the water quality guidelines (health considerations) of the application being supplied (see Clause **6**).

After choosing the degree of filtration or treatment, the sustainability aspects and the environmental impact should also be considered in order to determine the most appropriate type of filtration/treatment.

Types of filtration/treatment may include one or more of the following:

a) sedimentation/flotation, e.g. settlement tanks;

b) screening, e.g. large particulate filtration;

c) mechanical fine filtration, e.g. membranes;

d) biological treatment, e.g. aeration;

e) chemical treatment/disinfection, e.g. chlorine;

f) ultraviolet (UV) disinfection.

NOTE 2 This list is not exhaustive and is not intended to inhibit future innovation.

Different filtration or treatment methods may be used in combination to achieve the necessary results.

*NOTE 3 Where a stagnation control system is used e.g. on a drinking water system, the biological quality of run-off water cannot be guaranteed. Therefore, the run-off needs to be directed to the greywater system for treatment via the collection pipework, with backflow prevention installed (see **4.7.2**) as for any potable water source.*

4.4 Storage

4.4.1 General

The storage of untreated greywater should be avoided, wherever possible. Where storage of treated greywater is necessary, it may be incorporated as part of the greywater system or provided separately.

The selection of storage should take into account:

a) the maximum flow rate the treatment equipment delivers;

b) the necessary storage temperature;

c) the maximum storage period and any other conditions stated by the manufacturer of the treatment equipment;

d) whether the system is to be dedicated to greywater only or integrated with a rainwater harvesting system.

*NOTE Provided that the treated greywater quality conforms to Clause **6**, it is acceptable to combine the storage with a rainwater harvesting system (see Annex A).*

Where the greywater treatment equipment does not incorporate an automatic dump facility, the manufacturer's instructions should be consulted regarding arrangements for the discharge of stored treated greywater in the event that the maximum storage period is exceeded.

Where the treated greywater is to share common storage with a rainwater harvesting system, the manufacturer of the rainwater harvesting system should be consulted.

All tanks, cisterns and access fittings should be identified as containing treated greywater in accordance with Annex B.

4.4.2 Storage tanks and cisterns

4.4.2.1 General

Tanks may be positioned either above or below ground and should be appropriate to the site (see **5.2.1**).

NOTE 1 Tanks are normally prefabricated off site.

Tanks should be constructed from materials that create watertight structures without encouraging microbial growth.

NOTE 2 Suitable materials include concrete, glass reinforced plastic (GRP), polyethylene or polypropylene, and steel coated with non-corrodible materials, e.g. steel conforming to BS EN 10143. Guidance on the suitability

of non-metallic products for use in contact with water is given in the BS 6920 series.

All tanks and cisterns, whether used separately or connected to each other in order to create greater capacity, should avoid stagnation, e.g. by ensuring that pipework connections allow the through-flow of water.

All tanks and cisterns should have an overflow (see **4.9**), screened ventilation and fitted lids to prevent contamination of the water. All tanks and cisterns should be sited so that the stored water does not attain temperatures that could encourage unwanted microbial growth.

Where tanks are positioned above habitable or vulnerable areas, the risk of water leakage should be considered, e.g. bunding, additional drainage, sump pump.

The loading of the structure should be taken into account when locating tanks.

4.4.2.2 Above ground tanks and cisterns

NOTE Above ground tanks are particularly cost effective for retrofit applications.

Where they are used, above ground tanks and cisterns should be insulated and opaque to minimize the potential problems of freezing, warming and algal bloom.

4.4.2.3 Below ground tanks

NOTE 1 Below ground tanks can provide frost protection, prevent undue warming in the summer months and restrict algal growth owing to the lack of sunlight.

Below ground tanks (and their covers; see BS EN 124) should be sufficiently rigid to resist likely ground and traffic loadings. Tanks should be installed to resist flotation, where appropriate.

NOTE 2 This might require the use of concrete for backfilling.

4.5 Materials and fittings

The materials selected for the tank and other components should be suitable for the location and temperature ranges anticipated. All components of the greywater system should be capable of withstanding pH levels as low as 5 for the lifetime of the products.

Consideration should be given to the environmental impact of materials used. Existing resources on site should be utilized, where appropriate, and materials re-used where possible to limit the environmental impacts of the greywater system.

4.6 Power supply

Electrical power connections and earthing of the greywater system should be installed in accordance with BS 7671.

NOTE Attention is drawn to the Building Regulations [7]–[9].

Where a residual current detection (RCD) device is not installed in the power distribution board, such a device should be provided.

The power supply should be readily accessible, but also guarded, to prevent the inadvertent isolation or disconnection of electricity.

4.7 Back-up water supply and backflow prevention

NOTE Attention is drawn to the Water Fittings Regulations [12] which require adequate backflow prevention to be provided so that water supplied from the public mains for domestic uses does not become contaminated.

In premises where a public mains water supply exists, or is to be provided, notification needs to be given to the local water supplier prior to work commencing, with a plan, schematic diagram and details of what is proposed.

4.7.1 Back-up water supply

The greywater system should incorporate a back-up water supply from a reliable source, which may be introduced into:

a) a purpose-designed module, incorporating a break cistern prior to its pump, for delivery to the distribution pipework;

b) an intermediate storage cistern, usually located at high level; or

c) the treated greywater tank/cistern, by means of a connection into the tank/cistern or into the collection pipework.

In all cases, backflow prevention should be fitted in accordance with **4.7.2**.

NOTE For examples of typical systems with different back-up supply arrangements, see Annex C.

The back-up water supply should be fitted with a control mechanism to minimize the amount of water supplied to that needed for immediate use. It is recommended that this is provided from a make-up module or an intermediate storage cistern.

The back-up water supply should also be fitted with a warning mechanism that alerts the user to the failure of the inlet control valve (e.g. a float valve in the storage cistern) to close correctly. This warning may involve a warning pipe that can be readily seen or an electronic device, such as an alarm.

The warning mechanism should activate before the water level overflows. For storage tanks below ground, an alternative to a warning pipe should be used as it cannot be readily seen.

The back-up water supply should be sized to allow it to meet the full demand requirements. The impact that a sudden demand from the back-up mechanism might create in operation on the water supply, particularly in large communal systems, should be considered and it is important that the water supply infrastructure is capable of meeting this increase.

To prevent stagnation of the back-up water supply when it is not required, dead legs should be avoided, wherever possible, or a system employed to enable suitable turnover.

Where this is unavoidable, additional backflow prevention in the form of a single check valve should be provided at the branch of the pipework supplying the back-up mechanism to protect the potable water supply.

4.7.2 Backflow prevention

To prevent non-potable water entering the potable or public mains water supply, the back-up water supply should be fitted with a backflow prevention arrangement that is capable of providing category 5 protection (an air gap), such as:

a) a Type AA air gap conforming to BS EN 13076 (see Figure 1); or

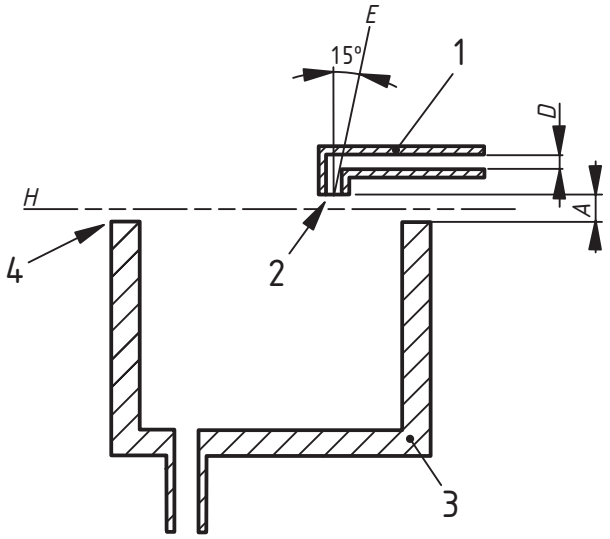
b) a Type AB air gap conforming to BS EN 13077 (see Figure 2).

Flow rates, head loss and installation requirements should be taken into account when selecting the backflow prevention arrangement.

No direct connection bypassing the backflow prevention arrangement should be installed.

The backflow prevention arrangement should be located above ground or within a building that is not subject to flooding and upstream of, or at, the point where water from the separate supplies meets.

Figure 1 **Unrestricted Type AA air gap (BS EN 13076)**



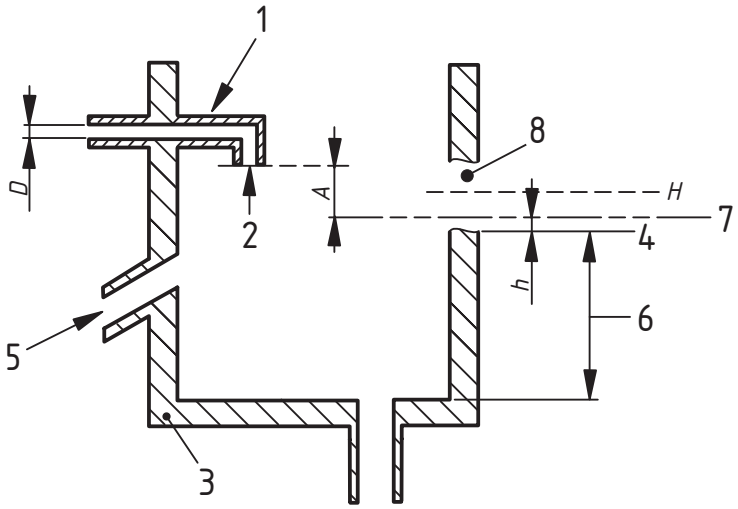
Key

1	Feed pipe	*A*	Air gap
2	Feed orifice	*H*	Maximum level
3	Receiving vessel	*E*	15° maximum from the vertical
4	Spillover level	*D*	Internal diameter of feed pipe (bore)

NOTE 1 This arrangement may be used where the discharge point from the public mains water or potable water supply can be placed above the spillover level of the rim of the storage cistern.

NOTE 2 Overflows and warning pipes have not been shown for clarity.

Figure 2 **Unrestricted Type AB air gap with non-circular overflow (BS EN 13077)**



Key

1	Feed pipe	7	Critical water level (distance *h*)
2	Feed orifice	8	Type AB air gap
3	Receiving vessel	*A*	Air gap
4	Spillover level	*H*	Maximum level
5	Overflow warning pipe	*D*	Internal diameter of feed pipe (bore)
6	Upstream face of the overflow arrangement *Uw* (*Uw* ≥ 5*h*)		

NOTE 1 This arrangement may be used where the discharge point from the public mains water or potable water supply is to be enclosed within the storage cistern. The slot that provides the spillover level is provided within the side of the cistern body (see item 8) and below the outlet of the inlet device. The size of the spill slot needs to conform to BS EN 13077 within critical limits. Owing to the complexities in sizing, detailed guidance is not given in this standard; however, a free-to-access online Type AB Air Gap Calculator is available from the Water Regulations Advisory Scheme [19]. The overflow warning pipe (see item 5) is generally of a standard size, governed by the inlet device to the tank/cistern.

NOTE 2 The critical water level is the physical or piezometric level of the liquid reached in any part of the appliance 2 seconds after closing the water inlet starting from maximum level.

4.8 Pumping (collection and distribution)

4.8.1 General

Where the greywater system does not distribute the greywater by gravity, a pump(s) should be used to ensure its continual availability. All pumps should conform to BS EN 60335-2-41.

Pumps should be sized so that each pump is capable of overcoming the static lift plus the friction losses in the pipework and valves.

NOTE The operational safety and hydraulic demand will dictate whether a single pump or multiple-pump systems are needed.

The pumps should be selected and arranged such that:

a) energy use and noise are minimized;

b) cavitation is prevented;

c) air is not introduced into the greywater system.

Pumps should be equipped with dry-run protection, which may be either integral to the pump or provided by an external control device.

Surges and water hammer from the pump should be absorbed and prevented from causing undue high pressures, e.g. the incorporation of expansion vessels or pressure controls prevents bursting, hunting of pumps and excessive draw off.

4.8.2 Pumps for collected greywater

Pumps for collected greywater should be able to accommodate any solid matter likely to be contained in the greywater as detailed in BS EN 12050-2.

The pump installation should be sized and laid out in accordance with BS EN 12056-4.

If the pump incorporates any filtering or traps, these should be accessible for maintenance and cleaning.

Where accumulation of the flow from the collection appliances would be detrimental to users and/or the system, means should be provided to divert untreated greywater to the foul sewer. Alternatively, duplicate pumping devices should be installed.

4.8.3 Pumps for treated greywater

*NOTE Where a non-potable supply is pumped directly to WCs, an alternative back-up water supply to the WC might be needed for hygiene purposes in case of pump or control failure. Attention is drawn to the Water Fittings Regulations [12] which require that, in such cases, backflow prevention is provided (see **4.7.2**).*

4.8.3.1 Pumps for treated greywater located outside the tank

If installed outside the tank, the pump should have its own self-priming mechanism or a control system which ensures a constant fully primed condition. The suction line to the pump should be laid with a steady gradient upwards towards the pump. The pump should be placed in a well-ventilated location and protected from extremes of temperature, with sound-absorbing and vibration-absorbing mountings.

A non-return valve should be provided in the suction line to the pump in order to prevent the water column from draining down. The pressure line of the pump should be supplied with an isolating valve.

4.8.3.2 Pumps for treated greywater located inside the tank

NOTE A minimum level of water needs to be maintained above the pump inlet in order to prevent damage by sucking in air, sediment or debris.

The immersion depth should be in accordance with the pump manufacturer's instructions. The pump should be removable for maintenance purposes. A non-return valve should be provided, with an isolating valve to enable the non-return valve to be maintained.

4.8.4 Pump control unit

The pump control unit should:

a) operate the pump(s) to match demand;

b) protect the pumps from running dry;

c) protect the motor from over-heating and electric overload.

The pump control unit should permit manual override.

4.9 Overflow, bypass, and drainage

An overflow should be fitted to all tanks/cisterns to allow excess water to be discharged. The overflow should be such that any backflow is prevented and vermin are unable to enter the greywater system. Overflows fitted to above ground tanks/cisterns should be screened to prevent the ingress of insects, vermin etc.

The capacity of the outlet pipe on the overflow pipe should be capable of draining the maximum inflow without compromising the inlet air gap.

Where appropriate, the overflow and bypass should be fitted with an anti-surcharge valve conforming to BS EN 13564 (all parts).

The overflow and bypass(es) should be connected to the foul sewer.

Any discharge to the drain(s) from the greywater treatment unit should minimize the volume of foam introduced to the sewer system.

4.10 Controls and metering

A control unit should be incorporated in the greywater system to ensure, as a minimum, that users are aware of whether the system is operating effectively.

For non-electrically powered greywater units, e.g. simple filters, provision should be made to enable the performance or condition of the treatment equipment to be monitored visually, so that it can then be replaced or cleaned as necessary.

For electrically powered units, the control unit should:

a) make the user aware when any consumable items need replenishment or replacement, to prevent a system failure;

b) ensure that treated greywater is not stored for a period that would allow water quality to deteriorate beyond the specified quality (see Clause **6**) or that exceeds the manufacturer's requirements;

c) in the event of any system failure:

   1) make the user aware, e.g. by a visible or audible warning;

   2) ensure that the bypass directs untreated water to the foul sewer;

d) in the event of a treatment failure, ensure that the applications supplied by the greywater system are fed from the back-up water supply;

e) control pumps and minimize operational wear and energy use;

f) activate the back-up water supply automatically when required by the treatment unit;

g) provide a volt-free output to enable the greywater system to be linked to a building management system (BMS), where appropriate.

NOTE Guidance on the design of a suitable control unit can be found in BS 6739.

In order to prevent waste, storage cisterns with valve-controlled water inputs should have a warning system so any failure is readily noticeable.

*COMMENTARY ON **4.10***
In addition to the control unit, system status monitoring may be incorporated that can inform the user of:

- *whether treated greywater or back-up supply water is being used;*
- *the volume of treated greywater used and the volume of water used from the back-up water supply. This can be logged and displayed;*
- *how full the tank or cistern is;*
- *any malfunctions. These should relate to the specific fault, e.g. pump failure, back-up water supply failure.*

Additional monitoring of the overflow, water quality, tank/cistern temperature and other parameters may also be included.

4.11 Distribution

*COMMENTARY ON **4.11***
Readers might wish to note that the requirements specified for potable water systems in BS 6700 and BS EN 806 are considered good plumbing practice for all systems, regardless of the source of water.

Attention is also drawn to the Water Fittings Regulations [12]. These apply to pipes and fittings that are supplied, or are to be supplied, with public mains water.

4.11.1 General

The greywater system should distribute the treated greywater by:

a) pumping it from the storage tank directly to the point of use;

b) pumping it from the storage tank to intermediate cisterns near the point of use;

c) using a gravity storage tank/cistern, where practicable; or

d) using a full gravity system, without pumps.

Consideration should be given to minimizing the energy used to distribute treated greywater.

Provision should be made for the complete draining down of the greywater system within the building, including all tanks, cisterns, pipework, filtration units and pumps.

4.11.2 Distribution pipework and fittings

*COMMENTARY ON **4.11.2***
A variety of materials may be used for the distribution pipework, including:

- *polybutylene conforming to BS 7291-2;*
- *cross-linked polyethylene (PE-X) conforming to BS 7291-3;*
- *copper conforming to BS EN 1057; or*
- *stainless steel containing molybdenum (Mo) and conforming to either BS EN 10216-5 for seamless pipes or BS EN 10217-7 for welded pipes;*
- *multi-layer pipes conforming to WRAS guidance.*

It is important to note that, where polybutylene or cross-linked polyethylene pipes are to be installed below ground, ducting is required.

Specific guidance on the types of pipe suitable for contaminated ground is given in WRAS Information and Guidance Note No. 9-04-03 [20].

To differentiate greywater pipework from potable water pipework, a contrasting type or colour of pipe material should be used. The pipework of the greywater system, including any below ground back-up water supply pipes, should not be blue, as blue pipework is often used for the potable water supply. It is recommended that pipes are either green, or black and green, in accordance with WRAS Information and Guidance Note No. 9-02-05 [N1] (see also BS 1710 and the National Joint Utilities Group's *NJUG Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus* [18]).

In addition, all pipework and fittings should be marked and/or labelled in accordance with Annex B (see also **5.4.2**).

Pipework should be sized to provide adequate flow and pressure (see BS 6700), e.g. oversized pipes can cause water quality issues from low flows and excessive pressures can cause undue consumption or leakage.

Pipework and fittings should be arranged in such a way as to:

a) be sufficiently strong to resist bursting from the pressure they are to be subjected to in operation (see **5.5** for hydraulic testing);

b) prevent cross-connections with any public mains water or potable water supply;

c) prevent the trapping of air during filling, and the formation of air locks during operation, that would cause water to be unduly drawn off to clear the greywater system.

NOTE Cross-connections between the potable and greywater systems can have serious consequences on the quality of the potable water supply. Attention is drawn to the Water Industry Act 1991, Section 73 [14].

5 Installation

5.1 General

NOTE Attention is drawn to local planning and building regulations, including the Water Fittings Regulations [12]. Guidance on the Water Fittings Regulations is available from WRAS or local water suppliers.

In premises where a public mains water supply exists, or is to be provided, notification needs to be given to the local water supplier prior to work commencing, with a plan, schematic diagram and details of what is proposed.

Installation should be carried out in accordance with instructions given by the manufacturer or supplier.

Installation should be such that all components, including tanks, are accessible for future maintenance and/or replacement of consumable parts. In particular, consideration should be given to the following points:

a) access to the greywater treatment equipment;

b) access to below ground tanks;

c) access for personnel to above ground tanks e.g. those located in lofts and roofs;

d) the location of access covers and filters (avoiding the need for access equipment wherever possible);

e) vehicular access to the site.

5.2 Tank installation

5.2.1 General

Prior to installation, any site specific factors that might affect the installation process should be taken into account. Such factors include:

a) groundwater levels;

b) ground strength and stability;

c) land contamination;

d) proximity to trees;

e) proximity to utilities and foundations

f) shading and temperature;

g) access routes;

h) vermin and birds etc.

All tanks should be fitted with lids that protect the water from contamination and prevent inadvertent human entry.

Where environmental conditions dictate, thermal insulation to the greywater system, e.g. the tank/cistern, treatment equipment or pipework, should be considered.

Any holes that have been cut in a tank, other than those provided by the manufacturer, should be round, so as to not cause any additional stress on the tank that might result in a split. Where non-circular apertures are unavoidable, stress relief should be applied to the aperture to minimize any risk of splitting.

Where specified in the design, an anti-surcharge valve conforming to BS EN 13564 should be fitted to the tank overflow to prevent backflow from drains and the foul sewer(s).

All tanks and access fittings should be identified as containing treated greywater in accordance with Annex B.

5.2.2 Above ground tanks

Above ground tanks should be securely mounted and supported on a stable base that extends at least 150 mm in all directions beyond the maximum dimensions of the tank, e.g. close boarding.

Tanks that are to be installed within a building should be able to withstand any temporary deformation that is required during installation (e.g. when being squeezed through a doorway). Tanks, when installed and correctly supported, should not deform as the water level in the tank changes.

Tanks should not be supported by pipework.

5.2.3 Below ground tanks

Below ground or partially buried tanks should be installed so that they are not deformed or damaged.

Measures, such as concrete surrounds or backfilling and/or controlled filling with water, should be taken to maximize the structural stability of these tanks.

NOTE Issues relating to structural stability include avoiding flotation, resisting ground pressures and water table fluctuations (structural deformation), resisting vehicle loadings and accommodating differential movement.

The area around the access covers of any below ground tank should be impervious and free draining away from the covers to avoid contamination during maintenance and inspection.

5.3 Cistern installation

Where treated greywater storage cisterns are needed within buildings, these should be installed as for any cold water cistern with appropriate support, insulation and means to prevent contamination. The cistern should be supported on a firm level base capable of withstanding the weight of the cistern when filled with water to the rim. Plastic cisterns should be supported on a flat rigid platform fully supporting the bottom of the cistern over the whole of its area. Any base used should extend at least 150 mm in all directions beyond the maximum dimensions of the cistern.

Overflows fitted to storage cisterns should be capable of discharging all inflows into the cistern. In addition, an automatic supply cut-off device activated by the overflowing water may be installed to minimize damage and the waste of water.

All cisterns should be identified as containing treated greywater in accordance with Annex B.

5.4 Pipework installation

5.4.1 General

The pipework connecting the collection appliances to the tank should be leaktight (see **5.5**). Pipes should not discharge into open gullies where splashing could occur.

Backflow prevention should conform to **4.7**.

5.4.2 Labelling and identification

All pipework (both collection and distribution), fittings and points of use for the greywater system should be marked and/or labelled in accordance with Annex B, in order to facilitate identification, to

prevent inadvertent consumption or cross-connection and to avoid operating errors (see also **4.2**).

5.5 Testing and commissioning

5.5.1 General

The system should be commissioned in accordance with the manufacturer's installation and commissioning manual, where provided. In all cases, the following tests should be undertaken prior to handover.

a) The pipework of the domestic wastewater system should be air-tested to ensure that the connections to the collection pipework of the greywater system are leak-free and that there are no unintentional cross-connections.

b) The distribution pipework of the greywater system should be flushed and either air-tested or dye-tested (in accordance with **5.5.2**) to ensure that pipework and containers are watertight and that there are no cross-connections with any potable water supply.

c) The distribution pipework and fittings of the greywater system should be tested in accordance with, and meet the requirements of, BS 6700:2006+A1, **6.1.12.3**, at a minimum of 1½ times the maximum working pressure under normal operating conditions.

The greywater system should also be tested in accordance with BS 7671 to ensure that wiring is electrically safe and that there is no interference to or from other electrical or electronic equipment, or wiring in the vicinity.

Where the installation conforms to this code of practice, confirmation of installation/commissioning should be provided.

5.5.2 Dye testing for distribution pipework cross-connections

NOTE 1 The test set-up for dye testing is shown in Figure 3.

NOTE 2 The local water company representative might wish to confirm that there are no cross connections by witnessing testing.

Testing for cross-connections should be carried out before final connections to the potable water or back-up water supply are made, as follows.

a) The greywater treatment unit and potable/back-up water supply pipe should be disconnected and capped prior to testing. The pumped testing units should be temporarily installed as shown in Figure 3.

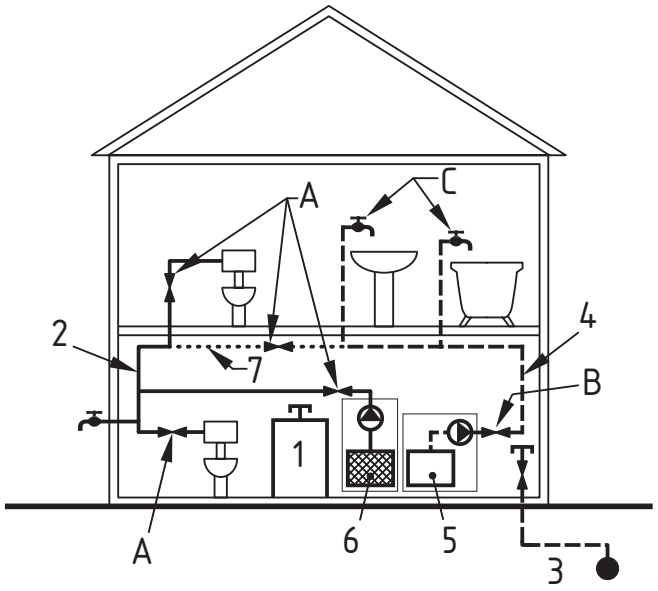
b) All in-line servicing and stop valves (A) should be opened on both the potable/back-up water supplies and the greywater system. The stop valve (B) on the potable/back-up water supply should be closed.

c) The greywater system should be filled with clean potable water and a suitable colourant, such as cochineal E124, added. Water should then be drawn through the greywater system until coloured water exits at the points of use. Outlets on the potable/back-up water supply should be systematically opened to check that no coloured water is discharged.

d) If any coloured water is discharged from a potable/back-up water outlet, the cause should be investigated and rectified.

After testing the greywater system should be thoroughly flushed to remove all residual traces of colourant before it is commissioned and put into operation. The potable/back-up water system should also be thoroughly flushed prior to reconnection.

Figure 3 **Cross-connection dye test**



Key

1 Greywater treatment unit
2 Greywater distribution pipework ——
3 Potable/back-up water supply
4 Potable/back-up water distribution pipework – – – –
5 Testing unit with pump for potable supply, filled with clean potable water
6 Testing unit with pump for greywater system, filled with coloured clean potable water
7 Example of pipework cross-connection .....

A In-line servicing and stop valve
B Stop valve
C Points of use to be inspected for evidence of cross-connection (i.e. coloured water)
T Pipe capped during test

5.6 Handover to user

Upon handover of the greywater system, the user should be provided with sufficient information to enable them to operate and maintain the system satisfactorily. The user should be advised of any procedures or precautions which need to be followed, e.g. in the form of an operation and maintenance manual or a list of "Dos and Don'ts". This information should cover such aspects to enable the reliable operation of the greywater system, such as:

a) general safety advice;

b) information on the use of any hazardous substances, including material safety data sheets (MSDS);

c) guidance on chemicals that might have either a detrimental or beneficial effect on the treatment process;

d) limitations to the use of the greywater system;

e) guidance on what action to take in the event of system failure or suspected poor greywater quality (see also Clause **6**);

f) guidance on what action to take prior to temporary suspension of the greywater system;

g) guidance on routine checks and any practices that could reduce or increase maintenance requirements (see also Clause **7**);

h) contact details for both the manufacturer and the installer.

The user should also be provided with confirmation of installation/commissioning (see **5.5**).

6 Water quality

*COMMENTARY ON CLAUSE **6***
It is essential that greywater systems are designed in a way that ensures the water produced is fit for purpose and presents no undue risk to health, although there are currently no specific regulatory requirements for water quality that apply to systems which use greywater for non-potable water use.

*The MTP has undertaken a review of rainwater and greywater systems and made recommendations for quality guidelines and monitoring arrangements. The recommendations and tables given in Clause **6** have been adapted from this MTP report.*[3)]

Frequent water sample testing is not necessary; however, observations for water quality should be made during maintenance visits to check the performance of the greywater system. Tests should then be undertaken to investigate the cause of any system that is not operating satisfactorily and any complaints of illness associated with water use from the system.

Water sampling for tests should be in accordance with Annex D.

Testing immediately following the commissioning of systems is not recommended as systems are generally filled with public mains water in order to facilitate the testing of components, and water quality is therefore not representative of the normal greywater collection.

Water quality should be measured in relation to the guideline values given in Table 2 for parameters relating to health risk, and Table 3 for parameters relating to system operation, which provide an indication of the water quality that a well-designed and maintained system is expected to achieve for the majority of operating conditions.

The results of bacteriological monitoring should be interpreted with reference to Table 4. The results of general system monitoring should be interpreted with reference to Table 5.

NOTE Water quality is likely to fluctuate as different people use the collection appliances, such as baths and showers, in different ways and the collected greywater is therefore subject to varying levels of dirtiness and use of surfactants.

3) Market Transformation Programme (MTP), *Rainwater and Grey Water – Review of water quality standards and recommendations for the UK* [21].

Table 2 **Guideline values (G) for bacteriological monitoring**

Parameter	Spray application	Non-spray application			Testing		System type
	Pressure washing, garden sprinkler use [A] and car washing	WC flushing	Garden watering [A]	Laundry, i.e. washing machine, use	Spray applications	Non-spray applications	
Escherichia coli number/100 mL	Not detected	250	250	Not detected	BS EN ISO 9308-1	BS EN ISO 9308-3	Single site and communal domestic systems
Intestinal enterococci number/100 mL	Not detected	100	100	Not detected	BS EN ISO 7899-2 or BS EN ISO 7899-1	BS EN ISO 7899-1	Single site and communal domestic systems
Legionella pneumophila number/100 mL	10	N/A	N/A	N/A	BS 6068-4.12	N/A	Where analysis is necessary as indicated by risk assessment (see Clause **8**)
Total coliforms [B] number/100 mL	10	1 000	1 000	10	Blue Book 223, Method D [N2]	BS EN ISO 9308-3	Single site and communal domestic systems

[A] If treated greywater is to be used in kitchen gardens on domestic crops, information regarding the preparation of these crops prior to consumption (e.g. boiling, peeling or thorough washing in potable water) should be provided for the user in the handover documentation (see **5.6**).

[B] "Total coliforms" is an indicator parameter for operational interpretation. The bacteriological guideline values given for treated greywater reflect the need to control the quality of treated water for supply and use.

Table 3 **Guideline values (G) for general system monitoring**

Parameter [A]	Spray application	Non-spray application			Testing	System type
	Pressure washing, garden sprinkler use and car washing	WC flushing	Garden watering	Laundry, i.e. washing machine, use		
Turbidity NTU	< 10	< 10	N/A	< 10	BS 1427	All systems
pH pH units	5–9.5	5–9.5	5–9.5	5–9.5	BS 1427	All systems
Residual chlorine mg/L	< 2.0	< 2.0	< 0.5	< 2.0	BS EN ISO 7393-2	All systems, where used
Residual bromine mg/L	0.0	< 5.0	0.0	< 5.0	Blue Book 218, Method E10 [N3]	All systems, where used

[A] In addition to these parameters, all systems should be checked for suspended solids and colour. The treated greywater should be visually clear, free from floating debris and not objectionable in colour for all uses. Colour is particularly relevant for washing machine use.

Table 4 **Interpretation of results from bacteriological monitoring**

Sample result [A]	Status	Interpretation
< G	Green	System under control
G to 10G	Amber	Re-sample to confirm result and investigate system operation
> 10G [B]	Red	Suspend use of greywater until problem is resolved

[A] G = guideline value (see Table 2).

[B] In the absence of *E.coli*, Intestinal enterococci and *Legionella*, where relevant, there is no need to suspend use of the system if levels of coliforms exceed 10 times the guideline value.

NOTE It might be necessary to include some type of disinfection, e.g. UV or chemical disinfection, to attain the more stringent bacteriological standards suggested, in situations where higher exposure might occur or for systems within public premises (see the Health and Safety Executive (HSE) Approved Code of Practice and guidance L8 [22]).

Table 5 **Interpretation of results from system monitoring** [A]

Sample result [B]	Status	Interpretation
< G	Green	System under control
> G	Amber	Re-sample to confirm result and investigate system operation

[A] When monitoring pH, the system is considered to be under control ("green" status) when levels are within the range recommended in Table 3. If levels are outside this range, the system status becomes "amber" and re-sampling is necessary. Where colour or suspended solids are present at levels which are objectionable, it is necessary to investigate the system operation to resolve the problem.

[B] G = guideline value (see Table 3).

7 Maintenance

Observations for water quality (see Clause **6**) should be taken before any maintenance procedures commence. Where possible, the greywater system should then be drained and flushed with clean water to reduce the risk of contamination to maintenance personnel, people in the vicinity and the physical surroundings. Electricity and all water supplies should be isolated before opening any sealed lids or covers.

Human entry into tanks should be avoided, wherever possible. Where entry is essential, it should only be undertaken by trained personnel with personal protection equipment suitable for confined spaces.

Maintenance procedures should be in accordance with the manufacturer's maintenance recommendations.

In the absence of any manufacturer's recommendations, the maintenance schedule given in Table 6 should be followed. The maintenance intervals listed are for initial guidance but the frequency should be modified in the light of operational experience.

A log should be kept of inspections and maintenance.

In order to maintain the functionality of the greywater system, users should be directed to consult the manufacturer's instructions for guidance on using the appliances connected to the greywater system as they are intended to be used.

Table 6 **Maintenance schedule**

System component	Operation	Notes	Frequency[A)]
Filters, membranes, biological support media and strainers	Inspection/ Maintenance	Check the condition of the filter(s) etc. and clean or replace, if necessary	Annually
Biocide, disinfectant or other consumable chemical	Inspection/ Maintenance	Check that any dispensing unit is operating appropriately; replenish the chemical supply if needed	Monthly
UV lamps (where fitted)	Inspection/ Maintenance	Clean and replace, if necessary	Every 6 months
Storage tank/cisterns	Inspection	Check that there are no leaks, that there has been no build up of debris and that all tanks and cisterns are stable and the covers are correctly fitted	Annually
	Maintenance	Drain down and clean the tanks and cisterns	Every 10 years
Pumps and pump controls	Inspection/ Maintenance	Check that there are no leaks and that there has been no corrosion; carry out a test run; check the gas charge within any expansion vessels or shock arrestors	Annually
Back-up water supply	Inspection	Check that the back-up water supply is functioning correctly and that the air gaps are maintained	Annually
Control unit	Inspection/ Maintenance	Check that the unit is operating appropriately, including the alarm functions where applicable	Annually
Water level gauge (if fitted)	Inspection	Check that any gauge indication responds correctly to the water level in the supply tank or cistern	Annually

Table 6 **Maintenance schedule** *(continued)*

System component	Operation	Notes	Frequency [A)]
Wiring	Inspection	Visually check that the wiring is electrically safe	Annually
Pipework	Inspection	Check that there are: no leaks, the pipes are watertight and any overflows are clear. This includes the collected and treated greywater supplies, any backwash supply and the back-up water supply.	Annually
Markings	Inspection	Check that warning notices and pipework and valve identification are correct, visible and in place	Annually
Supports and fixings	Inspection/ Maintenance	Adjust and tighten, where applicable	Annually
Backwash	Inspection/ maintenance	Check functionality	Annually

[A)] These frequencies are recommended if no information is given by the manufacturer.

8 Risk assessments

NOTE Attention is drawn to the Control of Substances Hazardous to Health Regulations 2002 [23] which give requirements for the storage, handling and labelling of any hazardous substances, e.g. chemicals used for disinfection.

8.1 General

A risk assessment should be carried out to determine whether the greywater system is safe and fit for purpose. This should take place when the system is being designed. The risk assessment should follow a recognized process, such as that described in BS 31100.

NOTE Additional guidance and examples are provided in WRAS Information and Guidance Note No. 9-02-04 [24]. See also the HSE Approved Code of Practice and guidance L8 [22].

The risk assessment should consider the design, installation, testing and commissioning, operation and maintenance of the greywater system, including water quality (see also **8.2**), structural stability, electrical safety and access provision.

The risk assessment should consider the effects of exposure to, and the potential impacts of, the water within the greywater system and any of the system's treatment processes on:

a) people, including operators, installers, maintainers, and water users, particularly those who might be more susceptible to poor water quality (e.g. children or the elderly);

b) the environment, including domestic and feral animals, birds and fish, plants, water courses and groundwater;

c) physical assets, including buildings, building fabrics, room decorations and, where external tanks are used, foundations, drains, paved areas and gardens.

The risk assessment should be used to identify additional actions, process improvements or enhanced controls that can reduce risks in a cost-effective manner.

8.2 Water quality risks

NOTE The World Health Organization endorses the "water safety plan" approach to protect the safety of water supplies. This involves a system of risk assessment and risk management.

The risk assessment should consider potential sources of contamination of water entering or already in the greywater system.

The risk assessment should be used to identify the need for any further water quality control measures, including additional monitoring.

Annex A (normative) Integrated greywater and rainwater systems

A.1 General

Where a greywater reuse or rainwater harvesting system alone cannot provide sufficient water for non-potable use, the integration of two systems can offer a viable solution.

However, before systems are integrated, the following points should be addressed.

a) A thorough assessment should be made of each system individually to determine whether it alone can meet the demand of the intended applications.

b) The benefits of providing additional storage for stormwater control (SUDS) are recognized in BS 8515 and, therefore, consideration should be given to the potential effects of an integrated approach.

The integrated systems can either be operated as separate, independent systems or be combined into a single supply source. Where systems are to be operated independently, the rainwater harvesting system should conform to BS 8515 and the greywater system should conform to this British Standard.

Where systems from different manufacturers are to be combined into a single supply, the compatibility of the systems should be investigated and taken into account. All elements of the system situated downstream of the point of integration should conform to this British Standard.

Where greywater (treated or untreated) and rainwater are integrated in storage tanks/cisterns, all overflows or bypass arrangements should discharge into the foul sewer as only surface water is permitted to be discharged into water courses. Excess rainwater should be diverted to a soakaway or surface water drainage system once the storage tank is full, so that the foul drains are not overwhelmed. Local wastewater companies should be consulted regarding these overflow and bypass connections to foul or surface water drains.

A.2 Systems integrated before treatment

These are considered to be specialized installations and careful consideration should be given to all aspects of the treatment system. The following issues should be taken into account:

a) the variability of influent;

b) the type of treatment equipment required;

c) the management of excess water loads;

d) environmental considerations, e.g. electricity consumption;

e) the validity of treating the whole of the flow from both greywater and rainwater.

NOTE This list is not exhaustive.

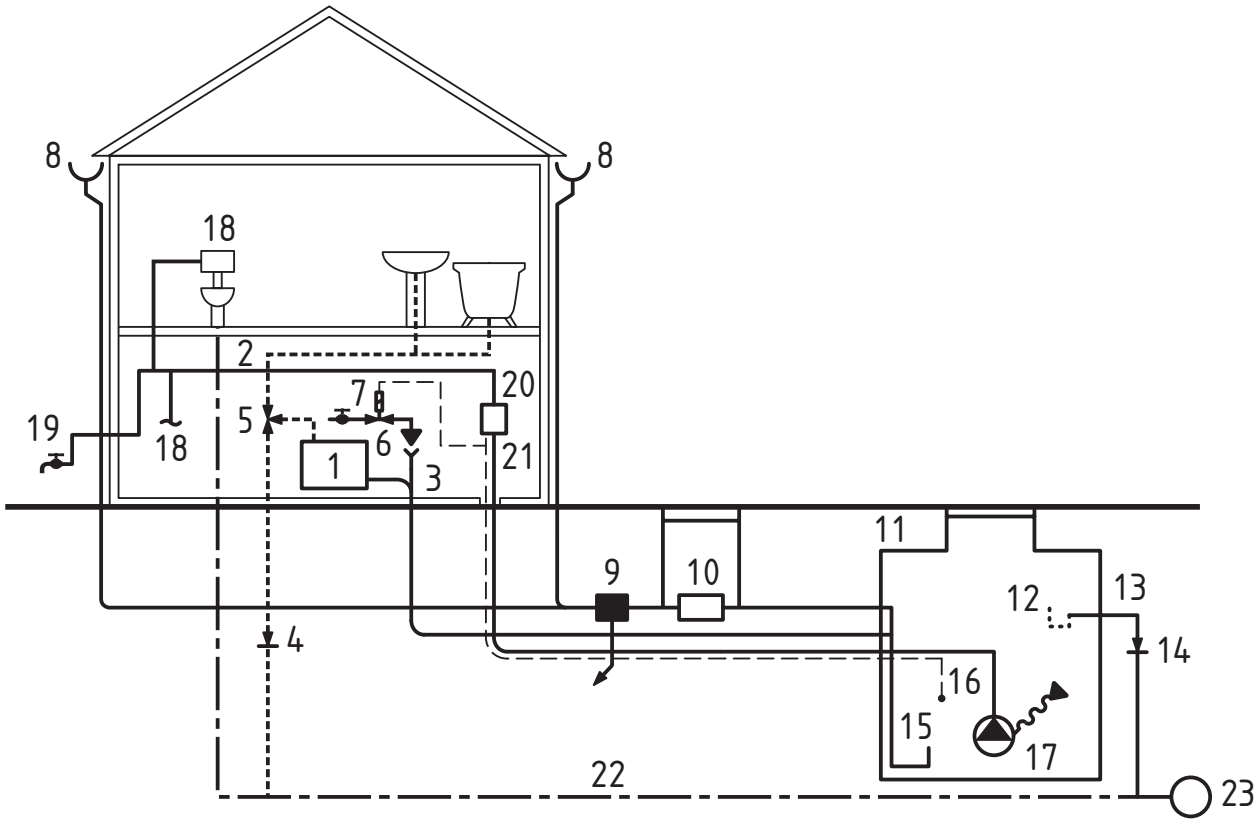
A.3 Systems integrated after treatment

Greywater and rainwater systems may be integrated at various points, e.g. within the tank/cistern, within the distribution pipework or at the point of use/appliance, with either a direct or indirect supply connection (see Figure A.1 and Figure A.2).

A.4 Sizing

When sizing the integrated system and its storage capacity, the ratio of demand (mass balance) for greywater and rainwater should be determined. A detailed approach should be followed (see **4.1.2.4** and BS 8515:2009, **4.1.2.4**).

Figure A.1 **Typical integrated greywater and rainwater system with single storage, direct non-potable supply and Type AA air gap**



Key

Greywater components

1 Greywater treatment unit
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater to storage
4 Anti-surcharge valve
5 Bypass
6 Type AA air gap
7 Back-up water supply with solenoid valve control

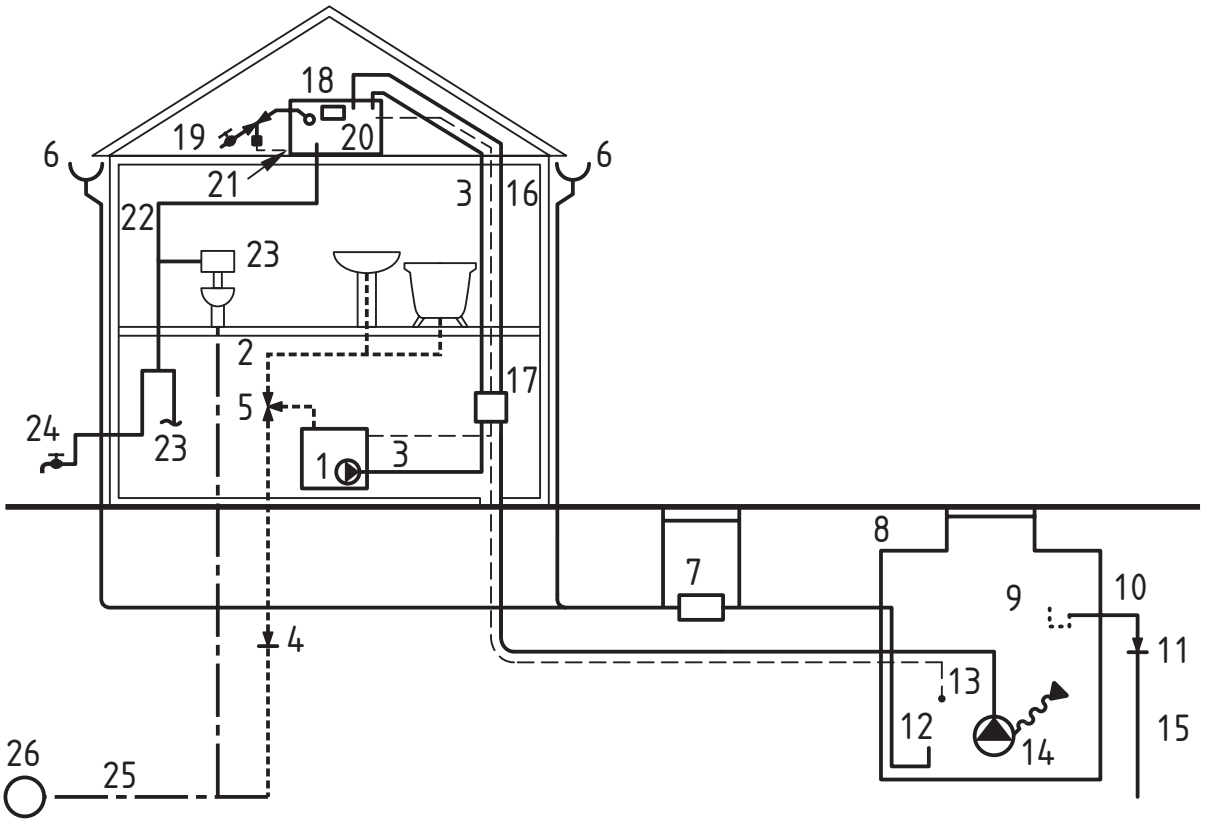
Rainwater components

8 Gutter
9 Diverter to soakaway/surface water drainage system (when storage tank full)
10 Filter in access chamber

Shared components

11 Storage tank
12 Optional outlet trap
13 Overflow pipe
14 Anti-surcharge valve and vermin trap
15 Calmed inlet
16 Sensor/float switch
17 Submersible pump with floating extraction
18 Non-potable application, e.g. WC, washing machine
19 Garden tap
20 Control panel with pump dry-run protection
21 Distribution pipework carrying rainwater/treated greywater to points of use
22 Foul drain
23 Foul sewer

Figure A.2 **Typical integrated greywater and rainwater system with indirect non-potable supply and Type AB air gap**



Key

Greywater components

1 Greywater treatment unit with pumped distribution
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater
4 Anti-surcharge valve
5 Bypass

Rainwater components

6 Gutter
7 Filter in access chamber
8 Storage tank
9 Optional outlet trap
10 Overflow pipe
11 Anti-surcharge valve and vermin trap
12 Calmed inlet
13 Sensor/float switch
14 Submersible pump with floating extraction
15 Overflow to soakaway/surface water drainage system
16 Distribution pipework carrying rainwater

Shared components

17 Control panel with pump dry-run protection
18 Type AB air gap
19 Back-up water supply with solenoid valve control
20 Storage cistern
21 Level sensor
22 Distribution pipework carrying rainwater/treated greywater to points of use
23 Non-potable application, e.g. WC, washing machine
24 Garden tap
25 Foul drain
26 Foul sewer

Annex B (normative) Marking and labelling

NOTE 1 Attention is drawn to the Water Fittings Regulations [12] which require that any water fitting conveying greywater to be clearly identified so as to be easily distinguished from any supply pipe or distributing pipe than that supplying wholesome water. This is to prevent inadvertent cross-connection between water of different qualities, particularly drinking water.

*NOTE 2 See also **4.11.2** for recommendations concerning the colour of distribution pipework.*

B.1 General

B.1.1 Collection pipework

All collection pipework should be identified as to what type of greywater is being collected, i.e. bathroom greywater. The following methods are recommended:

a) permanent marking made at the time of manufacture; and/or

b) labels attached during installation.

Marking and labels should be located along the length of the pipework, at intervals of no more than 0.5 m and at key connection points.

Where multiple greywater systems are in use, the identification should also note which greywater system is being supplied.

Where integrated greywater and rainwater systems are used, each pipe and outlet should be clearly identified. All rainwater harvesting system pipes should be identified in accordance with BS 8515:2009, Annex C.

B.1.2 Distribution pipework

All distribution pipework should be identified as supplying greywater and the identification should note the quality of the treated greywater (see Clause **6**). For most systems, more than one form of identification should be used so that identification is possible throughout the life of the installation. The following methods are recommended:

a) permanent marking made at the time of manufacture; and/or

b) labels attached during installation.

Insulated pipes should be labelled on the outer surface of the insulation, regardless of whether the pipe has been identified prior to insulation. Buried pipes should be clearly identifiable during any subsequent excavations.

Marking and labels should be located along the length of the pipework, at intervals of no more than 0.5 m and at key connection points.

The marking used for the identification of greywater distribution pipes should differentiate between non-potable supplies of different pressures, qualities and designated uses.

B.1.3 Storage tanks and cisterns

All storage tanks and cisterns should be marked so that their contents can be readily identified, e.g. on the underside of the access cover for below ground tanks or on a visible surface.

B.2 Labels

The labels used for the identification of greywater collection and distribution pipes should:

a) be either self-adhesive or mechanically secured to the pipe;

b) be no less than 100 mm in length;

c) be coloured green in accordance with BS 4800:1989, 12 D 45;

d) have "GREYWATER" and the additional information specified in **B.1.1** and **B.2.2**, in black lettering no less than 5 mm in height.

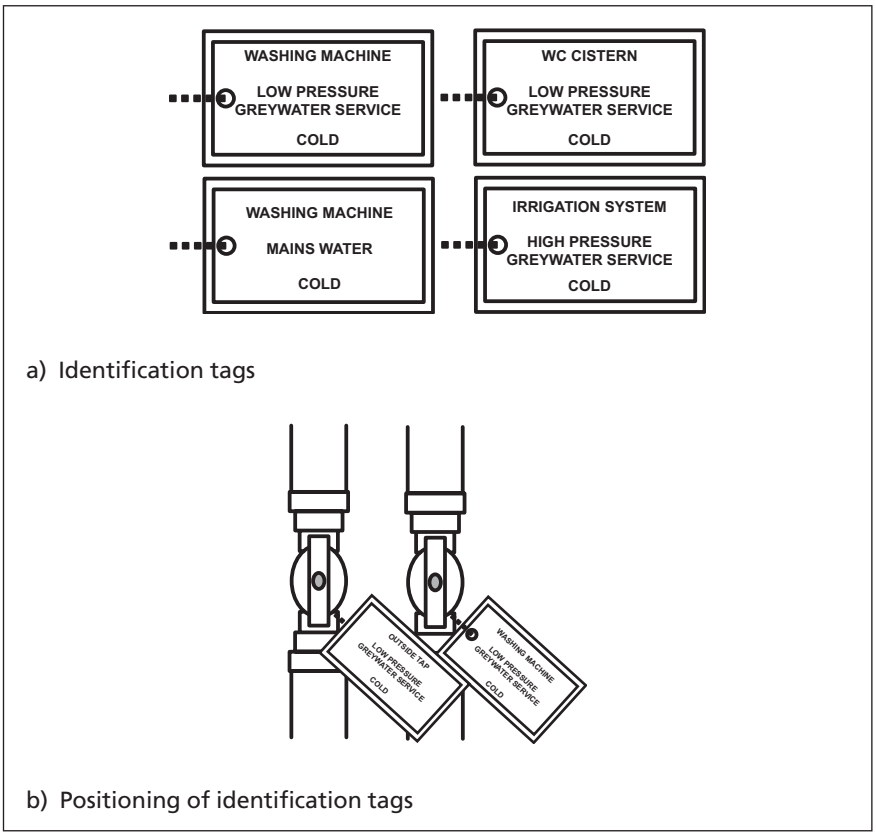
In addition, it is recommended that tags identifying each appliance and its water supply are secured to the distribution pipework at key connection points using flexible fasteners. The lettering on these tags should be black or green, on a white background, and no less than 5 mm in height.

NOTE 1 Tags may be green or edged in green.

The wording on identification tags should be concise and unambiguous, and should enable the various supplies to be uniquely identified (see Figure B.1).

NOTE 2 Identification codes alone are not sufficient.

Figure B.1 **Examples of identification tags and their positioning**



a) Identification tags

b) Positioning of identification tags

B.3 Points of use

Points of use for the greywater system, including all appliances, should be clearly identified with the words "Non-potable water" or a prohibition sign (see Figure B.2) so that users and maintenance personnel are aware of the non-potable water supply. Where other non-potable systems are available, e.g. greywater, the words "Non-potable water: GREYWATER" should be used.

NOTE If the majority of points of use on industrial premises are for non-potable water, the points of use for potable water may be identified by the words "Potable water" or by the "Potable water" sign shown in Figure B.3, provided that notices are posted to draw attention to this deviation from normal practice.

Figure B.2 **Signage for points of use supplied by non-potable water**

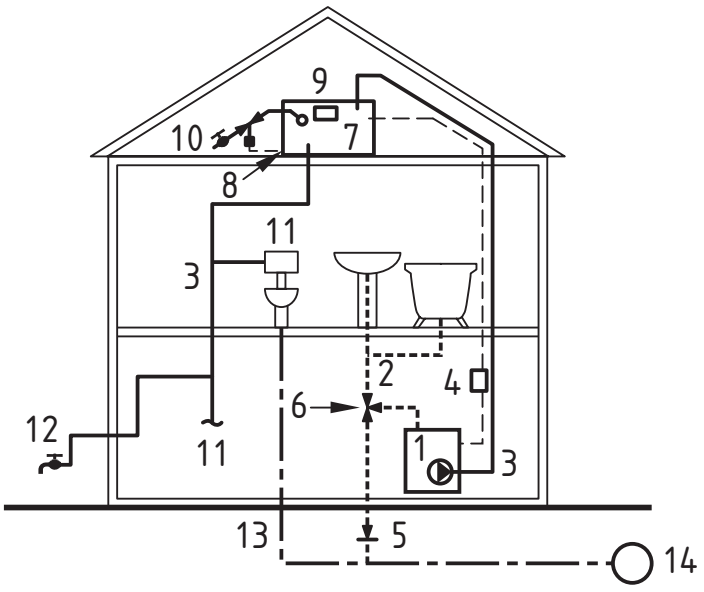
Figure B.3 **Signage for points of use supplied by potable water**

Annex C (informative)

Examples of typical greywater systems with different back-up water supply arrangements

Examples of typical greywater systems with different back-up water supply arrangements are given in Figure C.1, Figure C.2, Figure C.3 and Figure C.4.

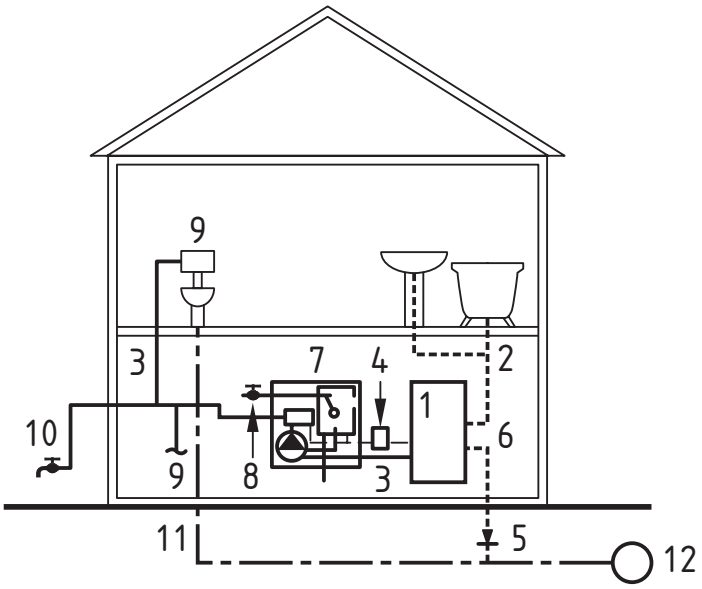
Figure C.1 **Typical system with indirect treated greywater supply and Type AB air gap**



Key

1 Greywater treatment unit with pumped outlet
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater
4 Control panel
5 Anti-surcharge valve
6 Bypass
7 Storage cistern at high level
8 Level sensor
9 Type AB air gap
10 Back-up water supply with electronic control
11 Non-potable application, e.g. WC, washing machine
12 Garden tap
13 Foul drain
14 Sewerage system

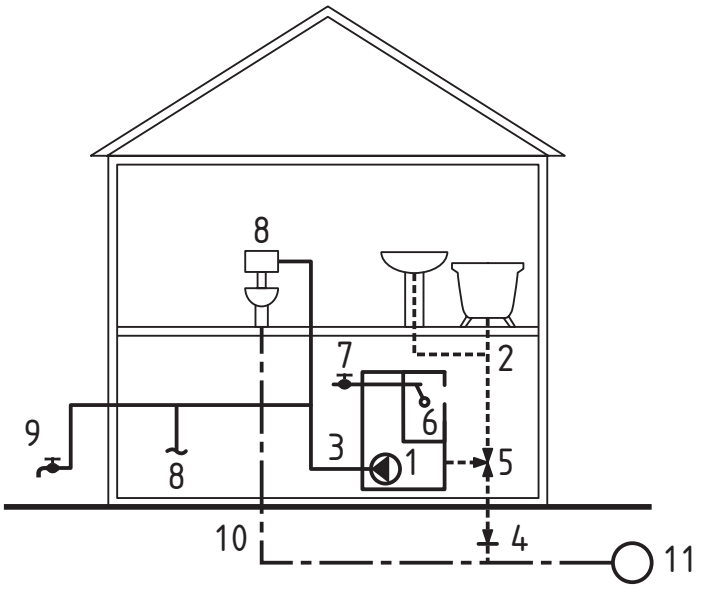
Figure C.2 **Typical system with direct treated greywater supply via module and Type AB air gap**



Key

1 Greywater treatment unit
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater
4 Control panel
5 Anti-surcharge valve
6 Internal bypass and overflow
7 Module with pump and Type AB air gap including overflow warning pipe
8 Back-up water supply
9 Non-potable application, e.g. WC, washing machine
10 Garden tap
11 Foul drain
12 Sewerage system

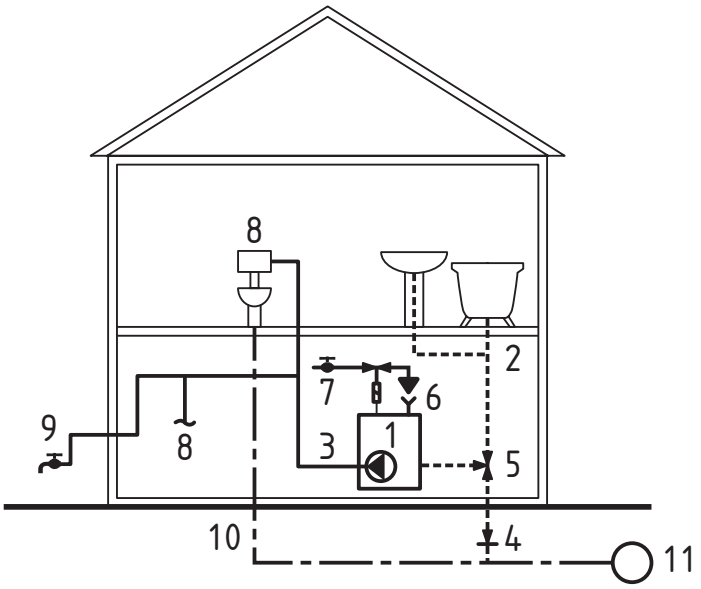
Figure C.3 **Typical system with direct treated greywater supply and Type AB air gap**



Key

1 Greywater treatment unit with pumped outlet
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater
4 Anti-surcharge valve
5 Bypass
6 Type AB air gap
7 Back-up water supply
8 Non-potable application, e.g. WC, washing machine
9 Garden tap
10 Foul drain
11 Sewerage system

Figure C.4 **Typical system with direct treated greywater supply and Type AA air gap**



Key

1 Greywater treatment unit with pumped outlet
2 Collection pipework carrying bathroom greywater for treatment
3 Distribution pipework carrying treated greywater
4 Anti-surcharge valve
5 Bypass
6 Type AA air gap
7 Back-up water supply with electronic control
8 Non-potable application, e.g. WC, washing machine
9 Garden tap
10 Foul drain
11 Sewerage system

Annex D (normative) Water sampling

D.1 General

Where routine observations indicate a problem with the greywater system, water sampling might be required if the cause of the problem cannot be readily identified. When considering sampling the following factors should be taken into account:

a) the type and nature of the problem;

b) the choice and number of sampling points (see **D.4**);

c) the location and timing of the sample in relation to the normal operating conditions and control measures of the greywater system, including the timing and levels of biocide dosing where applicable;

d) the type and quantity of samples to be collected;

e) the method of sampling.

To enable the quick and effective detection of a problem, samples should be as representative as possible of the treated greywater at the location of the sample point and the time of collection. Where there is any doubt, the advice of a water sampling expert should be sought.

D.2 Microbiological samples

Sampling for microbiological analyses should be carried out in accordance with BS EN ISO 19458.

In addition to those factors noted in **D.1**, the following should be taken into account:

a) the possible presence of biocides;

b) the need for disinfection of the sample point or equipment, e.g. dip samples;

NOTE The risk to the user is best indicated by samples collected without any cleansing or disinfection of the points of use (i.e. terminal fittings fed with treated greywater). If the quality of the greywater collected in this manner is satisfactory, no further testing is required.

The microbial population in the sample should undergo as little change as possible before the analysis begins (thus sample transportation and storage need to be correctly controlled.)

D.3 Chemical and physical samples

Sampling for chemical and physical analyses should be carried out in accordance with BS ISO 5667-5.

D.4 Sample point

Where sampling for routine monitoring is undertaken, samples should be collected from locations that best represent the whole system status, i.e. the point of use furthest from the tank(s). Samples should only be taken from tanks if routine sampling from points of use or other observations indicate a problem.

Where sampling from tanks is deemed necessary, and more than one tank or cistern is used in the system, samples should be taken from:

a) the most upstream storage tank, to test the quality of the treated greywater;

b) any subsequent tanks/cisterns if the stored greywater is likely to be either affected by temperature variations (e.g. in a loft) or mixed with water from the back-up water supply.

NOTE Tanks may be sampled in accordance with BS 7592.

*COMMENTARY ON **D.4***
A sample from a tap might give different results from a tank sample. An out-of-specification result from a terminal fitting (unless it has been cleaned/disinfected and flushed) suggests a problem with either the fitting or another part of the system. Explanations of these differences and the rationale for sample point selection are given in BS EN ISO 19458, BS EN ISO 5667-1 and BS 7592.

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