

BS 8525-1:2010



BSI Standards Publication

Greywater systems – Part 1: Code of practice

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Contents

Foreword *iii*

0	Introduction	1
1	Scope	2
2	Normative references	2
3	Terms and definitions	4
4	Design	6
5	Installation	20
6	Water quality	25
7	Maintenance	28
8	Risk assessments	29

Annexes

Annex A (normative)	Integrated greywater and rainwater systems	31
Annex B (normative)	Marking and labelling	35
Annex C (informative)	Examples of typical greywater systems with different back-up water supply arrangements	38
Annex D (normative)	Water sampling	41
Bibliography		43

List of figures

Figure 1 – Unrestricted Type AA air gap (BS EN 13076)	15
Figure 2 – Unrestricted Type AB air gap with non-circular overflow (BS EN 13077)	16
Figure 3 – Cross-connection dye test	24
Figure A.1 – Typical integrated greywater and rainwater system with single storage, direct non-potable supply and Type AA air gap	33
Figure A.2 – Typical integrated greywater and rainwater system with indirect non-potable supply and Type AB air gap	34
Figure B.1 – Examples of identification tags and their positioning	36
Figure B.2 – Signage for points of use supplied by non-potable water	37
Figure B.3 – Signage for points of use supplied by potable water	37
Figure C.1 – Typical system with indirect treated greywater supply and Type AB air gap	38
Figure C.2 – Typical system with direct treated greywater supply via module and Type AB air gap	39
Figure C.3 – Typical system with direct treated greywater supply and Type AB air gap	40
Figure C.4 – Typical system with direct treated greywater supply and Type AA air gap	41

List of tables

Table 1 – Typical average daily greywater yield and demand	8
Table 2 – Guideline values (G) for bacteriological monitoring	26
Table 3 – Guideline values (G) for general system monitoring	27
Table 4 – Interpretation of results from bacteriological monitoring	27
Table 5 – Interpretation of results from system monitoring	27
Table 6 – Maintenance schedule	28

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 46, an inside back cover and a back cover.

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-surge 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):

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

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.

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

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;