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Rainwater harvesting systems – Code of practice

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 56, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by is published by BSI Standards Limited, under licence from The British Standards Institution and came into effect on 31 January 2009. 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.

Supersession information

BS 8515:2009+A1:2013 supersedes BS 8515:2009, which is withdrawn.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags [A1⟩ ⟨A1]. Minor editorial changes are not tagged.

Use of this document

As a code of practice, this British Standard 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 British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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 1991 [1];
- The Workplace (Health, Safety and Welfare) Regulations 1992 [2];
- The Confined Spaces Regulations 1997 [3];
- The Work at Height Regulations 2005 [4];
- The Private Water Supplies (Scotland) Regulations 2006 [5].

In this document, the following national regulations, which apply to plumbing systems in premises to which a supply of public mains water has been provided, are referred to as the “Water Fittings Regulations [6]”:

- Water Supply (Water Fittings) Regulations 1999, in England & Wales;
- Water Byelaws 2004 (Scotland), in Scotland;
- Water Regulations (Northern Ireland) 1991, in Northern Ireland.

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0 Introduction

0.1 General

On-site collection and use of rainwater is an alternative to public mains water supply for a variety of non-potable water uses in the home, workplace and garden. It can also provide benefits for the attenuation of surface water run-off.

As the rainwater harvesting sector expands, 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 rainwater harvesting

There are three basic types of rainwater harvesting systems (see Figure 1):

a) water collected in storage tank(s) and pumped directly to the points of use;

b) water collected in storage tank(s) and fed by gravity to the points of use;

c) water collected in storage tank(s), pumped to an elevated cistern and fed by gravity to the points of use.

Within these basic types, there are variations such as:

1) internal or external locations for tanks;

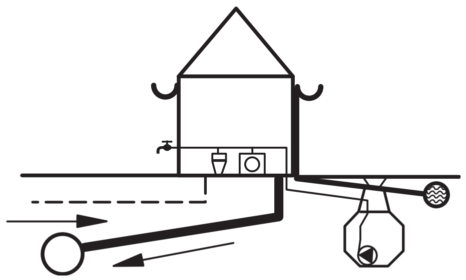
2) single or multiple linked tanks;

3) freestanding or fully or partially buried tanks;

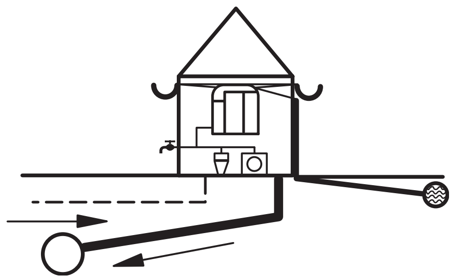
4) communal tanks supplying multiple properties;

5) packaged systems or components.

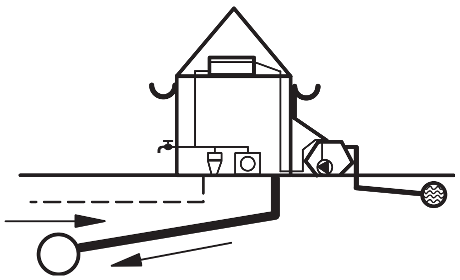
Figure 1 **Outline examples of rainwater harvesting systems**



a) Water pumped directly from storage tank (e.g. below ground)



b) Water fed by gravity from storage tank (e.g. elevated above ground)



c) Water pumped to intermediate cistern and fed by gravity from storage tank (e.g. above ground)

Key

Sewer

Surface water drainage e.g. soakaway

Public mains water supply

Pump

NOTE Drawings are not to scale.

1 Scope

This British Standard gives recommendations on the design, installation, testing and maintenance of rainwater harvesting systems supplying non-potable water in the UK.

It covers 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 flushing and garden watering. It does not cover systems supplying water for drinking, food preparation and cooking, dishwashing and personal hygiene.

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

It covers individual and communal systems, and those providing stormwater control. It does not cover water butts.

It also does not cover product design for specific system components.

It applies to retrofitting and new build.

[A1) This British Standard does not cover greywater recycling systems, for which see BS 8525-1. (A1]

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.

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

[A1) *Text deleted.* (A1]

BS 7592, *Sampling for Legionella bacteria in water systems – Code of practice*

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

[A1) BS 8558, *Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806*

BS 8580, *Water quality – Risk assessments for Legionella control – Code of practice*

BS EN 805, *Water supply – Requirements for systems and components outside buildings*

BS EN 806, *(all parts) – Specifications for installations inside buildings conveying water for human consumption* (A1]

BS EN 12056-3, *Gravity drainage systems inside buildings – Part 3: Roof drainage, 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*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 air gap
physical break between the lowest level of the water inlet and the maximum fault level or critical level of an appliance or installation, a feed pipe, or an air inlet orifice incorporated into a hydraulic circuit

[BS EN 1717]

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 sewers

3.3 backflow
movement of the fluid from downstream to upstream within an installation

[BS EN 1717]

3.4 backflow prevention device
device which is intended to prevent contamination of potable water by backflow in a water supply system

[BS EN 1717 (modified)]

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

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

3.7 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.

3.8 cistern
fixed container for holding water at atmospheric pressure for subsequent reuse as part of a plumbing system

3.9 control unit
unit which automatically controls and monitors the function of the rainwater harvesting system to facilitate effective operation

3.10 cross-connection
physical hydraulic link or a removable link between two separate systems, which can lead to cross-contamination

3.11 dead leg
section of pipework through which no water flows, usually created by closing a pipe after the removal of a terminal fitting

3.12 depression storage
volume of water lost from surfaces, e.g. by evaporation or absorption, before run-off commences

3.13 dip sample
sample of water collected by immersing a container into a body of water and withdrawing it

3.14 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.

[BS EN 1717 (modified)]

3.15 infiltration
<into the ground> the movement of surface water or treated effluent into the ground

[BS EN 1085]

3.16 green roof
roof covered with vegetation

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

3.18 non-potable water
any water other than potable water

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

3.19 overflow
device that relieves the system of excess volume

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

[BS EN 1717]

3.21 potable water
water suitable for human consumption that meets the requirements of Section 67 of the Water Industry Act 1991 [7]

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

3.22 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 [7] in England & Wales, the Water (Scotland) Act 1980 [8] in Scotland, or the Water and Sewerage Services (Northern Ireland) Order 2006 [9] in Northern Ireland

3.23 rainwater
water arising from atmospheric precipitation

3.24 rainwater butt
cask set on end to store rainwater for garden watering

3.25 return period
average period of time within which the depth or intensity of rainfall for a given duration, e.g. 5 min, 24 hr, will be equalled or exceeded once

3.26 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]

3.27 spillover level
level at which water will start to flow over the receiving vessel with all outlets closed

[A1) **3.28 sustainable drainage**
management of rainwater (including snow and other precipitation) with the aim of reducing damage from flooding ,improving water quality, protecting and improving the environment, protecting health and safety, and ensuring the stability and durability of drainage systems (A1]

3.29 stormwater control
measures to control the rate and quantity of surface water run-off

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

[BS EN 1085]

3.31 tank
closed, watertight, vented container for rainwater, which forms part of a drainage system

3.32 working capacity
maximum capacity of water that can be extracted from a tank in normal use, e.g. from the overflow to the lowest extraction point

4 Design

4.1 Sizing

4.1.1 General

As the optimum storage capacity for a rainwater harvesting system is a function of the rainwater availability and the non-potable water demand, the following factors should be identified in order to calculate the size of the system (see **4.1.2**):

a) the amount [A1) *Text deleted.* (A1] of rainfall;

b) the size and type of the collection surface;

c) the number and type of intended applications, both present and future.

[A1) *NOTE For combined rainwater and greywater systems see BS 8525.* (A1]

4.1.2 Calculation methods

*COMMENTARY ON **4.1.2***
*The three approaches to sizing recommended in **4.1.2** are based on methods given in DIN 1989-1.*

4.1.2.1 General

The storage capacity of the rainwater harvesting system should be determined using one of the following methods:

a) a simplified approach for residential properties, where there is consistent daily demand, for which no calculations have to be carried out (see **4.1.2.2**);

b) an intermediate approach which uses simple formulae to calculate a more accurate estimation of storage capacity than the simplified approach (see **4.1.2.3**);

c) a detailed approach for non-standard systems, where there is variable demand through the year (see **4.1.2.4**).

[A1⟩ *NOTE 1 The storage capacity of rainwater harvesting systems for stormwater management of runoff is given in Annex A. The use of rainwater harvesting for stormwater management (see **A.1**) may only be applied in situations where the average run-off yield is less than the average non-potable demand. This is because of the low likelihood of significant spare storage in the tank occurring at the time of a large storm when average yield is greater than demand.* ⟨A1]

NOTE 2 The simplified approach is not suitable for commercial premises as the assumptions relating to demand are not applicable. The intermediate approach may be used for certain commercial and industrial premises, [A1⟩ *but only those with relatively consistent daily demands* ⟨A1] *such as schools and offices.*

[A1⟩ *NOTE 3 For larger rainwater harvesting systems, the size of the system may benefit from using the detailed approach to ensure a cost-effective solution is developed.* ⟨A1]

Once the storage capacity has been determined, storage tanks should be selected on the basis of working capacity, rather than the total capacity of the container.

The size of the tank should allow for rainfall variation; however, it should be noted that construction above a certain size based on rainfall for that area provides very limited additional benefit unless stormwater attenuation is intended.

NOTE 4 The size of the tank will also affect how often the stored water overflows. Occasional overflowing can be useful for maintenance and might have benefits for water quality.

4.1.2.2 The simplified approach

To apply the simplified approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be estimated using the following method.

First, the roof plan area draining to the storage tank should be established in accordance with BS EN 12056-3, and the annual average rainfall depth for the location of the site should be determined from Figure 2.

In most cases, the storage capacity should then be read from the Y axis of Figure 3, using the appropriate diagonal line for the rainfall depth. However, where the site has a large roof plan area and/or is in a region with high annual rainfall, the storage capacity should be determined in relation to the population in the house.

Where the system is to provide both non-potable water for domestic use and stormwater control, the integrated sizing approach given in **A.1** should be used to estimate the additional storage capacity needed.

*COMMENTARY ON **4.1.2.2***
The simplified approach is based on the following assumptions:

a) relatively constant daily domestic use through the year of 50 litres per day per person for WC flushing and clothes washing;

b) annual average rainfall depth for the site location;

c) the use of standard tiled pitched roofs for the collection surface.

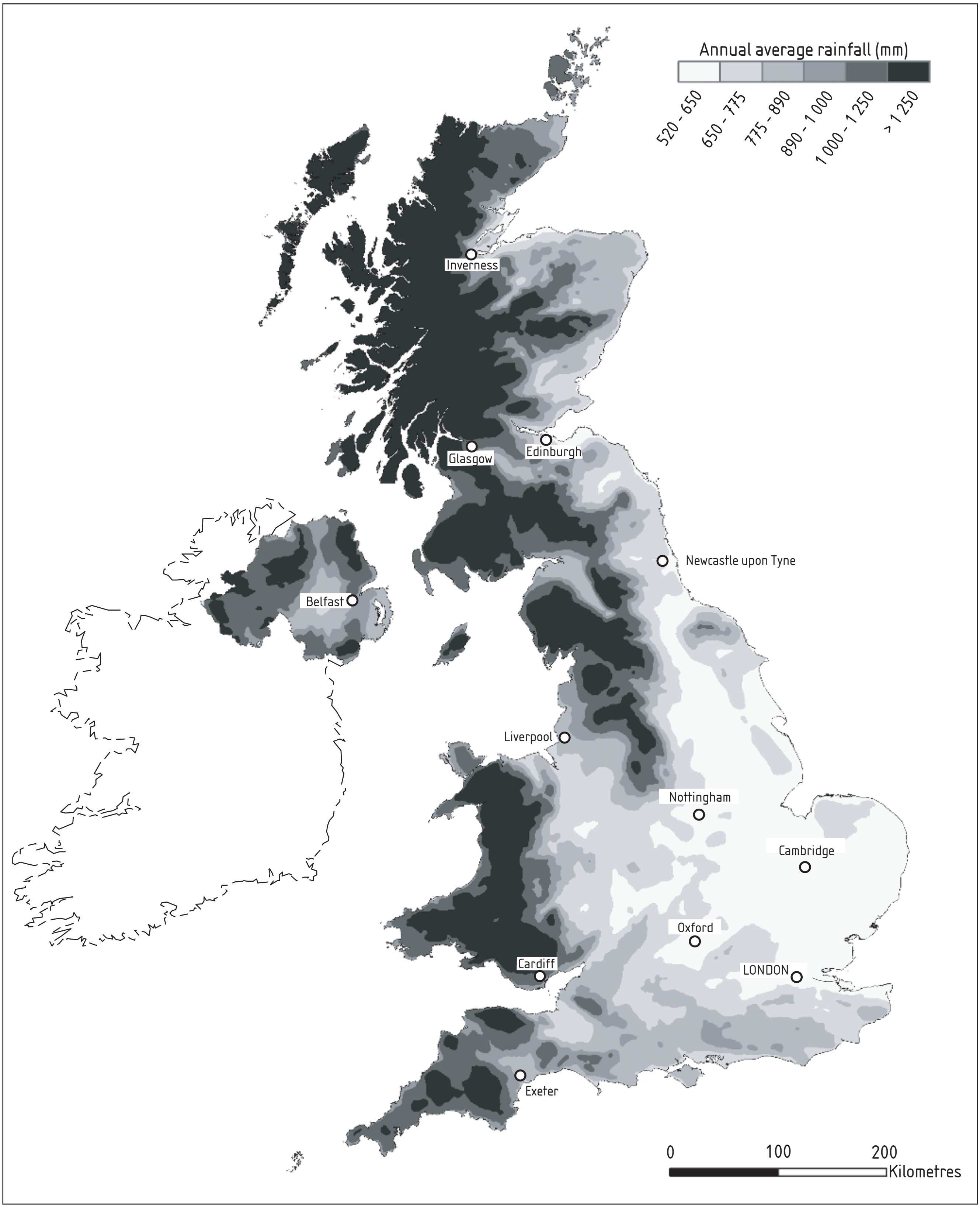
The storage is based on the general rule of 18 days of average rainfall, which caters for the variability of rainfall that occurs in the UK. Provision of greater storage capacity offers very little additional benefit. Around 80% of all the effective run-off from the collection surface in the year will be utilized. Where the storage capacity is dictated by the number of users and not the roof plan area/rainfall, the storage capacity can be reduced by up to 30% due to the supply being significantly greater than the demand.

It is noted that sizing for non-potable supply alone provides a limited beneficial element for stormwater control. However, as this volume is relatively small, it is normally ignored when designing for stormwater control.

*The integrated sizing approach (see **A.1**) may only be applied in situations where the average run-off yield is more than the average non-potable demand. This is because of the low likelihood of significant spare storage in the tank occurring at the time of a large storm and, if the demand is greater than the yield, the back-up supply could be used excessively.*

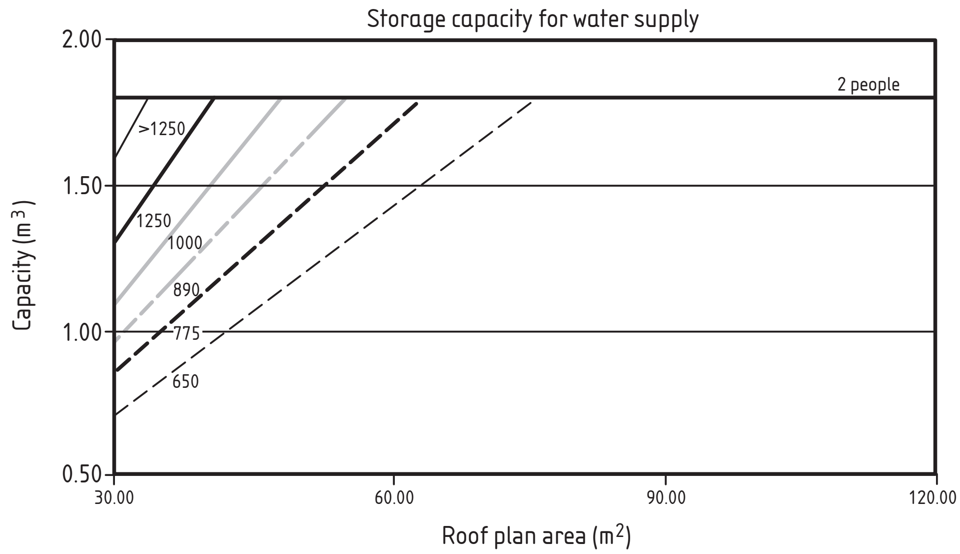
A1⟩

Figure 2 **Annual average rainfall depths across the UK (1961 – 1990)**

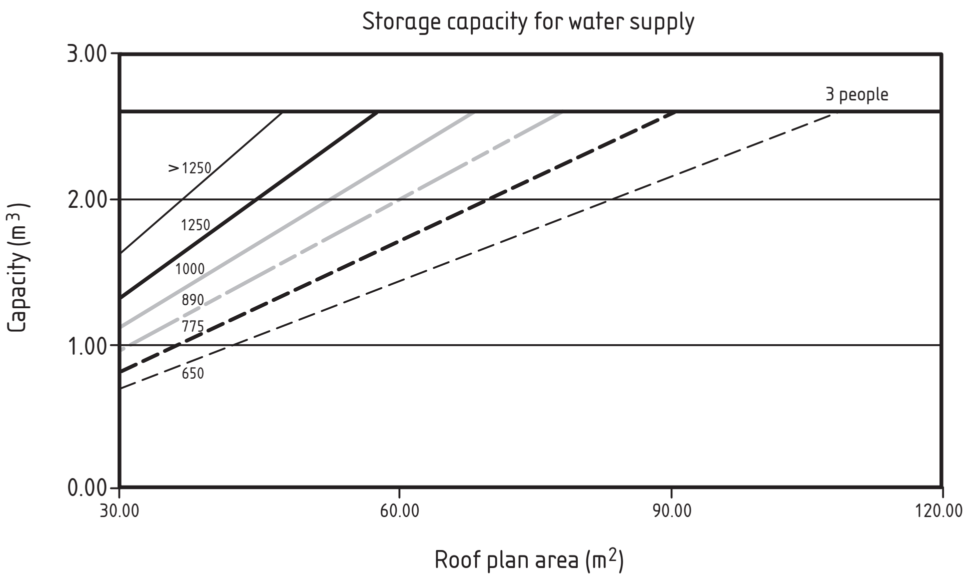


⟨A1

Figure 3 **Storage capacities for non-potable domestic water based on** [A1⟩ *Text deleted.* ⟨A1] **average annual rainfall and roof size for small populations (simplified approach)**

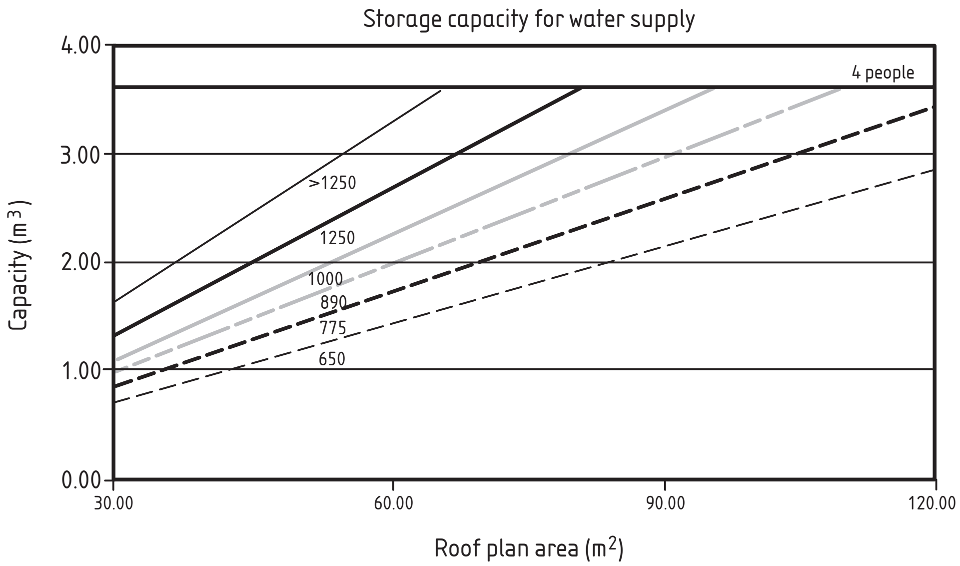


a) Storage capacity for a 2-person household

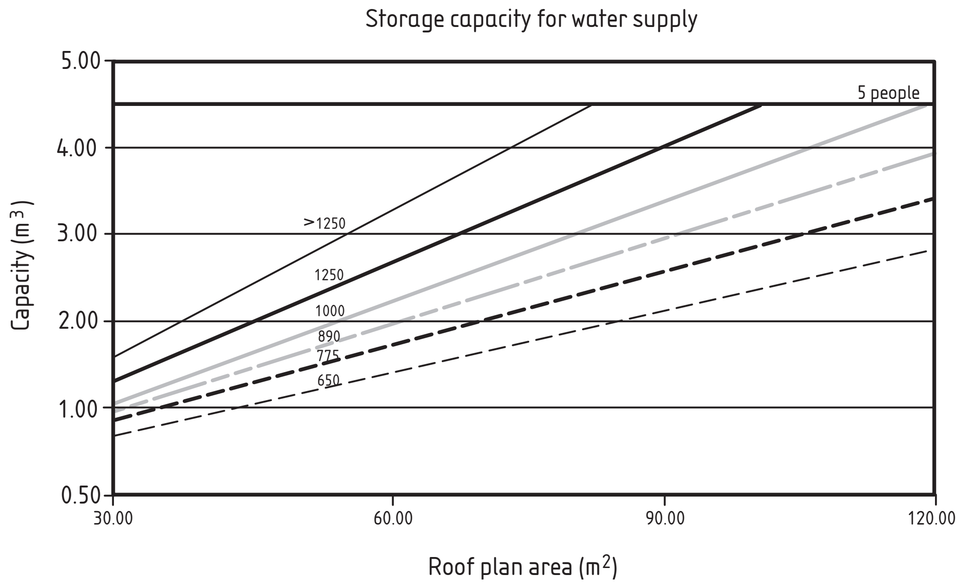


b) Storage capacity for a 3-person household

Figure 3 **Storage capacities for non-potable domestic water based on** [A1] *Text deleted.* [A1] **average annual rainfall and roof size for small populations (simplified approach)** *(continued)*



c) Storage capacity for a 4-person household



d) Storage capacity of a 5-person household

NOTE See Figure 2 for annual average rainfall data.

EXAMPLE

If a house has four residents, the maximum storage that might be useful is 3.6 m^3. However, if the house is in London, where the rainfall is up to 650 mm according to Figure 2 and the roof plan area draining to the tank is 90 m^2, the storage capacity ought to be reduced to around 2.1 m^3 in line with Figure 3c). It is not necessary to provide a 3.6 m^3 tank as the tank will rarely store more than 2.1 m^3 and thus very little extra water will be provided over the year.

4.1.2.3 The intermediate approach

*NOTE 1 The intermediate approach is similar to the method described in **4.1.2.2** and thus the results obtained are likely to be similar. Equations are provided to allow a more flexible and accurate facility for calculating the storage needed. The advantage of this is the variables can be modified to reflect the situation being considered.*

To apply the intermediate approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be calculated from the following equations and should be the lesser of 5% of the annual rainwater yield or 5% of the annual non-potable water demand.

[A1⟩ $$Y_R = A \times e \times AAR \times h \times 0.05 \quad (1)$$

where:

- Y_R is 5% of the annual rainwater yield (L);
- A is the collecting area (m^2);
- e is the yield coefficient (%);
- AAR is the depth of annual average rainfall for the location (mm);
- h is the hydraulic filter efficiency.

5% of the annual non-potable water demand should be calculated using the equation:

$$D_N = P_d \times n \times 365 \times 0.05 \quad (2)$$

where:

- D_N is 5% of the annual non-potable water demand (L);
- P_d is the daily requirement per person (L);
- n is the number of persons. ⟨A1]

Where the system is to provide both non-potable water for domestic use and stormwater control, the integrated sizing approach given in [A1⟩ Annex A ⟨A1] should be used to estimate the additional storage capacity needed.

[A1⟩ *NOTE 2 The number of persons in a household could be assumed to be the current household occupancy, or up to 2 persons in each bedroom. Table A.1 in Annex A provides occupancy values which are the national average based on the number of bedrooms in a property, but occupancy in individual houses range widely.*

NOTE 3 Uncertainty in the yield coefficient from a roof surface is fairly small for standard pitched roofs. However there are a range of roof types, each of which have their own runoff characteristics. The traditional approach is to use a coefficient which is of the order of 90%. In practice losses are minimal once initial wetting losses have taken place for each event, but to avoid a detailed time series approach a runoff coefficient is usually used.

For the intermediate approach, the coefficients given in Table 1 should be used.

Table 1 **Yield coefficients**

Surface type	Runoff coefficient
Pitched roof with profiled metal sheeting	0.95
Pitched roof with tiles	0.90
Flat roof without gravel	0.80
Flat roof with gravel	0.60
Green roof, intensive [A)]	0.30
Green roof, extensive [A)]	0.60
Permeable pavement [A)] – Granular media	0.60
Road/pavement – Plastic crates or tanks	0.75

A) The runoff yield is particularly uncertain for these surfaces and design should take account of the possibility of yields that are significantly higher or lower. In particular, the hydraulic runoff behaviour of green roofs depends on their design and the seasons.

*COMMENTARY ON **4.1.2.3***
The values normally used for each of the parameters in these equations are as follows.

a) 5% of annual demand or supply

This equates to 18 days a year and is needed to take account of [A1⟩ rainfall and demand ⟨A1] variability. In practice there are diminishing returns for tank sizes designed using 7 or 8 days.

b) Collection area

This is the plan area of the roof or other collection surface which is to be drained to the rainwater harvesting system. Modification of this value to allow for pitch and alignment to the prevailing wind is not usually made.

c) [A1⟩ Text deleted. ⟨A1]

*In general the combination of these two factors results in a value of 0.7 to 0.8 being assumed. Where flat roofs, green roofs or paved surfaces are used for collection, it is advised that the more detailed approach given in **4.1.2.4** is used.*

The filter efficiency in the region of 0.9 is commonly quoted and used. However where systems are designed for stormwater control, the filter performance during extreme events is important and information on this aspect needs to be explicitly obtained.

d) Non-potable demand

*This is usually set at around 50 litres per person per day and comprises the demand for WC flushing and clothes washing. Where car washing and garden watering is included, demand can be much greater. In this case, supply is normally much less than the demand. Also, the daily variation of demand for external use of rainwater is such that the detailed approach for storage requirements ought to be used (see **4.1.2.4**).*

4.1.2.4 The detailed approach

[A1⟩ Sizing the rainwater harvesting system for non-potable use for very large schemes where significant economic savings might be achieved or where daily demand or seasonal rainfall is quite variable, storage capacity should be estimated using a continuous rainfall time series that addresses both the demand and rainfall variability.

The uncertainty associated with both the demand and the supply of non-potable water should be explicitly addressed in evaluating options.

NOTE 1 A minimum analysis of daily rainfall events of three years is suggested, but five or more years would be preferable.

NOTE 2 Annex A provides an alternative methodology for sizing rainwater harvesting tanks for stormwater control to avoid the need for extended time series analysis where regular daily demand can be assumed.

NOTE 3 An understanding of the frequency and volumes of discharge of the overflow coming into operation can be found using this method. This has benefits for both evaluating water quality and also the impact on infiltration systems or stormwater systems to which they might discharge.

NOTE 4 The analysis also enables an easy assessment of a number of useful statistics such as how much water might be saved annually and the number of days that no rainwater is available, which might be particularly useful where there is no back-up water supply. A1

4.2 Collection

4.2.1 Surface

*COMMENTARY ON **4.2.1***
Hard roof surfaces are considered the most suitable for rainwater collection, although many common roofing materials may also be used.

*It is important to note that most collection surfaces are likely to be affected by some form of contamination, e.g. animal and bird faeces, soil, grit, hydrocarbons and various chemicals. These contaminants can have negative effects on the quality of the water collected. For further guidance, see **4.3**, Clause **6** and Clause **8**.*

When selecting a collection surface, the following factors should be taken into account, as these can affect the quality and quantity of the collected water:

a) the surface's materials and their drainage characteristics, e.g. run-off from a green roof will be significantly less than that from a hard roof and is also likely to be affected by a colouration caused by the soil or fertilizers;

b) the levels of pollution and the risk of contaminants entering the system.

Surfaces subject to as little pollution as possible should be used.

Ground level or trafficked surfaces can provide large areas for collection and may be used in areas where there is a high demand for non-potable water (e.g. commercial, industrial or public premises). As these surfaces carry a greater risk of pollutants entering the system, they should only be used once a specific risk assessment has been completed (see Clause **8**).

4.2.2 Guttering and collection pipework

Roof outlets, guttering and pipework should function as an integral part of the whole system, with access for routine maintenance and cleaning.

Collection pipework should allow the rainwater to flow from the collection surface to the storage tank by gravity or syphonic action.

Pipework should be free draining to avoid stagnation and should prevent contaminated water entering the system from other sources. In addition, sealed gullies should be used at ground level to minimize the risk of pollutants entering the system.

NOTE Conventional rainwater goods and drainage pipes may be used.

4.3 Filtration and treatment

*COMMENTARY ON **4.3***
*A rainwater harvesting system with filtration conforming to **4.3** provides water of a suitable quality for WC flushing, laundry and garden watering in most residential, commercial and industrial situations. However, readers might wish to note that some situations, e.g. where greater human exposure to the water is anticipated or where the water is to be used in public premises, could require higher water quality. In such cases, the system may incorporate treatment processes such as ultraviolet (UV) or chemical disinfection. For further guidance on disinfection, see the Market Transformation Programme (MTP) publication,* Rainwater and Grey Water: A guide for specifiers *[10].*

The use of disinfection equipment is site and material specific depending on the user's requirements and therefore expert advice is to be taken if such treatment is deemed appropriate. Consideration also needs to be given to the environmental impact of disinfection treatments.

Filtration should be incorporated in the system before the collected rainwater enters the main body of stored water, to [A1) minimize (A1] debris accumulating in the tank e.g. a filter may be placed in the collection pipework upstream of the tank.

The filter system should include a filter which:

a) is water and weather resistant;

b) is removable and readily accessible for maintenance purposes;

c) has an efficiency of at least 90%;

d) passes a maximum particle size of <1.25 mm.

Additionally, to prevent any other floating debris from entering the distribution system, the storage tank should be fitted with a calmed inlet.

Where feasible, a floating extraction point from the tank should be used, which is approximately 100 mm to 150 mm below the surface of the water. If floating extraction is not practicable, a fixed extraction point may be used but should be positioned approximately 150 mm above the base of the tank.

NOTE An additional filter may also be fitted at the extraction point.

4.4 Storage

4.4.1 General

The rainwater harvesting system should, as a minimum, include a tank for primary storage, which may be positioned either above or below ground. All tanks should be appropriate to the site (see **5.2.1**).

NOTE 1 Tanks are normally prefabricated off site.

The tank(s) used in the system 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 BS 6920.

NOTE 3 Storage may be accommodated in permeable pavement constructions or other structures, such as geo-cells.

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 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 multiplication of *Legionella*.

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 Above ground tanks and cisterns

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

[A1› To minimize the potential problems of freezing, warming and algal blooms, above ground tanks and cisterns should be opaque, and where they are exposed to temperatures below 0 °C or above 20 °C, they should be sheltered or insulated. ‹A1]

4.4.3 Below ground tanks

NOTE 1 Below ground tanks can provide frost protection, are cooler in the summer months and restrict algal growth due to the lack of sunlight.

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

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 [A1› (e.g. contaminated ground, exposure to UV) ‹A1] and temperature ranges anticipated. All components of the 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 system.

[A1› *NOTE Selecting suitable materials for components that are to be installed in ground that might be considered contaminated can be assessed using both BS 10175 and UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites [16]. Whilst this methodology has been designed for potable water pipe selection, its principles can be used for both rainwater pipes, fittings and tanks.* ‹A1]

4.6 Power supply

The power supply of the rainwater harvesting system should be readily accessible but also guarded to ensure against 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 [6] which require adequate backflow prevention to be provided so that water supplied from the public mains water supply for domestic uses does not become contaminated.

4.7.1 Back-up water supply

The rainwater harvesting system should incorporate a back-up water supply, 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 main collection tank, via a direct connection or discharging into the collection pipework, but not before filtration.

NOTE 1 Annex B gives examples of typical systems with different back-up supply arrangements.

The back-up supply should be fitted with a control mechanism which ensures that the amount of water supplied is minimized 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 supply should be sized to allow it to meet the full demand requirements in dry periods.

NOTE 2 It is important to consider the implications of using a back-up supply derived from public mains water during extended dry periods. As the rainwater harvesting system is likely to rely on the back-up supply to satisfy much of the demand, certain applications will not be appropriate. For instance, the use of the system for garden watering might be prohibited when water use restrictions (e.g. a hose pipe ban) are in place. In order to bring this to the user's attention, advice ought to be included in user instructions, wherever possible.

If the back-up supply is to be fed into the main collection tank, careful consideration should be given to tank selection in order to minimize the amount of water needed for continued normal operation before the next rainfall event, e.g. it might be beneficial to use a tank with a small sump area.

4.7.2 Backflow prevention

To prevent non-potable water entering the potable or public mains water supply, the back-up supply should be fitted with a backflow prevention device 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 4); or

b) a Type AB air gap conforming to BS EN 13077 (see Figure 5).

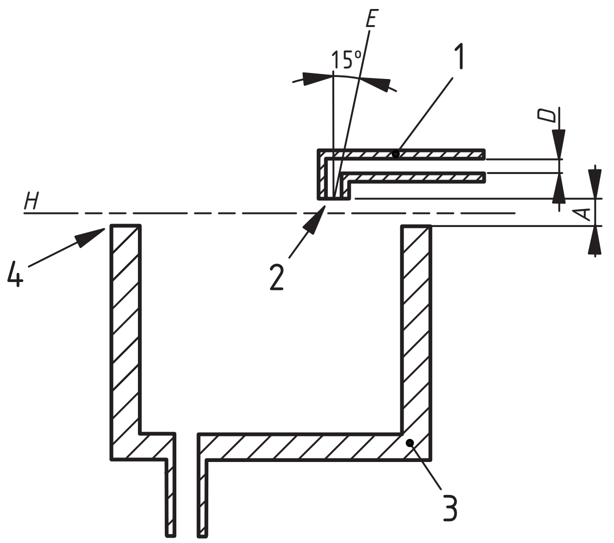
Flow rates, head loss and installation requirements should be taken into account when selecting the backflow prevention device.

The backflow prevention device should be located upstream of, or at, the point of delivery where the two supplies come into contact with each other.

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 supply infrastructure is capable of meeting this increase.

The design of the system should ensure that there are no dead legs and suitable turnover of water is achieved, reducing the opportunity for water to become stagnant when not required. 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.

Figure 4 **Unrestricted Type AA air gap (BS EN 13076)**



Key

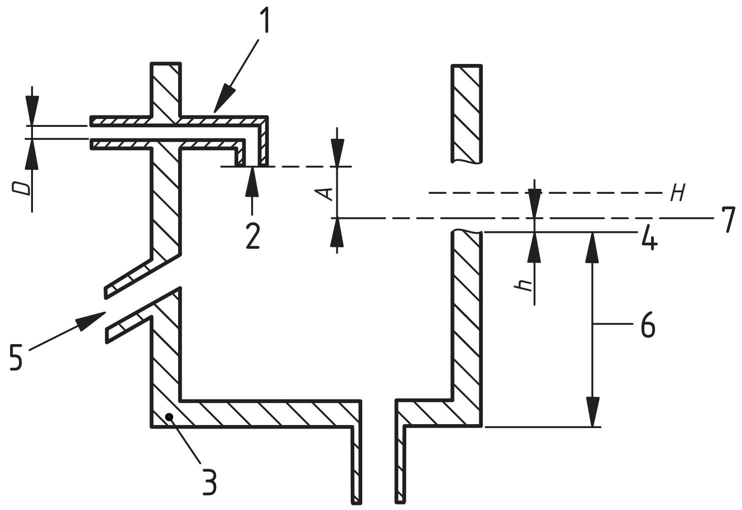
1 Feed pipe
2 Feed orifice
3 Receiving vessel
4 Spillover level
A Air gap
D Internal diameter of feed pipe (bore)
E 15° maximum from the vertical
H Maximum water level

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

NOTE Where the backflow prevention device is to be provided by a tundish arrangement and there is a risk of odours venting back into the premises, the use of a waterless trap may be considered downstream of the tundish.

When designing for backflow prevention, the appliances to be connected to the system should also be taken into account. Where an appliance with a single fill connection, e.g. washing machine, is to be supplied solely with rainwater, additional backflow prevention might not be required. However, if the appliance needs a supplementary potable source of water, e.g. public mains water (hot or cold), category 5 backflow prevention will be required for the potable supply. In such cases, the manufacturer should be consulted to establish whether suitable category 5 backflow prevention has been incorporated within the appliance.

Figure 5 **Unrestricted Type AB air gap with non-circular overflow (BS EN 13077)**



Key

1 Feed pipe

2 Feed orifice

3 Receiving vessel

4 Spillover level

5 Optional warning pipe

6 Upstream face of the overflow arrangement *Uw* (*Uw* ⩾ 5*h*)

7 Critical water level (distance *h*)

A Air gap

D Internal diameter of feed pipe (bore)

H Maximum water level

NOTE This arrangement may be used where the discharge point from the public mains 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 and below the outlet of the inlet device. The size of the spill slot needs to conform to BS EN 13077 within critical limits. An online Type AB Air Gap Calculator is available from the Water Regulations Advisory Scheme (WRAS) website at www.wras.co.uk/publications_default.htm

4.8 Pumping

4.8.1 General

For most systems, other than those which distribute the collected rainwater by gravity, a pump(s) should be used to ensure its continual availability.

NOTE 1 The operational safety and hydraulic demand will dictate whether a single pump or multiple-pump systems are needed.

The flow rate and the required pressure head of the pump should be determined in accordance with BS EN 12056-4.

The pump 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 system.

The pump should be equipped with dry-run protection, which may be either integral to the pump or provided by an external control device (see **4.8.5**).

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

NOTE 2 Where a pumped non-potable supply to WCs is used, an alternative back-up 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 which require that, in such cases, backflow protection is provided (see ***4.7.2****).*

4.8.2 Pumps 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 and vibration-free 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 Pumps 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 Multiple pump systems

Multiple pump systems should conform to BS EN 12056-4, with a standby pump as necessary.

4.8.5 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 and drainage

An overflow should be fitted to all tanks/cisterns to allow excess water to be discharged during extreme rainfall events. The overflow should be such that any backflow is prevented and vermin are unable to enter the tank/cistern. Overflows fitted to above ground tanks/cisterns should be screened.

The capacity of outlet pipe on the overflow should be equal to or greater than the capacity of the inlet pipe.

[A1) The overflow would normally be drained to a soakaway when ground conditions allow, otherwise the overflow should be connected to the surface water drainage system.

If backflow can take place through the overflow from a drain or sewer system to which it is connected, it should be fitted with an anti-surcharge valve conforming to BS EN 13564 (all parts).

The frequency of operation of an overflow is a function of both the size of the tank and the ratio of runoff yield to demand; in principle overflows should be operated occasionally to minimize the build-up of floating material. Where the frequency, volume or flow rate of spilling information is required for sizing the overflow and assessing the impact of spills downstream, this should be calculated using detailed modelling and the appropriate rainfall series length and resolution (daily down to 2 minute intensity) rainfall data. (A1]

NOTE 1 For some systems, it might be more appropriate to either pass the flow into the surface water drainage system or allow it to flood. The choice of drainage is dependent on factors such as ground conditions and the consequences of the performance being exceeded. For example, in locations where soils have very low permeability, a soakaway might overfill as a result of large rainfall events although this will result in minimal consequences like infrequent temporary local wet areas and run-off in most instances.

NOTE 2 [A1) Text deleted. (A1]

The overflow from the primary storage tank or cistern is likely to contain a small amount of floating material such as leaves washed from filters so, if the water is to be passed to a soakaway, appropriate trapping of the material should be provided.

NOTE 3 Additional information on soakaways and infiltration drainage systems is given in BS EN 752.

4.10 Controls and metering

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

The control unit should:

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

b) activate the back-up water supply automatically when the minimum water volume in the tank is reached;

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

NOTE Guidance on the design of a suitable control unit is given in BS 6739.

In order to prevent waste, storage tanks/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 informs the user of:

a) whether rainwater or back-up supply water is being used;

b) the volume of rainwater used and the volume of water used from the back-up supply. This can be logged and displayed;

c) how full the tank is;

d) any malfunctions. These should relate to the specific fault, e.g. pump failure, back-up supply failure.

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

4.11 Distribution

4.11.1 General

*COMMENTARY ON **4.11***
[A1) It is noted that the requirements specified for potable water systems in BS EN 805, BS EN 806 (all parts) and supplementary guidance in BS 8558 are considered good plumbing practice for the design and installation of all systems, regardless of the source of water. (A1]

Attention is also drawn to the Water Fittings Regulations [6]. These apply to pipes and fittings that are supplied, or are to be supplied, with public mains water.

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.

The system should distribute the collected rainwater by:

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

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

c) using a gravity distribution tank, where practicable; or

d) using a full gravity system, without pumps.

Consideration should be given to minimizing the energy used to distribute rainwater.

4.11.2 Distribution pipework and fittings

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

a) polybutylene conforming to BS 7291-2;

b) cross-linked polyethylene (PE-X) conforming to BS 7291-3;

c) copper conforming to BS EN 1057;

d) stainless steel containing molybdenum (Mo) and conforming to either BS EN 10216-5 for seamless pipes or BS EN 10217-7 for welded pipes;

e) [A1) multi-layer barrier pipes conforming to Water Industry Specification, WIS 4-32-19. (A1]

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

[A1] *Specific guidance on determining suitable types of pipe for contaminated ground is given in UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites [16].* [A1]

Where practicable, to differentiate rainwater pipework from potable water pipework, a contrasting type or colour of pipe material should be used. The pipework of the rainwater harvesting system, including any below ground back-up supply pipes, should not be blue, as this is the recognized standard 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 [12] (see also BS 1710).

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

Pipework should be sized to provide adequate flow and pressure, 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 **6.1** 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 system.

5 Installation

5.1 General

NOTE Attention is drawn to local planning and national building regulations, including the Water Fittings Regulations [6]. Guidance on the Water Fittings Regulations is available from the local water supplier, WRAS or the UK Rainwater Harvesting Association (UKRHA).

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

Installation should ensure 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 below ground tanks;

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

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

d) 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.

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

All tanks should be installed so that the stored water does not attain temperatures that could encourage multiplication of *Legionella*.

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.

5.2.2 Above ground tanks

Above ground tanks should be securely mounted and supported on a firm level base capable of withstanding the weight of the tank when filled with water to the rim.

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 or loft-hatch. 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 ensure 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 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. Flexible cisterns should be supported on a flat rigid platform fully supporting the bottom of the cistern over the whole of its area, e.g. close boarding.

Overflows fitted to storage cisterns should be capable of discharging all inflows into the cistern.

NOTE In addition, an automatic supply cut-off device activated by an overflow may be installed to minimize the waste of water.

5.4 Pipework installation

5.4.1 General

The pipework connecting the collection surface to the tank should be installed so that water losses are minimized. Pipes should not discharge into open gullies where splashing or additional contamination could occur.

Where specified in the design, it should be ensured that an anti-surcharge valve conforming to BS EN 13564 is fitted to the overflow to prevent wastewater backflow.

5.4.2 Labelling and identification

Where two or more water systems, i.e. potable and non-potable, supply one property, all pipework, fittings and points of use for the rainwater harvesting system should be marked and/or labelled in accordance with Annex C, in order to facilitate identification, to prevent inadvertent consumption or cross-connection between the systems, and to avoid operating errors.

5.5 Testing and commissioning

[A1⟩ 5.5.1 General

The system should be flushed and tested in accordance with **5.5.2** prior to handover to ensure that pipework and containers are watertight and that there are no cross-connections in accordance with BS EN 806 and the manufacturer’s recommendations.

All pipework and fittings should be tested in accordance with, and meet the requirements of, BS EN 806-4:2010, **6.1** and **6.2**, at a minimum of 1½ times the normal operating pressure.

The 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.

5.5.2 Dye testing for distribution pipework cross-connections

NOTE 1 The test set-up for dye testing is shown in Figure 6.

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 rainwater 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 6;

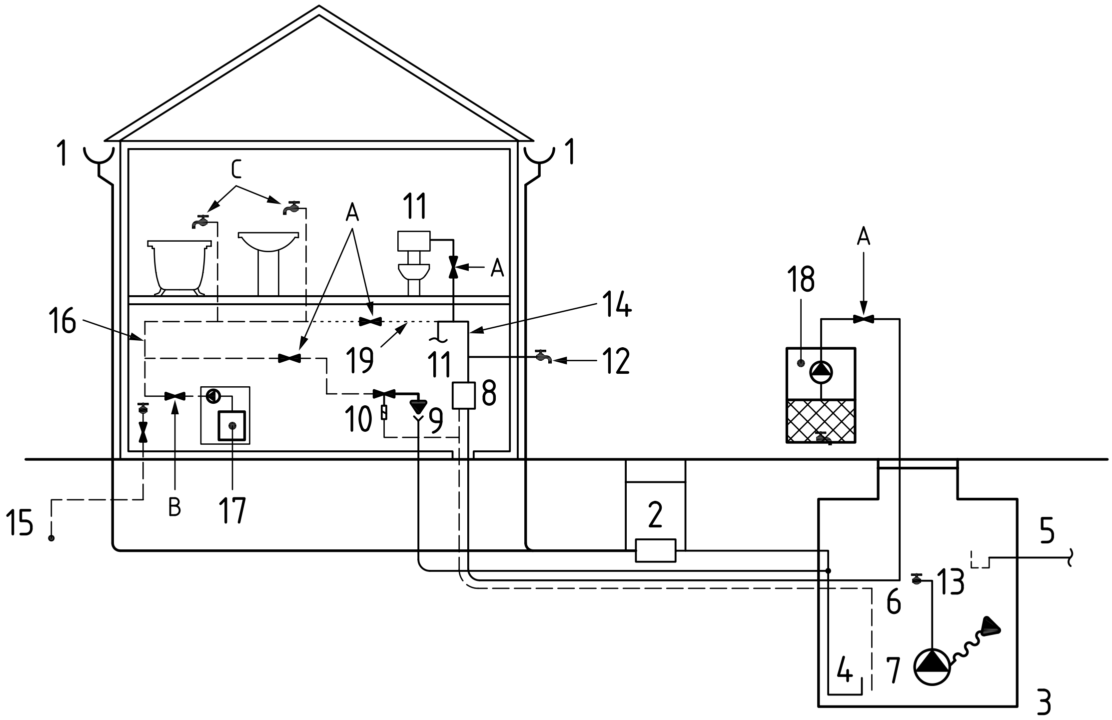
b) all in-line servicing and stop valves (A) should be opened on both the potable/back-up water supplies and the rainwater system. The stop valve (B) on the potable/back-up water supply should be closed;

c) the rainwater system should be filled with clean potable water and a suitable drinking water safe colourant, such as cochineal E124, added. Water should then be drawn through the rainwater 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 rainwater 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 6 **Dye testing distribution pipework**



Key

1 Gutter/downpipe
2 Filter in access chamber
3 Storage tank
4 Calmed inlet
5 Overflow pipe
6 Sensor/float switch
7 Submersible pump with floating extraction
8 Pump control with dry-running protection
9 Type AA air gap conforming to BS EN 1717 and BS EN 13076
10 Solenoid valve for back-up water supply
11 Non-potable applications, e.g. WC, washing machine
12 Garden tap
13 Optional outlet trap
14 Rainwater distribution pipework
15 Potable/back-up water supply
16 Potable/back-up water distribution pipework
17 Testing unit with pump for potable supply, filled with clean potable water
18 Testing unit with pump for rainwater system, filled with clean potable water
19 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)

A1

6 Water quality

*COMMENTARY ON CLAUSE **6***
It is essential that rainwater harvesting 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 re-use rainwater for non-potable water use.

Frequent water sample testing is not necessary; however, observations for water quality should be made during maintenance visits to check the performance of the 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. Sampling for tests should be carried out in accordance with Annex D.

Testing immediately following the commissioning of systems is not recommended as systems are generally filled with public mains water

The MTP has undertaken a review of rainwater and greywater systems and made recommendations for quality guidelines and monitoring arrangements.[1] *The recommendations and tables given in Clause* ***6*** *have been adapted from this MTP report.*

Further guidance on water quality risk management is given in ***8.2****.*

in order to facilitate the testing of components, and water quality is therefore not representative of the normal rainfall 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 will fluctuate particularly following rainfall events when there might be a short-term change.

1) Market Transformation Programme (MTP), *Rainwater and Grey Water: Review of water quality standards and recommendations for the UK*, www.mtprog.com [13].

[A1]

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

Parameter number/100 mL	**Spray application** **pressure washing, garden sprinkler use and car washing**	**Non-spray application**			**Testing**		**System type**
		WC flushing	**Garden watering** A)	**Laundry, i.e. washing machine use**	**Spray applications**	**Non-spray applications**	
Escherichia coli	Not detected	250	250	250	BS EN ISO 9308-1	BS EN ISO 9308-3	Single site and communal domestic systems
Intestinal *enterococci*	Not detected	100	100	100	BS EN ISO 7899-2 or BS EN ISO 7899-1	BS EN ISO 7899-1	Single site and communal domestic systems
Legionella pneumophila	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)	10	1 000	1 000	1 000	Blue Book 223, Method D [N2]	BS EN ISO 9308-3	Single site and communal domestic systems

A) If treated rainwater 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 rainwater reflect the need to control the quality of treated water for supply and use.

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

Parameter	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		
Dissolved oxygen in stored rainwater	>10% saturation or >1 mg/L O_2 (whichever is least) for all uses				Blue Book 16: 16 Method A (titrimetric) or Method B (instrumental using an oxygen probe) [N3]	All systems
Suspended solids	Visually clear and free from floating debris for all uses				Blue Book 105: SMP method [N3]	All systems
Colour	Not objectionable for all uses				Blue Book 103: Method B2 (formazin standards) [N3]	All systems
Turbidity NTU	<10 NT U for all uses (<1 NT U if UV disinfection is used)				BS 1427	All systems
PH PH units	5–9.5	5–9.5	5–9.5	5–9.5	BS 1427	Single site and communal domestic systems
Residual chlorine mg/L	<2 mg/L	<2 mg/L	<0.5 mg/L for garden watering	<2 mg/L	BS EN ISO 7393-2	All systems, where used
Residual bromine mg/L	<2 mg/L	<2 mg/L	<2 mg/L	<2 mg/L	Blue Book 218, Method E10 [N3]	All systems, where used

A1

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 rainwater 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 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 [14]).

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 2).

7 Maintenance

Human entry into tanks should be avoided, wherever possible. A1⟩ Maintenance procedures should conform to BS EN 806-5 and manufacturer's maintenance recommendations. ⟨A1

Maintenance procedures should be in accordance with 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 here 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.

A1⟩ Where faults are found, corrective actions should be taken as necessary. ⟨A1

Table 6 **Maintenance schedule**

System component	**Operation**	**Notes**	**Frequency** [A)]
Gutters/downpipes	Inspection/ Maintenance	Check that there are no leaks or blockages due to build up of debris; clean the gutters if necessary	Annually
Filter	Inspection/ Maintenance	Check the condition of the filter and clean, if necessary	Annually
Storage tank/cistern	Inspection	Check that there are no leaks, that there has been no build up of debris and that the tank is stable and the cover correctly fitted	Annually
	Maintenance	Drain down and clean the tank	Every 10 years
Pumps and pump control	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 the expansion vessel or shock arrestors	Annually
Back-up water supply	Inspection	Check that the back-up supply is functioning correctly, that there are no leaks and that the air gaps are maintained	Annually
Control unit	Inspection/ Maintenance	Check that the unit is operating appropriately, including the alarm function where applicable	Annually
Water level gauge	Inspection	Check that the gauge indication responds correctly to the water level in the tank	Annually
Wiring	Inspection	Visually check that the wiring is electrically safe	Annually
Pipework	Inspection	[A1⟩ Check that there are no leaks, that the pipes are watertight, that overflows are clear and that no cross-connections have been created. ⟨A1]	Annually
Markings	Inspection	Check that warning notices and pipework identification are correct and in place	Annually
Support and fixings	Inspection/ Maintenance	Adjust and tighten, where applicable	Annually
UV lamps	Inspection/ Maintenance	Clean and replace, if necessary	Every 6 months

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

8 Risk management

8.1 General

A risk assessment should be carried out to determine whether the 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.

[A1) *NOTE 1 Additional guidance and examples are provided in WRAS Information and Guidance Note No. 9-02-04 [15]. See also the HSE Approved Code of Practice and guidance L8 [14], the WHO Water Safety in Buildings document [17], and BS 8580.* (A1]

The risk assessment should consider the design, installation, testing and commissioning, operation and maintenance of the 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 system 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, 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.

NOTE 2 The use of rainwater for WC flushing and general garden watering is considered to be a low-risk application due to the low level of human exposure. However, there are some factors, such as the use of pressure washers and garden sprinklers, that increase the extent of exposure through aerosols, thus making risk assessment necessary.

8.2 Water quality

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 system.

The risk assessment should be used to identify the need for any further water quality control measures, including additional monitoring, for systems where a ground-level and/or highly trafficked collection surface is to be used.

[A1⟩ Annex A (normative) Sizing for stormwater control

*COMMENTARY ON **ANNEX A***
Annex A draws on the evidence and methodology given in the research report SR736 "Developing Stormwater Management using Rainwater Harvesting R2-0", (HR Wallingford 2012). [18]

A.1 General

This annex provides four methods that should be used for sizing stormwater storage for rainwater harvesting systems, three methods are based on the passive system approach: simple (see **A.3**), intermediate (see **A.4**) and detailed (see **A.5**), and a fourth method based on an active system design (see **A.6**).

The three methods based on the passive system should have a yield to demand ratio (Y/D) of not greater than 0.9 to ensure stormwater management benefits are gained, where the yield is the volume of rainwater harvested from the collection surface and the demand is for volume of non-potable water for reuse.

NOTE 1 If a value of Y/D greater than 0.9 is calculated, then there is no way of effectively using rainwater harvesting to control stormwater runoff using a passive system approach.

NOTE 2 Often rainwater harvesting tank sizing is designed for individual properties. In this situation the actual house occupancy can never be known as this continuously changes over time, so this results in some properties not achieving stormwater control because tanks are nearly always full when demand is lower than the estimate made for that property. Therefore it is necessary for an allowance to be made in the design of the "downstream" drainage system by assuming 1 in 3 properties do not provide effective stormwater storage. Where community schemes are built in which runoff from a group of houses is collected centrally, no allowance need be made assuming at least 10 properties are served. .For fewer properties some provision is required. This is because the average population tends towards the mean occupancy as the number of properties increases.

A.2 Active and passive rainwater harvesting systems

There are two principal methods which should be followed for sizing tanks for stormwater management; these are:

a) passive rainwater harvesting systems: a passive system is the most common rainwater harvesting system, where the storing and emptying of water in a tank (or spilling when full) is a function of demand;

b) active rainwater harvesting systems: an active system is one where the stored water volume is managed to maintain spare storage at all times for the eventuality of a large storm to ensure the runoff is stored (see **A.6**).

NOTE There are three advantages of using an active system; these are:

a) design storage volumes are generally less than those of passive systems;

b) the Y/D ratio value does not constrain the opportunity to use rainwater harvesting for stormwater management; and

c) all properties, irrespective of the uncertainty of their occupancy levels, can be assumed to achieve stormwater control for the design event.

A.3 The simple approach

A.3.1 General

The simplest approach that should be used for the tank design is to add the stormwater design volume to the water saving volume that is obtained from the method given in **4.1.2.2** for water saving. The stormwater volume should conform to Figure A.1 assuming that the equivalent of 60 mm rainfall event is stored to achieve zero runoff for a 60 mm event.

NOTE 1 The design rainfall depth of 60 mm is approximately equal to the 100 year, 6 hour event across much of England. However any design event depth can be used. Figure A.2 gives a simple rainfall depth map across the UK.

Total storage = $V_{SC} + V_{YR}$

where:

V_{YR} is the total storage for storm water control and rainwater for non-potable domestic use (L)

V_{SC} is the storage for stormwater control (L)

There are a number of constraints that should be taken into account when applying this methodology; these are:

a) the simplified approach should only be applied to houses where the average Y/D ratio is no greater than 0.7 (for a Y/D ratio >0.7 this requires use of the detailed approach in **A.5**);

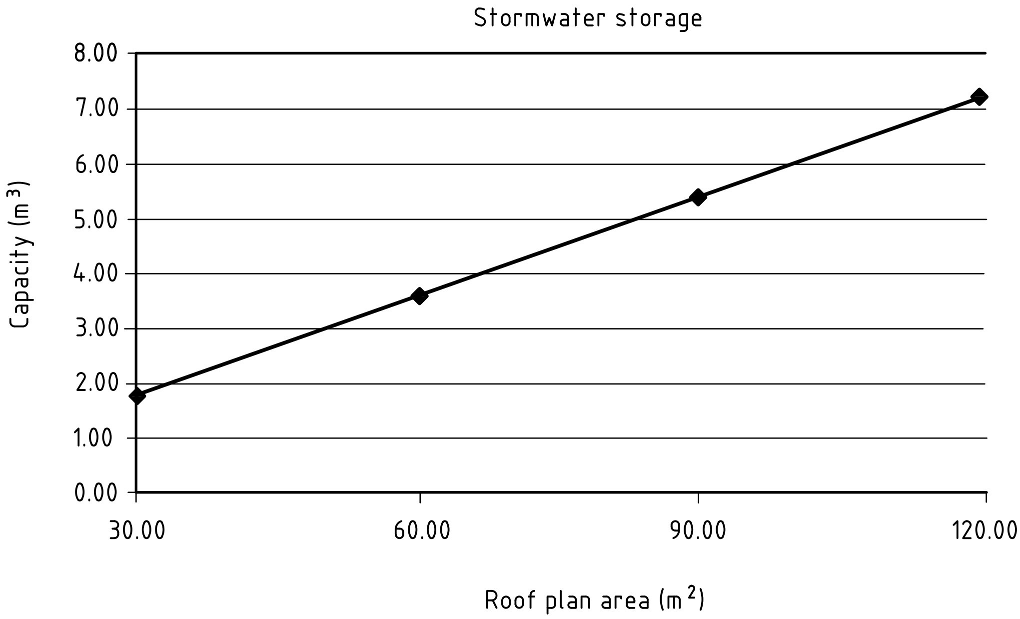
b) unless exact occupancy numbers can be determined and this is likely to remain the same, then the demand (D) should be based on the average occupancy for each size of house based on the statistical mean occupancy for that size of house (based on number of bedrooms for that region);

c) the demand should be estimated based on 40 to 50 litres per person per day (assuming toilet flushing and washing machine use).

Where the region is not considered to be typical in terms of dwelling occupancy characteristics, then the national statistics given in Table A.1 should not be used and regional information obtained.

NOTE The calculation of runoff yield for the storm event to be managed is assumed to be 100%.

Figure A.1 **Additional storage volume V_{sc}, over and above sizing for water saving, for rainwater harvesting tank sizes to provide stormwater control: simplified approach**



NOTE Figure A.1 is based on 100% run-off for 60 mm of rainfall, which approximately represents a 100 year, 6 hour rainfall event.

Table A.1 **Occupancy by accommodation type and number of bedrooms, England 2004-2007**

Type of accommodation and number of bedrooms	**Mean household size**
One bedroom	1.3
Two bedrooms	1.9
Three bedrooms	2.6
Four or more bedrooms	3.2

NOTE 1 This table is based on data from DCLG 2007

NOTE 2 Occupancy by accommodation type and number of bedrooms, England 2004-2007. Source: DCLG (2007)

NOTE 3 This table provides suggested occupancy numbers for the UK, but local regional statistics should be obtained where possible.

Having determined the tank size for the stormwater component, the total tank storage volume should be equal to storage volume given in Figure A.1 plus the storage volume from Figure 3 (**4.1.2.2**). However where the demand (D) is more than 3 times the yield (Y), the total storage should be taken as being only the volume from Figure A.1 as the tank is usually empty or nearly empty most of the time.

A.3.2 Site drainage design using the simplified rainwater harvesting tank sizing approach

When designing the drainage system for a site, it should not be assumed that all properties with individual rainwater tanks store the first 60 mm of the design event. An allowance should be made for those houses that have fewer people in them than the mean (as shown in Table A.1). In these situations Y/D might exceed 0.9 and it should not be assumed that the storage tank has room to store runoff from the design event. Therefore in designing the site attenuation drainage system it should be assumed that:

a) only the first 60 mm of rainfall does not contribute runoff to the site stormwater system; and

b) only 2 out of 3 houses are effective in preventing stormwater runoff.

NOTE All houses with a Y/D ratio less than 0.9 normally store significant volumes of rainfall in their tanks. However where Y/D > 0.7, this methodology is not conservative for controlling runoff for the design event due to the random nature of rainfall.

*COMMENTARY ON **A.3.2***

1) the use of 40 l/c/d is based on a literature search from the report SR736 "Developing Stormwater Management using Rainwater Harvesting_R2-0", HR Wallingford 2012 [18]. A figure of 50l/c/d is commonly used for sizing rainwater tanks, but in the case of stormwater management it is important to be sure that the ratio Y/D < 0.9.

2) the assumption of 1 in 3 properties not controlling the stormwater runoff is an approximation based on the assumption of a binomial distribution of occupants in properties resulting in the Y/D ratio being greater than 1.0 for approximately one third of properties depending on the mix of properties and their characteristics in the development;

3) the concept behind the design of rainwater harvesting is that daily demand can be assumed to occur irrespective of seasonal or weather conditions. If this is not the case, then detailed analysis is needed to assess the potential effectiveness of a rainwater harvesting for stormwater control benefits;

4) in situations where stormwater control is desirable, but demand is less than supply, it is still possible to obtain stormwater control benefits using the following techniques:

i) by reducing the runoff from the rainfall (reduction of Y). Options include the use of green roofs or reducing the size of the collection surface; or

ii) considering seasonal benefits where rainfall in summer might comply with the Y/D ratio criterion, or use of an active control system.

A.4 The intermediate approach

NOTE 1 The intermediate approach is much the same as the simple approach. Equations are provided to allow a more flexible and accurate facility for calculating the storage needed. The advantage of this is the variables can be modified to reflect the situation being considered. The main difference is that:

a) an allowance (reduction in size) can be made for the storage volume provided for the non-potable domestic water use;

b) the design rainfall event storage depth (other than 60 mm) can be chosen.

NOTE 2 The intermediate approach has the same constraints as the simple approach for:

a) Y/D < 0.7 (based on 40 to 50 l/c/d);

b) where D > 3.0Y, then the stormwater storage is the total storage required;

c) the mean household occupancy is assumed;

d) only 2 out of 3 houses are effective in preventing runoff from the design storm when sizing site drainage requirements.

Calculation of Y/D should be based on the values of Y_R and D_N from **4.1.2.3**.

When $D_N - 3.0Y_R < 0$

$$V_{SC} = R_d \times A - [(D_N - Y_R) \times 0.5]$$

where:

- V_{SC} is the additional tank size needed for stormwater control (L)
- Y_R is 5% of the annual rainfall Yield (L) (see **4.1.2.3**)
- D_N is 5% of the annual Demand (L) (see **4.1.2.3**)
- R_d is the design storm event rainfall depth (mm)
- A is the area of the collection surface (m^2)

$$V_{YR} = V_{SC} + Y_R$$

When $D_N - 3.0Y_R > 0$

$$V_{YR} = R_d \times A$$

Where:

- V_{YR} is the total storage for storm water control and rainwater for non-potable domestic use (L)

A.5 The detailed approach

A.5.1 General

This method is applicable for Y/D ratio < 0.9. This approach is the only method which should be used for situations where Y/D > 0.7 as the calculated values using the simple or intermediate methods under estimate the storage requirements.

NOTE 1 This is because the random nature of rainfall events requires additional storage to be provided when demand and yield rates are fairly similar. This additional storage can be significant as Y/D increases towards 0.9.

Where D > 3.0Y, the total tank storage volume should be:

$$V_{YR} = R_d \times A$$

where:

- V_{YR} is the total storage for storm water control and rainwater for non-potable domestic use (L)
- R_d is the design storm event rainfall depth (mm)
- A is the area of the collection surface (m^2)

NOTE 2 The detailed method calculates total storage requirements and does not require calculation of the water supply volume.

NOTE 3 The following methodology has been developed by Gerolin and Kellagher to avoid the need to carry out extensive analysis using time series rainfall and is detailed in the report SR736 Developing Stormwater Management using Rainwater Harvesting [18].

The calculation of Y (yield) should be made more precise by including depression storage loss (initial wetting before runoff commences) as well as continuing losses during the event. Values for both depression storage losses and runoff coefficients should conform to Table A.2.

NOTE 4 A reduction in the runoff coefficient value can be made for continuing evaporation through the event, losses from gutters (leakage, overflow) as well as filtration losses depending on the type of filtration used.

NOTE 5 Loss from roofs which are not standard pitched concrete or slate roofs are not only greater, but also tend to have seasonal characteristics due to varying evaporation and evapotranspiration rates. In particular cases where rain-shadow is thought to exist (vegetation, other buildings, orientation, strong prevailing winds etc.), a reduction in the coefficients may be appropriate.

It should be assumed that there are approximately 150 events each year for the calculation of depression losses.

NOTE 6 For example, a depression storage of 0.5 mm represents 75 mm per year, which is approximately 15% of the rainfall in the south of the UK. It therefore significantly affects the assessment of the ratio Y/D.

NOTE 7 As depression storage loss is related to the number of storms, this needs to be estimated. However care needs to be taken in not making this number too great as evaporation is needed to ensure depression storage is available for the next event.

Filter efficiencies should also be applied; these might depend on the type of filter used. Filter efficiency should be verified with the supplier.

Y_R using depression storage loss and continuing runoff coefficient should be calculated as follows

$$Y_R = [\mathrm{AAR} - (150 \times ds)]\ e2 \times h \times A$$

ds is the depression storage (mm)

e2 Run-off coefficient

A is the roof area (m^2);

where:

Y_R is 5% of the annual rainfall Yield (L) (see **4.1.2.3**);

AAR is the depth of annual average rainfall for the location (mm).

Table A.2 **Depression storage losses and Yield coefficients**

Surface type	**Runoff coefficient (*e*2)**	**Depression storage (*ds*) (mm)**
Pitched roof with profiled metal sheeting	1.0	0.2
Pitched roof with tiles	1.0	0.4
Flat roof without gravel	0.95	1.0
Flat roof with gravel	0.95	2.0
Green roof, intensive [A)] [B)]	0.8	2.0 – 6.0
Green roof, extensive [A)] [B)]	0.8	2.0 – 4.0
Permeable pavement [A)] – Granular media	0.9	4.0
Tarmac pavement [A)] – Plastic crates	0.6 – 0.9	1.5

A) The runoff yield is uncertain for these surfaces and design should take account of the possibility that yields could be significantly higher or lower.

B) The hydraulic runoff behaviour of green roofs depends on their design and the season.

NOTE 8 Table A.3 illustrates the typical sizes of storage tanks. This is based on the application of the detailed methodology using an R_d value of 60 mm. It can be seen that tank sizes increase significantly for Y/D > 0.7.

Table A.3 **Rainwater harvesting tank storage volumes as a function of Y/D and number of bedrooms per property**

Y/D ratio	**2 bedroom Persons/house (m^3)**	**3 bedroom Persons/house (m^3)**	**4 bedroom Persons/house (m^3)**
Y/D = 0.60	1.8	2.5	3.2
Y/D = 0.70	2.4	3.3	4.1
Y/D = 0.80	3.2	4.4	5.5
Y/D = 0.90	4.5	6.2	7.8

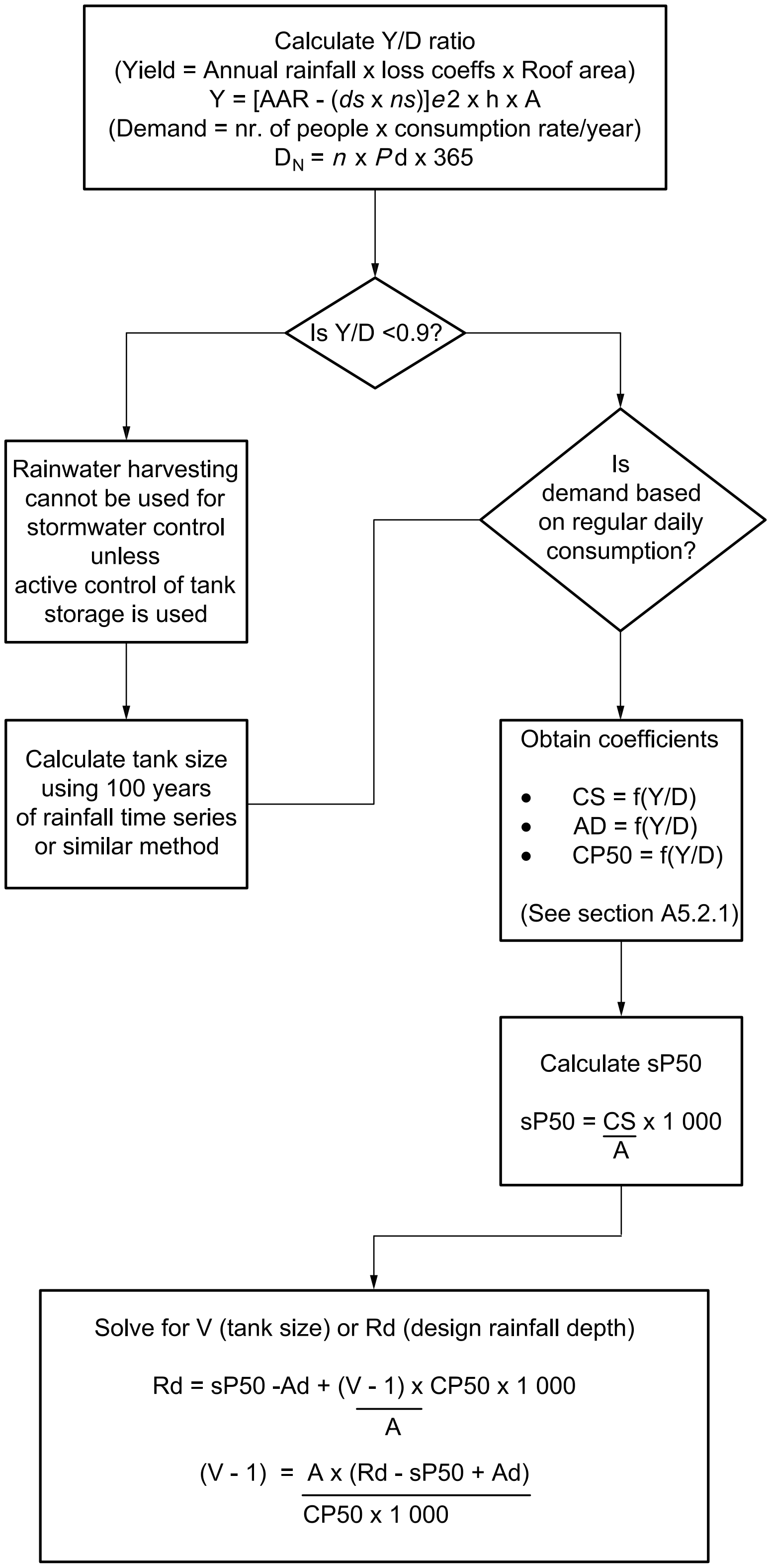
Rainwater harvesting tank storage volumes based on SR736 Developing stormwater management using rainwater harvesting 2.0 [18].

A.5.2 Methodology for sizing rainwater harvesting tanks

A.5.2.1 General

NOTE 1 The flow chart in Figure A.3 provides a detailed method for sizing a rainwater harvesting system for stormwater management. This methodology allows the estimation of the tank storage volume which is applicable across the whole of UK without having to carry out a detailed time series rainfall analysis.

Figure A.2 **Flow chart for sizing of rainwater harvesting tanks for stormwater control**



Key

AAR	Annual average rainfall (mm)
e2	Run-off coefficient
ds	Depression storage (mm)
ns	Estimate of the number of rainfall events per year ~ 150
h	Is the filter efficiency
A	Roof area (m^2)
Rd	Design storm rainfall depth (mm)
CS	Coefficient which is a function of Y/D
AD	Additional rainfall depth allowance to cater for the random nature of rainfall (mm)
CP50	Effective proportion of additional storage available for increasing the tank size from $1m^3$
sP50	Rainfall depth for $1m^3$ of storage (mm)

This methodology has effectively two main components: the tank size relationship required for a design rainfall depth given the parameters of contributing area, demand and design rainfall depth, and a second component which is an additional allowance for storage to take account of the variability of rainfall events and therefore the spare storage in the tank before a design event, so as to ensure that at least 90% of all design events are fully retained.

where: $R_d = sP50 - Ad + (V_{YR} - 1) / A \times CP50 \times 1000$

and

R_d is the net rainfall depth of the design storm (mm) (i.e. design storm depth × filter coefficient h);

sP50 is the rainfall depth for a $1 m^3$ storage tank (mm);

Ad is the additional rainfall depth allowance to cater for the uncertainty of storage availability for the design storm event (a function of Y/D) (mm);

A is the roof area (m^2);

CP50 is the effective proportion of additional storage available for increasing the tank size from 1 m^3;

V_{YR} is the tank size (m^3).

For the first $1 m^3$ of storage.

The value of *sP50* should be calculated as follows:

$sP50 = (1/A) \times CS \times 1\,000$

where:

sP50 is the storage depth of rainfall for a tank of $1 m^3$ (mm)

A is the collection area (m^2)

CS is a coefficient which is a function of Y/D

CS is a function of Y/D and varies slightly with annual average rainfall Figure 2 in Clause **4**. Cs can vary between 1 and 0.6. Where Y/D < 0.6 then:

$CS = 1.0$

Where the Y/D ratio is between 0.6 and 0.9, the following equations are to be used:

1) Where *AAR* < 750 mm and r > 0.35:

$CS = -0.677 \times (Y/D) + 1.40$

2) Where *AAR* > 750 mm and r < 0.35:

$CS = -0.847(Y/D) + 1.49$

Where: 'r' is the standard flood studies report (FSR) rainfall ratio parameter for the 1:5 year 1 hour / 2 day rainfall depth.

NOTE The difference between these equations is small and the differentiation in their use in terms of AAR and 'r' is to be treated as being approximate.

A.5.2.2 Allowance depth (*Ad*)

The *sP50* value, being an annual average measure of the storage space available means that for 50% of the time there should be less than this volume available for storage of a large event. *sP50* should therefore be reduced by an amount referred to as the allowance depth (*Ad*). This value should again be a function of Y/D. The correlation equation should give:

$Ad = 31.06(Y/D)^2 + 15.08(Y/D) + 0.36$

This value should tend to zero as Y/D becomes small.

A.5.2.3 The coefficient *CP50* for additional storage above 1 m^3

To ensure a specific flood event can be catered for the size of the tank should be increased from 1 m^3, using the coefficient *CP50* for determining the additional storage. However increasing the tank size should not increase the available storage by the same amount. Where Y/D < 0.6:

$$CP50 = 1.0$$

NOTE Where Y/D > 0.6, the effective storage volume of adding storage is less than the volume provided. This relationship is linear for any given ratio of Y/D < 1.0.

The following correlation equations for *CP50* for the range of Y/D between 0.6 and 0.9 should be used:

1) *CP50* for *AAR* < 750 mm and r > 0.35

$$CP50 = -3.29(Y/D)^2 + 4.16(Y/D) - 0.3$$

2) *CP50* for *AAR* > 750 mm and r < 0.35

$$CP50 = -4.06(Y/D)^2 + 4.94(Y/D) - 0.5$$

A.6 Active control of stormwater runoff using rainwater harvesting

A.6.1 General

NOTE 1 Most rainwater harvesting systems are designed as passive systems. However as they become more commonly used for stormwater control, active systems become more common. The advantages for choosing active systems are as follows:

a) minimizing the storage volume needed;

b) removing the uncertainty of being able to store the design event;

c) being able to use them in all situations (the Y/D ratio criterion does not need to be met).

Active control of the storage in a rainwater harvesting tank should allow storage to be maintained so that there is always room for runoff from a large rainfall event. However a management system should be such that if a tank has been filled by a large event, the action taken to empty it should avoid this occurring at a time when the downstream system is still suffering from the effects of the storm event.

This means that the tank should not be emptied when:

1) a significant rainfall event is likely to happen in the immediate future (event forecasting/nowcasting); or

2) a significant rainfall event is currently happening or has happened in the last 24 hours.

NOTE 2 There are two options for active management:

a) system management based on forecasting of an extreme event, and

b) control of the storage volume based on tank water levels.

A.6.1.1 Management based on forecasting of extreme rainfall

A decision to empty should be based on the ability to forecast a large event likely to occur in the near future. This system should have at least 6 hours if it is to be emptied and not contribute to exacerbating flooding in the drainage system downstream, or the receiving water course further downstream.

Retention of runoff for non-potable use should be maximized and discharge of stored water should only be triggered if a very big event is imminent.

NOTE 1 Although accurate rainfall depth forecasting for a specific location is still in its infancy, examples of this approach have already been applied to rainwater harvesting management in USA. However both the accuracy of the rainfall prediction technology along with the additional cost of all the communication systems, makes this unlikely to be a common approach for many years to come.

NOTE 2 W here demand is fairly regular on a daily basis, the benefit of retaining water as long as possible to maximize its use is likely to be fairly limited in the UK where the yield is fairly evenly spread throughout the year.

A.6.1.2 Storage management based on water level

An alternative approach to be taken to ensure adequate spare storage at any time other than during or immediately after an extreme event should also be prepared for. This means that tanks should be managed to provide sufficient storage.

NOTE The difficulty with managing storage using water level is deciding when to draw down the tank when it has exceeded a predefined threshold, not knowing whether a large event is currently on-going or has happened very recently.

Where Y/D is <0.9 this emptying process is relatively rare and filling above the threshold generally associated with a big event or a long wet period. However where Y/D> 1.0, action is needed to empty the tank frequently to maintain the required storage. The control strategy should take account of the Y/D ratio. A relatively small event (of the order of 5 mm to 10 mm) should be used for a ratio value less than 1.0, while a larger event (of the order of 10 mm to 15 mm) should apply to a ratio above 1.0.

A.6.2 The mechanics of operating an active control system

An active control rainwater harvesting stormwater management system should actively manage the water level in the tank.

A sensor should be used to trigger the need to drawdown the water in the tank, and a timer should be used to delay this action by an appropriate period.

NOTE 1 An appropriate period is considered to be 48 hours.

The sensor should activate a drawdown of water in the tank when it rises beyond the set threshold and deactivate it when it reaches a level based on the storage volume of the chosen event for setting the drawdown range.

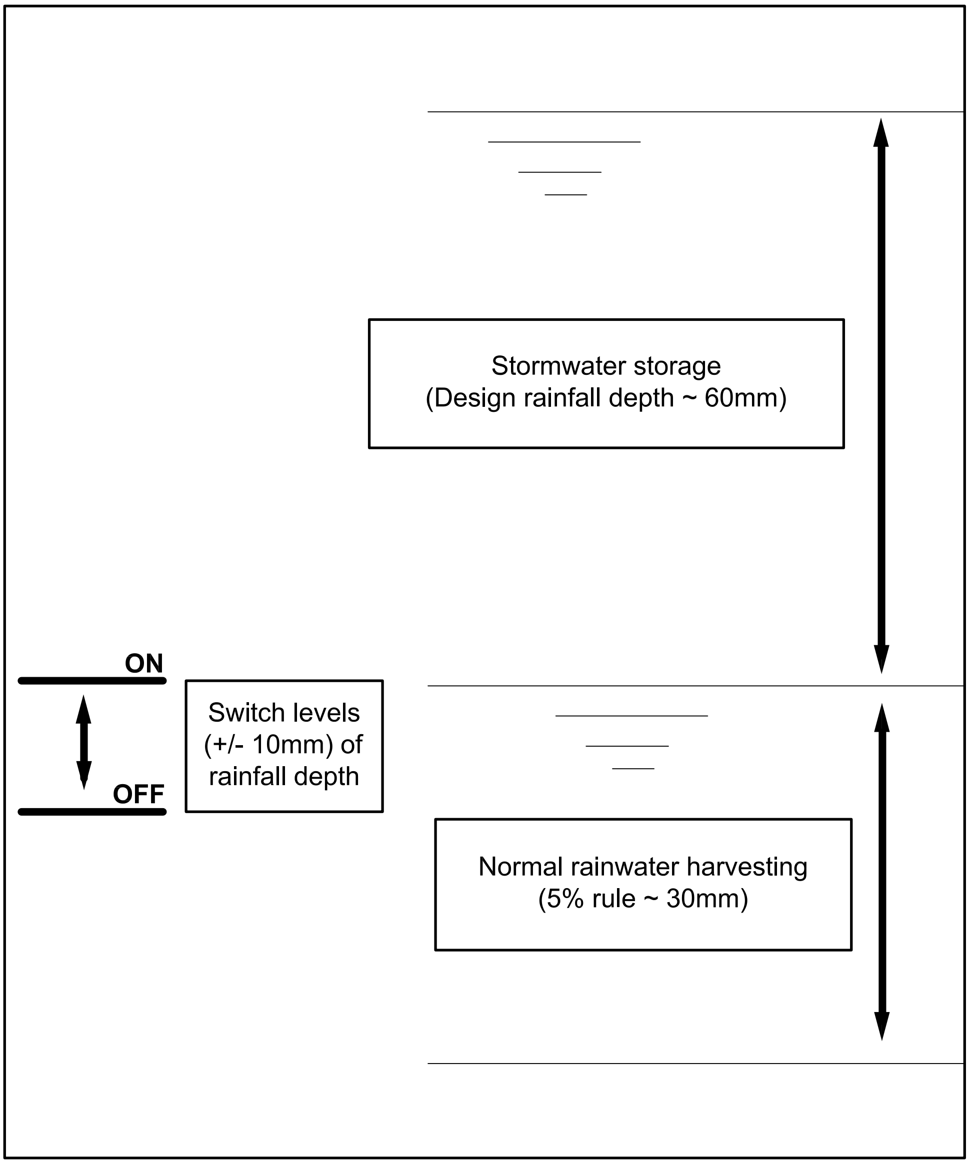
If the Y/D ratio is <0.9 then switch on and off levels set between 5 mm to 10 mm (of effective rainfall) apart should be used as, the drawdown should be infrequent. However where the Y/D ratio is >1.0 this value should be increased to between 10 mm and 15 mm, to minimize the drawdown frequency.

NOTE 2 The drawdown might be cancelled during the 48 hour delay period if the water demand reduces the water level below the on drawdown level switch.

The active control mechanism should be equipped with a fail-safe function.

NOTE 3 An example of the mechanics is shown in Figure A.3.

Figure A.3 **Rainwater harvesting tanks with active control for stormwater management**



A.6.3 Sizing of active control tanks

The size of an active rainwater harvesting system should be similar to the intermediate passive system design where Y/D < 0.7, and should be smaller than the detailed design passive system where Y/D > 0.7.

A.6.3.1 Storage for normal water supply

Storage for normal water supply that is not less than 5% for yield or demand, should conform to Clause **4**.

A.6.3.2 Size of the storage for the stormwater design event

The storage volume designed for a specific stormwater event (R_d) should be equal to the net runoff from that event.

A.6.3.3 Set point storage provision

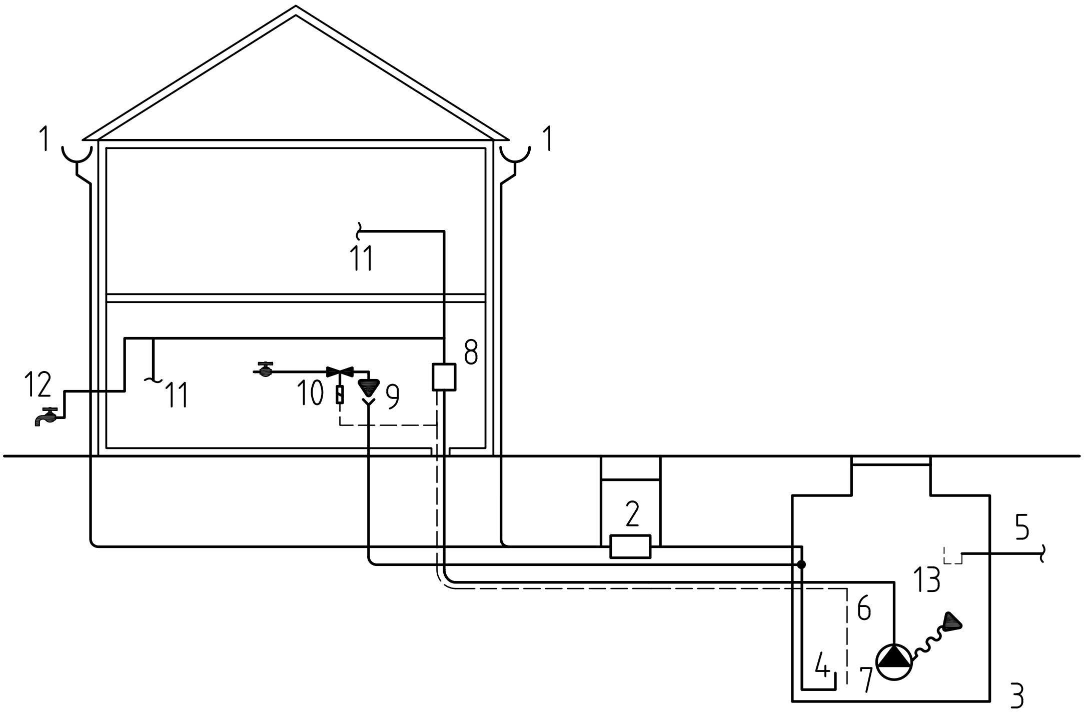
The "on" switch level should be set at the maximum level for the normal water storage. The "off" level should be set at the relevant level below this based on the selected rainfall event depth for the active system control. ⟨A1⟩

Annex B (informative) Examples of typical rainwater harvesting systems with different back-up supply arrangements

Examples of typical systems with different back-up supply arrangements are given in Figures B.1 to B.3.

A1

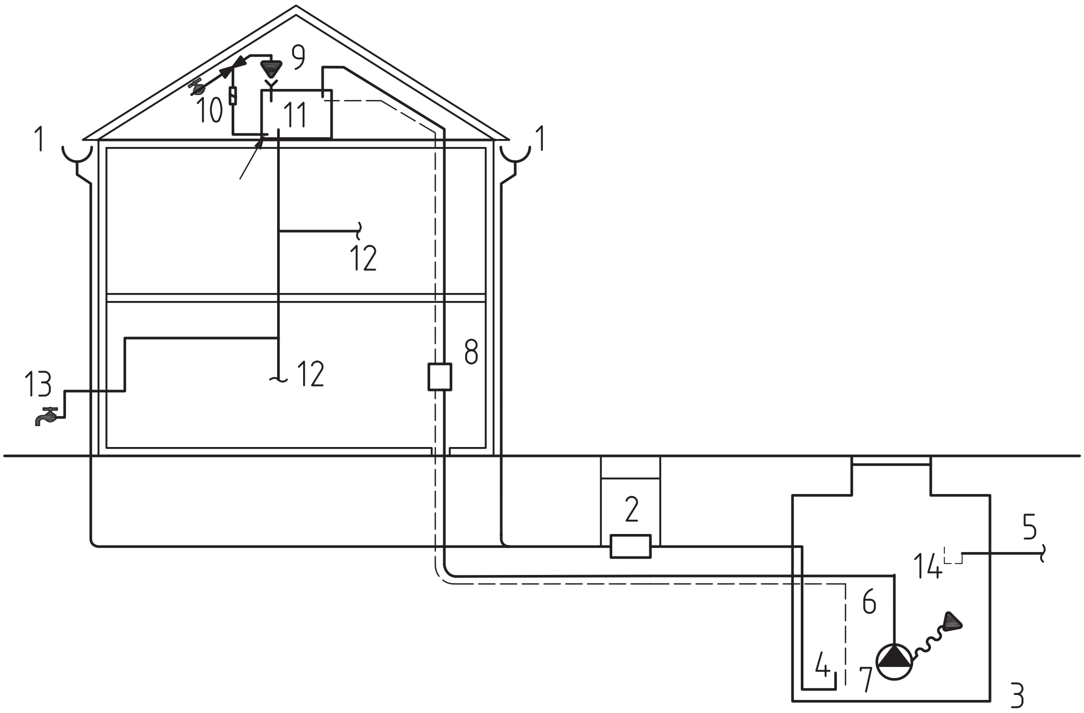
Figure B.1 **Typical system with direct primary supply and Type AA air gap**



Key

1 Gutter/downpipe
2 Filter
3 Storage tank
4 Calmed inlet
5 Overflow pipe
6 Sensor/float switch
7 Submersible pump with floating extraction
8 Pump control with dry-running protection
9 Type AA air gap in accordance with BS EN 1717 and BS EN 13076
10 Solenoid valve for back-up water supply
11 Non-potable applications, e.g. WC, washing machine
12 Garden tap
13 Optional outlet trap

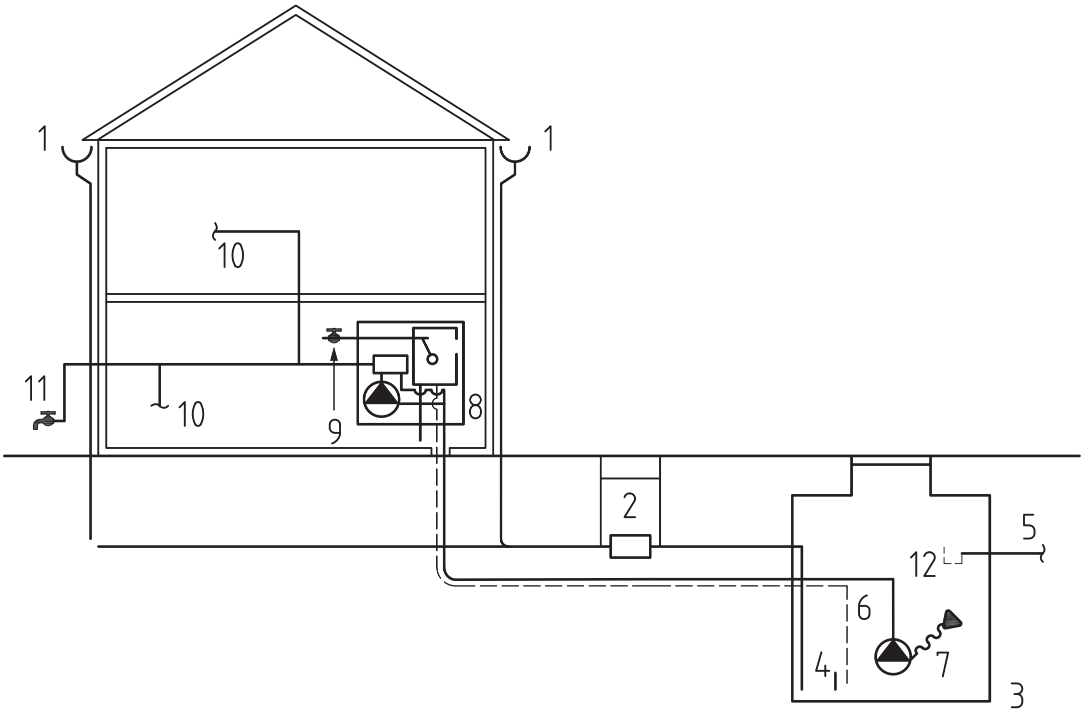
Figure B.2 **Typical system with indirect primary supply and Type AA air gap**



Key

1 Gutter/downpipe
2 Filter
3 Storage tank
4 Calmed inlet
5 Overflow pipe
6 Sensor/float switch
7 Submersible pump with floating extraction
8 Pump control with dry-running protection
9 Type AA air gap in accordance with BS EN 1717 and BS EN 13076
10 Solenoid valve for back-up water supply
11 Cistern in loft
12 Non-potable applications, e.g. WC, washing machine
13 Garden tap
14 Optional outlet trap

Figure B.3 **Typical system with module and Type AB air gap**



Key

1 Gutter/downpipe
2 Filter
3 Storage tank
4 Calmed inlet
5 Overflow pipe
6 Sensor/float switch
7 Floating extraction
8 Module including pump, pump control with dry-running protection and back-up water supply with Type AB air gap in accordance with BS EN 1717 and BS EN 13077
9 Back-up water supply
10 Non-potable applications, e.g. WC, washing machine
11 Garden tap
12 Optional outlet trap

A1

A1 *Also see WRAS Information and Guidance Note IGN 9-02-05 Marking & Identification of Pipework for Water Reuse Systems [19].* A1

Annex C (normative) Marking and labelling

NOTE 1 Attention is drawn to the Water Fittings Regulations [6] which require that any water fitting conveying rainwater to be clearly identified so as to be easily distinguished from any supply pipe or distributing pipe supplying wholesome water. This is to prevent inadvertent cross-connection between waters of different qualities, particularly drinking water.

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

C.1 Pipework

C.1.1 General

All distribution pipework should be identified as supplying rainwater. For most systems, more than one form of identification should be used to ensure 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.

Marking and labels used for the identification of rainwater distribution pipes should differentiate between non-potable supplies of different pressures, qualities and designated uses.

C.1.2 Labelling

The labels used for the identification of rainwater distribution pipes should:

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

2) be no less than 100 mm in length;

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

4) have "RAINWATER" in black lettering, no less than 5 mm in height.

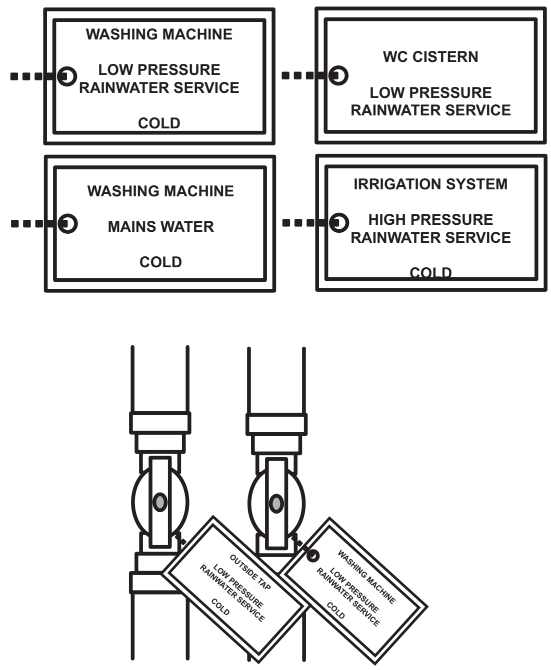
In addition, it is recommended that tags identifying each appliance and its water supply are secured to the pipework at key connection points using flexible fasteners. The lettering on these tags should be black or green, on a white background, and no less than 5 mm in height.

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 C.1).

NOTE 2 Identification codes alone are not sufficient.

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



C.2 Points of use

Points of use for the rainwater harvesting system, including all appliances, should be clearly identified with the words "Non-potable water" or a prohibition sign (see Figure C.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: RAINWATER" 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 C.3, provided that notices are posted to draw attention to this deviation from normal practice.

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

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

Annex D (normative) Water sampling

In order to test water quality, a dip sample should be taken from the tank or cistern in accordance with BS 7592. Where 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 collected rainwater;

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

Samples should only be taken from points of use, i.e. terminal fittings fed with water from the rainwater harvesting system, if routine sampling or observations indicate a problem.

NOTE Further guidance on water sampling is given in BS EN ISO 19458, BS EN ISO 5667-1 and BS EN ISO 5667-3.

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