BCDC 7 (853) DTZS

DRAFT TANZANIA STANDARD

On-site non-potable water systems. Part 1: Systems for the use of rainwater

TANZANIA BUREAU OF STANDARDS

First Edition

0 National Foreword

This draft Tanzania Standard is being prepared by BCDC 7 Sanitation structure and sanitary appliances Technical Committee under the supervision of the Building and Construction Divisional Committee (BCDC).

The Committee is composed of Tanzania Bureau Standards secretariat, together with the representatives of key stakeholders including government, academia, consumer groups, private sector and other interested organization.

After passing through Divisional committee, the draft Tanzania Standards is circulated to stakeholders for comments. The comments received are discussed and incorporated before finalization of standards, in accordance with the principles and procedures for development of Tanzania standards.

In the preparation of this draft Tanzania Standard, assistance was adopted from:

BS EN 16941-1:2018 *On-site non-potable water systems. Part 1: Systems for the use of rainwater* published by British Standards Institution.

Introduction

Ecological and sustainable water management is a goal of rainwater management. Herein rainwater harvesting and infiltration, as well as the decentralized detention of rainwater, are alternatives to the customary drainage of rainwater. Rainwater harvesting also reduces the potable water demand and the discharge of water.

In order to keep the natural cycle of water, excess water from the rainwater harvesting system can be infiltrated or otherwise evacuated in line with national or regional requirements.

On-site collection and use of rainwater covers a variety of applications like toilet flushing, laundry, irrigation, climate control of buildings, cleaning, etc. at private and rented properties, residential areas, community developments, industrial sites, hotels, streets, parks, golf courses, theme parks, car parks, stadia, etc.

A generic flow chart of rainwater use on-site is presented in Figure 1.

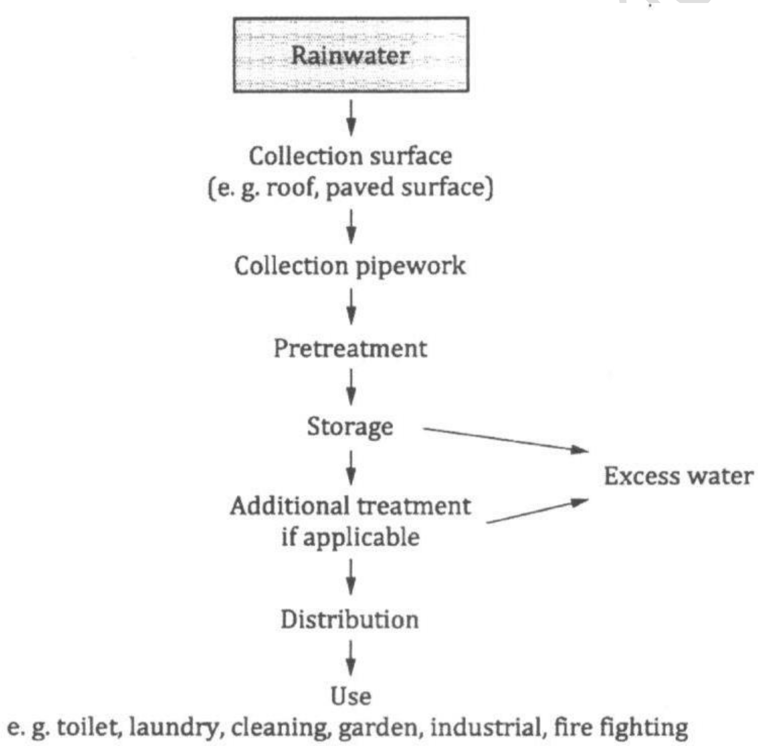


Figure 1: Generic flow chart of rainwater use

DRAFT TANZANIA STANDARD

1. Scope

This draft Tanzania Standard specifies the requirements and gives recommendations for the design, sizing, installation, identification, commissioning and maintenance of rainwater harvesting systems for the use of rainwater on-site as non-potable water. This Standard also specifies the minimum requirements for these systems.

Excluded from the scope of this draft Tanzania Standard are:

- the use as drinking water and for food preparation;
- the use for personal hygiene purposes;
- decentralized attenuation;
- infiltration.

Note 1 Conformity with the standard does not exempt from compliance with the obligations arising from local or national regulations.

2 Normative references

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

EN 476 *General requirements for components used in drains and sewers.*

EN 805 *Water supply- Requirements for systems and components outside buildings.*

EN 806-2 *Specification for installations inside buildings conveying water for human consumption – Part 2: Design.*

EN 806-3 *Specifications for installations inside buildings conveying water for human consumption - Part 3: Pipe sizing - Simplified method.*

EN 809 *Pumps and pump units for liquids - Common safety requirements.*

EN 1295-1 *Structural design of buried pipelines under various conditions of loading - Part 1: General requirements*

TZS 2345-2:2019/ISO 21138-2:2007 *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene.*

EN 171, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow.*

EN 12050 (all parts) *Wastewater lifting plants for buildings and sites.*

EN 12056-1 *Gravity drainage systems inside buildings - Part 1: General and performance requirements.*

EN 12056-, *Gravity drainage systems inside buildings - Part 3: Roof drainage, layout and* *calculation*

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

EN 12056-5 *Gravity drainage systems inside buildings - Part 5: Installation and testing, instructions for - operation, maintenance and use*

EN 12566-3 *Small wastewater treatment systems for up to 50 PT. Part 3: Packaged and/or site assembled domestic wastewater treatment plants*

EN 13076 *Devices to prevent pollution by backflow of potable water - Unrestricted air gap-Family A -Type A*

EN 13077, *Devices to prevent pollution by backflow of potable water - Air gap with non-circular overflow (unrestricted) - Family A- Type B*

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

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

ISO 4064 (all parts), *Water meters for cold potable water and hot water*

3 Terms and definitions

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

3.1
rainwater
water arising from atmospheric precipitation

3.2
rainwater harvesting
collecting rainwater from surfaces in order to be used

3.3
rainwater harvesting system
system for collecting rainwater from surfaces in order to be used, which consists of collection, treatment, storage and distribution elements

3.4
storage device
unit for the storage of harvested rainwater

3.5
cistern
fixed container for holding water at atmospheric pressure for use as part of the plumbing system

3.6
non-potable water
water which has been made available for use, except for drinking, food preparation and personal hygiene

3.7
non-return valve
device that prevents backflow of water

3.8
volume of useable water
maximum volume of water that can be extracted from a storage *device* in normal use which is usually from the overflow to the lowest extraction point.

4 Functional elements of rainwater harvesting systems

Any rainwater harvesting system is described through four main functional elements:

-collection;

-treatment;

-storage; and

-distribution.

Rainwater harvesting systems shall be designed, installed, marked, operated and maintained in such a way that the required level of safety is ensured at any time and that the required servicing work can be easily carried out.

Rainwater harvesting systems shall not cause flooding and therefore shall include potential bypasses and/or properly dimensioned overflows.

5 Design

5.1 Collection

5.1.1 General

The purpose of collection is to harvest rainwater and transport it to a storage device.

The following factors should be taken into account, as these can affect the quality and/or quantity of the collected water:

-the local rainfall pattern;

-the size of the collection surface;

-the surface's materials and their drainage characteristics;

-sizing and material of piping systems;

-the levels of pollution of the collection surface;

-the risk of contaminating the system.

5.1.2 Collection surfaces

5.1.2.1 Qualitative aspects

The characteristics of the collection surface (e.g. roofs and paved areas) shall be taken into consideration depending on the intended use of the rainwater. Pollutants from other sources, e.g.

traffic, industry and animals have to be taken into account.

Common roof materials, e.g. glazed tiles and slate, do not cause any negative effect on the quality of harvested rainwater.

Other roof collection surfaces may have potential to negatively affect the quality of the water harvested (see examples in Table 1).

Table 1- Examples of potential effects of collection surface on the quality of harvested rainwater

Collection surface	**Potential effect**
Green roof	colouration
Bitumen containing material	colouration
Cement with fibres	emission of fibres in the long term
Copper, lead or zinc roofs	increased concentrations of heavy metals
Weathered rough surfaces	wash out of solids

Where paved areas or roof areas allowing human amenity are used for collection possible pollutants due to the use of these areas shall be taken into account.

5.1.2.2 Quantitative aspects

Collection surfaces made of different materials have different characteristics regarding the drainage of rainwater. The volume of the harvested rainwater is influenced by the run-off coefficient (e). Unless otherwise specified, typical values are given for different materials in 6.1.2, Table 2.

5.1.3 Collection piping system -

Collection piping systems should allow the rainwater to flow from the collection surface to the storage device by gravity or siphonic action. Access for inspection, maintenance and cleaning has to be planned and installed.

Collection pipework from the roof within the rainwater harvesting system should not discharge into open gullies because additional contamination could occur.

The non-pressure pipes and fittings shall meet the general requirements according to EN 476 and the relevant product standards. The dimensioning shall be done in accordance with EN 12056-1 and EN 12056-3. Underground rainwater pipes shall be designed according to TZS 2345-2:2019/ISO 21138-2:2007

5.2 Treatment

5.2.1 General

The main purpose of treatment is to ensure a specific water quality depending on the intended use. Additional purposes are the protection of the system components and the reduction of maintenance. Treatment may involve biological, chemical or physical processes or a combination of them. Treatment shall be done upstream within and potentially downstream of the storage device.
Treatment covers several operations:

-removal of coarse particles upstream of the storage (see 5.2.2);

-retention of fine particles by sedimentation and flotation in the storage device (see 5.3);

-filtering downstream of the storage device, depending on the intended use.

Disinfection, deodorization and/or discoloration may be required additionally (see 5.2.3).

A rainwater harvesting system shall provide water suitable for flushing toilets, laundry and garden watering in most residential, industrial and commercial situations without the necessity of additional treatment (see 5.2.3) unless identified by risk assessment referred to in 5.9.
The treatment system shall:
-be water resistant and durable;
-be accessible for maintenance (see Clause 11);
-not affect the hydraulic operation of the overall drainage system;
-withstand the maximum stresses and loads exerted during its handling, installation, use and maintenance;
-and have a hydraulic efficiency ratio of at least 90 %.

The flow section of the overflow of the treatment device shall be designed for the discharge of maximum flow.

5.2.2 Preliminary treatment

Preliminary treatment (e.g. filters, separators) shall be designed and located upstream of the storage device and may consist of more than one device. The type and dimensioning of preliminary treatment shall be selected according to the nature and size of the collection surface.

purpose of preliminary treatment is to prevent the inflow of most coarse solids and organic matter into the storage device. The maximum particle size entering the storage device shall be equal or less than 1 mm for in-house use. If solids are retained, they shall be removed regularly or during a manual intervention.

5.2.3 Additional treatment

Additional treatment (e.g. filtration, disinfection) of the stored rainwater shall be included if the intended use demands higher quality.

5.3 Storage

5.3.1 General

The rainwater harvesting system shall, at a minimum, include one storage device which may be positioned either above or below ground.

The purpose of the storage device is:

-to conserve a suitable volume of rainwater for the intended use and the collection possibilities;
-to treat the incoming water (sedimentation, flotation); and

-to protect the quality of this water from risks of deterioration.

The storage device shall be protected against frost, extreme temperatures and direct sunlight, for instance buried underground.

The structural behaviour shall be taken into account when positioning the storage device.

5.3.2 Materials

The materials used shall not have a negative effect on the quality of the stored water and the environment of the installation.

The materials (e.g. concrete, steel, Poly (vinyl chloride) (PVC-U), Polyethylene (PE), Polypropylene (PP), Glass Reinforced Polyester (GRP-UP) used for prefabricated factory built storage devices shall meet the conditions described in EN 12566-3.

The material shall be non-translucent and/or UV stable. Where translucent material is used, light shall be excluded.

The materials constituting the submerged components shall be corrosion resistant.

5.3.3 Dimensions

When prefabricated components are used, the overall dimensions, access and connection dimensions and tolerances shall be stated by the manufacturer. Individual storage devices may be connected to each other.

5.3.4 Capacity

The nominal capacity is the maximum volume of water that can be retained within the storage device and shall be stated by the manufacturer or designer within ±0.1 m^3
The capacity can be determined by testing or calculation.

5.3.5 Structural behaviour

Storage devices shall withstand the maximum stresses and loads exerted during its handling, installation, use and maintenance. This shall be assessed either by calculation or testing.

Above-ground storage devices shall withstand the action of hydrostatic pressure without generating excessive deformation adversely affecting its function.

5.3.6 Watertightness

The storage device shall be watertight at the level of:

-the walls constituting it;

-the couplings ensuring the hydraulic connections; and

-the storage device wall penetrations used for the possible passage of electric cables.

5.3.7 Connections and internal pipe system

The nominal diameters of the inlet and outlet fittings of the storage device shall be stated by the manufacturer.

The inlets, outlets and other connections of the storage device shall be equipped with fittings with standardized dimensions (i.e. sockets, spigots) equipped with seals and enabling assembly using standardized pipes.

The inflow pipe of the harvested rainwater is terminated below the minimum water level of the storage device to prevent the disturbance of any material at surface level. A calming inlet (see Figure 4) shall be installed to prevent re-suspension of the solids that may have accumulated on the bottom.

Protection against the entry of small animals shall be provided.

5.3.8 Access

The storage device shall be equipped with an access to permit regular inspection and maintenance. The access shall be secured (e.g. by a cover with a locking feature or sufficient weight).

For the access of a person, the dimensions given in EN 476 shall be considered. When access of a person is not intended, an opening with a dimension (i.e. width for a square section or diameter for a circular section) not less than 400 mm minimum shall be used.

Shafts and access covers shall prevent unintentional contamination of the storage device.

5.3.9 Overflow

Storage devices shall be equipped with an overflow to allow excess water to be discharged. Excess water should be infiltrated or otherwise evacuated into surface water bodies. Discharge into the sewer system should only occur if inevitable.

Where the overflow is connected to a sewer system, the overflow shall be equipped with an odour trap. Where the overflow is connected to the sewer system where there is a risk of backflow from the sewer system, the overflow shall be equipped with an anti-flooding device according to EN 13564 (all parts). The anti-flooding device shall remain accessible for servicing.

Every overflow shall have provisions to avoid pollution. Any protection provided shall not reduce the effective cross-sectional area of the overflow. Overflows fitted to above ground storage devices should be screened.

During overflow a siphonage of the storage device shall be avoided.

The overflow pipe shall be dimensioned to evacuate the possible maximum inflow of the storage device.

5.4 Back-up water supply

5.4.1 General

The rainwater harvesting system shall incorporate a back-up water supply where continuous flow is needed. The back-up water may be introduced into:

a) a break cistern prior to its pump, for delivery to the distribution pipework, e.g. purpose-designed module; or

b) an intermediate cistern, usually located at high level, e.g. gravity supply; or

c) the storage device, either directly or by discharging into the collection pipework, but not before

treatment

Note 2 Annex B gives examples of typical systems with different back-up supply arrangements.

In the case of back-up water supply using potable water, the potable water supply system shall be protected with an appropriate protection unit (see 5.4.2).

The possibility of a flooding of the back-up water supply device (e.g. via reflux) shall be eliminated, e.g. by installing the back-up water supply device above the backwater level.

When the water level in the storage device is below a given minimum, the back-up water supply control shall automatically ensure the operational reliability of the system. This can also be achieved by a control system (see 5.6).

The back-up water supply shall 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 cistern.

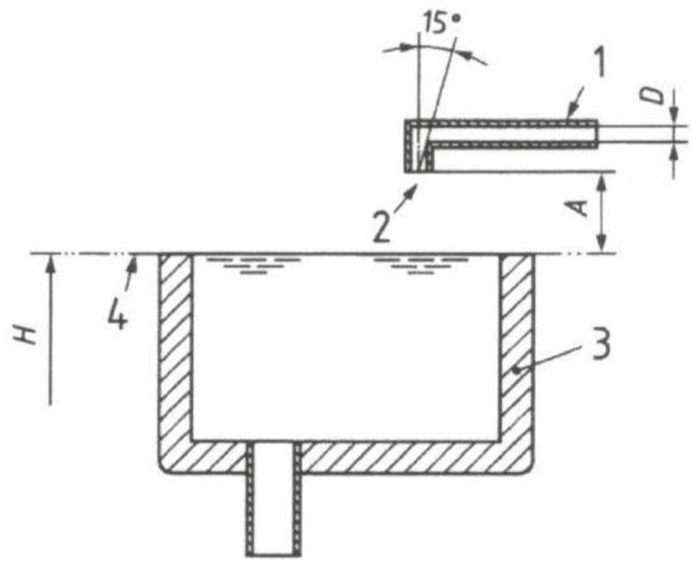
The design of the system shall ensure that there are no dead legs upstream, e.g. on the potable water supply and suitable turnover of water is achieved, to avoid water to become stagnant

In order to prevent wasting potable water, the storage device with valve-controlled water inputs shall have a warning system so any failure is readily noticeable.

5.4.2 Backflow protection device

To prevent non-potable water entering the potable or public water supply, the back-up water supply shall be fitted with a protection unit that is capable of providing fluid category 5 (an air gap) in accordance with EN 1717, such as described:

-in EN 13076, for family A, type A, "AA unrestricted air gap", disconnectors (see Figure 2): An "AA" - air gap is a visible unobstructed and complete air gap placed permanently and vertically between the lowest point of the inlet feed orifice and any surface of the receiving vessel that determines the maximum operational level at which the device overflows.

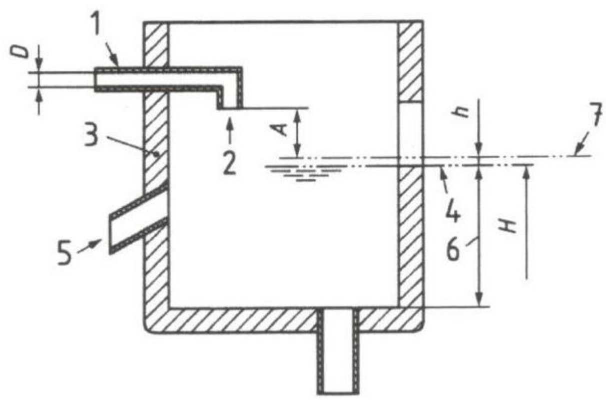


Key

1	feed pipe	A	gap (double the inner diameter of the feed orifice with a minimum of 20 mm)
2	feed orifice	D	internal diameter of feed pipe (bore)
3	receiving vessel	H	maximum water level
4	spillover level		
5	maximum angle from the vertical (15°)		

Figure 2 - Unrestricted Type AA air gap according to EN 13076

- in EN 13077, for family A type B, "AB air gap with non-circular overflow" disconnectors (see Figure 3): An "AB" air gap is a permanent and vertical distance between the lowest point of the feed orifice and the critical water level. The overflow shall be of non-circular design and shall be able to evacuate the maximum flow of water in the event of overpressure.



key

1	feed pipe	6	upstream face of the overflow arrangement U_w ($U_w \geq 5$ h)
2	feed orifice	7	critical water level
3	receiving vessel	**A**	air gap
4	spillover level	D	internal diameter of feed pipe (bore)
5	optional warning pipe	H	maximum water level
		h	distance between overflow and critical water level

Figure 3 - Unrestricted Type AB air gap with non-circular overflow according to EN 13077

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

Where the backflow prevention device is to provide water to the storage device directly and there is a risk of odours venting back into the building, an odour trap shall be installed.

5.5 Pumping

5.5.1 General

For systems, other than those which distribute the collected rainwater by gravity, one or more pumps shall be used to ensure its continual availability.

Note 3 The operational safety and hydraulic demand will dictate whether a single pump or multiple-pump system is needed.

The flow rate and the required pressure head of the pump shall be determined in accordance with EN 12056-4, EN 12050, EN 806-2 and/or EN 806-3, as applicable.

The pump shall be selected and arranged such that:

-energy use and noise are minimized;

-air is not introduced into the suction lines; it -

-is protected against freezing; and

-it is provided with isolation valves for maintenance and repair.

-it is provided with isolation valves for maintenance and repair

Surges, water hammer and hunting from the pump shall 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.

The pump shall comply with either EN 60335-2-41 for a domestic installation or EN 809 for other types of installations.
Multiple-pump systems shall conform to EN 12056-4 or EN 12050 with a standby pump if necessary.

Note 4 Several pumps can operate alternately to equalize their operating time.

The pump shall ensure the distribution of water under the conditions stated in 5.8 of this Standard. A non-return valve shall be provided to prevent back-flow.

5.5.2 Submerged pump

Where a submerged pump is used, it shall comply with the following:

- a minimum water level shall be maintained above the suction point to ensure that neither air, sediment nor floating debris are sucked in;
- the pump shall be installed in a way to prevent it from unintended movement, e.g. keeping the suction line in the correct positioning;
- a non-return valve shall be installed in the pipe in order to keep the pipe primed; and

- it shall be possible to remove and replace the pump without needing special tools or to enter the tank, e.g. for maintenance.

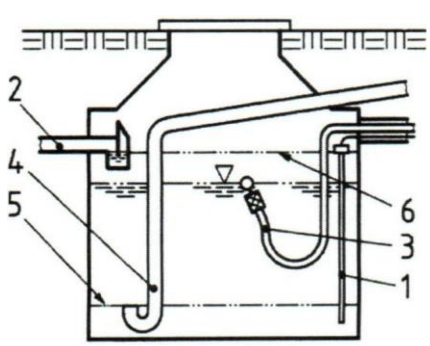
5.5.3 Non-submerged pump

Where a non-submersible pump is used, it shall comply with the following:

- the suction lines shall be airtight;
- the suction lines shall be installed in a way to minimize hydraulic friction loss;
- the suction lines shall be laid in a steady gradient towards the pump;
- a non-return valve shall be installed in the pipe in order to keep the suction pipe primed; and
- the water intake shall be constructed so as to avoid suction of the supernatant layer, sediments or air.

Self-priming pumps are recommended, because of ease of operation (e.g. easy commissioning, overcoming of potential air bubbles in suction lines).

An example of a floating sunction device on a non-submerged pump is shown in Figure 4.



Key

1. indicator/sensor
2. overflow with odour trap
3. floating suction device
4. calming inlet
5. minimum water level
6. maximum water level

Figure 4 - Example of a floating suction device on a non-submerged pump

The pump shall be placed in a well-ventilated location with sound and vibration free mountings.

5.5.4 Expansion vessel

An expansion vessel may be required to prevent the pump from starting too frequently if the system has a risk of low extraction or leaks.

The expansion vessel shall be sized according to the type of controls used (e. g. fixed or variable speed) and installed in a manner which prevents any deterioration of water quality within the vessel, e.g. in the vertical orientation.

Note 5 Using an expansion vessel may allow the pump to be used less and therefore improve the energy balance.

5.5.5 Pump control unit

Pumps shall be equipped with a pump control unit to automatically control the pumps with a manual override. The control shall permit manual operation.
The pump control unit shall:

- control pumps and minimize operational wear and energy use; and
- protect the pumps from running dry.

5.6 System control with monitoring

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

The system control shall inform the user of:

- the status of water supply (non-potable water or back-up water); and
- many malfunctions, e.g. pump failure, back-up supply failure.

Other monitoring may also be included, e.g. water metering, water level, the overflow, tank temperature and other parameters.

The control unit should permit manual override. Data may be monitored and stored. The system control may be linked to a building management system.

5.7 Metering

Water meters may be used to control the rainwater harvesting system.

When meters are required to quantify the volumes of non-potable water used inside the building and discharged into the public sewer system, reference shall be made to the specifications of ISO 4064-1 to

EN ISO 4064-5.

5.8 Distribution

The purpose of distribution is to feed the points of use with non-potable water and the possibility of back-up water supply. The distribution performed shall ensure the integrity and protection of public and private potable water distribution systems.

The treated rainwater/non-potable water shall be distributed by:
a)pumping it from the storage device directly to the point of use; or
b)pumping it from the storage device to an intermediate cistern/tank near the point of use; or
c)using a gravity cistern; or
d)using a full gravity system.

Cross-connection of non-potable water distribution pipes with other piping systems shall not occur.

Domestic type water distribution systems (e.g. for toilet flushing) used for the distribution of non-portable water shall be designed according to the applicable Tanzania Standards.
For the identification of pipes for conveying rainwater, see Clause 8 and the relevant product standards. Rainwater, non-potable water and drinking water usually have different chemical characteristics (pH for instance). The materials constituting the pressure pipe shall be chosen considering the risk of corrosion.

5.9 Risk assessment

Risk assessment shall 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 shall consider the effects of exposure to, and the potential impacts of, the system on people, the environment, and physical assets

The risk assessment shall consider the design, installation, testing and commissioning, operation and maintenance of the system, including water quality, structural stability, electrical safety and access provision.

7. Sizing

6.1 Storage device

i. General

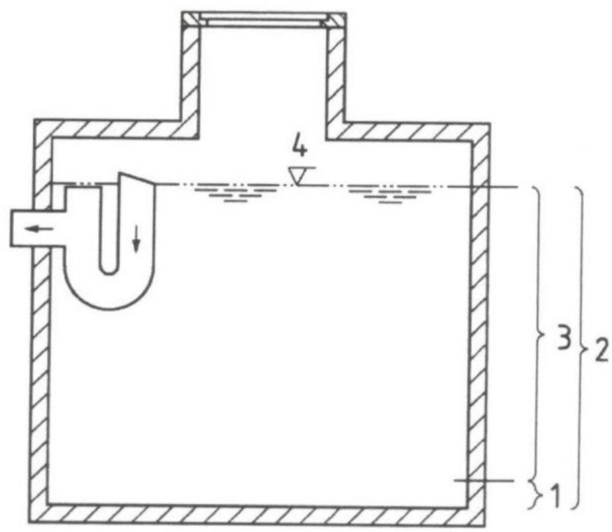
The sizing of the volume of the rainwater storage device results from an analysis of the relationship between the rainwater that can be harvested and the demand of the non-potable water for the intended use requirements.
The following factors shall be considered in order to be able to calculate the size of the storage device:

- the rainfall data (amount, intensity, pattern of rainfall, dry periods);
- the size and type of the collection surface;

- the number and type of intended applications, both present and future;
- and the hydraulic efficiency of equipment used (e.g. filters).

Other factors may influence the choice of the size of the storage device (e.g. available area, groundwater level).

The nominal capacity as shown in Figure 5 consists of:
-the volume of useable rainwater; and
-the volume of non-useable rainwater.



Key

1. volume of non-usable rainwater
2. volume of nominal capacity
3. volume of usable capacity
4. maximum water level

Figure 5 – Capacities of storage device

The storage device capacity of the rainwater harvesting system can be determined using one of methods described in the Annex A.

The storage devices should be selected on the basis of useable volume, rather than the total capacity of the storage device.

6.1.2 Determination of the available volume of rainwater

The available volume of rainwater (Y_R) that can potentially be harvested for a time step (t) from different areas (index $_i$) defined using the following formula:

$$Y_R = \sum A_i \times h_i \times e_i \times \eta_i$$

where

Y_R is the rainwater yield per time step *t,* expressed in litres (l);

A is the horizontal projection of the collection area, expressed in square metres (m^2) (see a);

h is the total rainfall for a chosen time step *t,* expressed in millimetres (mm) (see b);

e is the run-off coefficient (see c);

η_i is the hydraulic treatment efficiency coefficient (see d).

a) collection area (A)

The collection area (A) is the horizontally projected area of the roof or other collection surface which is to be drained to the rainwater harvesting system.

b) total rainfall for a chosen time step *t* (*h*)

The total rainfall *(h)* shall be representative of the site.

The time step (yearly, monthly, daily) for this data shall be chosen depending on the sizing approach.

c) Run-Off coefficient (*e*)

Table 2 provides the surface yield coefficients (Run-Off) that shall be used.

Table 2- Run-Off Coefficients for Different Surfaces

Surface	Run-Off Coefficient (e)
1. Roof catchments • Roof tiles • Corrugated sheets	 0.8 to 0.9 0.7 to 0.9
2. Ground surface covering • Concreted • Bitumen, plastic sheeting, butyl rubber • Pavement of stone, bricks with open joints • Pavement of stone, bricks with tightly cemented joints	 0.6 to 0.8 0.8 to 0.9 0.5 to 0.6 0.75-0.85
3. Compacted and smoothened soil	0.3 to 0.5
4. Lawns, sandy soil • 2% slope • 2.7% slope • >7%	 0.05-0.10 0.10-0.15 0.15-0.20
5. Lawns, heavy soil • 2% Slope • 2.7% slope • >7%	 0.13-0.17 0.18-0.22 0.25-0.35
6. • Uncovered surface, flat terrain • Uncovered surface, slope less than 10% • Rocky natural catchments	 0.3 0.0 to 0.4 0.2 to 0.5

d) hydraulic treatment efficiency coefficient (η)

The hydraulic treatment efficiency coefficient is the ratio of outcoming flow of the treated water to incoming flow of the collected rainwater. If not specified by the manufacturer the coefficient for systems without additional treatment 0.9 can be used for calculation.

6.1.3 Determination of the non-potable water demand per day

The non-potable water demand D is estimated based on the forecasted uses, their frequency and their seasonality. This demand varies substantially according to the region, climate and type of building.

The non-potable water requirements are comprised of person-related demand D_p (e.g toilet) in accordance with:

$$D_{p,d} = D_p \times n$$

Where;

$D_{p,d}$ is the non-potable water demand per day; expressed in litres per day (l/d);

D_P is the per-person non-potable water demand; expressed in litres per capita per day (l/(cap x d));

n is the number of capita in the connected building (s) (cap).

Non-person-related demand D_r (e.g. green areas, industrial and commercial uses) shall be taken into account by adding to the equation, where applicable.

6.1.4 Calculation methods

For the determination of the capacity of rainwater harvesting systems different calculation methods exist. These may be applied.

Calculation methods are given in Annex A. These calculation methods can be used to define the storage device capacity of the rainwater harvesting system:

- a basic approach for projects with regular demand and yield based on an annual time step, which uses storage days until the potential next rainfall (see A.2.1); or

- a detailed approach for large and complex projects and/or projects with irregular demand and yield based on a daily time step (see A.2.2).

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

If the yearly rainwater yield is lower than the yearly non-potable water demand, a back-up supply is necessary.

6.2 Back-up water supply

The back-up water supply pipe shall ensure the maximum required flow for the installation, subject to the supply capacity of the back-up source. Where the back-up source supply is insufficient to meet the flow design requirements, additional measures, such as greater volumes of storage is required, to ensure critical services can be maintained.

In a system with separate break cistern back-up supply (see Annex 8) the incoming flow of the back-up water supply shall match the potential flow rate of the pump including the loss of flow rate due to the air gap.

8. Installation

The system installation shall be carried out in accordance with the design of the system following good practice and national regulations.

The location of the underground storage device shall respect a minimum distance of 3 m from any tree or plant that develops a significant root system. A grassed surface is permitted. Plants closer than 3 m to the storage devices may require the implementation of root barriers intended to protect it

When prefabricated components are used, the installation shall be carried out in accordance with the manufacturer's installation instructions.

Manufacturer's installation instructions shall contain comprehensive data for the installation of the system and shall, where appropriate, cover at a minimum:

- location characteristics;
- backfill for underground installation;
- groundwater level situations for underground installation;
- assembly of components;
- access for maintenance and/or replacement of consumable parts;
- pipe connections;
- electrical connections;
- temperature considerations; and
- health and safety aspects (e.g. secure access).

Prior to installation of underground devices, any site specific factors that might affect the installation process shall be taken into account Such additional factors include:

- ground strength and stability;
- land contamination;
- proximity to utilities and foundations;
- avoidance of any future loads above the storage device which are not considered in the design;
- existing pipework and cables;
- access routes.

8 Differentiation and identification

Differentiation and identification through labelling and marking provides users and maintenance staff who are likely to work on the installation with suitable information to ensure safe operation of the greywater treatment and potable water distribution system.

To prohibit misuse it is recommended that all non-potable water taps shall be equipped with a safety device (e.g. detachable lever)

All pipework (both collection and distribution), fittings and points of use for non-potable water systems shall be marked and labelled to prevent accidental consumption or cross-connection between the potable and non-potable water and cross-connection between the different collection pipework:

- draw-off points for non-potable water shall be identified with the words "Non-potable water" or by a prohibition sign as shown in Figure 6. If the majority of draw-off points on industrial premises are for non-potable water, the draw-off points for potable water may be identified by the words "Potable water" or by the "Potable water" symbol specified in Figure 6, provided that notices are posted to draw attention to the deviation from normal practice;

Figure 6 - Signs "Potable water" (left) and "Non-potable water" (right) according to EN 806-2

- the pipes of the non-potable water distribution systems shall be clearly identifiable (this can be ensured by different colour from potable water pipes or by an identification band with the pipe); and
- a sign with a notice of the existence of a non-potable water system shall be installed close to the drinking water mains valve.

9 Commissioning

The complete installed rainwater harvesting system shall be checked according to design, standards and manufacturer's instructions before it is commissioned. The distribution pipework shall be flushed and inspected for watertightness and cross-connections between potable and non-potable pipes.

The electrical part of the rainwater harvesting system shall also be tested in accordance with applicable standards and national regulations to ensure that it is electrically safe and that there is no interference to or from other electrical or electronic equipment, or wiring in the vicinity. before it is commissioned.

A commissioning sheet shall be established, certifying that the system is technically correct and fully operational. The commissioning sheet shall be submitted to the owner of the installation. An example commissioning sheet is given in Annex C.

10 Quality of non-potable water

Rainwater harvesting systems shall be designed and installed such that the non-potable water is fit for purpose and presents no undue risk to health following national regulations, standards and guidance.

11 Maintenance

The designer's or manufacturer's specification shall supply installation and operation instructions with each rainwater harvesting system. These instructions shall contain comprehensive data for the installation and all operating conditions including pipes connections, electrical connections and commissioning and start-up procedures. These instructions shall cover all installation conditions, including any limitation due to the effect of ambient temperature.

Inspection and maintenance instructions depend on the possible use of non-potable water, the dimension of the rainwater harvesting system and national requirements. Table D.1 gives an example of an inspection and maintenance instruction sheet.

In the case of an installation distributing non-potable water inside the buildings, the owner shall establish a log book in accordance with Annex D, including the following information:

- contact data of the person or of the company in charge of the servicing;
- the rainwater harvesting equipment drawing, showing the piping and draw-off taps for the non-potable water distribution systems and for human consumption, which should be submitted to the occupants of the building;
- the commissioning sheet; and
- the date of the checks made and the details of the servicing operations.

The owner is responsible for storing the log book.

In the event of a system failure or during maintenance it shall not be permitted to permanently or temporarily connect the potable water supply to the rainwater system without category 5 protection (see 5.4.2).

Annex A
(informative)

Examples of calculation methods for storage capacity

A.1 General

This annex gives examples for storage size calculations based on a basic (A.2.1), or a detailed (A.2.2) approach.

A.2 Examples of calculation methods

A.2.1 Basic approach with annual time step

This approach is a simplified approach for projects with constant rainwater demand.

The annual rainwater yield should be calculated using the formula:

$$Y_R = A \times h \times e \times \eta \qquad \text{(A.1)}$$

where

Y_R is the annual rainwater yield, expressed in litres (l);
A is the horizontal projection of the collection area, expressed in square meters (m^2) (see 6.1.2. a);

h is the total annual rainfall, expressed in millimetres (mm) (see 6.1.2. b)); *e* is

the surface yield coefficient (see 6.1.2. c);
η is the hydraulic treatment efficiency coefficient (see 6.1.2. d).

The annual non-potable water demand per person $D_{p,a}$, shall be calculated using the formula:

$$D_{p,a} = D_{p,d} \times n \times 365 \qquad \text{(A.2)}$$

where

$D_{p,a}$ is the annual non-potable water demand; expressed in litres per year (L/a);

$D_{p,d}$ is the daily per-person demand; expressed in litres per person and day (L/(p x d));
n is the number of persons in the connected building(s).

The maximum non-person related demand per day $D_{f,d}$ (e.g. green areas, industrial and commercial uses) shall be taken into account.

The storage size needed to ensure supply during the chosen dry period shall be calculated in the following way:

$$D_{N,d} = D_{p,d} + D_{f,d} \qquad \text{(A.3)}$$

$$V = D_{N,d} + d_d \qquad \text{(A.4)}$$

where

$D_{N,d}$ is the total daily non-potable water demand, expressed in litres per day (l/d);

$D_{p,d}$ is the daily per-person demand of non-potable water, expressed in litres per day (l/d);

$D_{f,d}$ is the maximum daily non-potable water demand for fixed non-person related use, expressed in litres per day (l/d)

V is the volume of the storage device, expressed in litres (l);

d_d is the chosen dry period (storage days until the potential next rainfall, e.g. 100 d), expressed in days (d).

EXAMPLE

Non-potable water demand of four (4) persons per day: 4 x 50 l/d;

Non-person related water demand per day (e.g. cleaning): 100 l/d;

Non-person related water demand per day during dry periods (e.g. irrigation): 1000L/d.

$$D_{N,d} = (4 \times 50) + 100 + 1000$$

Chosen dry period: d_d = 20 days

V =1300 L/d x 20 = 26000L = 26M^3

A.2.2 Detailed approach

A.2.2.1 General

This approach shall be used to calculate the storage size more accurately for all situations and particularly where:

-the demand is irregular (e.g. external use, non-residential use, tourism);

-the yield is uncertain (e.g. due to the use of green roofs, permeable pavements); and

- costly, larger or complex rainwater harvesting systems are proposed.

To apply the detailed approach to sizing the rainwater harvesting system for non-potable domestic use, storage capacity should be estimated by building up a model of yield and demand, which is based on a continuous rainfall time series of at least 5 years. This time series shall use daily rainfall data for assessing non-potable system storage.

NOTE 1 The longer the simulated period of time, the more precise reality will be mapped out by the results.

NOTE 2 Analysing the results of a time series for design, the frequency of overflowing can be estimated.

Occasional overflowing allows any floating material to be discharged and offers potential benefits for water quality.

NOTE 3 The analysis also enables an assessment of how much water might be saved annually and the number of days that no rainwater is available,which is particularly useful if there is no back-up supply.

A.2.2.2 Input data

The following information is necessary for carrying out the detailed approach:

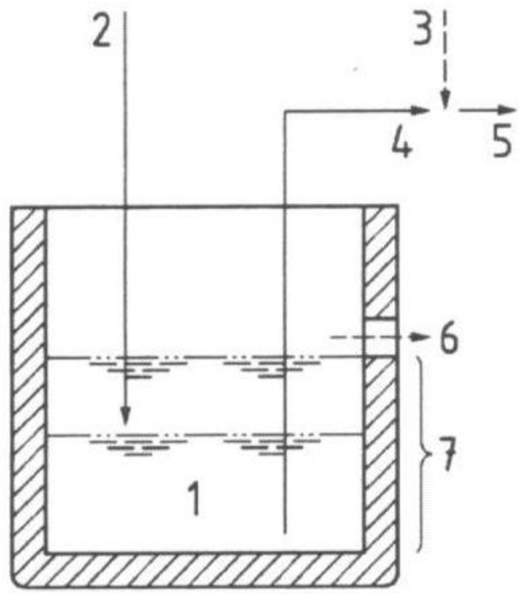
- daily rainfall on the site (h_d) over a minimum of 5 years period (preferably recent years), expressed in millimetres per day (mm/d); and

- daily non-potable water demand (d_d), expressed in litres per day (l/d).

A.2.2.3 Simulation principle

The detailed approach method identifies two inputs (rainwater supply and if appropriate potable water back-up supply) and two outputs (daily requirements and overflow if appropriate). This therefore involves carrying out a daily assessment of the inputs and outputs over a defined period to determine the most suitable rainwater storage usable volume according to the project's characteristics.

These rainwater harvesting system water flows are shown in Figure A.1.



Key

1. volume of rainwater in the storage device (V_{rd})
2. rainwater coming into the storage (V_{rd})
3. potable water back-up
4. non-potable water abstraction from storage device ($S_{N,d}$)
5. non-potable water demand ($D_{N,d}$)
6. overflow
7. usable volume of non-potable water *(V)*

Figure A.1-- Water flows of rainwater harvesting systems

where

$S_{N,d}$	daily rainwater abstraction from the storage device, expressed in litres per day (l/d);
d_d	non-potable water demand for day *d,* expressed in litres per day (l/d);
V_{rd}	volume of rainwater in the storage device at the end of day *d,* expressed in litres (l);
$V_{r(d-1)}$	volume of rainwater in the storage device at the end of day *d-l,* expressed in litres(l);
V	nominal capacity of storage tank, expressed in litres (l);
Y_{rd}	rainwater harvested and coming into the storage device during day *d,* expressed in litres per day (l/d).

$Y_{r,d} = A \times h_d \times e \times \eta$ (A.5)

A is the horizontal projection of the collection area, expressed in square meters (m^2);

h_d is the daily rainfall,expressed in millimetres per day (mm/d) or litres per square meter per day (L/(m^2 x d);

e is the surface yield coefficient (see 6.1.2. c);

η is the hydraulic treatment efficiency coefficient (see 6.1.2.d).

The algorithm used for describing the behaviour of the non-potable water use and harvesting system with daily values is as follows:

$S_{rd} = min \binom{D_d}{V_{r(d-1)}}$ (A.6)

$V_{rd} = min \binom{D_{r(d-1)} + R_{rhd} - S_{rd}}{V - S_{rd}}$ (A.7)

For a given usable volume of the storage device (V), the algorithm applied to the series of rainfall data is used to determine the requirements coverage rate $C_r(V)$ which is defined using the following formula:

$$C_r(V) = \frac{\sum_d S_{rd}}{\sum_d D_d}$$

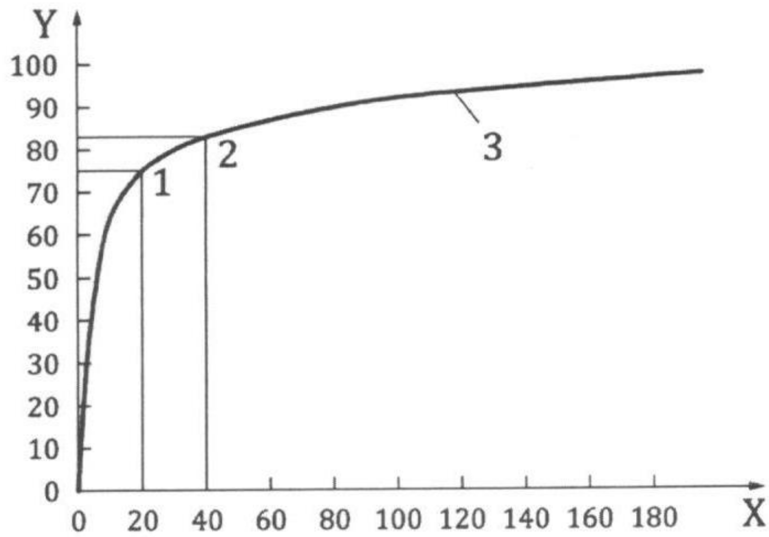
NOTE The initial value of the volume of water of the rainwater storage device at the beginning of the simulation is set at zero.

If V_{rd} becomes negative during simulation, a back-up water supply will be needed and V_{rd} should be set to 0 in the simulation

A.2.2.4 Application of results

The curve C_r,= f(V) is plotted for the various values of V until the maximum C_r value is reached. This curve is used for the determination of the usable storage volume.

An example is shown in Figure A.2



Key

X usable storage volume, expressed in cubic metres (m^3)

Y coverage rate of the non-potable water demand, expressed in percent(%)

0 to obtain a non-potable water demand coverage rate of 75%, a storage device with a usable storage volume of $20m^3$ is required.

1 to obtain a non-potable water demand coverage rate of 83%, a storage device with a usable storage volume of $40m^3$ is required.

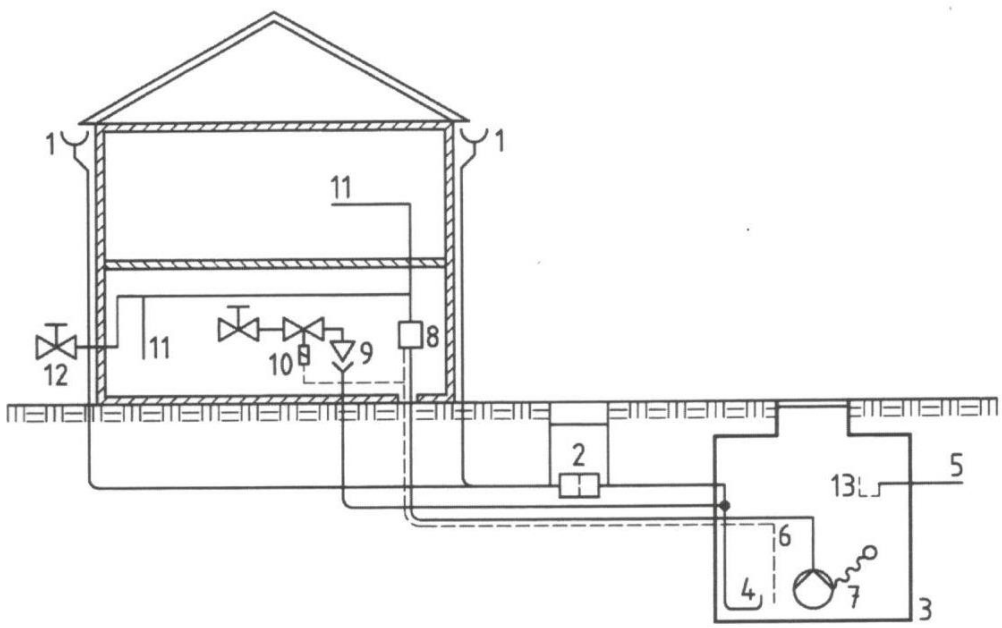
2 Curve $C_r = f(V)$

Figure A.2 Example for the determination of usable storage volume

This curve allows the various involved parties of a project to decide on a compromise between the non-potable water demand coverage, technical constraints and financial feasibility (e.g. availability of space, budget, recovery rate).

Annex B
(informative)

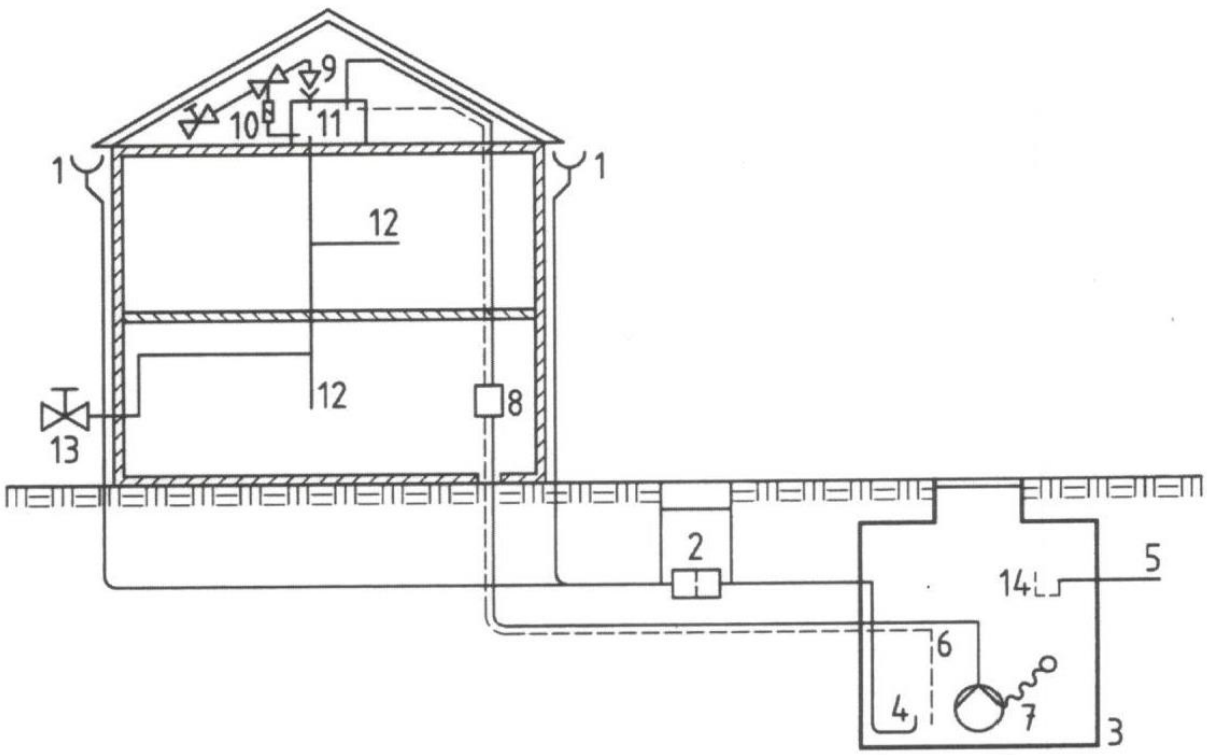
Examples of rainwater harvesting systems with different back-up supply arrangements



Key

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

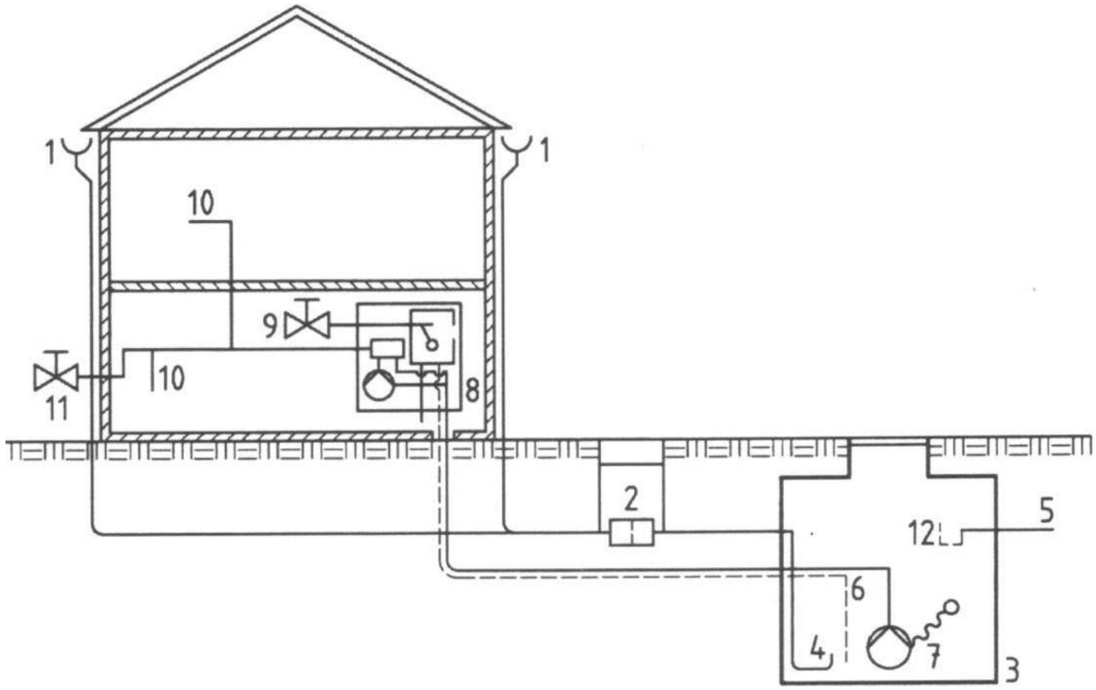
Figure B.1- Example for a system with direct primary supply and Type AA air gap



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 EN 1717 and EN 13076
10 solenoid valve for back-up water supply
11 Cistern in loft
12 non-potable applications, e.g. WC, washing machine
12 Garden tap
13 Optional outlet trap

Figure B.2-- Example for a system with indirect primary supply and Type AA air gap



Key

1	gutter/downpipe	8	make-up module including pump, pump control with dry-running protection and back-up water supply with typr AB air gap in according with EN 1717 and EN 13077
2	filter	9	back-up water supply
3	Storage tank	10	non-potable applications, e.g. WC, washing machine
4	Calmed inlet	11	Garden tap
5	Overflow pipe	12	Optional outlet trap
6	Sensor/float switch		
7	Floating extraction		

Figure B.3 -- Example for a system with module and Type AB air gap

Annex C

(informative)

Example for a commissioning sheet and logbook

C.1 Commissioning sheet

Contact details of the owner of the installation:

Site address:

Commissioning carried out by: _

Things to check	Checked	Comments
Nature of the roof:		
Pre-treatment and/or filtration upstream storage		
Rain water storage Material: Including: Calmed inlet Floating extraction Access for maintenance Secure access		
Overflow storage Sufficient discharge capacity Protection against entry of small animals e.g. rodent trap		
If overflow connected to wastewater system: Anti-flooding devices		
No cross connections to drinking water system especially at emergency back-up supply: Backflow prevention (air gap)		
Pump operational -type:		
Control system operational		
Pipe work clearly marked as non-potable water pipe work		
Signage at rainwater point of use		

Additional notes of the person responsible for commissioning:

Further comments from the owner:

The necessary instructions for the operation of the system have been given; all the technical documentation required and all existing services and maintenance manuals according to the list provided.

Hereby the person responsible for the commissioning of the installation (or his representative) confirms that the installation has been carried out in accordance to manufacturer's instructions and that the system is in fully working condition.

Commissioning date ………………. .

Name………………………….. Signature……………… .

Person responsible for commissioning

.

C.2 Logbook

Rainwater harvesting system provided by (firm):

(person responsible for maintenance)

Date	Water meter readings	Components checked	Operations done	Name / Signature of the person responsible

Annex D
(informative)
Inspection and maintenance

Table D.1- Example of inspection and maintenance instruction sheet

System element	**Inspection**	**Minimum frequency of inspection!**	**Maintenance if required**
Preliminary treatment upstream of the storage incl. filter, channels, gutters, roof drains, basket strainers, grating and downpipes	Check efficiency and overall good condition	6 months	Elimination of deposits.
Storage device	Check the overall good condition and cleanliness	12 months	Cleaning by personnel being trained and equipped to work in confined spaces
Overflow siphon and check valve	Check proper operation	12 months	Repair
Makeup feed module	Observation of an operating cycle and the absence of leaks	6 months	According to the manufacturer's instruction
Suction strainer	Check proper operation	12 months	Elimination of deposits.
Pumps	Check proper operation and absence of leaks	6 months	According to the manufacturer's instruction
Pressurised tank	Check proper operation (inflation pressure) and tightness	12 months	According to the manufacturer's instruction
Backflow prevention and the separation of rainwater and potable water systems	Check proper operation with the tap wide open: air gap, overflow,	12 months	According to the manufacturer's instruction
Filling level of the rainwater tank	Check adequacy between the actual filling level and the level displayed	12 months	Adjustment or replacement
Pipes	Check the overall condition and absence of leaks	12 months	Repair and check the tightness
Water meters	Check proper operation applicable standards)	12 months	Replacement and check of the tightness
Lockable valves and draw-off taps	Check the overall good condition, the absence of leaks and the locking system. Operate the taps	12 months	Repair and check the tightness
Marking	Check if present and its good condition	12 months	Repair
a The inspection and maintenance intervals may be altered according to the specific environmental conditions.			