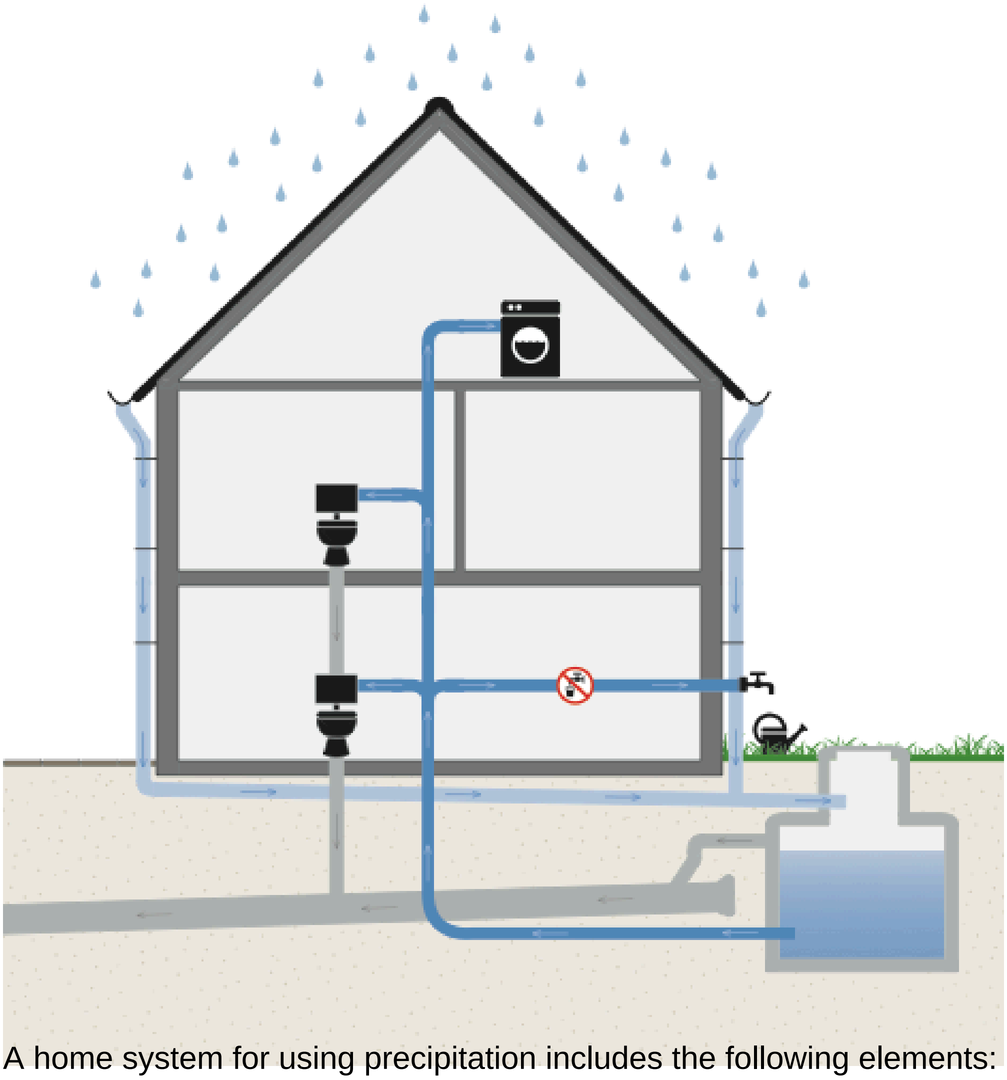
System for using precipitation in homes



A home system for using precipitation includes the following elements: a reservoir, a pump, a connection to points of use, an overflow and a top-up system. The benefit of such a system is that the dimensions of the reservoir content can be matched to the amount of precipitation available and/or the projected use.

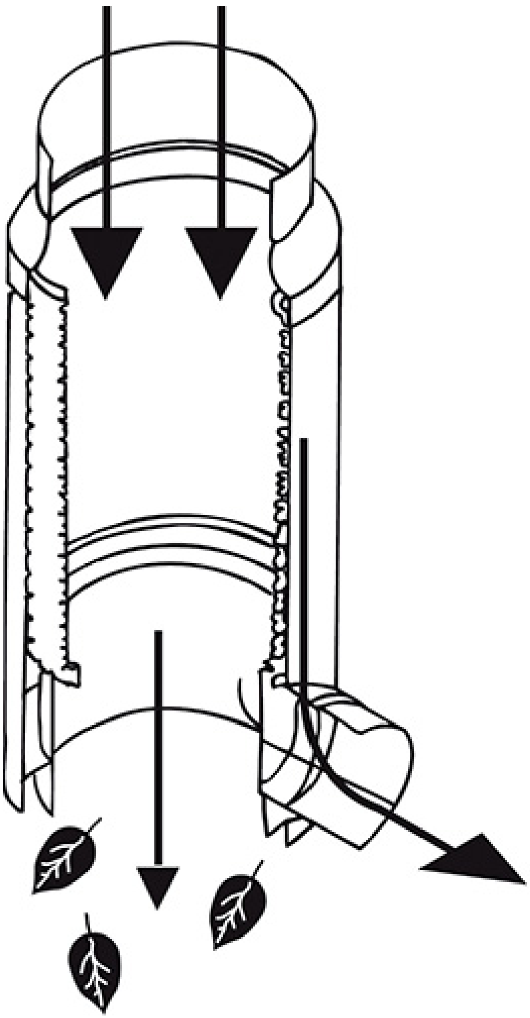
If the dimensioned are optimised, not only will the reduction in the consumption of drinking water be optimised; a large proportion of the precipitation will also be buffered at peak times. For health reasons, the water should only be used for low-grade purposes. Filter systems are available that can be used to maximise the quality of the water, by eliminating all or some of the pollutants. Surplus water resulting from low use or large quantities of precipitation is led off. If the ground is suitable, the water is allowed to infiltrate; otherwise it can be retained in a pond or other buffering facility.

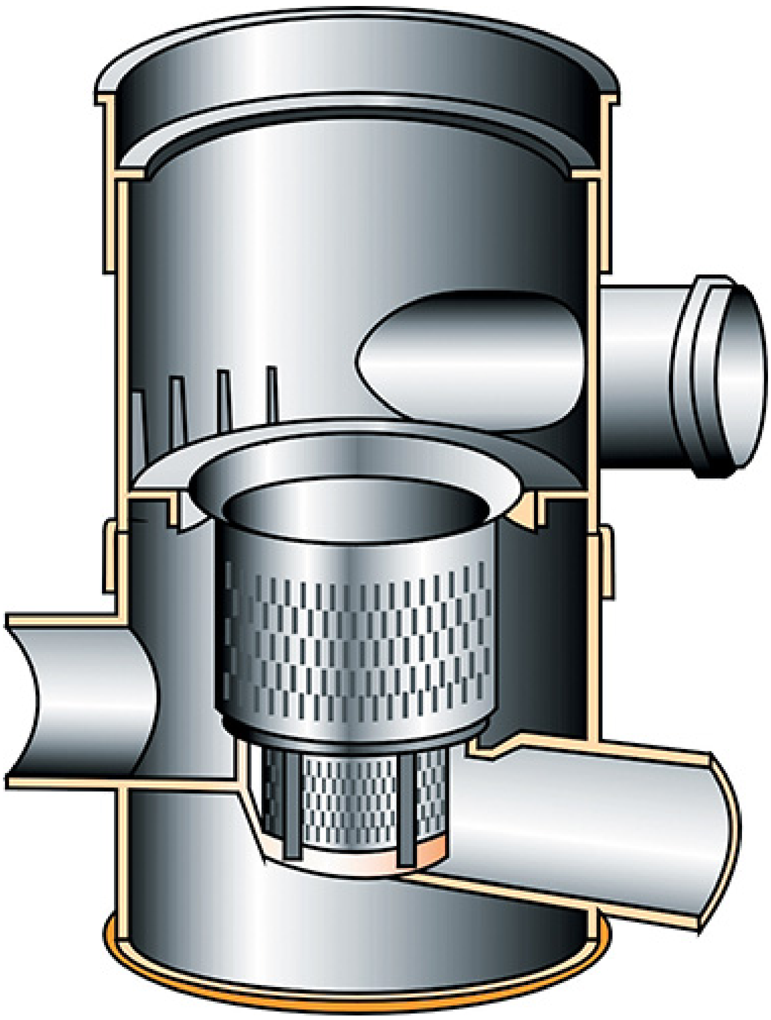
Parts of the system

Filter

Runoff contains solid substances that are best filtered out to prevent them from rotting and having an adverse impact on the quality of the water or damaging the system. A range of different filters exist. Tubular filters, which come in several shapes and sizes, can be placed directly in the vertical precipitation drain. These tubular filters filter the solid matter out of the water and discharge it separately.

Underground filters, such as cyclone and cascade filters, are fitted inside flat precipitation drains and are moreover suitable for filtering larger volumes of water. Solid matter is retained together with some of the water and/or discharged into the surface water, infiltration systems or rainwater sewer. These filters can be placed either before or in the reservoir.





Water inlet

In spite of filtration a part of the sludge comes in the reservoir. In order to prevent that this swirls up, the rainwater must gradually flow into the reservoir. This can be easily realized by letting the water inlet go to the bottom of the reservoir and creating a 180° curve in this inlet pipe.

Reservoir

Reservoirs come in various different forms: concrete or plastic. The choice will generally be determined by the size preferred, the space available and planning.

Concrete reservoirs are strong, with the added benefit that the rough texture of the sides forms a good basis for micro-organisms, which can attach themselves to the sides and break down the pollutants in the water. The reservoirs are heavy, though, and if placed in courtyards the location must be reachable with a crane.

With small reservoirs, plastic tanks are the logical choice. They are light, and in existing situations they can be placed inside in the crawlspace or outside in the garden, if necessary. Smaller reservoirs can be hooked up in a series to achieve the preferred reservoir volume.

Where groundwater levels are higher, the upward pressure needs to be taken into account. With plastic reservoirs that weigh little by themselves, a layer of gravel of granules can be placed in the tank, with the added benefit that it serves as a base for micro-organisms that break down the pollutants in the water.

The weight of the empty tank, or of the tank with ballast, must be greater than the upward pressure caused by the part of the reservoir situated below the highest groundwater level.

Water bag

A specific solution is available for the Dutch situation of homes without basements, but instead crawlspaces below the ground floor. A plastic water bag is placed in the crawlspace, to serve as a reservoir. The other parts of the system (pump, etc.) are placed in a shaft that can be accessed from above in the need for repairs and maintenance.

The reservoir may not fall dry, to ensure that sufficient water is always available to supply functions such as flushing toilets and running washing machines. This means that it must be possible to top up the reservoir in sustained dry periods. Another reason to top up the reservoir is that if the reservoir falls empty the sludge in it will dry and larger pollutants might be released into the water when the reservoir is full once more.

Topping up the reservoir with drinking water by using a float-operated switch is a simple matter. However, the drinking water company requires a break between the drinking water grid net and the rainwater. This requirement can be fulfilled by positioning the inflow opening for topping up the reservoir sufficiently far above the highest water level in the reservoir. When the reservoir is topped up it need not be filled completely: the volume needed for one day is sufficient.

Pressure-increasing systems

Pressure-increasing systems, or hydraulic accumulators, are standard appliances that are already fitted in many separate apartment blocks to increase the pressure on the drinking water grid. For some individual systems, the pump is delivered in a set together with the reservoir.

Overflow

The reservoir might overflow in the case of heavy rainfall or if little of the precipitation is used. The overflow should preferably be connected to an infiltration system or to surface water. If that is impossible, it can be connected to the rainwater sewer or the combined sewer.

Precipitation grid

To rule out any risks of the water pipes becoming interchanged, it is advisable that the precipitation pipes be coded, for example by using a different colour or by marking the pipes. This helps reduce the risk of confusion.

System maintenance

Large reservoirs have manholes to enable regular cleaning. Sludge can be removed and the reservoir cleaned periodically (on average 1 x per 10 years). [VMM, 2010]

Sample calculations for a precipitation system

To calculate the dimensions of a precipitation system, the local precipitation data are required, as well as the perpendicular projection of the available roof surface, the drainage coefficient and the expected consumption. The consumption estimation depends on the number of people in the home or building and the amount of water used by the connected appliances. The drainage coefficient gives the ratio between the precipitation drained off directly and the total precipitation.

Roof surface	Drain coefficient
Sloping roofs	
Tiles, unglazed	0,9
Tiles, glazed	0,95
Plastic roofs	0,95
Flat roofs	
Plastic roofs	0,8
Green roofs extensive	0,4-0,5
Green roofs intensive	0,4-0,5

Sample calculation for a home

For a home with a roof area of 70 m^2 and a drainage coefficient of 0.9, assuming an average monthly precipitation level of 65 mm, the amount of precipitation available on a monthly basis is 70 m^2 x 0.9 x 0.065 m = 4 m^3. The size of the reservoir should be selected to suit this volume. This is enough water to cover a prolonged relatively dry spell.

Assuming a household consisting of 3 people, this is almost enough to be able to flush toilets and launder textile. On a daily basis, each person uses an average of 35 litres for flushing toilets and 15 litres for laundry, i.e., 50 litres per person per day. On a monthly basis, three people use 4.5 m^3 of precipitation. That means that in the present example 0.5 m^3 of drinking water has to be added to top up the precipitation. The amount of drinking water saved in this example is almost 40%.

In practice, a reservoir of 3 m^3 can be assumed to be enough for a small ground-level house, and a reservoir of 5 m^3 for a large house. A tool to calculate the use of rainwater in homes is available online at: http://www.ateliergroenblauw.nl/regenwateropvang/

Sample calculation: district level

If rainwater is used on a structural basis, for example in a newly constructed district with a density of 25 homes per hectare, the amount of rainwater to be discharged can be reduced by 40%. This figure is assuming a standard newly constructed district of which the impervious surface area totals 50%, with the remaining surface area being either unpaved or open water. Of that 50%, 40% consists of the roof surfaces of the houses. The precipitation retained in reservoirs need not be buffered elsewhere in the district (this should be adjusted for a location in a VINEX district and, for example, IJburg in Amsterdam).

Sample calculation: non-residential building

A four-level office building with a roof area of 1000 m^2, a flat roof with synthetic roofing and an average occupancy of 160 FTEs can avail itself of 1000 m^2 x 0.065 m x 0.8 = 52 m^3 of rainwater per month. An average office worker uses around 16 litres per day for flushing toilets, which comes to 320 litres per month assuming 20 working days. With 160 FTEs, that comes to 51 m^3 per month.

This means that in the present example 100% of the drinking water normally used for flushing toilets can be replaced by precipitation.

Rule of thumb

The following rule of thumb can be used for calculating the dimensions of precipitation reservoirs: 5 m^3 of reservoir for every 100 m^2 of roof surface.

In some situations, for example with large detached houses, the supply will exceed the demand and the dimensions of the reservoir can be suited to meet the demand.

Here the dimensions of a precipitation reservoir for a particular house can be computed.