Sustainable Water Supplies & Surface Water Management

A UK Rainwater Management Association Briefing Guide

Climate Change Impacts

Although the carbon impact of climate change receives most public attention, its impact on water in the UK is in many ways equally important and cannot be overlooked.

Famed until recently for its equally mild and wet summers and winters, in the last few years UK weather has reflected a pattern towards long dry spells throughout the year coupled with shorter spells of more intense rain.

The importance of this is that, although overall annual rainfall may not change markedly, steady persistent rain is easier to capture and store for mains water use and is less likely to overwhelm the national storm-drain infrastructure and cause flooding.

The converse equally applies.

Water Shortages

The most recent Government-sponsored study on water-shortages *("Water for People & the Environment" – Ref-1)* predicts a continually deteriorating position caused by the twin pressures of climate change and population growth.

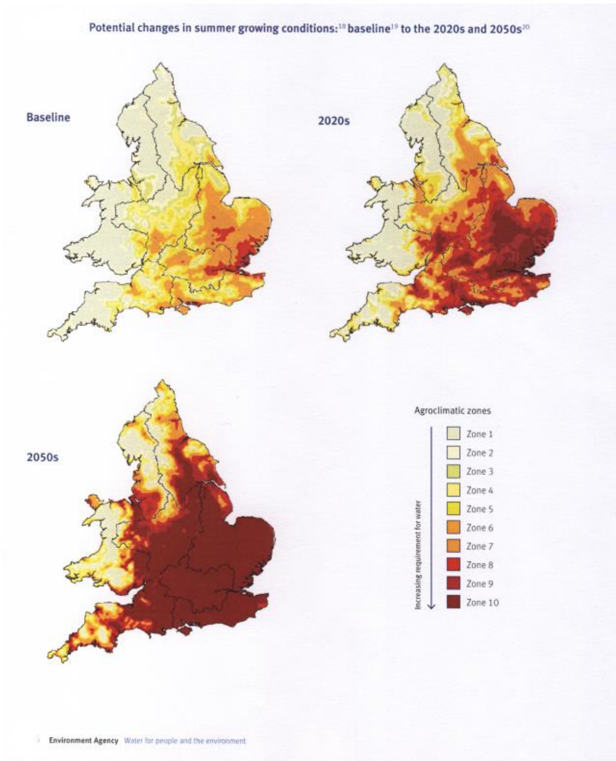
The report predicts that if unaddressed, this will result in nearly all land in England becoming unable to sustain agriculture; the report also flags-up rainwater Management (RWH) as one of the available remedies.

Effectiveness of Rainwater Management

Rainwater Management reduces demand on mains water supplies by intercepting rainfall that would otherwise be unrecoverable and substituting it for non-wholesome applications such as toilet-flushing, clothes-washing and irrigation.

The formula for calculating the amount of mains water saved in this way is quite straightforward being a function of the area and type of the collection surface, and local average rainfall. In domestic applications the quantity of water that can be substituted in this way is limited to around 75-litres per person per day, the remainder of domestic water use requiring wholesome water for bathing, drinking, cooking and dish-washing.

As a typical example, a small modern new-build home with an 80-m^2 roof will harvest around 43,000-litres annually in the relatively dry south-east of England, thus reducing household consumption by about this amount whilst meeting around 80% of the non-wholesome water requirements of two people; other example yields are shown in the table at the end of this paper.



In non-domestic applications, the parameters change substantially as usually there is a very strong bias towards the use of non-wholesome water in the workplace, often in excess of 90%, or around 25-litres per person per day whilst at work. This means that this requirement can be met entirely by harvested rainwater in the relatively dry south-east of England whenever the ratio of roof area to workforce is around 10-m^2 per person.

Projected forward, fitting RWH to all new homes over the timescale of the Ref-1 report would produce a harvest of around 280-million cubic metres of water annually; this could potentially be more than doubled by a combination of new-build commercial developments, the retrofitting of systems to existing commercial buildings, and retrofitting to some existing homes for garden irrigation.

Taking the market in Germany as a reasonable comparator, studies undertaken in 2009 showed that about 65,000 systems were installed that year (ten-fold the UK rate), bringing the total installed nationally to around 1.8M.

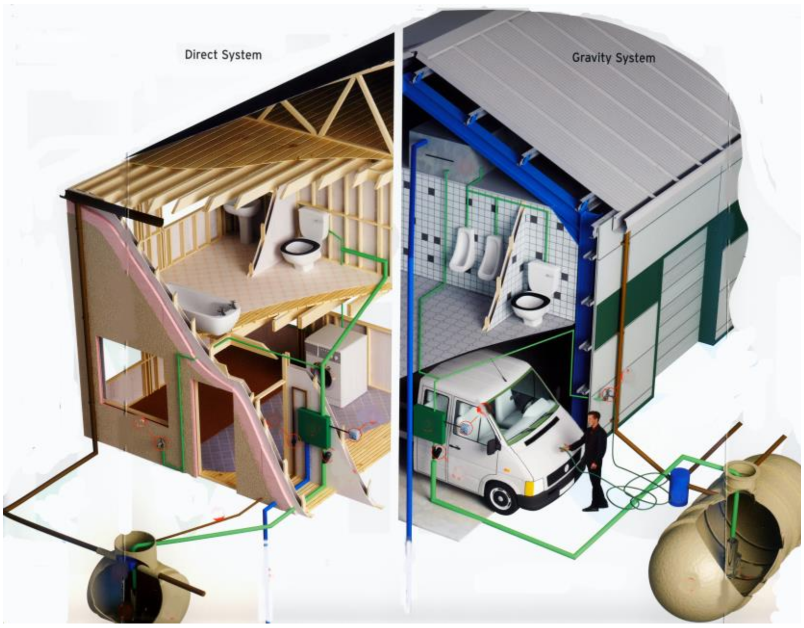
Application & Costs

Unless the price of water rises very substantially to reflect growing shortages, domestic RWH systems are best installed whilst a property is being built or re-plumbed; this is because RWH systems require separate pipe-work to be installed to the services they supply.

The price of a typical system for a new-build property with an 80-m^2 roof will typically range between £1,500 and around £3,000 per unit delivered to site, depending upon its specification; prices have fallen substantially since the turn of the century, and are likely to fall further as the industry gains scale. To this needs to be added the cost of installation which will depend on a number of local factors.

For existing dwellings, irrigation-only systems would normally be recommended as these are much less expensive and also much simpler to install; the main motivation from the buyers' point of view would be a combination of having a secure source of garden irrigation water during future periods of hosepipe bans, and insurance against future rises in the price of mains water.

Although the constraints of separate pipe-work apply equally to non-domestic installations, retrofitting is usually made possible by the accessibility of open or ducted pipe-work in commercial buildings. Due to their scale, non-domestic systems will be more costly, but are usually more cost-effective. This means that even at today's relatively low mains water prices, commercial systems that combine a large collection area with a high demand for non-wholesome water can enjoy a capital payback of below 3-years.



Integration with SUDS

Supply shortages are only one aspect of new developments that need to be considered, the other being the avoidance of local and downstream flood risks, to be achieved through SUDS ("Sustainable Urban Drainage Systems").

The fundamental principle of SUDS is that to avoid overloading storm-water infrastructure, and thus cause local or downstream flooding, no more surface water is allowed to leave a site post-development than did beforehand. The volume of rainfall usually assumed for the above purposes is based upon the heaviest downpours likely to be experienced in 100-years, plus a 25% safety margin to allow for future climate change.

National legislation on SUDS has moved forward in a number of ways with passing of the *"The Flood & Water Management Act 2010";* in particular, the introduction of SUDS Adoption Boards strongly implies that future systems will need to be maintainable, and thus fully accessible. At the same time, the quality and amenity value of surface water will need to be placed on an equal footing with dealing with water quantity issues.

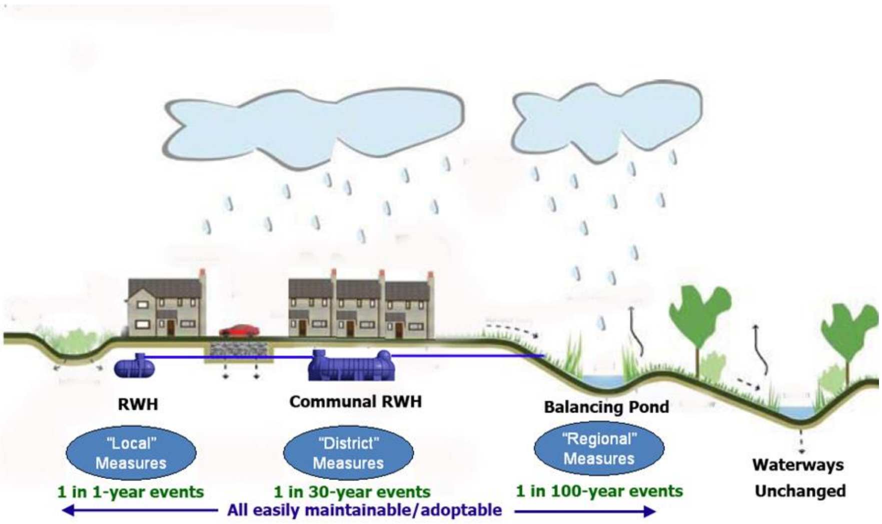
An influential Government-sponsored report on the implications of these changes *(short title "Developer Guidelines" – Ref-2)* recommends that the future ideal SUDS will comprise systems operating on three different levels.

Level-1 must deal with as much surface water as possible at "source" (ie individual properties), achieved by measures such as porous hard-standings, garden water features such as ponds or by local capture for re-use (ie rainwater Management).

Surface water that cannot be controlled at source must then be dealt with at a second level on the basis of attenuation (ie storing until it can be safely dissipated) that can handle as much as possible of the excess water from groups of properties.

Recognising that Levels 1 & 2 of the SUDS system may not under the most extreme 100-year events be able to attenuate all the rainfall falling on individual and groups of properties, Level-3 must also be in place to deal with the whole of the what is left, typically by using it as a site-amenity such as a well-landscaped balancing pond or streetscape swales.

Employing dedicated RWH systems on all suitable properties as the main means of "source control" (Level-1), and communal RWH systems for groups of higher-density properties (Level-2) provides a particularly elegant and cost-effective integrated approach that tackles both water shortages and surface water management. From an adoption point of view, it also means that all three levels of the system are maintainable, the RWH systems de-facto as they are the source of non-wholesome water for the properties being served, and the balancing pond/swales being open to visual inspection and periodic cleansing.



The advantage of this integrated approach to incorporating RWH into SUDS has been internationally recognised with some countries introducing mandatory inclusion of RWH in all new developments for SUDS, rather than water-shortages, reasons.

Carbon Footprint Implications

The most authoritative Government-sponsored study into the carbon footprint of systems *("Energy & Carbon Implications of RWH …" – Ref-3)* concluded that RWH systems use around 0.5kWh of energy more than mains water per 1,000-litres delivered. Using this assumption, and the example small new-build property illustrated earlier, this means that the additional carbon footprint of that property per year would be around 22-kWh, which is the equivalent of perhaps £2 of electricity consumption per year at today's energy prices.

It is recognised that this is an unwelcome element in the building of the zero-carbon homes of the future, which needs to be balanced against the imperatives of SUDS and water shortages.

Alongside this, the industry is also doing everything it can to minimise its carbon footprint through supply-chain and technological improvements, and development of energy-efficient header-tank systems.

However, it should also be recognised that the above study did not take into account the impact of two exceptionally dry winters and the debate this has sparked for the need to develop more mains water infrastructure, including massive region-to-region water transfer proposals.

If it is found to be necessary to implement such suggestions, then the carbon-footprint case for RWH close to the point of consumption is likely to become overwhelming.

National RWH Policy & Strategic Implementation

Government RWH policy was stated most recently in May 2011 *(Ref-4)*; the UK Rainwater Management Association believes this policy to be well-balanced and therefore needs consistent strategic implementation.

Our proposals for the strategic implementation of the published national policy are:

- Existing limitations on mains water consumption should continue to be fully reflected in Building Regulations, the Code for Sustainable Homes, and BREEAM
- Use of RWH systems to provide best-practice SUDS systems should be advocated through the Planning System
- Retrofitting of mains water economising measures should be encouraged through water-supply pricing policies, and by permanent hose-pipe bans in water-stress areas

The reference documents noted above can be accessed on-line as follows:

Ref-1: http://publications.environment-agency.gov.uk/PDF/GEHO0309BPKX-E-E.pdf
Ref-2: http://uk-sda.co.uk/downloads/developer-guidelines
Ref-3: http://publications.environment-agency.gov.uk/PDF/SCHO0610BSMQ-E-E.pdf
Ref-4: http://www.environment-agency.gov.uk/research/library/position/131546.aspx

Example yields for typical roof-sizes, annual rainfall and system storage-tank size combinations are illustrated in the table below:

Roof – m^2	Local rainfall in mm per year				
	500	600	700	800	900
60	27,000	32,400	37,800	43,200	48,600
80	36,000	43,200	50,400	57,600	64,800
100	45,000	54,000	63,000	72,000	81,000
120	54,000	64,800	75,600	86,400	97,200
140	63,000	75,600	88,200	100,800	113,400
160	72,000	86,400	100,800	115,200	129,600
180	81,000	97,200	113,400	129,600	145,800
200	90,000	108,000	126,000	144,000	162,000

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