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Rainwater Harvesting and Grey Water Recycling Systems

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Water water everywhere

Liam McCarton and **Dr Sean O'Hogain,** Department of Civil and Structural Engineering, DIT continue their report on water conservation by focusing on rainwater harvesting and grey water recycling.

The application of an appropriate rainwater harvesting technology can supply a significant amount of water for household needs such as washing machines, toilet flushing and watering the garden. The critical factor in any rainwater harvesting system is the quality of the water. To obtain a high quality requires filtering the rainwater entering the collection system, storing it so that the quality does not deteriorate and finally delivering it to the site of utilisation without quality reduction (Grant et al., 2000).

POTENTIAL WATER YIELD

The potential yield from rainwater is a function of the roof size, roof type and filter efficiency. **Table 1** shows the relationship between roof size, annual rainfall and rain water yield.

RAINWATER HARVESTING - COMMERCIAL SYSTEM

As shown in Table 1, where a large roof catchment is available the potential yield from rainwater can be significant. Therefore, rainwater reuse in commercial establishments can provide a significant alternative water source for appliance use and/or production facilities.

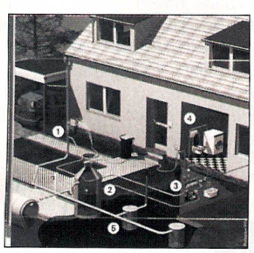
Commercial systems tend to be larger versions of domestic systems previously described. Storm water attenuation may also be designed into the system as well as a reserve supply for fire fighting for large industrial buildings. Additional filtration in the form of fine sediment filtration and ultraviolet sterilisation can be included where large storage times are necessary.

Plan Roof Area (m2)		50	75	100	150	300	500	1000
Annual Rainfall (mm)	750	25	38	51	76	152	253	506
	900	30	46	61	91	182	304	608
	1000	34	51	68	101	203	338	675
	1200	41	61	81	122	243	405	810
	1400	4 7	71	95	142	284	473	945

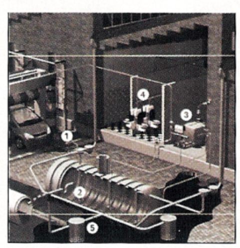
Table 1. Potential annual yield of rainwater (m3) for a range of roof sizes.

RAINWATER HARVESTING - DOMESTIC SYSTEM

Figure 2 shows a typical domestic rainwater system where rainwater is collected from the roof and processed through a vortex filter. The filtered water passes through to a storage tank. A submersible pump delivers water on demand via a floating suction filter to wc, washing machine and garden tap. A float switch provides mains water back-up via an air gap tundish. Other systems pump water directly from the storage tank to a header tank in the attic.



Typical domestic rainwater harvesting system (Konig, 2001)
1 = Filter System
2 = Cistern / Storage module
3 = Mains water backup valve
4 = Users
5 = Seepage System



Office building / industry rainwater harvesting system (Konig, 2001)
1 = Filter System
2 = Cistern / Storage module
3 = Mains water backup valve
4 = Users
5 = Seepage System

POTENTIAL DOMESTIC WATER SAVING

Table 2 presents a comparison of the potential water demand reductions in terms of per capita consumption figures achievable from the use of water efficient appliance/fittings, rainwater harvesting and a combination of the two. These results are based on an average PCC of 131 l/h/d, an average household occupancy rate of 4 persons and a roof size of 50 square metres. The rainwater yield could provide 35 per cent of the annual water demand for toilet flushing and washing machine use, resulting in a total reduction in the annual domestic water demand of 7,600 litres per person. If water efficient measures are installed in advance of a rainwater harvesting system the rainwater yield could potentially provide 95 per cent of the toilet and washing machine demand. These figures illustrate the potential savings that could accrue from efficiency measures and/or rainwater harvesting systems.

This reduction in mains water demand by utilising efficiency measures, in parallel with rainwater harvesting where appropriate, could provide significant additional capacity and has the potential to meet the predicted increase in water demand without increasing total supply, with consequential cost savings to local authorities.

POTENTIAL COMMERCIAL WATER SAVINGS

Industry in Ireland in the past 10 years has recognised the need for minimising water use as the cost of both potable water supplies and wastewater disposal has increased. Most major 'wet' industries have adopted in-house water conservation policies and programmes.

Low-tech solutions such as water efficient toilets and rainwater harvesting have a significant potential to reduce a companies annual water demand. Since rainwater yield is proportional to roof size (Table 1), office buildings, factories, hotels, etc with larger roof areas offer the potential to supply 100 per cent of their toilet flushing demand from rainwater supply.

Table 3 illustrates an example showing the potential mains water savings resulting from installing water efficient conveniences and rainwater harvesting in an office building with

	PCC (2002) (l/hd/d)	Reduction in water Demand (l/hd/d)	Reduced PCC(l/hd/d)
Scenario One Water efficient wcs and washing machines installed	131	31.5	99.5
Scenario Two Rainwater Harvesting	131	21	110
Scenario Three Combined water efficiency measures & rainwater harvesting	131	52	79

Table 2. Comparison of PCC reductions using various scenarios

50 persons and a roof plan area of 1000 square metres.
Water savings of up to 195,000 litres per year could be achieved by installing low flush toilets. Rainwater harvesting has the potential to supply 100 per cent of the demand for toilet flushing. The excess water could be stored and used in the manufacturing process thereby further reducing the demand for mains water with additional annual cost savings to the company.

Demand Type	Annual Water Demand (litres)	Rainwater Yield (litres)
Toilet Conventional 9 l/use Low flow 4 l/use	351,000 156,000	573,750

Table 3. Potential water savings for commercial buildings.

POTENTIAL WATER SAVING FOR FARM BUILDINGS

Agriculture has a significant water demand for both irrigation and general washings. The introduction of water rates for non-domestic users means water costs could become a significant part of the annual running costs of a farm. Rainwater harvesting has a significant potential to provide an alternative supply at relatively low capital and running costs. Figure 4 illustrates a rainwater harvesting facility for garden or agricultural use.

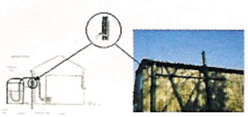


Fig 4 Rainwater Harvesting Agriculture (Rainharvesting Systems 2002)

Rainwater harvesting system for agricultural/garden use (Rainharvesting Systems, 2002)

An average Irish farm building with roof dimensions 14.4 metres by 13 metres at a pitch of 22 degrees and an average annual rainfall of 900mm has a potential rainwater yield of 113,603 litres per year. This could be reused for irrigation, farm washings and could be treated to provide potable water for livestock.

RAINWATER QUALITY ISSUES

The quality of water intended for human consumption in Ireland is governed by rigorous legislation, which covers a total of 53 bacteriological, chemical and physical parameters.
There is no such legislation governing the use of water for non-potable uses such as toilet flushing.
In order to develop a market for such reuse technologies in Ireland, standards or guidance for use of water in the homes for purposes other than drinking will be necessary. Research on rainwater quality in Germany, which has an estimated 600,000 rainwater recycling systems installed in the last 15 years, suggest that suitably collected and treated rainwater poses no risk to human health (Sayers, 1999).
When reporting contamination of a faecal nature German authorities use the EU Bathing Water Directive as a comparison. The highest potential risk to public health appears to be associated with an illegal cross connection of the recycled water into a municipal water distribution system.
Thus appropriate technical inspection of the rainwater utilisation system and the installation of safety devices to prevent backflow are essential. Accurate labelling of the two systems is also important. Water quality problems associated with the use of rainwater systems can be minimised through the use of best practice design guidance and the use of filtration and disinfection technologies where appropriate.

GREYWATER RECYCLING

Grey and rainwater are completely different and require different technologies and water quality standards. Greywater systems filter and recycle the water from bathroom sinks, showers and washing machines for use in flushing toilets and or irrigating landscape.
Greywater can be characterised as rich in nutrients, high in contaminants and an ideal medium for bacteriological growth and microbial activity. That accruing from kitchen sinks and dishwashers is more contaminated than greywater from washing machines, baths showers and hand basins.
As a result most packaged greywater systems do not utilise kitchen sink or dishwasher waste. Theoretically it is possible to treat this waste but the cost of filtration and treatment against the extra volume of water produced is not viable.

TREATMENT SYSTEM

Systems differ in how they arrange the components and the technologies used for filtration and disinfection. Most greywater systems consist of:

- filtration unit
- storage tank with overflow to sewer
- pump
- disinfection (chemical dosing) header tank with both overflow and mains top up facilities
- connecting pipework

The filtration and storage units collect water from wash basins, bath and shower. **Figure 5** illustrates a typical proprietary system. Sensors can be installed that switch the system off if the foul sewer backs up and the connection to the mains water supply means the system can be automatically supplemented when greywater flow is low or demand is relatively high (Leggett and Shaffer, 2002).

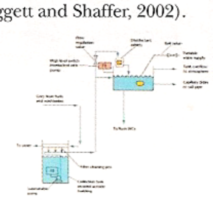


Fig 5 . Well Butt Greywater Reuse System (Environment Agency,2001).

Well Butt Greywater Reuse System (Environment Agency, 2001)

REUSE OPTIONS

Greywater can be considered as reuse or recycling of used water. Reuse of greywater, where it has not undergone treatment must be immediate as its quality deteriorates significantly within a few hours. Recycling means the greywater has undergone treatment and most systems filter and disinfect as they recycle.
The most common use of greywater is for toilet flushing. Packaged greywater systems provide a close match between the greywater arising and the demand for treated water for flushing, as both are related to occupancy of the building.
Storage systems for greywater are smaller than those used for rainwater harvesting, since greywater systems do not have to store water for a long period before new greywater is supplied to the storage tank.
Among the disadvantages of greywater in comparison to rainwater harvesting is that the system needs to be more complex and robust than for rainwater, with higher maintenance demands.
Although water recycling has been practised for some decades, technical systems have been developed only recently. Examples of available technologies include two stage filtration and chemical disinfection systems that remove coliforms, leaving the water high in turbidity and organic pollution.
Other devices include advanced filtration systems that reduce all components of grey water but do not reliably meet all recycling standards and membrane bio-reactors that are presently very costly (Jefferson et al., 1999).

CONCLUSIONS

The benefits of water efficiency measures, rainwater harvesting and greywater reuse are principally water savings and reduced volume of consumption. Cost savings can accrue to the water supplier and water user. These benefits can be felt at a local level. Only with widespread use of such technology will reduced pressure on water resources and the supply infrastructure be realised.
These technologies should be considered in the context of an overall water conservation strategy and each situation evaluated separately. A water audit should be undertaken to establish existing water usage and possible demands that can be met by using these technologies.
A programme to develop public awareness and to source and promote these technologies is also required. Standards for fittings and legal standards for rainwater quality are required if these technologies are to become generally installed.
The use of these technologies should be driven by the need to develop a sustainable strategy of urban water demand management.

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