Dual Purpose Rainwater Harvesting; A Genuine “2 for 1 offer”?

Does such a thing exist?

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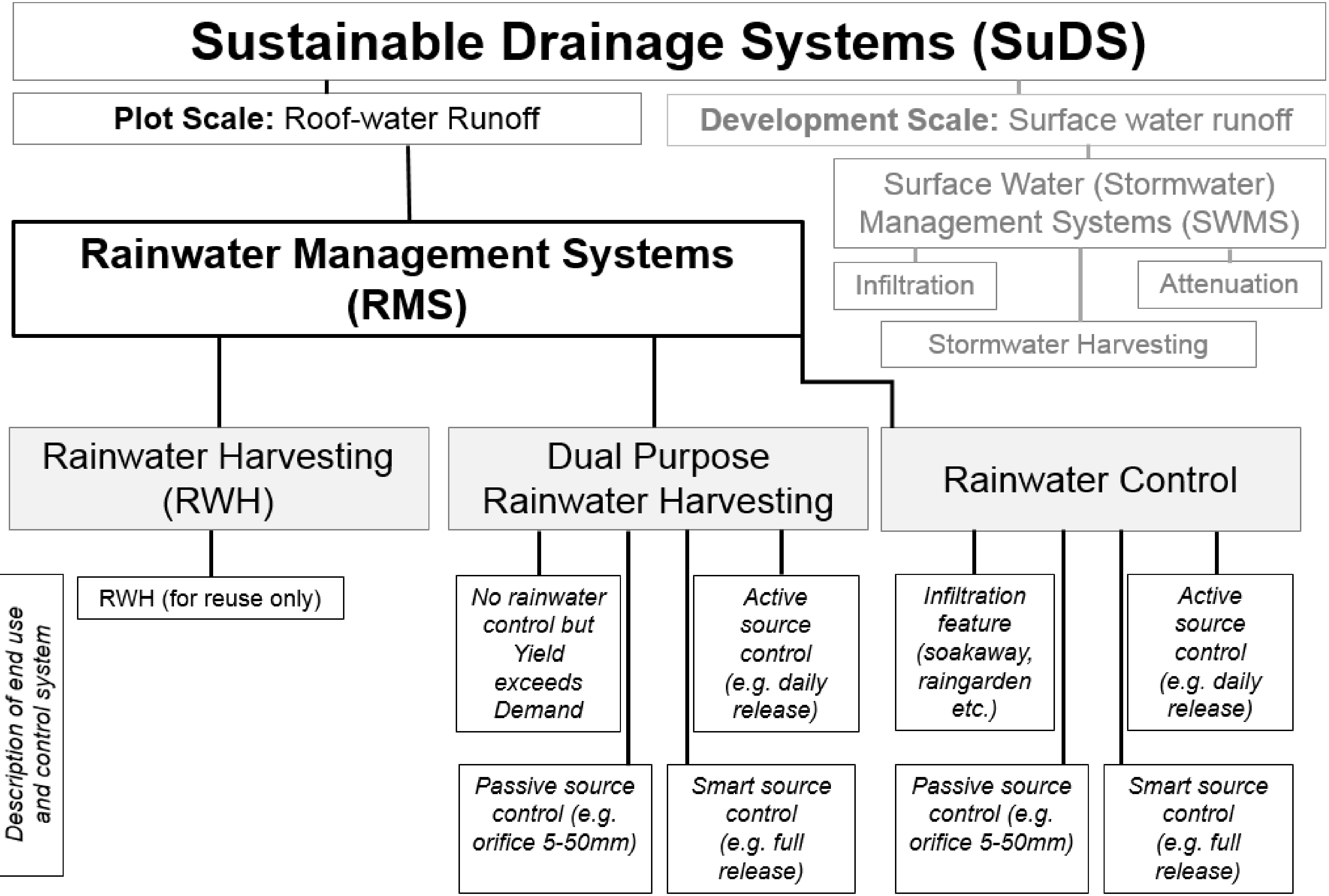
What is Dual Purpose Rainwater Harvesting?

How can it be designed?

Can we test it in the lab?

Will it work in the "real world"?

Is it truly *buy one get one free*?


Sustainable Drainage Systems (SuDS)
Plot Scale: Roof-water Runoff
Development Scale: Surface water runoff
Surface Water (Stormwater) Management Systems (SWMS)
Infiltration
Attenuation
Stormwater Harvesting
Rainwater Management Systems (RMS)
Rainwater Harvesting (RWH)
Dual Purpose Rainwater Harvesting
Rainwater Control
Description of end use and control system
RWH (for reuse only)
No rainwater control but Yield exceeds Demand
Active source control (e.g. daily release)
Passive source control (e.g. orifice 5-50mm)
Smart source control (e.g. full release)
Infiltration feature (soakaway, raingarden etc.)
Active source control (e.g. daily release)
Passive source control (e.g. orifice 5-50mm)
Smart source control (e.g. full release)

What is Dual Purpose Rainwater Harvesting?

PATENT SPECIFICATION

293,224

Application Date: Aug. 27, 1927. No. 22,554/27.

Complete Left: May 29, 1928.

Complete Accepted: July 5, 1928.

PROVISIONAL SPECIFICATION.

Improvements in Roof Rain Water Collectors.

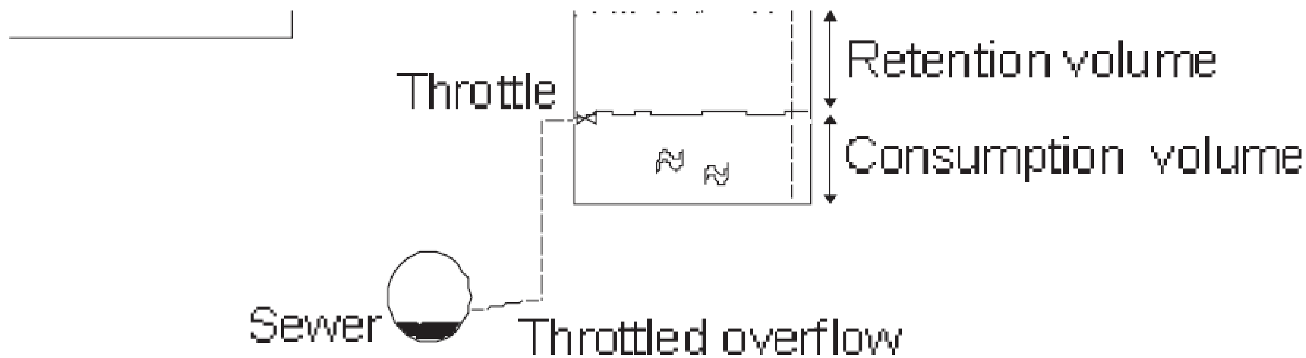
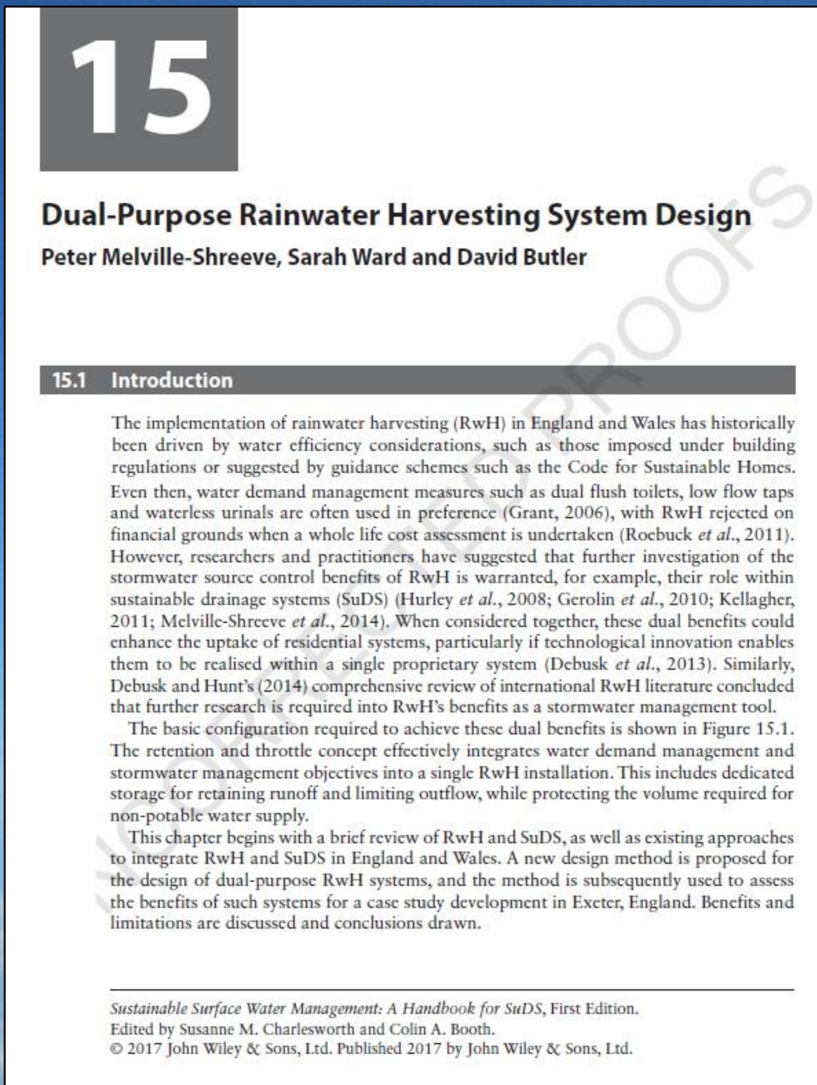


Fig. 4. Retention and throttle type rainwater usage system.

Our Research: Design Methods



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Dual-Purpose Rainwater Harvesting System Design

Peter Melville-Shreeve, Sarah Ward and David Butler

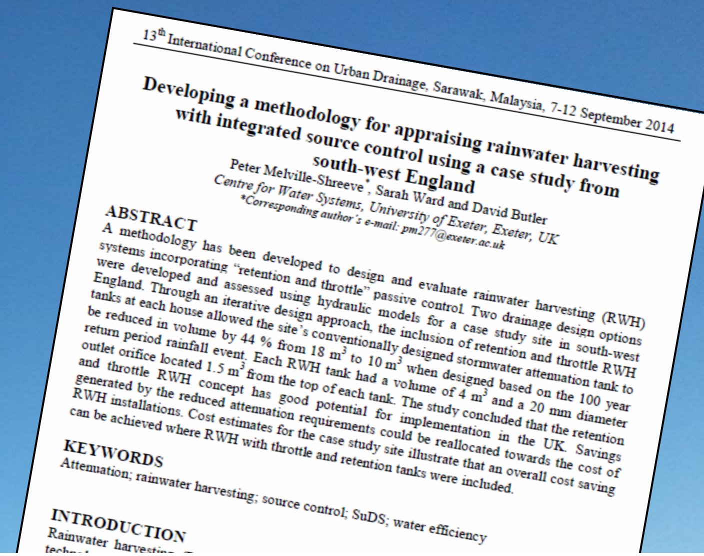
15.1 Introduction

The implementation of rainwater harvesting (RwH) in England and Wales has historically been driven by water efficiency considerations, such as those imposed under building regulations or suggested by guidance schemes such as the Code for Sustainable Homes. Even then, water demand management measures such as dual flush toilets, low flow taps and waterless urinals are often used in preference (Grant, 2006), with RwH rejected on financial grounds when a whole life cost assessment is undertaken (Roebuck *et al.*, 2011). However, researchers and practitioners have suggested that further investigation of the stormwater source control benefits of RwH is warranted, for example, their role within sustainable drainage systems (SuDS) (Hurley *et al.*, 2008; Gerolin *et al.*, 2010; Kellagher, 2011; Melville-Shreeve *et al.*, 2014). When considered together, these dual benefits could enhance the uptake of residential systems, particularly if technological innovation enables them to be realised within a single proprietary system (Debusk *et al.*, 2013). Similarly, Debusk and Hunt's (2014) comprehensive review of international RwH literature concluded that further research is required into RwH's benefits as a stormwater management tool.

The basic configuration required to achieve these dual benefits is shown in Figure 15.1. The retention and throttle concept effectively integrates water demand management and stormwater management objectives into a single RwH installation. This includes dedicated storage for retaining runoff and limiting outflow, while protecting the volume required for non-potable water supply.

This chapter begins with a brief review of RwH and SuDS, as well as existing approaches to integrate RwH and SuDS in England and Wales. A new design method is proposed for the design of dual-purpose RwH systems, and the method is subsequently used to assess the benefits of such systems for a case study development in Exeter, England. Benefits and limitations are discussed and conclusions drawn.

Sustainable Surface Water Management: A Handbook for SuDS, First Edition.
Edited by Susanne M. Charlesworth and Colin A. Booth.



13th International Conference on Urban Drainage, Sarawak, Malaysia, 7-12 September 2014

Developing a methodology for appraising rainwater harvesting with integrated source control using a case study from south-west England

Peter Melville-Shreeve*, Sarah Ward and David Butler
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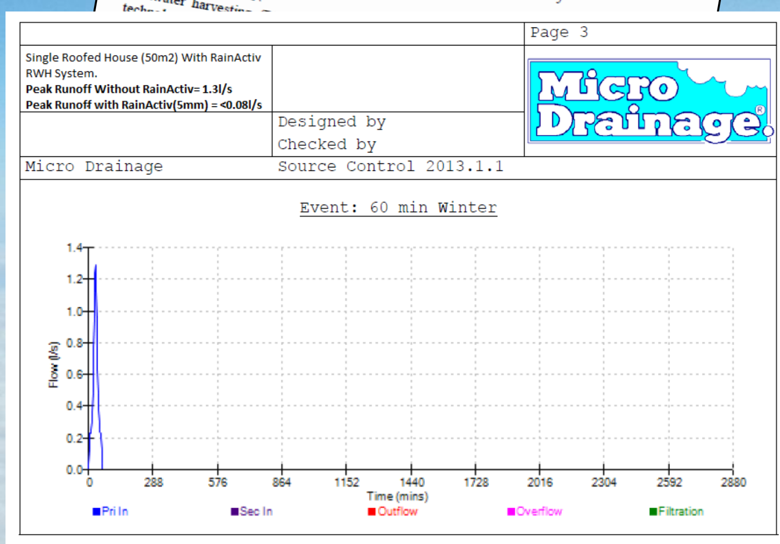
**Corresponding author's e-mail: pm277@exeter.ac.uk*

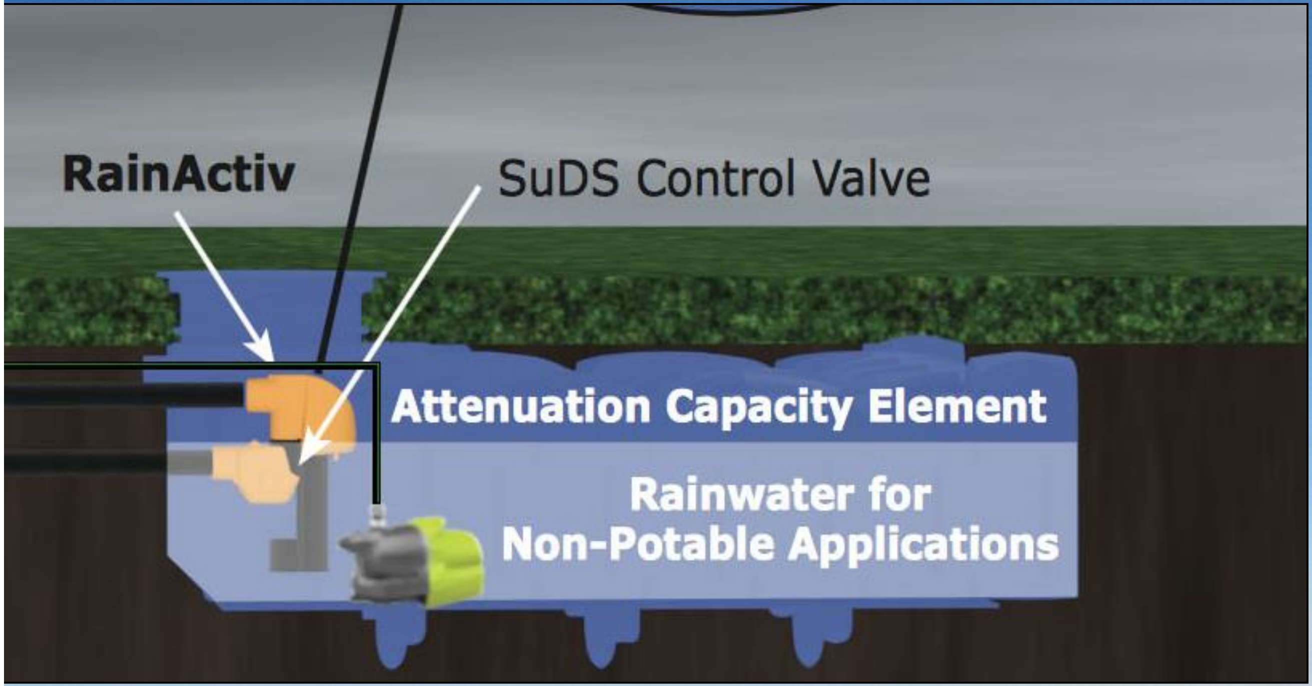
ABSTRACT
A methodology has been developed to design and evaluate rainwater harvesting (RWH) systems incorporating "retention and throttle" passive control. Two drainage design options were developed and assessed using hydraulic models for a case study site in south-west England. Through an iterative design approach, the inclusion of retention and throttle RWH tanks at each house allowed the site's conventionally designed stormwater attenuation tank to be reduced in volume by 44 % from 18 m^3 to 10 m^3 when designed based on the 100 year return period rainfall event. Each RWH tank had a volume of 4 m^3 and a 20 mm diameter outlet orifice located 1.5 m^3 from the top of each tank. The study concluded that the retention and throttle RWH concept has good potential for implementation in the UK. Savings generated by the reduced attenuation requirements could be reallocated towards the cost of RWH installations. Cost estimates for the case study site illustrate that an overall cost saving can be achieved where RWH with throttle and retention tanks were included.

KEYWORDS
Attenuation; rainwater harvesting; source control; SuDS; water efficiency

INTRODUCTION



… now available "off the shelf"



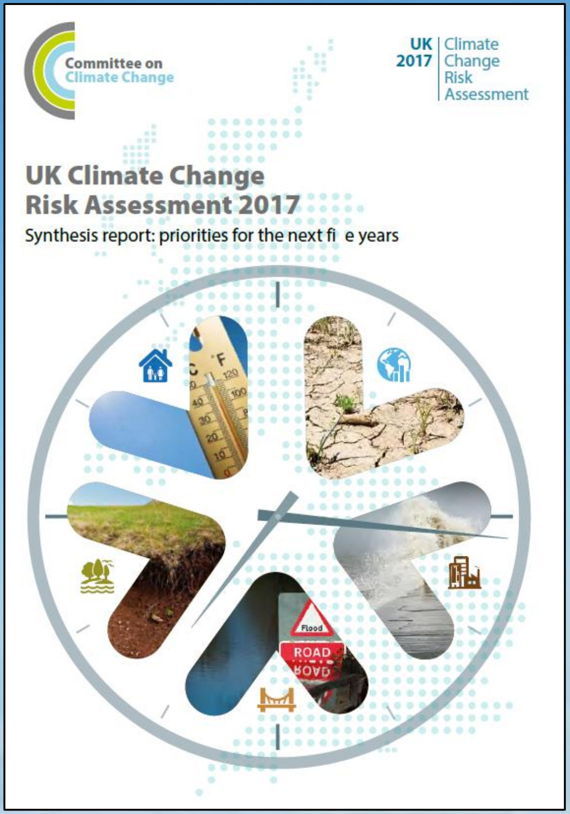
Designing RWH to mitigate droughts AND flooding in a Changing Climate

A checklist?

Figure SR.1: Top six areas of inter-related climate change risks for the United Kingdom

Flooding and coastal change risks to communities, businesses and infrastructure (Ch3, Ch4 **Ch5**, Ch6)	**MORE ACTION NEEDED**
Risks to health, well-being and productivity from high temperatures (**Ch5**, Ch6)	**MORE ACTION NEEDED**
Risk of shortages in the public water supply, and for agriculture, energy generation and industry (Ch3, **Ch4**, Ch5, Ch6)	**MORE ACTION NEEDED**
Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity (**Ch3**)	**MORE ACTION NEEDED**
Risks to domestic and international food production and trade (Ch3, Ch6, **Ch7**)	**MORE ACTION NEEDED**
New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals (Ch3, **Ch5**, Ch7)	**RESEARCH PRIORITY**

NOW -----→ RISK MAGNITUDE -----→ **FUTURE** | LOW | MEDIUM | HIGH



Designing RWH to mitigate droughts AND flooding in a Changing Climate

PRIVATE EYE

No. 1360
21 February – 6 March 2014
£1.50

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GIFTMART CATALOGUE

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Says TV's Ed Miliband
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Choice of colours:
Bob Crow Black (that's it)

Price £9.99 *(per boot)*

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Impress your local fish with the amazing submersible...

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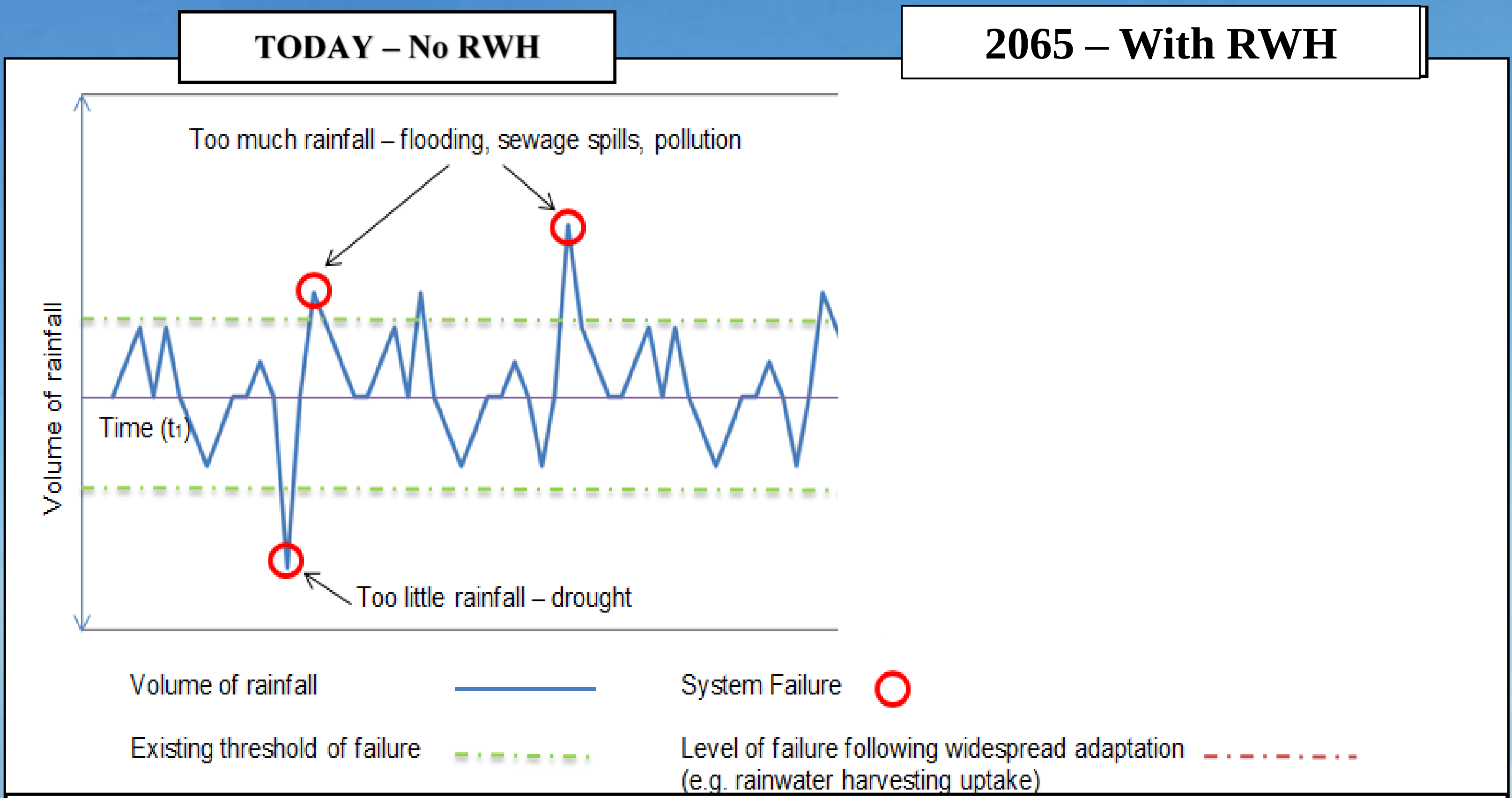
Half fish, half gnome, the MER-GNOME is today's answer to the problems of climate change for the ordinary garden lover

Designed by top ceramicists
Flud and Law

Price £37.99

VARIETIES: Gardening, Fishing, Drowning
(Dredging *not available*)

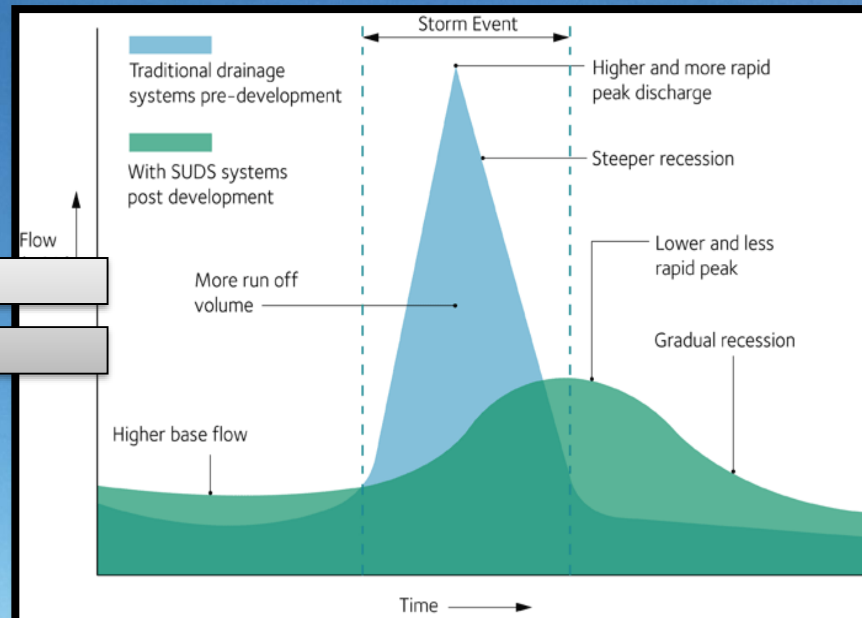
Conceptual Model



Implementing Smart Rainwater Harvesting for Climate Change Adaptation (Melville-Shreeve et al. 2016)

An Industry-wide Hypothesis?

If we install RWH it will achieve source control by reducing discharge volumes and peak discharge rates.



An Industry-wide Hypothesis?

Are RWH tanks empty when the storm comes?

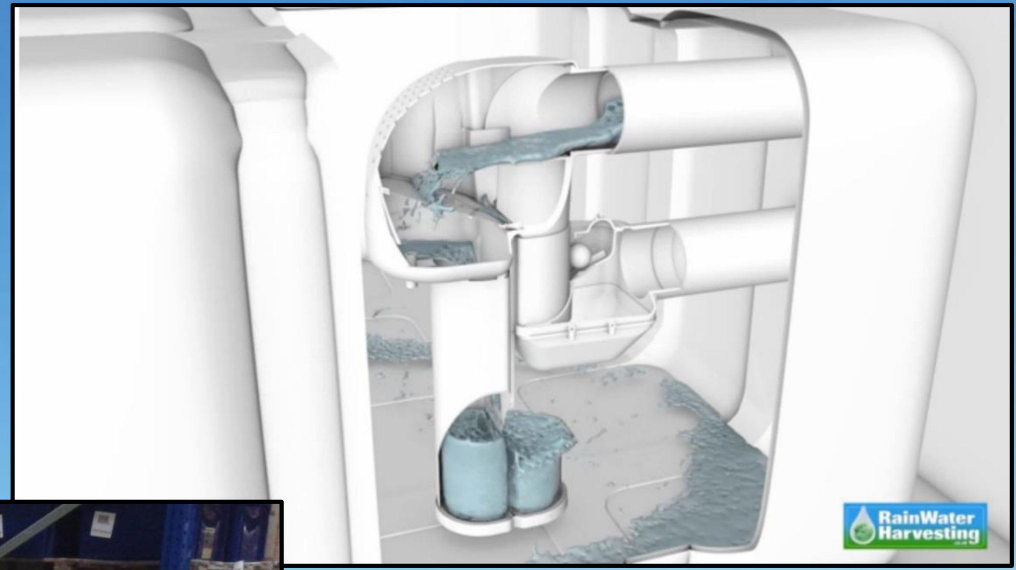
BRITISH STANDARD

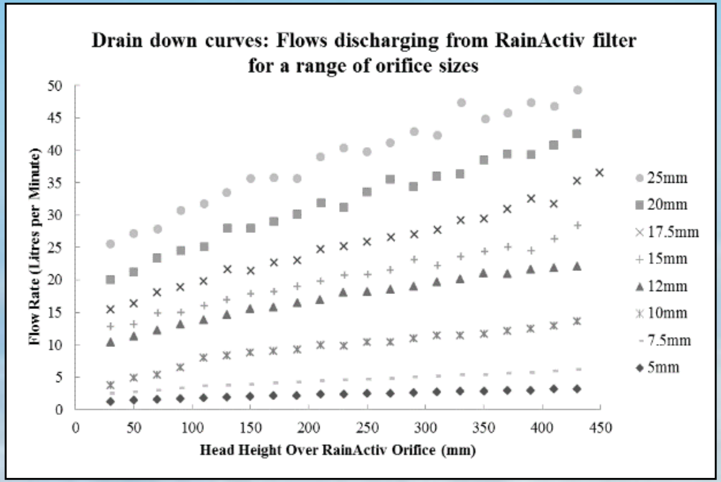
BS 8515:2009+A1:2013

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.

Lab and prototype testing





How can we fund more RWH?

Image courtesy of www.rainwaterharvesting.co.uk

-Shallow dig, gravity fed systems.

-Low energy.

-Automatic mains water backup in time of low rainfall.

-Protected against pump failure and power cut.

-User configurable modes.

-Simple to install, one piece shallow dig tanks reduce installation costs.

-Submersible pump means silent operation.

-Safe, Clean, Non-potable water.

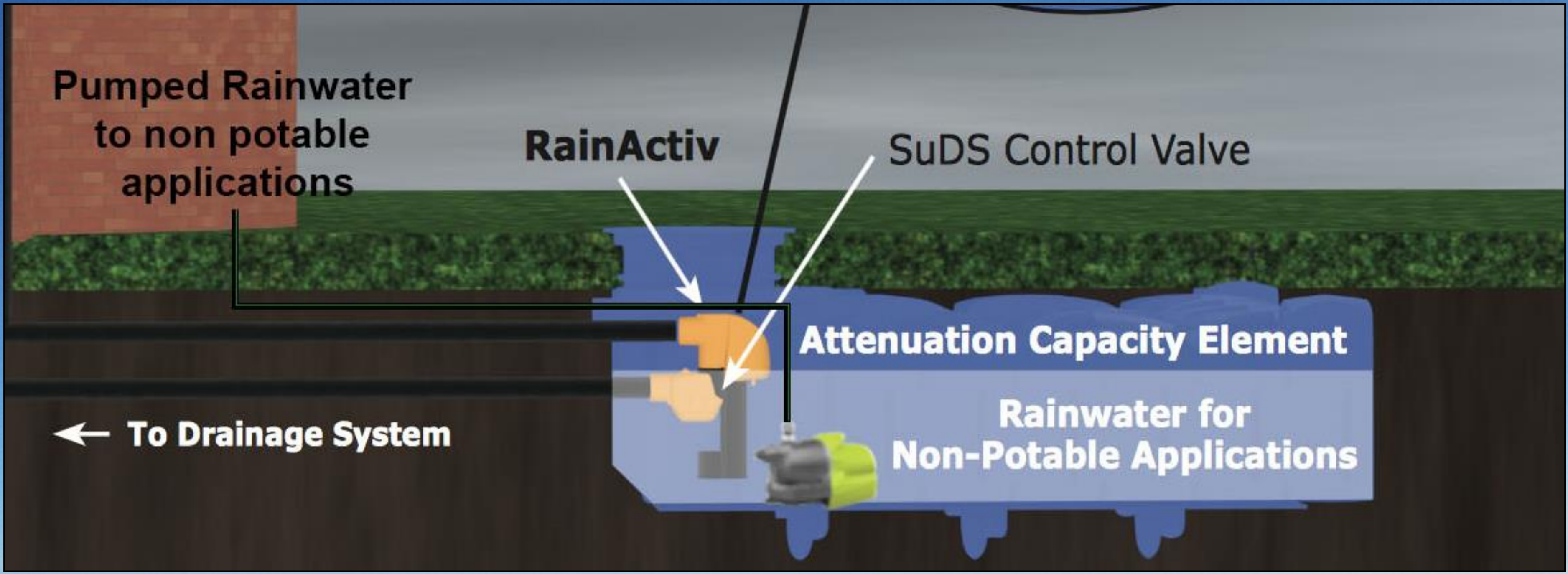
Dual Purpose RWH fits the developer's needs and budgets to manage drainage.

Meet the "Drainage" Planning Conditions

14. The development shall not commence until details of surface drainage works have been submitted to and approved in writing by the Local Planning Authority. The details must be based on an assessment of the potential for disposing of surface water by means of a sustainable drainage system in accordance with the principles as set out in the Technical Guidance to the National Planning Policy Framework and shall be designed to a 1 in 1 and 1 in 100 year storm event allowing for climate change. The drainage system shall be installed/operational prior to first occupation and a continuing management and maintenance plan put in place to ensure its continued function over the lifetime of the development. The development shall be carried out strictly in accordance with the details so approved and maintained as such thereafter.

Reason: To ensure the sustainable management of water, minimise flood risk and to minimise discharge of surface water outside of the curtilage of the property in accordance with Policy 28 of the

Benefits for developers?



Potential Large Site Benefits

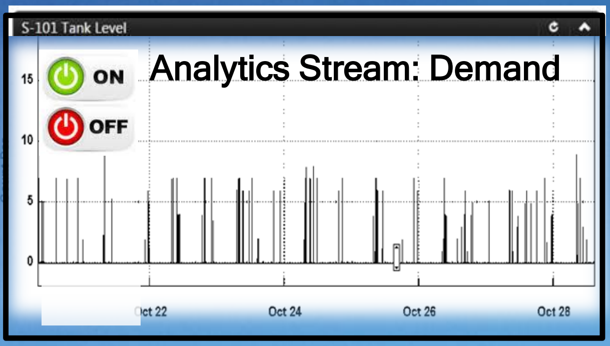
Current

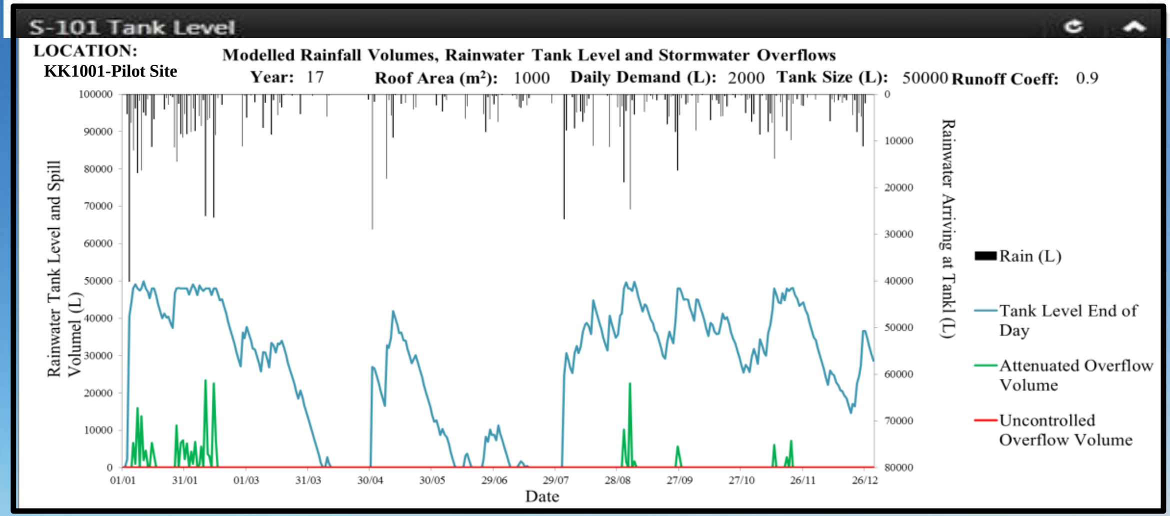
With RainActiv

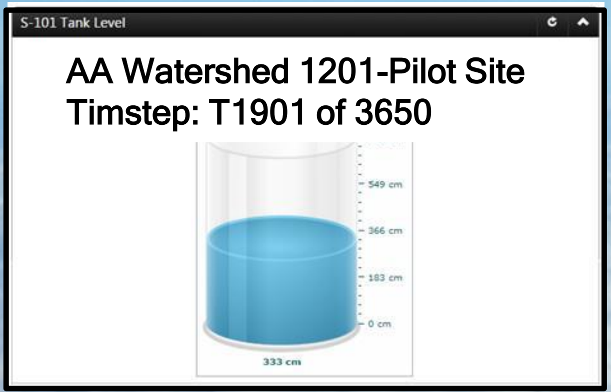
- **SuDS built at source, 1 plot at a time**
- **Reduction in green space allocated as SuDS ponds**
- **Regulators can request and obtain genuine flow control for <u>all storms up to 1 in 100 year+</u>**

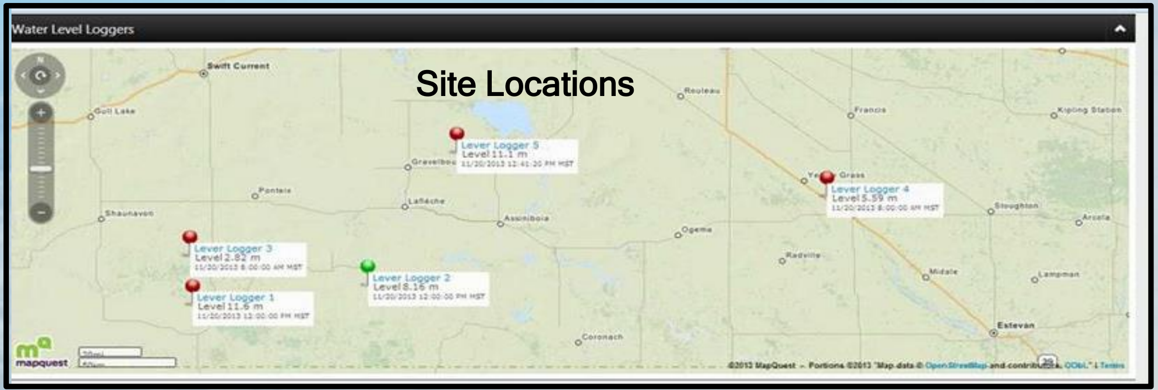
Small storms **now contribute increased flows… not greenfield runoff characteristics?**

Evaluation Tools:
Rainwater Management Dashboard





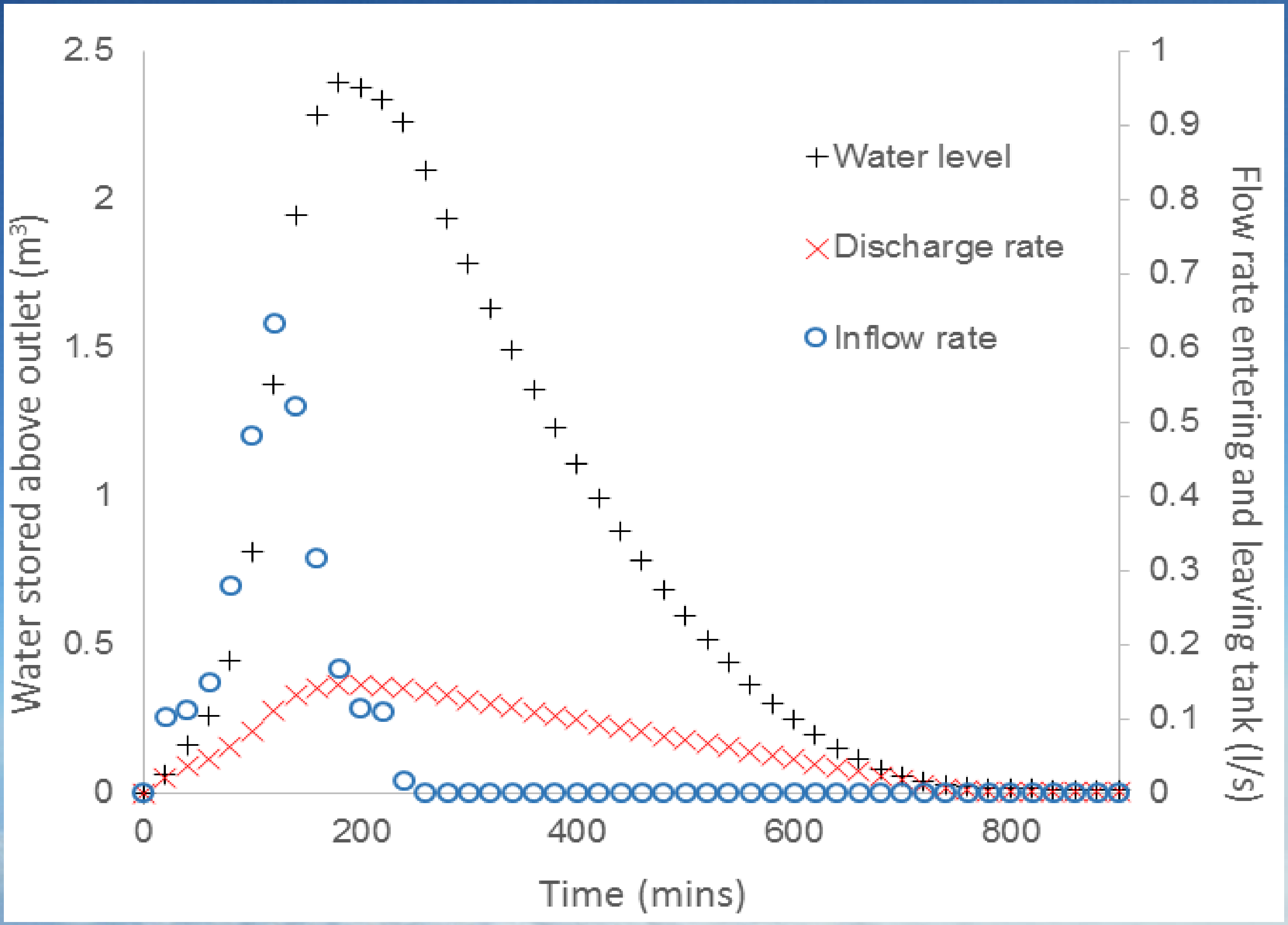




Emerging Case Study Data

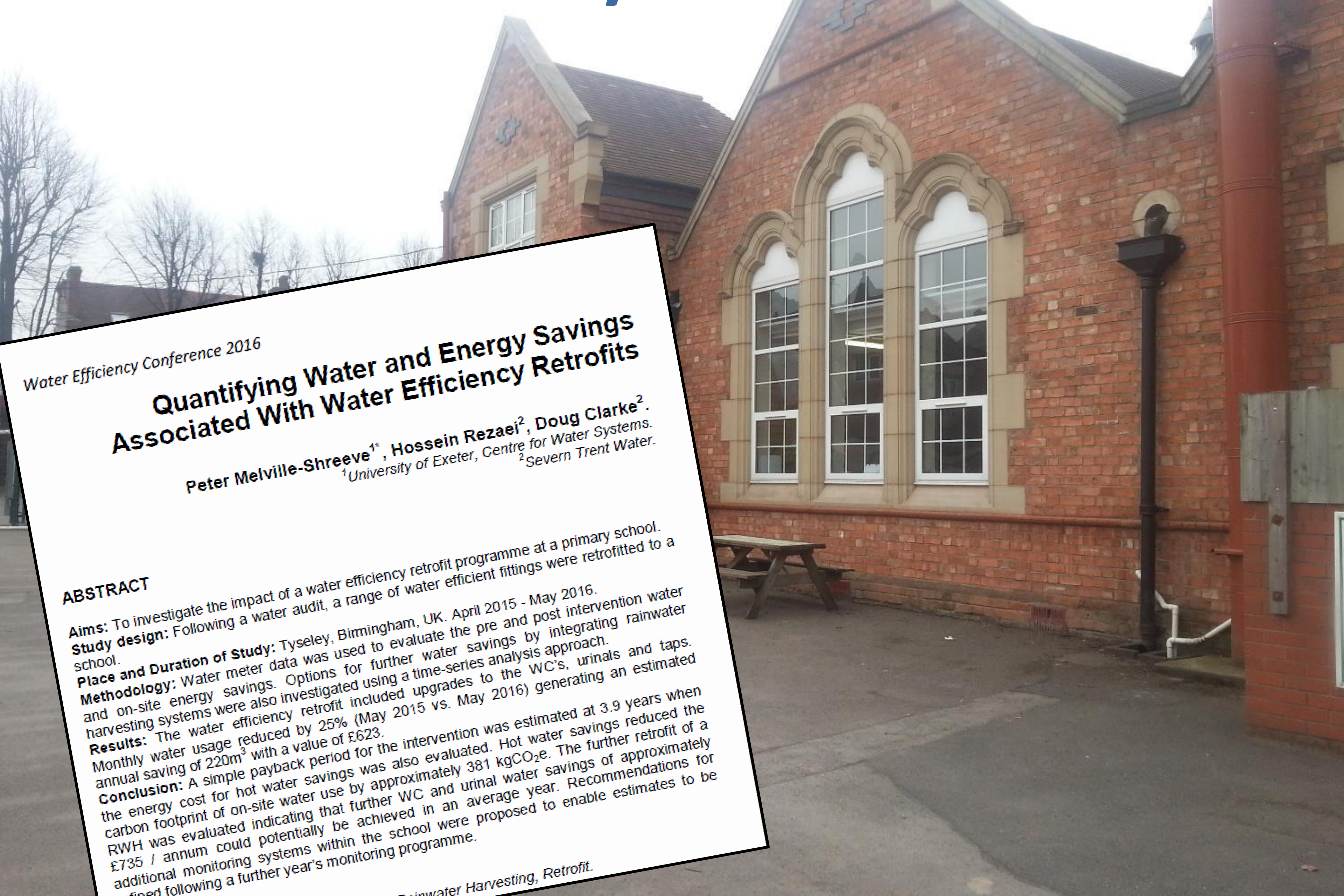
$5m^3$ RWH tank supplying 30-$60m^3$/annum…
With $2.5m^3$ attenuation capacity.

Case Study: Preliminary Site Data



TWENTY65 where next?

Water Efficiency at Redhill School



Water Efficiency Conference 2016

Quantifying Water and Energy Savings Associated With Water Efficiency Retrofits

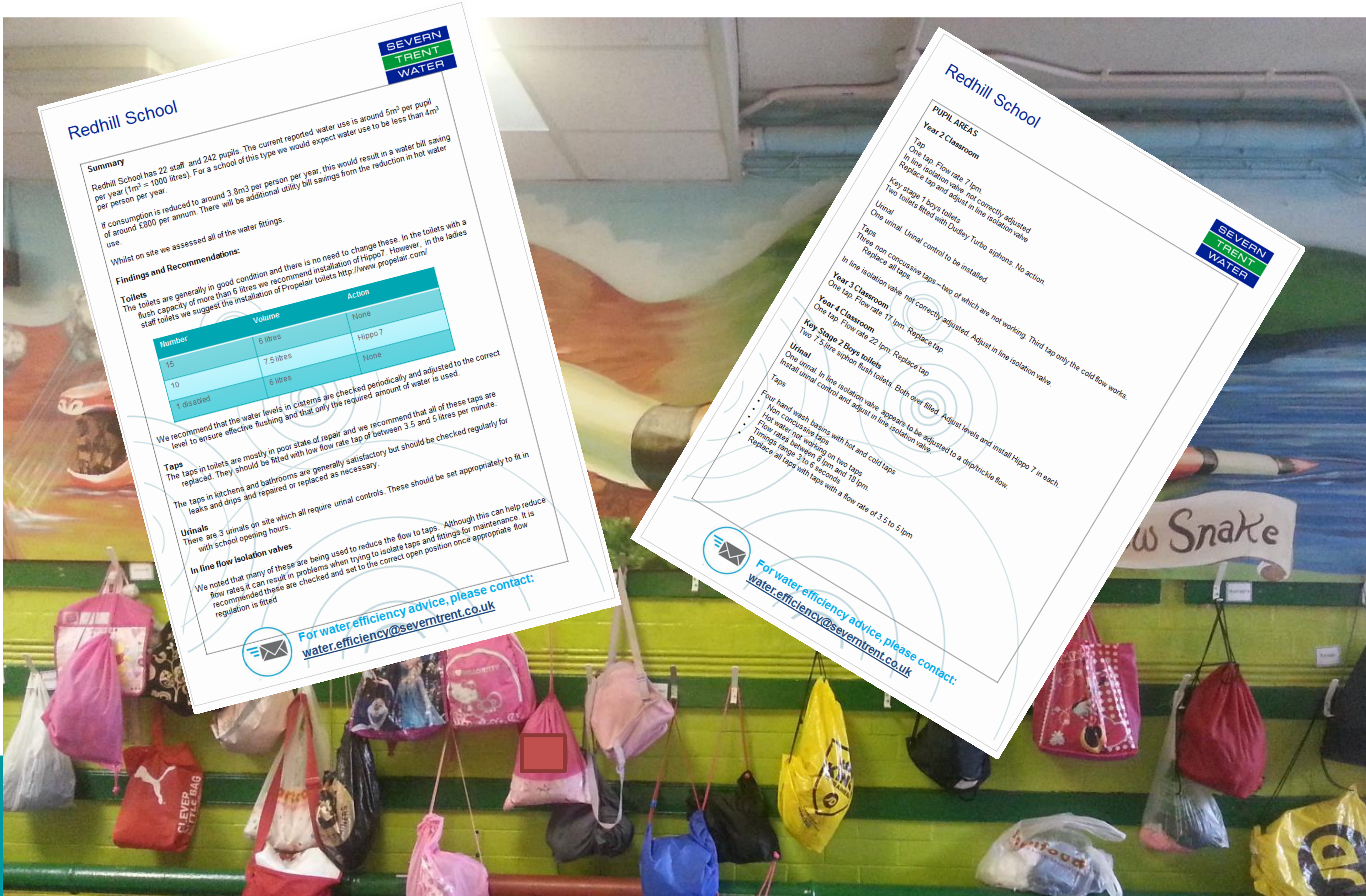
Peter Melville-Shreeve[1*], Hossein Rezaei[2], Doug Clarke[2].
[1]University of Exeter, Centre for Water Systems.
[2]Severn Trent Water.

ABSTRACT

Aims: To investigate the impact of a water efficiency retrofit programme at a primary school.
Study design: Following a water audit, a range of water efficient fittings were retrofitted to a school.
Place and Duration of Study: Tyseley, Birmingham, UK. April 2015 - May 2016.
Methodology: Water meter data was used to evaluate the pre and post intervention water and on-site energy savings. Options for further water savings by integrating rainwater harvesting systems were also investigated using a time-series analysis approach.
Results: The water efficiency retrofit included upgrades to the WC's, urinals and taps. Monthly water usage reduced by 25% (May 2015 vs. May 2016) generating an estimated annual saving of 220m^3 with a value of £623.
Conclusion: A simple payback period for the intervention was estimated at 3.9 years when the energy cost for hot water savings was also evaluated. Hot water savings reduced the carbon footprint of on-site water use by approximately 381 kgCO_2e. The further retrofit of a RWH was evaluated indicating that further WC and urinal water savings of approximately £735 / annum could potentially be achieved in an average year. Recommendations for additional monitoring systems within the school were proposed to enable estimates to be fined following a further year's monitoring programme.

Rainwater Harvesting, Retrofit.

Methods: Survey, Install & Monitor



Redhill School

Summary

Redhill School has 22 staff and 242 pupils. The current reported water use is around $5m^3$ per pupil per year ($1m^3$ = 1000 litres). For a school of this type we would expect water use to be less than $4m^3$ per person per year.

If consumption is reduced to around 3.8m3 per person per year, this would result in a water bill saving of around £800 per annum. There will be additional utility bill savings from the reduction in hot water use.

Whilst on site we assessed all of the water fittings.

Findings and Recommendations:

Toilets
The toilets are generally in good condition and there is no need to change these. In the toilets with a flush capacity of more than 6 litres we recommend installation of Hippo7. However, in the ladies staff toilets we suggest the installation of Propelair toilets http://www.propelair.com/

Number	Volume	Action
15	6 litres	None
10	7.5 litres	Hippo 7
1 disabled	6 litres	None

We recommend that the water levels in cisterns are checked periodically and adjusted to the correct level to ensure effective flushing and that only the required amount of water is used.

Taps
The taps in toilets are mostly in poor state of repair and we recommend that all of these taps are replaced. They should be fitted with low flow rate tap of between 3.5 and 5 litres per minute.

The taps in kitchens and bathrooms are generally satisfactory but should be checked regularly for leaks and drips and repaired or replaced as necessary.

Urinals
There are 3 urinals on site which all require urinal controls. These should be set appropriately to fit in with school opening hours.

In line flow isolation valves
We noted that many of these are being used to reduce the flow to taps. Although this can help reduce flow rates it can result in problems when trying to isolate taps and fittings for maintenance. It is recommended these are checked and set to the correct open position once appropriate flow regulation is fitted

For water efficiency advice, please contact:
water.efficiency@severntrent.co.uk

Redhill School

PUPIL AREAS

Year 2 Classroom
Tap
One tap. Flow rate 7 lpm.
In line isolation valve not correctly adjusted
Replace tap and adjust in line isolation valve

Key stage 1 boys toilets
Two toilets fitted with Dudley Turbo siphons. No action.

Urinal
One urinal. Urinal control to be installed.

Taps
Three non concussive taps – two of which are not working. Third tap only the cold flow works.
Replace all taps.
In line isolation valve not correctly adjusted. Adjust in line isolation valve.

Year 3 Classroom
One tap. Flow rate 17 lpm. Replace tap.

Year 4 Classroom
One tap. Flow rate 22 lpm. Replace tap

Key Stage 2 Boys toilets
Two 7.5 litre siphon flush toilets. Both over filled. Adjust levels and install Hippo 7 in each.

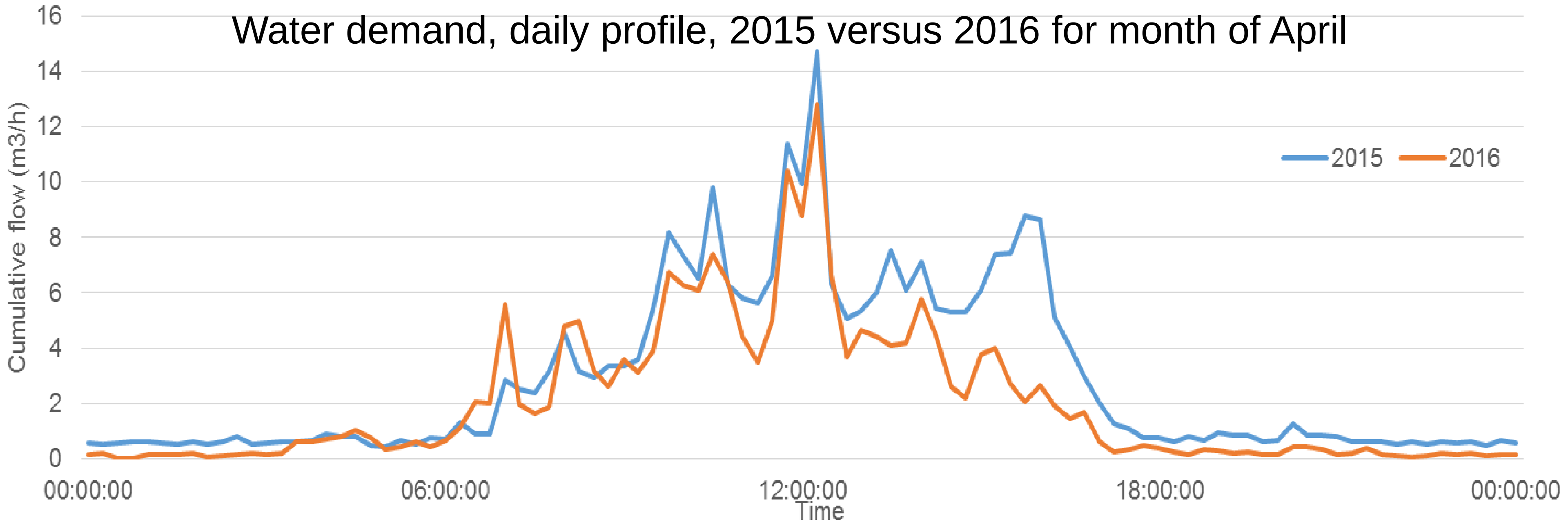
Urinal
One urinal. In line isolation valve appears to be adjusted to a drip/trickle flow.
Install urinal control and adjust in line isolation valve.

Taps
- Four hand wash basins with hot and cold taps
- Non concussive taps
- Hot water not working on two taps
- Flow rates between 8 lpm and 18 lpm.
- Timings range 3 to 6 seconds
- Replace all taps with taps with a flow rate of 3.5 to 5 lpm

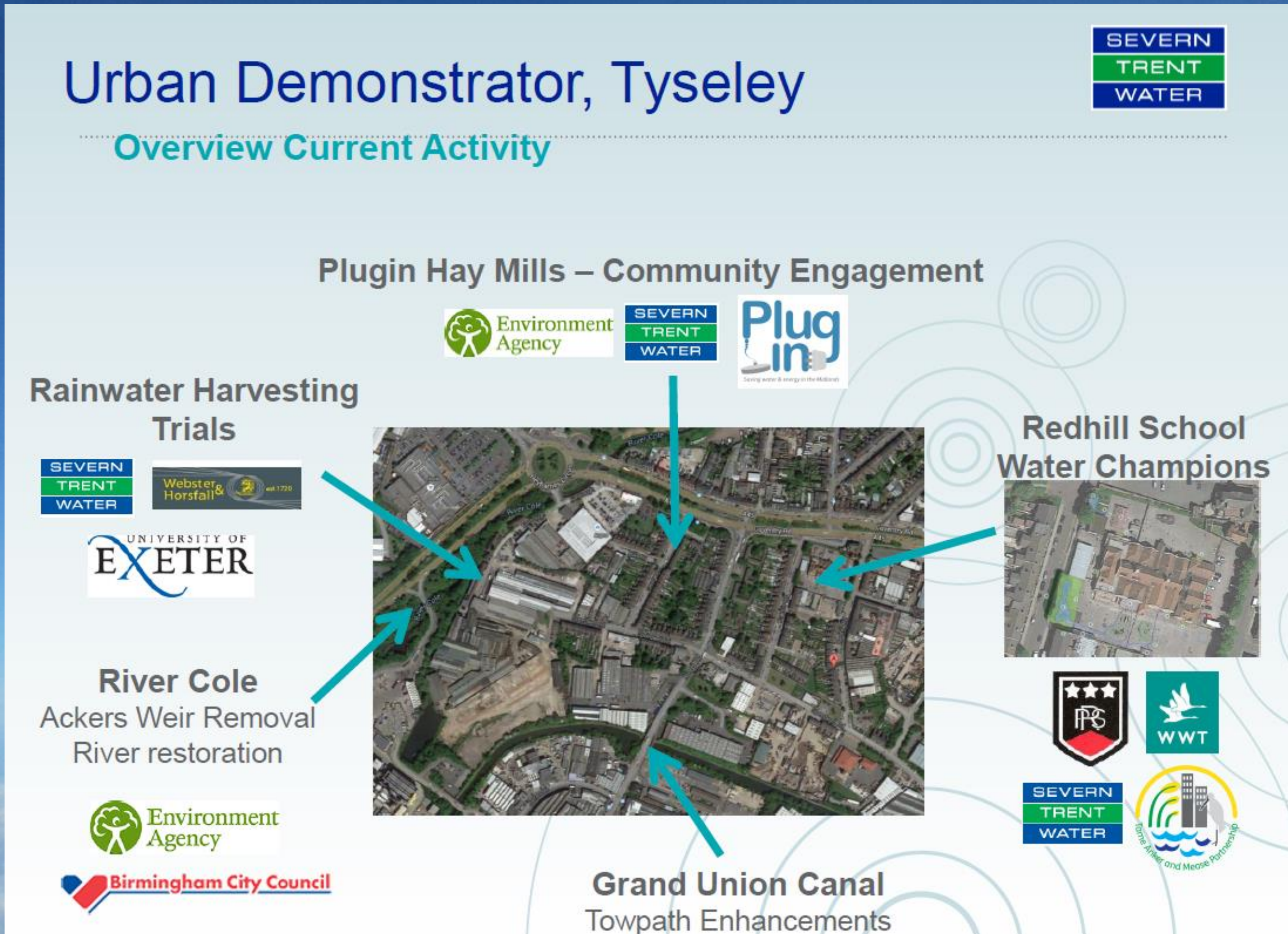
For water efficiency advice, please contact:
water.efficiency@severntrent.co.uk

Results –Water Demand

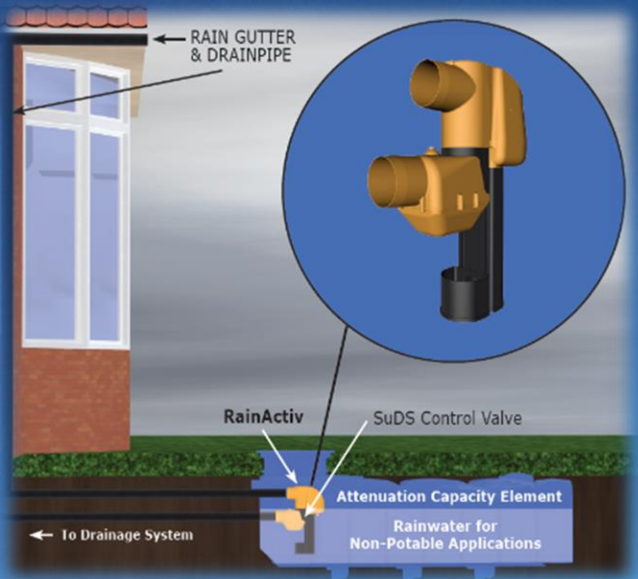
Reduced by 29% from 70.2m³ to 49.8m³ = £623/annum
Payback of 4.5 years with installation cost of £2,800.

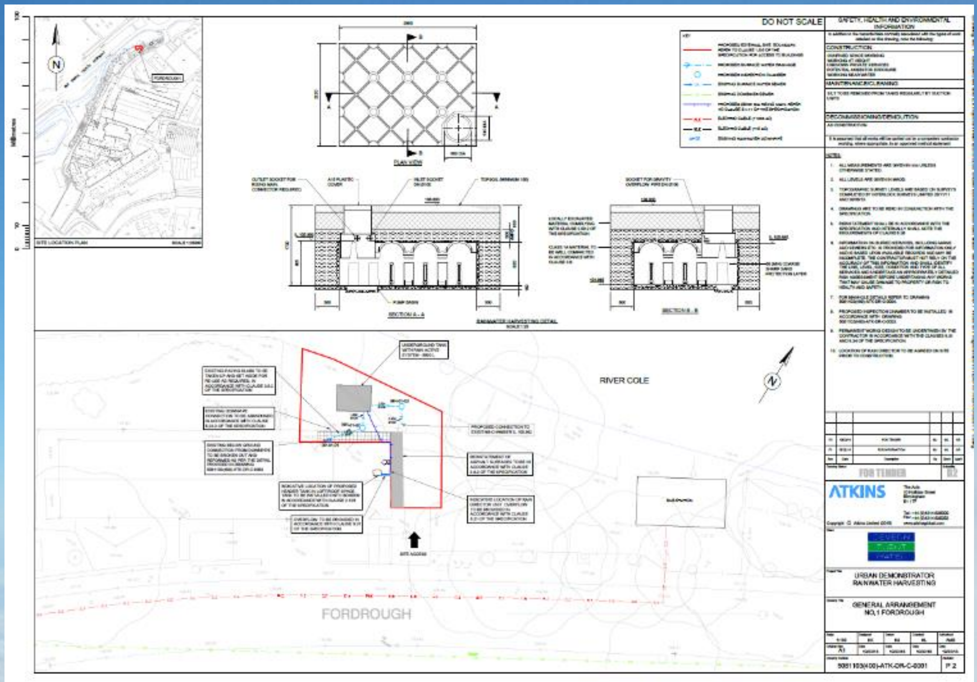


TWENTY65 where next?



TWENTY65 where next?





Key Messages?

1) RWH systems can be designed to achieve multiple objectives, (e.g. reduce stormwater flooding and mitigate drought)

2) Dual purpose RWH can be achieved through appropriate design of the installation to satisfy planning objectives (e.g. control discharge in the 1 in 100 year rainfall event)

3) True multiple benefits of RWH represent the focus of our ongoing research projects in TWENTY65

You buy one…. You get one free.