A pilot study into attitudes towards and perceptions of rainwater harvesting in the UK

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Abstract

Rainwater harvesting (RWH) has been identified as having dual benefits — as an alternative water supply, which helps reduce demand on potable supplies and as a stormwater detention method to help relieve urban flooding. In the UK the uptake of such systems has been slow, but is envisaged to increase as the new water strategy, *Future Water* and water service provider *Strategic Direction Statements* begin to promote its use. Understanding current user perceptions, including concerns and drivers, will help to facilitate a positive reaction to the promotion of such systems. Consultation and information provision are fundamental in strengthening public acceptance of innovative technologies and understanding stakeholder perceptions is central to this. A pilot study was conducted using an online questionnaire to assess attitudes towards and perceptions of certain aspects of RWH systems (RWHS). Respondents showed a preference for using their own roof as a catchment area, over roofs of neighbours or car parks and surrounding areas. Furthermore, the perceived risk associated with eight use types increased as the use type became increasingly personal. It was also identified that perception of maintenance activity costs was more closely aligned to actual costs than perception of maintenance activity frequency requirements. Finally, grants were identified as the factor most likely to encourage consideration of installation of a RWHS.

Introduction

Integrated urban water management (IUWM) offers the possibility of enhancing the sustainability of water systems, via the use of demand management techniques and innovative technologies to reduce pressure on existing supplies. However, IUWM is an emerging paradigm which contradicts the traditional and embedded 'norms' and perceptions of water that the public hold. Water is considered by most people to be a social 'right', which can lead to difficulties in curtailing usage or introducing water conservation activities; public perception is regarded as a primary barrier to conservation and reuse projects (Jeffrey and Geary, 2006).

Public consultation has been identified as a key factor for enhancing receptivity and acceptance of water demand management approaches (Sharp, 2006). Clarification of the issues associated with household motivations to use RWH technologies could facilitate production of better information and the targeted promotion of such systems, which would in turn contribute to the easing of water resources problems (White, 2007). However, little is known about public attitudes towards and perceptions of RWH, whether in a residential or commercial setting, particularly for the UK. There are several gaps in knowledge and understanding, some of which this paper aims to address.

Background

Research into attitudes and perceptions of alternative water sources has mainly been carried out in relation to recycled water use. Hurlimann (2006) conducted an online survey with office workers about to be relocated to an office building containing a recycled water system in Melbourne, Australia. The system was to be used for supplying the cooling system, toilet flushing, plant and street tree watering, and street cleaning. 47% of respondents were 'happy' to use recycled water for drinking and 99% were 'happy' to use it for watering gardens and street vegetation. The study also found that prior experience of recycled water systems positively influenced acceptance of proposed use within the office building.

Hurlimann (2007a) conducted the same survey, with a few additions, on a second office building in Bendigo, Australia. Similarly to the first study, 42% of respondents were 'happy' to use recycled water for drinking and 99% for toilet flushing. In contrast to the first study, however, it was identified that there were significant differences between demographic groups. Males were found to be more accepting than females and respondents over the age of 50 were happier to use recycled water for washing hands, indirect and direct drinking. Additionally, respondents with a university degree were happier to drink recycled water indirectly (added to the drinking water

reservoir/river after being treated).

A final study by Hurlimann (2007b) directly assessed perceptions of risk associated with a range of uses of recycled water within an Australian community (Mawson Lakes, Adelaide, Australia). Respondents were asked to rate how risky they thought certain uses were on a scale of 0 to 10, with 0 being 'not at all risky' and 10 being 'extremely risky'. It was identified that the perception of risk increased as the use became increasingly personal.

In contrast to the above, research into attitudes towards and perceptions of RWH has been limited in scope. Previous studies have focused on the technical specifications of such systems, their general acceptability and characterization of the factors motivating householders to install them (Leggett *et al.*, 2001; BMRB, 2006; White, 2007, respectively). Few studies have probed deeper in order to assess perceptions of more detailed aspects of RWHS, such as the level of risk associated with certain types of use, awareness of system maintenance requirements and factors likely to encourage consideration of installing a system.

The adoption of RWH technologies within the UK has been slow, but momentum will begin to increase due to the inclusion of RWH within key strategic documents such as the *Code for Sustainable Homes*, the *BREEAM*, *Future Water* and water service provider *Strategic Direction Statements*. However, little is known about the attitudes and perceptions of the UK public to such technologies, or indeed the experiences and beliefs held by actual RWH system users.

The previous discussion has highlighted that there is currently a knowledge gap in relation to attitudes and perceptions of RWH systems within the UK. To better understand the experiences and perceptions of system users and non-users alike, a full scale questionnaire study is being developed. This paper outlines the methodology and initial results of the pilot study conducted in order to develop the full study.

Methodology

Questionnaire design and construction

In light of previous research and the identification of the current knowledge gap, as discussed above, questions were asked on a range of topics, including:

- Water saving devices - to obtain a perspective on prior experience with water efficient devices and alternative water sources (such as RWH and greywater reuse (GWR));
- Willingness to use alternative water sources – RWHS and GWR from different catchments and properties;
- Perceptions of risk associated with types of use – both non-potable, sub-potable and potable;
- Awareness of and a willingness to pay for maintenance activities;
- Factors encouraging an individual to consider implementing a RWHS;
- A final section on the structure, content and ease of use of the actual questionnaire itself (though these will not be discussed in detail within this paper).

Standard demographic questions, such as age, gender, occupation, educational status and home ownership status were included, to identify any differences between groups and as a basis for comparison with previous studies.

The questionnaire was designed using the Advanced Psychometric And Reaction Test, 'APART', software developed by research teams at the University of Exeter. The tool allows construction of a bank of 'stimuli' (questions) and 'responses' (answers), which can then be used to generate online questionnaires. The bank of questions is particularly useful if the same questions or a different combination of questions are to be administered to different respondent groups. For the pilot study, responses were recorded in relation to over 140 items pertaining to water conservation and RWHS; however, not all will be discussed within this paper.

Multiple-choice 'drop-down' menu response sets were set up to enable respondents to quickly and simply answer each question. Generally these consisted of 'Yes, No, Maybe, Unsure, Not Applicable'. However, there were some question-specific response sets, such as 'Used-positive, Used-negative, Used-mixed' for a question on prior experience with water saving devices. Likert (1967) scales were used to assess risk, in line with Hurlimann (2007b), where 1 indicated the least risk and 10 indicated extreme risk. Where there existed the potential for an unanticipated response to be used, an 'Other, please specify' open-ended response was provided, to ensure that no unanticipated responses were missed.

Respondent groups

Limited information is available on the perceptions of and attitudes towards RWH from both UK RWHS users and the UK public in general. As such, it was decided to administer the survey to both RWHS users and non-users alike. The questionnaires were administered by sending a link to the online questionnaire to a single contact within a particular organisation who then forwarded it to participants. The link was accompanied by a group-unique 'batch' login code and password. This enabled the responses of the different organisations to be differentiated, to facilitate comparisons between groups at a future juncture. Organisations contacted included a national charity, a human resources company, an accountancy software company, a rural housing association, a water company, a RWHS supplier, a university department and an engineering consultancy.

Confidentiality statements were included and individuals participating reassured of their anonymity at the beginning of the questionnaire, as well as reiterating that all information gathered would be treated confidentially. Further to this, access to the questionnaire was set to a maximum of one month from the day of sending the link to the participating organisations.

As the link to the online questionnaire was sent to a contact within different organisations and then forwarded to participants, rather than being sent to a set number of individuals, a response rate could not be ascertained. However, the number of respondents that completed the questionnaire within the allocated duration was 46. This was deemed to be sufficient for a pilot study, in line with White (2007).

Results and discussion

The pilot study was a useful exercise in two respects. Firstly, it identified preliminary indicators of perceptions associated with RWHS; in particular, the risk associated with different uses and the frequency and cost of maintenance requirements. Secondly, it provided useful feedback and pointers on the actual questionnaire structure and content itself, which will allow refinement of the final questionnaire before the full study commences.

Demographics

Table 1 summarises the demographic characteristics of the 46 respondents participating within the pilot study. As can be seen, there was a larger contingent of female than male respondents and a substantial contingent of homeowners (65%). There was also a large contingent of respondents with qualifications above A-level (63%). As a result, comparisons were not made based on educational background, as those without higher qualifications were underrepresented. Of the 46 respondents, 8 had access to a RWHS within their home or place of work and 38 did not.

Prior experience

Table 2 shows the percentage of respondents which had prior experience with different water saving devices and the type of experience they had with each use (whether a positive, negative or mixed experience). A large proportion had previously used water saving devices, with which they had a differing range of experiences. For example, 67% of respondents had used a water butt and had positive experiences, whereas 2% had used one but had a mixed experience (positive and negative).

With regards to RWHS, only 24% of respondents had prior experience (whether positive or mixed) with a system. Presumably the majority of these were the respondents who had access to a system within their home or workplace. The number of respondents with prior experience (whether positive or mixed) of a greywater system of any kind was a meagre 8%. However, it is worth noting that for both of these systems no respondent used the response option indicating a purely negative experience with such systems.

Willingness to use alternative water sources

In order to ascertain which sources of rainwater or greywater would be acceptable to respondents, a question was asked about which catchments or properties respondents would consider for supplying a RWHS or GWR system. The results are shown in Table 3. 100% of respondents were willing to consider the use of a RWHS with their own roof as the catchment. This decreased to 91% when the catchment would be neighbouring roofs and decreased further to 52% when the catchment would be surrounding roads and car parks. With respect to greywater systems, respondent's own houses were more preferable as

Table 1 *Demographic characteristics of the respondents*

Age	*Percentage*	*Gender*	*Percentage*
21–30	43	Male	37
31–40	30	Female	63
41–50	15		
51–65	9		
>65	2		
Highest qualification	*Percentage*	*Housing status*	*Percentage*
None	2	Owner-occupier	63
GCSE	4	Shared-owner	2
A-level/GNVQ	30	Tenant-private	24
First degree	33	Tenant-housing association	4
Masters degree	26	Tenant-other	7
Doctorate	4		

Table 2 *Percentage of respondents who had prior experience of different water saving devices and their type of experience*

Water Saving Device	*Experience*				
	Used-positive	*Used-negative*	*Used-mixed*	*Not used*	*Unsure*
Hippo/'Save-a-flush'	26.1	4.3	17.4	52.2	/
Dual flush WC	67.4	/	17.4	13	2.2
Aerator taps	26.1	2.2	15.2	43.5	13
Shower head flow restrictor	2.2	6.5	6.5	71.7	13
Water meter	47.8	2.2	8.7	37	4.3
Water butt	67.4	/	2.2	30.4	/
RWHS	21.7	/	2.2	71.7	4.3
GWR system	4.3	/	4.3	82.6	8.7

Table 3 *Percentage of respondents willing to use different systems and catchments*

Type of catchment/system	*Response*			
	Yes	*No*	*Maybe*	*Unsure*
Rainwater (collected from own roof)	100	/	/	/
Rainwater (collected from neighbouring roofs)	91.3	2.2	4.3	2.2
Rainwater (collected from surrounding roads/car parks)	52.2	30.4	13	4.3
Greywater (collected from own house)	78.3	2.2	17.4	2.2
Greywater (collected from neighbouring houses)	39.1	37	17.4	6.5

sources than neighbouring properties. These results appear to indicate important implications for communal or interlinked systems. Where such systems are considered it would be essential to consult with building occupants to ensure any concerns were assuaged, for example by providing information on the level and complexity of filtering or treatment a source would receive.

Risk perception

Respondents were asked if they thought there were any associated risks with various uses of RWH. Responses available for selection were 'Yes, No, Maybe and Unsure'. In addition, respondents were asked to rate on a scale of 1 to 10 the risk they associated with each type of use (1 represented the least risk, 10 the greatest). Mean responses from the total set of respondents are shown in Figure 1. As can be seen, the perceived risk increases as the type of use becomes increasingly personal, with garden watering being perceived as the least risky and drinking as the most risky. These results are similar to those obtained by Hurlimann (2007b), who found toilet flushing had the least perceived risk (0.8) and drinking the highest (9.06). Within the pilot study, toilet flushing was inadvertently excluded; as it is the most common use for rainwater harvesting it was assumed it would be accepted by most respondents. Nevertheless, it should have been included and will be added to the full study questionnaire. Hurlimann (2007b) also asked respondents for reasons why they had given particular risk ratings. This was not done in the pilot study as it was felt the questionnaire was already quite lengthy. However, inclusion of an optional question may be considered for the full questionnaire. It would be interesting to identify individual's specific concerns as these could then be addressed in system guidance information.

Maintenance requirement awareness

RWHS are not a 'fit and forget' technology. They have a maintenance requirement involving the system pump, filters and catchment area in order to maintain reliable operation (Leggett *et al.*, 2001). Activities range from simply checking an item to cleaning or even replacing it at the end of its useful life. The frequency and cost of such activities is often overlooked during the consideration and design phase. Often it is not until a system has been installed that building owners become aware of maintenance commitments. In order to assess perceptions regarding four maintenance activities (cleaning the catchment surface, cleaning the filters, replacing the UV lamp and checking the pump), respondents were asked how frequently they thought the activities should be conducted and how much they thought they would cost.

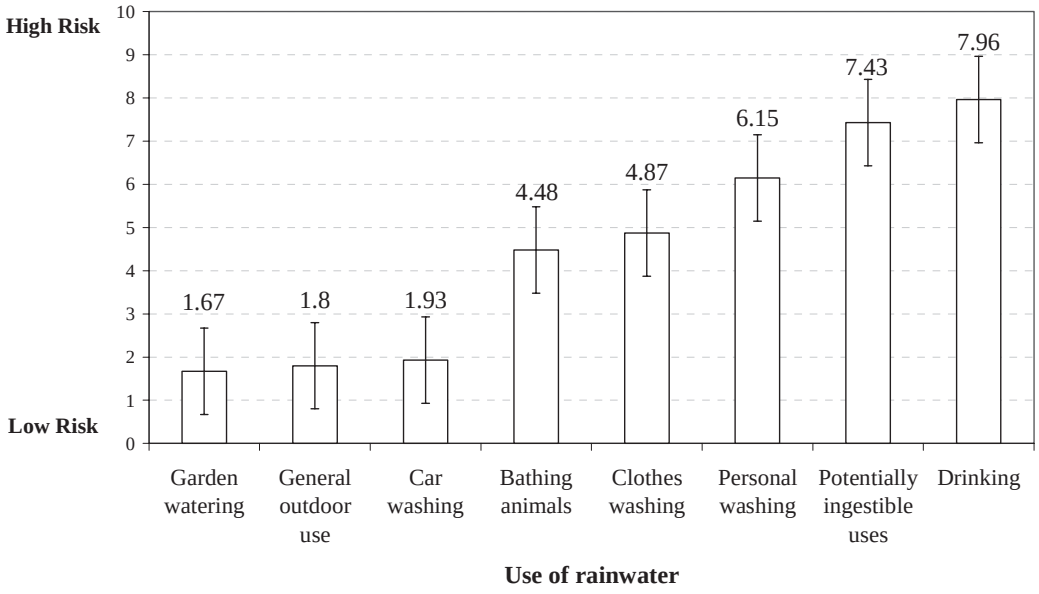

Figure 1 *Respondents' mean perception of risk associated with various uses of rainwater*

With regard to the frequency of maintenance activities, respondents were asked to estimate how often they thought activities should be undertaken using a response set with seven options (shown in Figure 2). Figure 2 illustrates that a fairly large number of respondents (24%) simply did not know or want to guess at the frequency with which the four maintenance activities should be carried out. The actual average frequency for conducting the predetermined maintenance activities is three times per year (Roebuck, 2007), which received a low response (2%). Furthermore, the results show that 50% responded with frequencies of less than three times per year and 24% with more than three times per year. This would appear to indicate that there is an overall underestimation, within the respondent group in the pilot study, of the recommended frequency for conducting maintenance activities.

In relation to cost, respondents were initially asked to estimate a total cost for the four previously mentioned maintenance activities using a response set with six options (shown in Figure 3). Figure 3 illustrates that there was a far greater spread in the range of costs estimated by women than men. Furthermore, a total of 90% of respondents estimated costs of either between £100 and £200 or less than £100 per year.

Respondents were then asked how much they would be prepared to pay for the same activities using the same response set. As shown in Figure 3, the majority of both male and female respondents (73%) would be prepared to pay around £200 or less per year for these activities. The actual cost for an average domestic property would be between £140 and £240 per year, or £250 for an annual contract with a maintenance provider (Roebuck, 2007). Thus the results would appear to indicate that perceptions of maintenance costs are, within the respondent group in the pilot study, generally aligned with the lower end of the scale of actual costs.

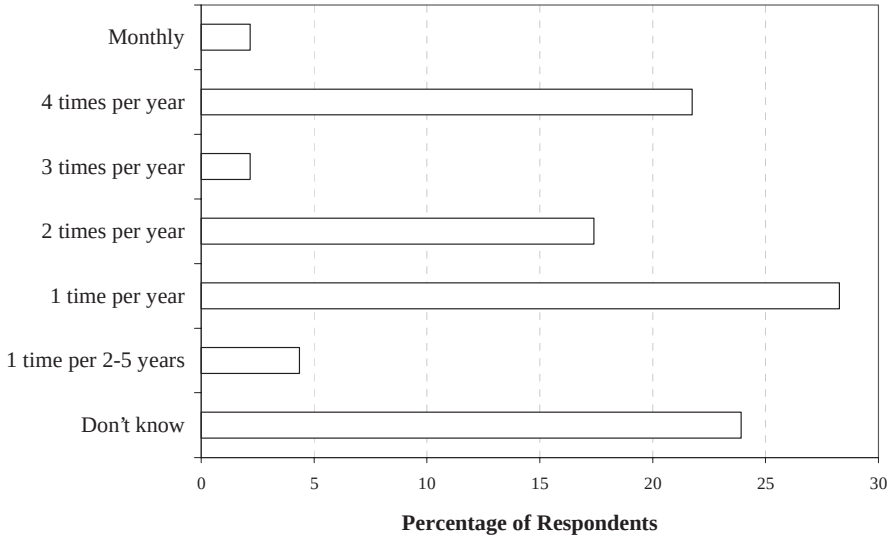

Figure 2 *Respondent responses regarding estimated maintenance activity frequency (percent)*

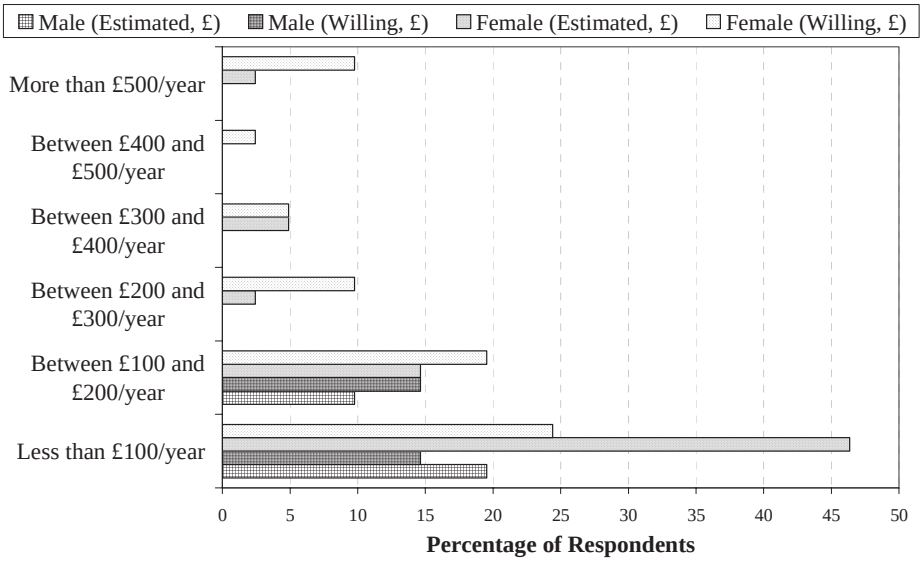

Figure 3 *Respondent responses regarding estimated costs and willingness to pay for maintenance activities, by gender (percent)*

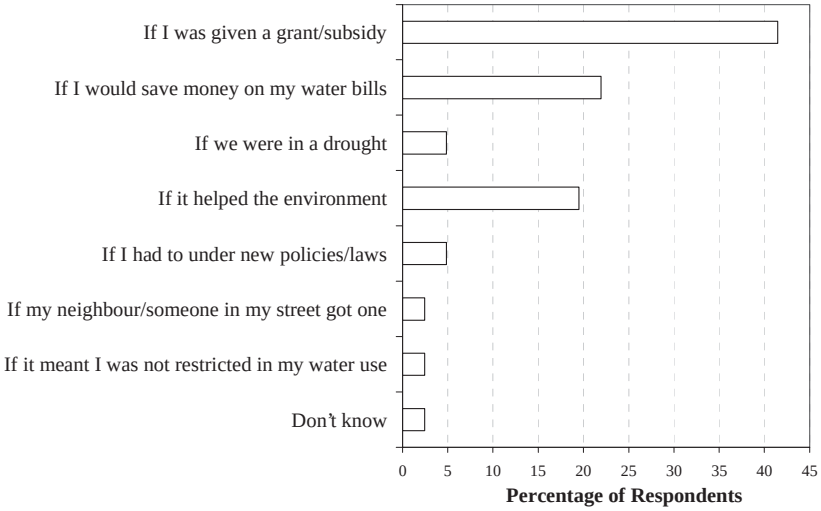

Figure 4 *Factors enhancing respondents' consideration of installing a RWHS*

Consideration Factors

In order to ascertain what factors would encourage people's consideration of installing a RWHS, respondents were given a list of factors, from which they could choose only one option. Neutral options such as 'Don't know' or 'None of these' were included and an 'Other, please specify' item was added to collect responses that did not fit within the predetermined response set. Although some respondents did choose the 'Don't know' response, none selected the 'None of these' option or filled in a response that was not within the response set. Thus it can be implied that the predetermined response set covered all factors that respondents deemed relevant when considering installing a RWHS. Figure 4 shows the respondents' responses to this question. As can be seen, the most popular consideration factor was 'If I was given a grant/subsidy' with 41% of respondents choosing this response. These results are in line with the previously referred-to UK survey (BMRB, 2006), which highlighted grants as a favourable consideration factor. This has important implications for the present grant/subsidy structure within the UK, especially as 65% of the respondents were homeowners.

Currently, only businesses receive any kind of monetary incentive when considering installing a RWHS; the Enhanced Capital Allowance Scheme allows businesses to claim 100% first year capital allowances on expenditure on RWHS (and other items on the Water Technology List). This scheme does not apply to the domestic market so home owners wanting to install a RWHS currently receive no financial assistance or incentive. This is in contrast to technologies for energy microgeneration (for example, solar photovoltaics, wind turbines and ground source heat pumps) where domestic installers can receive substantial financial assistance; up to £2,500 per property (BERR, 2008).

Conclusions

Results from the pilot study demonstrate that in general people are aware of and have experience with a range of water saving devices, from water butts to dual flush toilets. However, experience with more technically complex water saving devices/alternative water sources, such as RWH and GWR, is limited. This has potentially important implications for the use of demonstration sites as a tool to enhance visibility of such IUWM techniques.

Respondents showed a comprehensively positive response to consideration of the use and implementation of a RWHS. However, when asked to consider different collection sources other than their own roofs (or houses for GWR), such as neighbouring houses or surrounding car parks, responses were less favourable. This has implications for the potential use of communal systems, or the potential for systems to be supplied by unconventional catchment areas that may be considered in the future.

In relation to risk perceptions, it was ascertained that the perception of risk associated with particular uses of rainwater is in line with previous studies on recycled water; i.e. the risk associated with a particular use increases as the use becomes increasingly personal.

With regard to the perception of maintenance activities, two interesting points were observed. Firstly, respondents demonstrated an underestimation of the recommended frequency for conducting four maintenance activities (cleaning the catchment surface, cleaning the filters, replacing the UV lamp and checking the pump). Secondly, respondents' perceptions of maintenance costs, for the same activities, were generally aligned with the lower end of the scale of actual costs. Maintenance commitments are perhaps an area the RWH industry needs to focus on in terms of enhancing guidance information provision.

Of the consideration factors presented to the respondents, a large proportion selected the availability of a grant or subsidy as the item which would most likely encourage them to consider installing a RWHS. This has important implications for the current UK grant/subsidy structure, which at present only applies to businesses and not to domestic purchasers/installers.

Further work

The work described has been carried out as a pilot study for a full scale study. The proposed full study will administer the same online questionnaire (but with

refinements uncovered during the pilot study) to a larger sample of both users and non-users. Approximately 500 commercial (office system users and non-users) and 400 residential (domestic system users and non-users) respondents will be contacted for this study. The results of the full study will also be subject to appropriate statistical analyses. These were not used within the pilot study because of time constraints and the limited sample size. It is hoped that the results from the full study will facilitate a better representation of the social parameters (risk, acceptability, public awareness) associated with RHW and GWR within the 'Technology Library' of the Urban Water Optioneering Tool (UWOT) developed by Liu *et al.* (2007).

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