

The Effectiveness of Converting WCs to Dual Flush

R&D Technical Summary W6-011/TS

Background

With the growing pressure on water resources, identified in the Environment Agency's national water resources strategy *Water Resources for the Future*, there is a clear need for demand management solutions to stabilise and even reduce water demand.

The water companies have a duty under Section 93A of the Water Industry Act 1991 (introduced 1995) to *promote the efficient use of water by their customers*. To date, many water companies have satisfied the economic regulator, Ofwat, that they are meeting this duty by issuing cistern displacement devices, leaflets and self-audit packs. The effects of these low-cost initiatives have proved difficult to accurately measure and so the water companies are unable to submit them as robust options in their water resources plan submissions to the Agency (first submission 1999). Against this background Southern Water and Anglian Water are to be commended for their support and commitment to the project, which comprised the first detailed studies of dual flush retrofits carried out in the UK.

The Agency has a duty under the Water Resources Act 1991 to *secure the proper use of water resources*.

In 1995, the National Rivers Authority published a consultation document *Saving Water* which set out a possible demand management strategy for England and Wales. The water saving potential of many demand management options were evaluated and compared to the costs of resource development (of providing an equivalent volume of water as provided

by the demand management option). It showed that replacing toilets (a policy option practised in the USA from the 1980s) was extremely expensive for the amount of water saved. An alternative approach of converting toilets to dual flush (5 litres short, 9 litres long) could however, 'potentially reduce demand by 850 Ml/day across England and Wales at a cost of 18p/m³ at a ratio of between 0.3 and 0.6 of resource development to give the same yield'.

The consultation responses revealed some scepticism over the assumed effectiveness of dual flush toilets. Dual flush toilets were once mandatory for new (domestic) properties and it is *believed* they were phased out because principally people didn't know how to use them and so repeatedly used the short flush when the long flush was required, thereby negating any possible water saving. However preliminary research established that this was entirely anecdotal; there being no documented evidence, with calculations, to support this assertion. The objective of this project was to determine the water saving effectiveness of retrofitting dual flush devices into existing 9 litre WC cisterns in the household environment, for applicability to England and Wales. The project demonstrates that most retrofits on average save water, although the amount saved, and therefore the cost-effectiveness remains uncertain.

Context

Water companies and other abstractors will continue to seek new licenses to meet projected growth in the demand for water. It is therefore essential that the Agency identifies and appreciates the potential and

cost effectiveness of, demand management options. These options can then be set out as legitimate expectations for the abstractor to meet. Hence the project will be of value to staff who assess the demand management content of water resources plans submitted to the Agency and to Ofwat who will assess the supply-demand balance submissions. The project's findings will also be of value to water conservation practitioners in water companies planning demand management activity and regulators in the Department for the Environment, Food and Rural Affairs (DEFRA) who are responsible for water fittings regulations.

Project Method

The project consisted of two separate but complementary studies, with the Agency working collaboratively with Anglian Water and Southern Water over the period 1998-2000. In both cases a study area was identified within the respective water company boundaries and volunteers sought from the general public to participate in a trial. The participants had a meter installed on the inlet to a toilet in their household. The flow into the toilet was then monitored pre and post retrofit of a dual flush device. The devices allowed the user to select a short or long flush each time they used the toilet. A variety of different devices were tested including short and long flush default and an interruptible flush device that allowed the user to stop the flush action at the point of their choice. In total 93 households participated in the study with 33 in the Southern study and 60 in the Anglian study. Data were downloaded on a monthly basis and the resolution of the meters and loggers allowed the identification of individual flush events. Opinions on the user friendliness of the devices were obtained from questionnaires and these varied considerably depending on which device was used.

Results

The reports identify:

- savings in toilet use due to the installation of the retrofits;
- small increases in the amount of double flushing;
- savings were higher at lower occupancies; and
- savings were higher in single toilet households.

In the Southern trial an average 27% saving in toilet water use was observed across the study sample, equivalent to a volumetric saving of 2.6 litres per flush. But there was a high degree of variability in the savings observed at the individual property level, from a maximum saving of 64% to a net increase of 28%. It was difficult to draw conclusions, due to the small sample size, of the relationship between device type and % saving. In the Anglian study the volumetric savings for the interruptible flush and the low flush default mechanisms, were on average 7%, compared to the high flush default where a 2% increase in consumption was observed. One reason for the difference could be the method of analysis. In the Southern study it was determined that there was no significant increase in 'double flushing' as a consequence of the retrofit dual flush installation. As a result the water use, before and after the installation,

was calculated on the basis of savings *per flush*. In contrast the Anglian study calculations are based on a comparison of *average daily toilet demand* before and after the retrofit, which does not take into account possible changes in usage patterns and temporary changes in occupancy. Another important factor was that in the Anglian study area, 17 properties, prior to this investigation were fitted with dual flush siphons. However, records of these properties were misplaced and so this factor could not be accounted for in the analysis. Even though the majority of these households were unaware of this, it is likely, given that they would be of the short flush default type, they would have been used to some extent, therefore savings would not be as high as might be anticipated.

Both studies investigated whether double flushing (where a second flush is required, because the initial short flush fails to clear the pan) increased post retrofit. In the Southern study it was determined that double flushing increased from 4.3% to 4.9% of all events as a result of the dual flush retrofit. This appears to be a significant result given the anecdotal evidence referred to earlier. However in the Anglian study a regression model showed that for the short flush default, the number of flush events per day increased by 1.4, indicating the possibility of some double flushing. Similarly for interruptible flush there was an increase of 0.5 events/day, whilst for the long flush default there was a fall of 0.3 events/day. It needs to be recognised that all the properties in the Anglian study were two or more toilet households, where only one toilet was monitored. Hence, increases or decreases in the total number of flush events could represent users displaying post retrofit preferences in addition to reflecting any temporary changes in occupancy. Comparing analyses is further complicated by the lack of definition of what constitutes a *flush event*. It can be concluded from both studies that the rise in double flushing events was not great enough to negate the water savings obtained from using the shorter flush, with the exception of the new style dual flush device used in the Anglian study.

The Southern study indicated that savings were greater in smaller houses with one or two occupants compared to larger properties with bigger families. Clearly savings will be higher where there are one or two committed enthusiasts in comparison with a larger family unit where some family members will be either slow or unwilling to modify their behaviour. The average occupancy of the properties in the Southern study was 2.5 compared to 2.8 for the Anglian study. This alone is unlikely to account for the discrepancy in the results.

More significant is the fact that in the Southern study the majority of the participants lived in one toilet households, compared to the Anglian study where the majority of households had two or more toilets with only one of them converted to dual flush operation. The Southern study indicated that the savings were greater in one-toilet households. The principal reason for reduced savings in multi-toilet properties was the difficulty of adapting to the dual flush system, when at

least one other toilet in the property is operated with a normal single flush. Had all the toilets been converted in the multi-toilet properties the results may have been comparable to those obtained from single toilet households.

Both studies include a cost benefit analysis of a water company carrying out a widescale retrofit programme. The Southern study, using its higher savings and lower unit prices indicate that at a cost of £0.6m to reduce demand by 1Ml/day it compares favourably with traditional resource development schemes. Conversely, the Anglian study, with its lower savings and higher estimated unit costs, concludes that such a scheme would be uneconomic, with the exception of areas of tight headroom where large expenditure in expanded infrastructure could be deferred.

Conclusions

As a result of the 1989 water byelaws, dual flush cisterns have been prohibited since January 1993. The Water Supply (Water Fittings) Regulations 1999 allow for the re-introduction of dual flush cisterns (siphonic or valve type) on new installations. However paragraph 25(6) of Section 2 states that '*...a single flush cistern may not be replaced by a dual flush cistern.*' As a result retrofit options for dual flush installations are still prohibited. (A relaxation was granted by DEFRA for the purposes of this study). Southern Water has since written to DEFRA requesting advice on the need for relaxation of paragraph 25(6) of Section 2. The Secretary of State has rejected a general relaxation primarily due to the small sample size (only 33 properties for the overall study and only four properties for the double flushing analysis). However permission was granted for the existing householders to keep their retrofit devices provided they wanted to do so.

Both studies have demonstrated that on average, dual flush retrofit devices do save water and do not result in an increase in water use as was previously thought. However, there are clear differences in the findings from the two studies. The average saving from the Southern study was 27% suggesting that dual and interruptible flush retrofit is cost effective. From the Anglian study the average saving was a much smaller 4% thereby raising doubts about cost-effectiveness. One of the devices from the Anglian study (the new style dual flush, with long flush default) suggested that overall water use may increase, albeit by only 2%. This device was not liked by the users and there were a number of 'teething' problems that could account for its relatively poor performance. Taking the two studies together it can be concluded the:

- Southern study demonstrates the potential for dual flush retrofit devices to save water, cost effectively;
- Anglian study, whilst far less conclusive, nevertheless indicates that dual flush devices do not, *on average*, result in an increase in water use.

The reasons for the widely differing results are likely to be due to the devices themselves and the differing

customer responses to using them, in addition to the different methods of analysis.

The findings presented here call into question the need to maintain paragraph 25(6) of Section 2 of the Water Supply (Water Fittings) Regulations 1999, prohibiting dual flush retrofit. Based on the 93 properties from the two studies, *on average* dual flush retrofits do not result in more water being used.. What remains an issue, and will require further research via a larger study, is the magnitude of the savings, but this is an issue of cost benefit, rather than one to assess whether or not such devices should be prohibited.

This R&D Technical Summary relates to information from R&D Project W6-011 reported in detail in the following output:-

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