BNWAT28: Water consumption in new and existing homes

Version 1.0

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis form part of the Evidence Base created by Defra's Market Transformation Programme.

1 Summary

This Briefing Note provides details of the key findings from a recent water industry collaborative research project conducted by WRc Plc into the water consumption of microcomponents in new properties[1]. The Market Transformation Programme (MTP) has access to limited outputs from the research, including the summary statistics, but not the full database of information.

2 Background

It is projected that there will be 3 million new homes built in the UK by 2020. Understanding water use in new dwellings is a key factor in forecasting domestic water use, quantifying the impact of water efficiency measures and estimating the impact of new policy initiatives. These initiatives include the Code for Sustainable Homes and the proposed revision to the Building Regulations to include a whole-of-house water efficiency requirement. Some concern has been expressed that predicted water efficiency savings may not be realised in practice owing to uncertainties in evidence relating to actual water use, consumer behaviour, and product performance (new and retrofit) in new homes.

The project conducted by WRc aimed to collect data on the microcomponents of water use in new dwellings to better understand how water use in new dwellings differs from that in older, unmeasured properties. Measuring the microcomponents of water use allows us to break down domestic water consumption into individual components (WC use, bathing, showering, tap use, outside use, washing machine use, dishwasher use etc) expressed in terms of ownership, volume per use and frequency of use.

[1] WRc portfolio project CP337 Water use in new dwellings
http://www.waterportfolio.com/asp/project_information.asp?project_id=327&status=Ongoing

2.1 The Identiflow® system

The domestic consumption of water consists of a number of 'microcomponents'. Typically, these differentiate the use of appliances such as washing machines or dishwashers, personal washing by bath or shower, toilet use, and the use of internal or external taps. Measurement of these microcomponents provides reliable information on the way in which domestic consumers use water in the home. The Identiflow®[2] technique used to collect data for this project involves measurement of household water use at the flow meter supplying the house and is a means of categorising its constituent microcomponents from these measurements.

2.2 The Identiflow® sample structure

The property sample structure for the project was designed around three key criteria:

- Ability to compare results with a dataset of microcomponent information on older, unmeasured properties
- Trends in house building
- Consideration of all major influences on demand.

The final sample structure of 70 properties is given in Table 2.1.

Table 2.1 Final property sample structure by house type

Property type	Number desired in sample	Number monitored
2-bedroom flats	22	21
Other flats	10	7
Detached houses	12	13
Semi-detached houses	13	13
Terraced houses	10	12
Bungalows	3	4
Total	70	70

Occupancy levels (number of residents at time of monitoring) within the properties are unknown. Socio-economic classification of the properties was sought and, where possible, the properties were selected to represent both privately owned and social housing.

The monitoring period for each property was to encompass at least five weekdays and four non-week days, so that one full week of normal activity can be analysed for each property.

All monitoring was to occur over winter non-peak periods, with the Christmas and New Year holidays avoided as there was a high likelihood of untypical behaviour due to multiple guests or vacated properties.

[2] http://www.wrcplc.co.uk/pdf/Identiflowflyer07.pdf

3 Summary statistics

3.1 Ownership, frequency and volume statistics

Table 3.1 shows the average ownership, frequency of use and volume per use statistics for each microcomponent for the 70 properties monitored.

The ownership denotes the possession and use of the appliance. It is possible that an appliance may be present in a household but not used throughout the analysis period, in which case this property will not be considered to 'own' that appliance. The frequency of use denotes the frequency of use per property per day at those properties where the device is owned.

Household consumption is the product of ownership, frequency of use and volume per use.

Table 3.1 Average ownership, frequency and volume

Device	Ownership	Frequency of use (uses/property/day)	Volume per use (litres/use)	Household consumption (litres/property/day)	% of total consumption
Toilet	100%	10.60	5.93	62.81 (4.15)	19.67
Internal tap	100%	50.23	1.52	76.38 (6.78)	23.93
Bath	60%	1.17	68.55	48.31 (6.64)	15.13
Washing machine	99%	0.85	45.73	38.48 (3.58)	12.05
Shower	96%	1.86	41.17	73.6 (8.04)	23.05
External tap	11%	0.55	171.61	10.45 (10.47)	3.27
Dishwasher	43%	0.72	15.15	4.69 (1.00)	1.47
Other appliances	26%	16.91	1.03	4.52 (3.33)	1.42
			Total	319.25	100

Note: The standard error of each mean is shown in brackets. This is the standard deviation of the sample divided by the square root of the sample size. Columns may not add to total value given due to rounding.

The average ownership, frequency of use and volume per use figures were also analysed for the dataset split into two subsets: flats and non-flats, because the final dataset consists of 40% flats and 60% of houses. The details are presented in Table 3.2 and Table 3.3.

Table 3.2 Average ownership, frequency and volume for flats

Device	Ownership	Frequency of use (uses/property/day)	Volume per use (litres/use)	Household consumption (litres/property/day)	% of total consumption
Toilet	100%	9.06	5.67	51.4	18.05
Internal tap	100%	38.81	1.81	70.2	24.68
Bath	57%	1.10	65.71	41.2	14.48
Washing machine	96%	0.55	50.92	26.9	9.45
Shower	93%	1.34	34.37	42.8	15.05
External tap	11%	0.76	176.14	14.7	5.17
Dishwasher	18%	0.43	13.67	1.1	0.37
Other appliances	39%	20.09	4.63	36.3	12.75
			Total	284.59	100

Note: Columns may not add to total value given due to rounding.

Table 3.3 Average ownership, frequency and volume for houses

Device	Ownership	Frequency of use (uses/property/day)	Volume per use (litres/use)	Household consumption (litres/property/day)	% of total consumption
Toilet	100%	11.67	6.62	77.3	19.76
Internal tap	100%	57.93	1.69	97.9	25.04
Bath	62%	1.22	80.86	61.2	15.65
Washing machine	100%	0.96	50.71	48.7	12.45
Shower	98%	2.20	39.96	86.2	22.04
External tap	12%	0.43	118.98	6.1	1.57
Dishwasher	60%	0.78	16.18	7.6	1.94
Other appliances	17%	11.92	2.99	6.1	1.55
			Total	390.93	100

Note: Columns may not add to total value given due to rounding.

It can be seen from the two tables that an average household consumption for flats is about 100 litres lower than for houses. This figure, however, needs to be taken with caution owing to the unknown occupancy, which is expected to be lower for flats.

4 Comparison with older, unmeasured properties

In 2005, WRc completed a project, CP187 (Increasing the value of domestic water use data for demand management), which analysed a sample of unmeasured properties (i.e. built before 1989 when the 1989 Water Act marked the start of widespread domestic metering). During the study a database of microcomponent data was constructed containing measured information on domestic water consumption derived from the use of the Identiflow® system at 622 visits to 447 properties across England in the period 2000-2002. Both peak and non-peak periods were examined and the following mix of house types was studied:

- Detached houses - 32%
- Semi-detached houses - 35%
- Terraced houses - 23%
- Bungalows - 7%
- Flats - 3%.

The table of ownership, frequency of use and volume per use from WRc's report CP187 (Increasing the value of domestic water use data for demand management) is given for comparison purposes in Table 4.1.

Table 4.1 Average ownership, frequency and volume for the older unmeasured properties dataset

Device	Ownership	Frequency of use (uses/property/ day)	Volume per use (litres/use)	Household consumption[2] (litres/property/ day)	% of total consumption
Toilet	100%	11.52	9.4	108.29 (2.52)	29.2
Internal tap	100%	37.9	2.3	87.17 (2.08)	23.5
Bath	88.10%	0.95	73.3	61.35 (2.95)	16.5
Washing machine	93.70%	0.81	61	46.30 (1.63)	12.5
Shower	85.20%	1.46	25.7	31.97 (1.61)	8.6
External tap	65.20%	0.89	46.7	27.10 (5.30)	7.3
Dishwasher	37.00%	0.71	21.3	5.60 (0.69)	1.5
Unknown	19.20%	0.53	20.4	2.08 (1.90)	0.6
Water softener[1]	1.60%	0.39	182.5	1.14 (2.88)	0.3

Note 1 Eight households in the sample used a water softener. One property was visited twice in the sample.
Note 2: The standard error of each mean is shown in brackets. This is the standard deviation of the sample divided by the square root of the sample size.

4.1 What is driving consumption in new and older properties?

Pie charts indicating the proportion of total water consumption by each microcomponent in the datasets for older properties and new properties are given in Figure 4.1 and Figure 4.2 respectively.

Figure 4.1 Microcomponents of domestic consumption pie chart for older, unmeasured properties

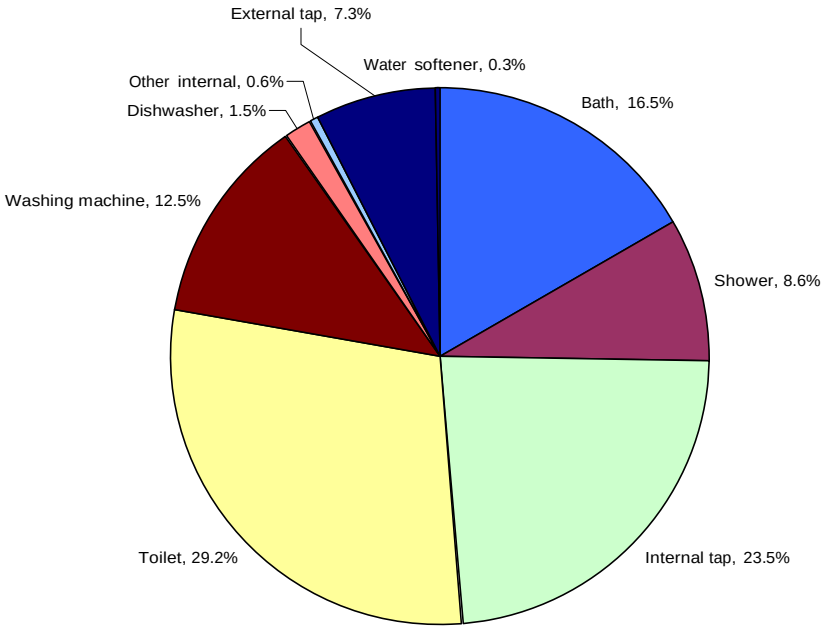
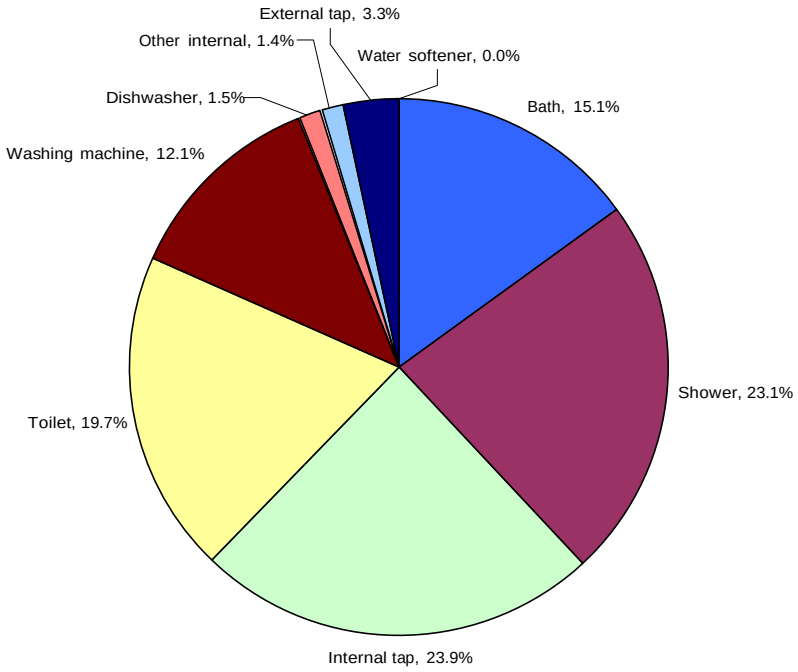


Figure 4.2 Microcomponents of domestic consumption pie chart for new properties



It is clearly evident from Figure 4.1 and Figure 4.2 that the two elements with the largest differences between the two datasets are toilets and showers.

Overall there is a difference of 50 litres per household per day between the older, unmeasured properties dataset (average PHC[3] 370 litres) and the new properties dataset (average PHC 320 litres). The average occupancy of the properties in the new dataset is unknown, therefore it is possible that this difference could be due to differing occupancy levels alone. However, some of the microcomponent detail suggests that this might not be the case. It is interesting to explore which microcomponents are driving this difference between the two datasets.

Evidently toilets are responsible for much lower consumption in new properties than in older, unmeasured properties. In terms of proportions of domestic use this is a 9.5% difference, though in terms of absolute volume used there is a difference of 45.5 litres. Alone, this could account for the drop in PHC between the two datasets. However, a difference in showering can also be seen between Figure 4.1 and Figure 4.2 which would need to be accounted for.

The proportion of PHC accounted for by showering is 14.5% higher in the new properties dataset than in the older, unmeasured properties dataset. This equates to an absolute volume of 41.6 litres - almost the same as the savings achieved through the more efficient toilets.

[3] PHC is per household consumption

The proportion of PHC, and absolute volume, used for baths is lower in the new properties dataset. Although there is only about 2% difference in proportion of PHC, this is equivalent to an absolute volume of 13 litres, which most likely displaces some of the increase in volume used for showering.

The remaining savings shown in new properties over older, unmeasured properties are from decreases in the absolute volumes used for washing machines, dishwashers, internal taps and external taps. These savings are driven by a drop in the volume per use for these appliances, except for external taps where there has been a drop in the frequency of use and ownership of the appliance.

Interestingly, although ownership of dishwashers is higher in the new properties dataset and frequency of use is the same, the overall proportion of PHC accounted for by dishwashers has fallen, reflecting the advancements in technology that have taken place over the last five to ten years. A similar, but slightly less dramatic change has been seen in the consumption by washing machines. Again, ownership and frequency of use are both higher in the new properties dataset, but the overall proportion of PHC accounted for by washing machines has remained constant - reflecting a drop in volume per use.

Behavioural changes in how taps are used are also evident between the two datasets, with the volume per use in the new properties dataset being lower than the average volume per use in the older, unmeasured properties dataset, but frequency of use being higher. Overall, the lower volume of use and higher frequency appear to cancel each other out, as the overall proportion of PHC accounted for by tap use is almost the same in both datasets.

5 Toilet specific information

Certain toilet specific information was sought from the new properties database.

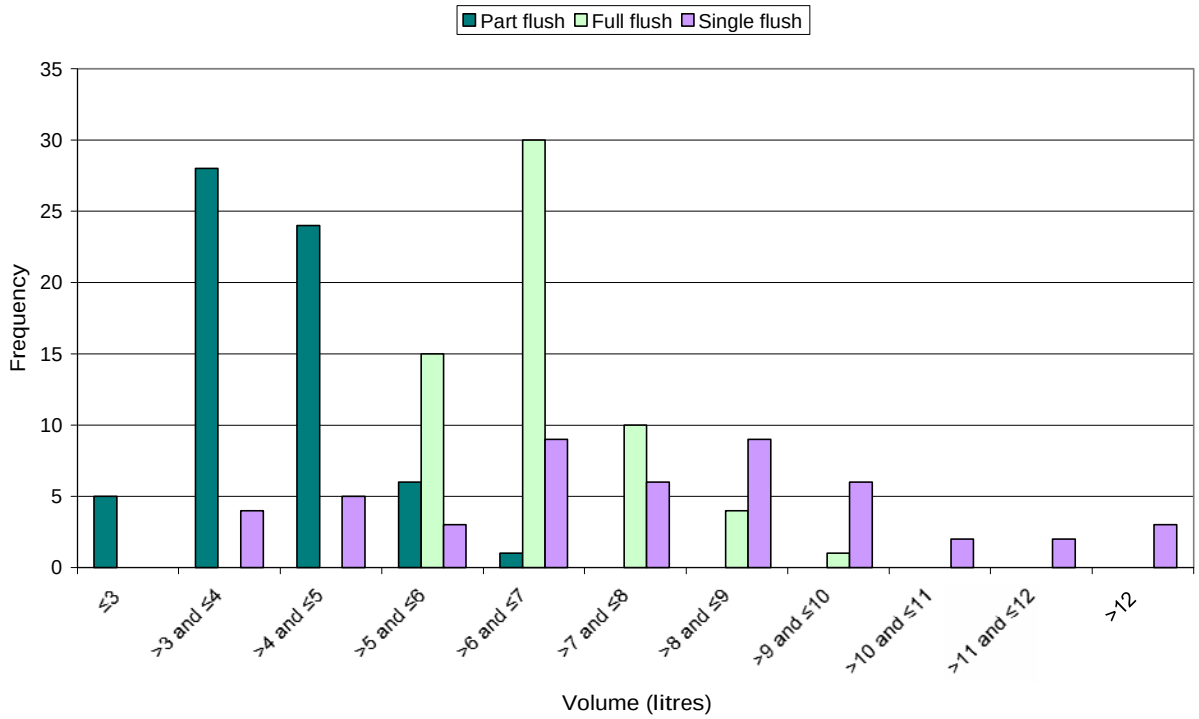
5.1 Flush volumes

From 1 January 2001, the Water Supply (Water Fittings) Regulations 1999[4] have required that no flushing device installed for use with a WC pan shall give a single flush exceeding 6 litres. This means, therefore, that all the houses within the sample that underwent Identiflow® logging for this project should conform to these regulations, as all were built during or after 2001.

Theoretically, therefore, the maximum flush volume recorded in these homes should be 6 litres, with part flushes of a smaller volume (maximum 4 litres) also being evident in those where dual flush WCs have been installed. Figure 5.1 shows a histogram of flush volumes for single flush WCs, the full flush of dual flush WCs and the part flush of dual flush WCs as identified by the analyst.

[4] The Water Supply (Water Fittings) Regulations 1999 available at http://www.opsi.gov.uk/si/si1999/19991148.htm

Figure 5.1 Histogram of toilet flush volumes



A total of 83 toilets, out of the 174 toilets identified[5], had an average flush volume of greater than 6 litres. Of these 83, 59 had an average flush volume greater than 6.5 litres and 44 had an average volume greater than 7 litres. Figure 5.1 indicates clearly that those WCs with the largest average flush volume have been classified by the analyst as single-flush WCs (ie at those properties there was no clear part flush present).

5.2 Dual flush ratio

Data have been extracted on the ratio of uses of full to part flush for each property that underwent Identiflow® logging. Note, it is the analysts' decision whether a particular 'toilet' classification represented a full or part flush based on volume. Some properties will have multiple 'full flush' toilets and multiple 'part flush' toilets. In these cases, the average flush volume has been stated and the total number of flushes classified as full or part. Double flush events have been excluded from this analysis (ie are not included as either two part flushes or one full flush event). Over the analysis period, a total of three properties had double flush events identified.

Dual-flush toilets were identified at 46 of the 70 properties within the dataset. The overall flush ratio of full to part flushes was calculated at 23 to 20, or 1.15, with an effective flush volume[6] of 5.4 litres. The most efficient dual-flush ratio recorded at any property was approximately 2 to 13 full to part flush, with an effective flush volume of 4.8 litres. The least efficient dual-flush ratio recorded at any property was approximately 17 to 1, with an effective flush volume of 5.39 litres.

[5] Single-flush toilets, the full flush of a dual-flush toilet and the part flush of a dual-flush toilet are all classified as 'separate' toilets.
[6] The effective flush volume is the weighted average of the full-flush volume and part-flush volume based on the effective flush ratio of full to part flushes.

5.3 Leaking toilets

The analysis of Identiflow® data did not immediately indicate that there was a definite problem with leaking toilets at any properties. Several properties showed evidence of drips, but they could not be associated with any particular appliance.

Unusual appliance activity was identified at two flats, where fills of approximately 1 litre were occurring periodically every 10 to 15 minutes. After a customer survey, an accompanying letter and a further letter advising of the abnormal flow, the resident revealed that they had experienced problems with their cistern leaking, and the flush button eventually jammed causing continuous flow. This required emergency plumbing attention. The occupier of the second property received similar notification and also reported that they had found the toilet cistern leaking into the pan and had arranged for repair. The flats were in the same proximity but in different developments.

6 Conclusions

The average daily water consumption per household in new properties is lower than for older, unmeasured properties. Some of this change could be accounted for by changes in average occupancy, which is unknown for the new properties dataset.

The average daily consumption of flats in the new properties dataset is approximately 100 litres lower than the average daily consumption of houses. As the new properties dataset contains a higher proportion of flats than the older, unmeasured properties dataset, this could account for the lower average PHC in the new properties dataset.

At a microcomponent level, toilets account for a much lower proportion of PHC in new properties than in older properties, reflecting the success of limiting the maximum flush of newly installed WCs to 6 litres within the Water Supply (Water Fittings) Regulations. The dual-flush ratio, of 1.15 for toilets is significantly different to the widely used assumption of one full to three part flushes, possibly indicating that better education is required on how and when to use different flush volumes.

The proportion of average daily PHC accounted for by showers is significantly higher in the new properties dataset than in the older, unmeasured dataset. This is only partially offset by a reduction in the proportion of PHC accounted for by baths.

Changes from version

This is the first version of this briefing note

Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email info@mtprog.com quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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