

# **BN DW WC: Actions to improve water closet design and efficiency - Briefing Note relating to Policy scenario objectives in Policy Brief**

**Version 3.0**

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 covers the information, rationale, assumptions and methods used within the demand forecasting model for WC water consumption reported in the Policy Brief for WCs. Market Transformation Programme (MTP) targets relating to the outputs of the model are then discussed and action plans to reach these targets are formulated.

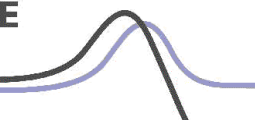
## **2 Demand forecasting model**

Predictions for domestic water demand are based upon the output of a model consisting of a spreadsheet and embedded macros. The model generates estimates of annual water demand for domestic bath, shower and WC appliances until 2020. Stock information is used to derive the average water consumption per appliance usage.

The main variables for each appliance are:

- Ownership (stock) - the number of appliances established in UK houses.
- Sales volume - the number of appliances sold annually.
- Replacement factor - the proportion of sales that accounts for the replacement of existing appliances and therefore not adding to ownership. This is based on product life expectancy.
- Volume per use - the volume of mains water consumed at each use.
- Frequency of use - expressed as uses per appliance per year.

The equation for annual water demand is as follows:



$$\text{Annual water demand} = \text{ownership} \times \text{frequency of use}_{app} \times \text{volume per use}$$

Estimates for annual water demand for the first year of the modelled scenario are based upon current data for microcomponents of domestic water usage<sup>1</sup>.

## 3 Product types

The main factor affecting the amount of water used per household for WCs is flush volume. Key product types are included, as shown in Table 3.1.

**Table 3.1 Product types included in MTP modelling**

WC type by nominal flush volume	Effective flush volume* (litres)
9+ litres single flush	9
9+ litres single flush with hippo	7
7.5 litres	7.5
7.5 litres with hippo	5.5
6 litres	6
6/4 litres dual-flush	5
4.5 litres	4.5
<4.5 litres	3.3

\*Assumes a full flush to reduced flush ratio of 1:1.

## 4 Reference scenario

### 4.1 Key factors influencing the market

An increase in new-build homes has resulted in growth for the WC market. The UK Building Regulations (Part M) state that the accessible storey in these new homes must have a bathroom. Dual-flush 6/4-litre WCs are emerging as the industry standard.

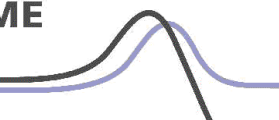
### 4.2 Key trends influencing the established base, usage and consumption

The Building Regulations have had a major influence on the WC market as most new-build homes now have at least two WCs installed.

The Water Supply (Water Fittings) Regulations 1999<sup>2</sup>, Regulator's Specification for the Performance of WC Suites Installed after 1 January 2001 set a mandatory maximum flush of 6 litres. It is possible that WCs may be being sold that do not comply with this specification. Dual-flush systems are now permissible in dwellings, and there has been a rapid increase in the use of this type of WC.

<sup>1</sup> The installed base and types of WC sold in the UK market, BSRIA, 2002.

<sup>2</sup> [www.opsi.gov.uk/si/si1999/19991148.htm](http://www.opsi.gov.uk/si/si1999/19991148.htm)



## 4.3 Establishment

The assumption is made that UK dwellings have a 100% penetration level for WCs. Further estimates are made that almost 70% of new homes are constructed with two or more WCs installed.

The number of new WCs sold each year is expected to rise from about 2.6 million in 2008, to over 3 million by 2020. The total stock of all WCs in 2007 is estimated to be over 36 million installed, responsible for consumption of over 680,000 million litres of water over the year.

The lifespan of WCs is estimated at 15 years, in line with industry estimates of the bathroom replacement rate.

The mix of products (% of sales) in any given year to 2020 is given in Table 4.1 for WCs.

**Table 4.1 Product mix of WCs under the Reference scenario (% of sales)**

	Reference					
	9 litre	7.5 litre	6 litre	6/4 litre	4.5 litre	<4.5 litre
2008	0	0	8	91	1	0
2009	0	0	8	90	2	0
2010	0	0	8	88	4	0
2011	0	0	8	87	5	0
2012	0	0	8	86	5	1
2013	0	0	7	85	7	1
2014	0	0	6	85	8	1
2015	0	0	4	85	10	1
2016	0	0	4	82	13	2
2017	0	0	3	81	15	2
2018	0	0	0	84	15	2
2019	0	0	0	84	15	2
2020	0	0	0	84	14	3

## 4.4 Consumption

Water consumption per WC flush varies according to the cistern volume and mechanism of the WC.

Where a single-flush WC is used, the actual flush volume is assumed to be the nominal flush volume of the WC. For dual-flush toilets, an effective flush ratio of one full flush to one part flush has been assumed. Briefing Note BNWAT05<sup>3</sup> provides justification for this assumption.

## 4.5 Frequency of use

Frequency of use has been calculated using a consumer survey which asked questions relating to both the weekday and weekend use of WCs. An average frequency of 4.71 times per day per person was calculated. Age, gender and metering were all taken into consideration. An ageing population may affect the frequency of use of WCs, as a larger retired population will spend more time at

<sup>3</sup> <http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=360>

home. This is effectively built into the model as the frequency of use forecast is weighted using age and gender data.

Frequency of use per household per day is expected to drop from about 11 uses in 2007 to only 10.2 by 2020. This reflects the decreasing occupancy rates of houses expected.

## **5 Policy scenario (P1)**

The impacts of all policies<sup>4</sup> in the Policy Action Plan have been assessed with respect to the ownership, frequency of use and volume per use of WCs which flush with the following flush volumes: 9 litres, 7.5 litres, 6 litres, 6/4 litres, 4.5 litres and less than 4.5 litres.

### **5.1 General assumptions**

It is assumed that there are no additional changes in overall ownership levels of WCs over and above any trends already being seen under the Reference scenario. It is also assumed that there are no further changes to the volume per use of appliances in any given efficiency class, although it is possible that cistern displacement devices might be retrofitted to an existing high-volume cistern which affects the volume used.

### **5.2 Volume per use**

Changes in the volume per use of WCs are assumed to be the result of policies relating to the fitting and distribution of retrofit products. Intuitively, these products will impact on the flush volumes of the more elderly stock first (>6 litres), where savings can be made immediately and effectively by installing cistern displacement devices, flush arrestors and so forth. Much less significant savings going forward are assumed for WCs flushing at a nominal 6 litres or less. Any retrofitting activities carried out on 6-litre WCs are assumed to generate negligible savings owing to multiple flushing. It is assumed that retrofitting is discouraged for WCs with effective flush volumes less than or equal to 4.5 litres. By 2020 under the P1 scenario it is assumed that over 520,000 devices will still be installed in high-volume cisterns, each saving an average 2 litres of water each time the WC is flushed.

In addition to these devices, further savings are expected from dual-flush WCs through better education and labelling of these WCs to improve the full to part flush ratio. By 2015 it is assumed that a ratio of one full flush to three part flushes is achieved.

### **5.3 Frequency of use**

No change to the frequency of use of WCs over and above the Reference scenario has been assumed.

### **5.4 Sales mix of new products**

The sales mix of new WCs is given in Table 5.1.

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<sup>4</sup> Note, it is assumed that any policy implemented by Government to cover England and Wales will be similarly implemented by the appropriate bodies in Scotland and Northern Ireland. MTP modelling covers UK water consumption.

**Table 5.1 Sales mix of new WCs sold under the P1 scenario (% of sales)**

	P1					
	9 litre	7.5 litre	6 litre	6/4 litre	4.5 litre	<4.5 litre
2008	0	0	8	91	1	0
2009	0	0	4	76	20	0
2010	0	0	4	64	32	0
2011	0	0	4	54	40	2
2012	0	0	4	38	55	4
2013	0	0	0	20	68	12
2014	0	0	0	0	78	22
2015	0	0	0	0	78	22
2016	0	0	0	0	77	23
2017	0	0	0	0	76	24
2018	0	0	0	0	75	25
2019	0	0	0	0	74	26
2020	0	0	0	0	73	27

Initially, 6/4-litre dual-flush WCs retain the majority of the market share as they remain popular among refurbishment and retrofit projects, and also in some new builds. The 4.5-litre WCs (either single-flush or 6/3-litre dual-flush) increase in popularity as they become attractive to developers building to the revised Building Regulations, and increasingly to the higher levels of the Code for Sustainable Homes. The very low flush WCs (<4.5 litres) also increase in popularity for the same reasons. The 6-litre WCs lose market share and are completely phased out by 2018 as it is thought that installation will be precluded under the revised Water Supply (Water Fittings) Regulations by this date. The 6/4-litre dual-flush WCs also lose market share over time as retailers shift towards stocking a higher proportion of efficient WCs demanded by the new-build sector.

## 6 Earliest Best Practice (EBP) scenario

Relative to the Policy scenario impacts, retrofitting policies are more proactively and aggressively pursued and result in a ten-fold improvement in total water savings from existing 9-litre and 7.5-litre stock through retrofitting. Sales of 4.5-litre and less than 4.5-litre flush toilets take off earlier than under the Policy scenario, as soon as reliable products come to market, to the detriment of sales of 6/4-litre dual-flush toilets throughout the forecast period.

The sales mix of new WCs installed under the EBP scenario is given in Table 6.1.

**Table 6.1 Sales mix of new WCs sold under the EBP scenario (% of sales)**

	EBP					
	9 litre	7.5 litre	6 litre	6/4 litre	4.5 litre	<4.5 litre
2008	0	0	0	99	1	0
2009	0	0	0	45	50	5
2010	0	0	0	10	70	20
2011	0	0	0	5	75	20
2012	0	0	0	5	60	35
2013	0	0	0	5	50	45
2014	0	0	0	5	50	45
2015	0	0	0	5	50	45
2016	0	0	0	5	50	45
2017	0	0	0	5	45	50
2018	0	0	0	5	45	50
2019	0	0	0	5	45	50
2020	0	0	0	0	50	50

## 7 Market transformation targets

### 7.1 Market transformation target 1

Increase the sale of water-efficient WCs to achieve significant market penetration.

Policies: Water Product Information Scheme; common test methodologies; minimum standards; incentives; emerging technologies.

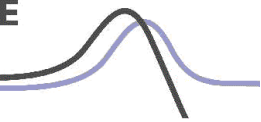
#### 7.1.1 Action Plan

1. Agree a test method for assessing the effective flush volume of complete WC suites (dual and single flush), retrofit dual-flush mechanisms and retrofit interruptible flush mechanisms as proposed in Briefing Note BNWAT05<sup>5</sup> (MTP/Defra, manufacturers).
2. Define water-efficient WC performance in terms of effective flush volume (MTP/Defra).
3. Develop a Water Product Information Scheme to provide better point-of-sale information, including performance targets (MTP/Defra).
4. Hold discussions with retailers to achieve a voluntary agreement to phase out sales of high flush volume WCs and to promote water-efficient products (MTP/Defra).
5. Propose and implement, when required, future revisions to the Water Supply (Water Fittings) Regulations 1999<sup>6</sup>, reducing maximum flush volumes (eg dual-flush 6/3 litres specification) (MTP, WRAC).
6. Propose and agree minimum standards for inclusion in specifications made by social landlords during tendering for social housing (MTP, DCLG, local authorities).

<sup>5</sup> <http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=360>

<sup>6</sup> [www.opsi.gov.uk/si/si1999/19991148.htm](http://www.opsi.gov.uk/si/si1999/19991148.htm)



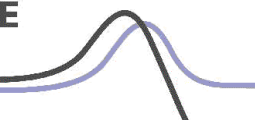


7. Evaluate the new ultra-low flush WC technology, including any consequences for drain design criteria and the operation of the sewer system (MTP).
8. Propose and agree guidance for developers and specifiers, indicating opportunities presented by water-efficient WCs for achieving levels set out in the Code for Sustainable Homes (MTP, NHBC, DCLG).
9. Encourage stakeholders to promote new WC technologies to consumers and specifiers (MTP, retailers, suppliers).
10. Explore options for developing economic incentives for water-efficient WCs (Defra, Government departments).

## 7.1.2 Related issues

1. Can low-volume (eg 4.5 litres) cisterns be retrofitted on existing WC pans and will such a flush be effective in an older-type toilet bowl?
2. Can suitable drainage system designs for low-volume flush WCs be developed, possibly using siphonic flushing systems to improve the hydraulic flow through the horizontal pipes? This is currently being addressed by a project in the UK, led by HR Wallingford. However, low-volume flush WCs have actually been in use in Australia for many years. The experience there was that the reduction in flush volume was not a problem in 100 mm diameter pipes, but some problems have occurred with 75 mm pipes. Tests had been carried out in two towns with populations of 100 with data recorded using counters and TV surveys. The chairman of the Water Regulations Advisory Committee (WRAC) stated that in the UK, although WRAC recommends the flush volumes for WCs, it is the Building Regulations Advisory Committee (BRAC) that makes the recommendations for the diameters of the drainage pipes. BRAC had recently decided not to require all drains to be 150 mm, but would keep the minimum as 100 mm for ten houses or fewer.
3. How can water companies and environmental agencies be engaged in the promotion of low-volume flush (eg <4.5 litres) WCs to the public?
4. Can low-volume flush WCs be made easily distinguishable at the sales outlets (eg through labelling or point-of-sale information)?
5. The Water Supply (Water Fittings) Regulations 1999<sup>7</sup> limit on installed flush volume needs to be implemented at the point of sale.
6. The development of product information for WCs to inform consumers could help specifiers and procurers. However, the creation of a labelling system or scheme would require clear criteria and test methods to be specified, along with the intended location of any labels.
7. If the product information were to be displayed at the point of sale, similar arrangements to those of the current energy efficiency labelling scheme would be

<sup>7</sup> [www.opsi.gov.uk/si/si1999/19991148.htm](http://www.opsi.gov.uk/si/si1999/19991148.htm)



required. In the energy scheme, the labels appear on the products in showrooms, on data sheets at Internet shops, and on the outside of the packaging.

8. Better information at the point of sale can help consumers to make informed choices. However, such schemes are more likely to encourage product development by manufacturers, as evidenced by the current UK Electrical Appliance Labelling Scheme. The scheme would need to be developed in collaboration with manufacturers to ensure that it maximises incentives for product development.
9. Even if any product information and promotion schemes are fully implemented by their target dates, significant water savings may not be apparent immediately owing to the number of replacement sales.

## 7.2 Market transformation target 2

Replace existing high flush volume WCs with water-efficient WCs.

Policies: minimum standards; incentives; best practice - replacing/retrofitting existing high-volume stock; raising awareness.

### 7.2.1 Action Plan

1. Estimate the number of WCs in the UK with flush volumes of 12 litres or greater (MTP, BMA, Water UK, Defra).
2. Consider the need for data on geographical and demographic distributions of high flush volume WCs for targeting incentive schemes (Defra/MTP).
3. Explore options for developing economic incentives for water-efficient WCs (Defra, Government departments).
4. Evaluate the performance in use of dual-flush toilets and consider initiatives to improve understanding of their operation by the consumer (MTP).
5. Identify circumstances in which ultra low-volume flush WCs are not appropriate for existing drains and develop guidance (MTP).

### 7.2.2 Related issues

1. The use of a retrofit programme could enable the WC stock to be updated, but it would be costly. Such schemes can also be beneficial to local plumbers, the UK sanitaryware industry and other related industries. The cost benefits to the local and national employment situation may need to be taken into account, so the overall cost to the nation may not be negative.
2. The investment in training skilled staff to carry out the manufacture and installation of appliances may need to be increased to meet demand.
3. When given a free choice, will consumers buy UK-manufactured sanitaryware or sanitaryware from other countries?
4. The Environment Agency has commented that the replacement programme would only be of benefit where a supply/demand issue exists such that an



accelerated rate of installation might re-balance the situation. The savings are not in addition to those from the application of the regulations, rather it is an issue of timing (ie the same savings may accrue from applying the regulations as implementing an installation programme, but the rate of change may be accelerated).

## 7.3 Market transformation target 3

Five per cent of WCs sold to be ultra-low flush (<3 litres) technology or waterless by 2020.

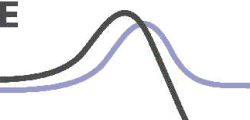
Policies: emerging technologies.

### 7.3.1 Action Plan

1. Evaluate new ultra-low flush technology, including any consequences for drain design criteria and the operation of the sewer system.
2. Examine the available research on consumer acceptance of waterless toilets in developed countries (MTP). Note: some research has been carried out in Finland where this technology is widespread.
3. Review the potential for the use of waterless WCs in houses (MTP working with other parties).

### 7.3.2 Related issues

1. How are waterless toilets perceived? Public perceptions may need to be addressed. The transition from a WC to a waterless toilet should not be seen as a retrograde step towards the old-fashioned earth closet. Waterless toilets may currently not be perceived as acceptable, or physically suitable, for all applications and for all ages of user.
2. What are the health risks associated with handling the output of a waterless toilet?
3. What are the additional spatial requirements for waterless toilets? Some require storage of the contents to enable composting to take place and most are larger in volume than conventional WC suites.
4. What are the system's regular maintenance requirements? Composting toilets require the emptying of composted material; will this be practicable in a typical household?
5. Is the payback period of the investment in purchasing and installing a waterless system reasonable?
6. What are the implications for ethnic and religious communities that teach that the use of water is synonymous with hygiene? Could waterless toilets become a source of racial and religious prejudice?



## 7.4 Market transformation target 4

Reduce the mean water consumption of high flush volume WC cisterns by 5% through the use of cistern water displacement devices and retrofit dual-flush/interruptible siphon fittings by 2008.

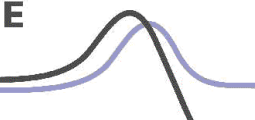
Policies: incentives; best practice - replacing/retrofitting existing high-volume stock; raising awareness.

### 7.4.1 Action Plan

1. Determine the applicability of cistern water displacement devices and retrofit dual-flush/interruptible siphon fittings in the UK WC stock (Water UK, Ofwat, MTP, Waterwise).
2. Evaluate the cost and efficacy of displacement devices, retrofit dual-flush/interruptible siphon fittings and other retrofit devices (MTP).
3. Stakeholders to agree to an increase in promotional initiatives delivered by water companies, including informing the public on the types of device available, and the potential benefits and problems (WC manufacturers, Ofwat, water companies).
4. Produce clear guidelines for selection and installation to ensure that cistern displacement devices and retrofit dual-flush/interruptible siphon fittings are installed only in appropriate situations (Water UK, BMA, MTP, IPHE, WRAS).
5. Increase coordination (between water companies) of research and monitoring into the effectiveness of cistern displacements and other retrofit activities (MTP, water companies, Ofwat).
6. Produce a best practice register to underpin further improvements in retrofitting and distribution methods (Ofwat, water companies, MTP).
7. Explore options for developing economic incentives for retrofitting devices (Defra, Government departments).
8. Explore incentive mechanisms or funding streams to support water company large-scale retrofitting/distribution programmes (Ofwat).

### 7.4.2 Related issues

1. Who will ensure that cistern water displacement devices and interruptible siphon fittings are installed correctly and in appropriate situations? Not all cisterns will be able to accommodate displacement devices and some will be in situations where the full volume of the flush is required for the transport of solids through the drainage system. The devices may make dual-flush WCs particularly ineffective with the short flush.
2. Currently, the water companies and the regulator have different opinions about the use of displacement devices. Although the regulator obliges water companies to promote cistern water displacement devices, some water companies have experienced problems with installations that have led to increased consumption.



If the public perceive that the advice from water companies leads to malfunctions with their WCs, the credibility of future advice from the water companies could be undermined. The blanket issuing of displacement devices by water companies can give the wrong message to consumers and developers.

3. Financial savings are achieved only in households with a metered water supply.
4. The Environment Agency is of the opinion that the use of cistern water displacement devices, although relatively cheap, is not a satisfactory alternative to cistern replacement as there are questions of reliability in the longer term and suitability in a range of circumstances. Assuming a 1-litre saving per flush, it would require a considerable proportion of WCs to operate effectively with such a device in order to deliver a 5% saving on overall WC consumption. Another issue is the need to understand the WC stock in order to improve the assessment of appropriate situations where cistern water displacement devices could be installed.
5. Leaking valves could mean that water consumption is continuous and above the nominal flush volume. The potential of valves to leak and the extent of the potential problem need to be established and appropriate criteria and/or installation guidance developed.

## Related MTP information

Briefing Note BNWAT05: Water closets - water efficiency performance tests.

## Changes from version 2.3

Updated in line with 2007-2008 modelling

## 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](mailto:info@mtprog.com) quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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