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CONSORTIUM OF EIGHT WATER SUPPLY COMPANIES

FINAL REPORT ON LEAKY TOILETS PROJECT

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Executive Summary

This is the final report which describes the work undertaken throughout the duration of the project and provides the results and observations from the leaking toilet valves project. The project's objective was gather evidence on the scale of the problem to determine to possible causes of leaking valves and therefore solutions.

Quantitative data on leak volumes was collected from two sources; first, from high consumption queries and second, from Water Regulations visits. Qualitative, anecdotal evidence was also collated. The data was collated and then analysed in order to investigate the quantity of the potential problem relating to leaking toilets and from this to derive a figure for the quantity of water wasted as a result of leaking toilets, which can be used for water company water efficiency targets.

Leakage from WCs represents a significant volume of water wastage:
400 litres/toilet/day should be used to estimate the losses that should be claimed against the water efficiency target when a leaking toilet valve is detected and repaired.

This figure represents the mean of the data set and is justified as representing a 'Category B' leak, which is the leak which is most likely to be identified and fixed.

The scale of the problem derived from the questionnaire data shows that **10% of toilets were found to be leaking** and that both types of flush mechanism are at risk of failing.

Using this figure, an active programme to educate consumers, detect and repair all leaking WCs could potentially reduce pcc from 150 to 133 l/person/day, which is a significant step towards the Government's aspirational target of 130 l/person/day.

The project could identify no empirical evidence to identify the specific causes of leaking WCs. A diverse range of problems and attributed caused have been documented, which makes it difficult to ascertain a main cause and solution to this issue.

Recommendations include;

- Further research is needed to determine the most likely causes for the water wastage occurring through leaking toilets.
- Collect a larger sample of data to confirm and refine the scale of the issue, to better understand causes and to identify if any particular groups of households are more likely to have leaking WCs.
- Research the most efficient methods of detecting and locating leaking WCs for example, through educating customers or analysing bill data.

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1 Introduction

This is the final report which describes the work undertaken throughout the duration of the project and provides the results and observations from the leaking toilet valves project. The project's objective was to provide clarification of the available evidence on the scale of water leakage relating to toilet valves and to determine to possible causes of the problem and therefore solutions.

Importantly, the project has gathered a range of information and data to be able to determine a quantification of the volume of water wasted. The production of a credible figure will then be used by water companies for the water efficiency targets. This will then become an industry accepted flow value for the water lost from leaky WC valves.

A project Interim Report submitted in April 2011 provided an initial conclusion that the average leakage for the whole data set (used up to that time) when combined was 442.3 l/day per property and this is the proposed figure to be used for the water efficiency targets For the Interim Report the data collected came from two sources; first, from visits made as a result of high consumption queries. These leaks were identified because customers had flagged higher than expected bills (and therefore water consumption) to the company; and second from the data derived from visits by the Water Regulations teams of each company.

This Final Report has taken these preliminary conclusions forward with new data, new perspectives and further analysis.

1.1 Project description

The issue of water leakage and thus water wastage by a WC is technically a customer "problem" rather than a water supply company problem. The water wastage occurring due to this leakage is recorded as consumption and hence counts towards the companies' per capita consumption (pcc) figures. This type of leak is persistent and often goes undetected. However a better understanding of the extent of the problems and a course to remediate could play an important role in improving water efficiency and conservation, thereby helping to lower pcc levels. There is also the risk that for un-metered properties, this form of leakage may not be included in the companies' domestic consumption monitors and therefore un-metered pcc could be underestimated.

The definition of a "leaky toilet" that we are using is twofold:

- first, it is the leak that allows water to pass through the inlet valve to the cistern, thereby creating an overflow of water to an external overflow or into the toilet pan;
- and second, it is the leak through the valve at the base of the cistern (where water passes during a flush) that allows water to overflow into the pan or an external overflow.

The reason why the leaks from toilets can go undetected for extended periods of time is that the wasted water often leaks into the pan of the WC and is difficult for the customer to detect.

The possible solutions lie in quantifying the scale of the problem and identifying the causes. With this evidence the water companies would be better placed to lobby Defra and CLG to encourage them to do more to help provide resources to gather the detailed new evidence and then help in implementing a solution (and this may require changes to Water Regulations or Standards). Finally, tackling this problem may be one of the solutions which could make a major contribution to the reduction of pcc towards the target of 130 l/head/day for England and Wales.

The main outputs of this report are;

- To derive a number for the water efficiency targets – this will be the average water saving per leaky WC that can be used to report water savings.
- To provide an assessment of the scale of the problem and discuss the likely causes and solutions.

2 Background

Toilet use is responsible for about 30% of total water use in a household. There are approximately 45 million[1] toilets in UK homes which use an estimated 2 billion litres of fresh water every day. Of these an estimated 7 million are old style single flush toilets which use up to 13 litres of water per flush.

However, a significant change to Water Regulations in 1999 regarding the working and performance of WC suites resulted in the opening up of the UK market to flushing devices that were designed to reduce flush volumes and the reintroduction of dual flush cistern types. Approximately 5 million toilets in the UK are of the low-flush model which when functioning according to their design intention as dual flush, are water-efficient toilets using only six litres for a full flush and four litres with a reduced flush.

Concern however has been expressed about the potential for the valve operated toilets to leak, and consequently the water savings achieved by the installation of a new toilet may not always be realised. In addition in order to properly achieve the intended water savings education and behavioural knowledge is also important (many people do not know what button to press or the buttons are so close that both get pushed together).

Toilets represent a large area of domestic water use with the potential to save significant volumes of water. The issue of 'efficient' toilets not operating to their design standard (for a variety of reasons and resulting in wastage), requires the attention of those within the water supply sector, otherwise the Government's aspirational target of 130litres/person/day per capita consumption will take longer to be achieved and will remain a problematic policy goal.

2.1 Regulatory requirements for WC's

The provision of flushing cisterns with water closets (WCs) is a Regulatory requirement in the UK defined in the current Water Regulations and former Water Byelaws.

[1] Source: Waterwise website: http://www.waterwise.org.uk/pages/indoors.html

In relation to WC flushing the former Byelaws and new Regulations differ in several respects, most significantly in the types devices permitted and the provision of warning/overflow pipes.

The Byelaw 74 which outlined the requirement for water closet pans states that every WC pan will be;

a) Supplied with water from a flushing cistern or trough of the valveless type which incorporates siphonic apparatus; and
b) So be made and installed that after normal use its contents can be cleared effectively by either –
    i. A single flush of water, or
    ii. Where the cistern or trough is designed to give flushes of different volumes, the larger or largest of those flushes.
    iii. Supplied with water from a flushing cistern or trough of the valveless type which incorporates siphonic apparatus

Byelaw 80 prescribed that every flushing cistern or trough installed in any premises supplying a water closet had to be fitted with a warning pipe (or overflow). The latter being defined as an overflow pipe so fixed so that its outlet, whether inside or outside the building, is in a conspicuous position where the discharge of water can readily be seen. In practice therefore, warning pipes were fitted to discharge from the outside of the building and consequently visible when discharging thus identifying a problem.

Both Byelaws were supervised by the water supply companies but on 1st July 1999 each of the Water Suppliers in England and Wales ceased to enforce their own Water Bylaws and instead, began enforcing the new Regulations of the Secretaries of State of England and Wales superseded by the Water Regulations and so the requirements for water closets are now as follows;

Regulation 25.11 WC pans and WC flushing devices
WC pans and WC flushing cisterns have to conform to the requirements of a specification approved by the Regulator and the types of flushing devices for use with WC pans are;

a. Flushing cistern with siphonic outlet
b. Dual flushing cistern with siphonic outlet
c. Flushing cistern with 'drop' or 'flap' valve outlet

Regulation 25.11a
The Warning Pipe may be omitted if an internal overflow and approved inlet valve are fitted as an equally effective device.

The new Regulations in England Wales and Byelaws for Scotland extended the range of acceptable flushing apparatus beyond siphonic with the addition dual flushing siphonic outlets, drop valves and flap valves. The allowance of internal overflow pipes has meant that a problem will be less apparent and less easily visible than if externally discharging. Consequently leakage and other problems will not be immediately detected, as it might have been the case where an external inspection was possible.

The justifications made at the time by Defra for making these changes were as follows;

- The need to conserve water (the introduction of dual flush mechanisms for toilet flushes was considered to be an important step forward in reducing water use)
- Need to remove prescriptive regulation
- Integration with European Standards on single market access
- Establishing appropriate conformity testing

These regulations aimed to ensure that newly installed WC systems are compliant. However, although the regulations set standards for WCs it is not an offence in the UK to sell a non-compliant product only to install a non-compliant product. It is therefore possible for non-compliant products to be purchased and installed.

The obligation to maintain the cistern flushing device and other equipment falls to the property owner. Like all things mechanical flushing devices require to be maintained for their effective operation. Since the mechanisms are concealed from view within a cistern and therefore also under water maintenance activity is usually prompted by a failure of performance or function. A failure of a float or drop valve will normally manifest itself as a leak into the pan which depending on its severity may or may not be apparent to the eye. Thus a leaking valve may go undetected for an extended period. Leaks from a cistern either through faulty inlet leading to overfilling or a faulty flushing valve flushing valve can now be difficult to diagnose. In the former case the presence of an internal overflow can make the leak difficult to see, since the traditional warning pipe discharging to the exterior of a building eases such diagnosis since it has a nuisance value and is apparent not just to the building owner.

2.2 Water Regulations Advisory Scheme (WRAS)

The Water Suppliers in the UK collectively manage and fund the Water Regulations Advisory Scheme (WRAS) for the approval of products and component non-metallic materials against the Regulators Specifications[2]. This is **a voluntary scheme** that WC manufacturers can use to demonstrate third party certification of compliance with Regulators Specifications.

All new components should comply with the performance requirements for pipes and fittings set out in separate **Regulators Specifications.** These form the basis for testing to demonstrate the compliance of products with the Regulations/Bylaws.

When installing a product which will carry or receive water from the public mains water supply in the UK, it is a criminal offence if it does not comply with the Water Supply (Water Fittings) Regulations or Scottish Byelaws. These require that a water fitting should not cause waste, misuse, undue consumption or contamination of the water supply and must be 'of an appropriate quality and standard'. However, under the new regime, products are not required by law to be tested by WRAS or to be approved by WRAS, but they are required to conform to WRAS regulations. It is estimated by WRAS that about 30% of devices on the market have undergone a WRAS approval testing process and it might be that the increase in the number of products not formally approved by WRAS has introduced an element of risk that they may fail and hence leak.

[2] WRAS: http://www.wras.co.uk/Default.asp

In order to satisfy the requirements of the Water Supply (Water Fittings) Regulations 1999 (WS(WF)R) WRAS states that a physical endurance and leakage test[3] of 200,000 flushes is required. The flushing device is inspected frequently throughout the test for signs of leakage. A leak is defined as being a visible discharge of water amounting to more than 3 separate drops. If three leaks are detected from the same device, a further four devices must be tested. All four subsequent devices must satisfy all the requirements in order for the device to meet the requirements of the WS(WF)R. If the product meets the requirements it will then be forwarded to the Product Assessment Group (PAG). The PAG comprises representatives of the UK Water Industry and they that grant any subsequent approval.

WRAS test products in a laboratory setting concerning testing of flushing valves, endurance and chemical tests. WRAS do not have any information about how these products operate over long term use in the domestic setting. Also the test criteria though designed to measure endurance may not simulate all conditions experienced in use. As part of this project, overseas water product testing houses were contacted; KIWA (The Netherlands) and DVGW (Germany) and they mentioned that they do not test for leaking toilet valves and no data or information was available.

2.3 UK previous studies

In 2007, The Market Transformation Programme (MTP) identified the need to investigate anecdotal evidence that WC valve flushing mechanisms were leaking and therefore leading to large volumes of wasted water.

MTP contacted all the water companies across England for information about this issue. An article was then published in the Institute of Plumbing and Heating Engineers Magazine, asking for any plumbers with experience of the problem to contact MTP. MTP also asked WRAS for their opinion of the problem, and openly discussed the issue at the National Water Conservation Group meeting held in October 2007.

The research undertaken as part of this study did show that leakage from toilet valves appears to be a problem. However there was insufficient data available to provide any estimate of its scale in terms of the number of units affected or the volume of water being wasted.

In addition to this there was no reliable documented evidence on the cause(s) of the malfunction of these units although possible causes were suggested to include[4];

- Swarf or scale on the valve seat
- Poor seating of valve due to incorrect installation
- Poor seating of valve due to distortion of plastic cisterns during installation
- Jamming of valve mechanism due to lime scale deposits
- Partial opening of the valve due to incorrect adjustment or assembly of button mechanisms
- Cracked plastic components
- Accidental damage caused by curious plumbers and DIY enthusiasts

[3] WRAS test & acceptance criteria test code sheet number 121115, Issue 4 www.wras.co.uk
[4] Grant, N & Moodie, M (2002) *Focus – Water Closets* Elemental Solutions www.elementalsolutions.co.uk

Given the lack of reliable evidence a recommendation of the study was to conduct further research, in the form of a survey of installed WCs, to determine the proportion of WCs leaking, the mechanisms of these WCs, obvious causes and solutions of the problem and where possible to determine the flow rate of the wasted water. To date however, the MTP report has not been published (hence not referenced) and the further study was not undertaken.

2.4 USA flapper studies

The toilet flush valve seals in the USA (commonly termed flappers) use a flap of rubber instead of a drop valve. Drop valves are not common place in the USA, just as flap valves are not common in the UK. Toilet flappers have been a large problem with water wastage over the years. The cause of this is believed to be the lack of resistance of the rubber to chlorine and tank treatment chemicals, causing them to deteriorate and then leak. The problem is believed to be so significant, that some municipalities have created additional performance testing to try to deal with this issue. The California Urban Water Conservation Council has undertaken a study on flap valves[5], and even though the device is not the same as the drop valves found in the UK, some of the results and findings may be transferable or relevant.

The study was a direct result of growing concerns over the vulnerability of flappers to normal aging, to possible degradation caused by consumers' use of in-tank bowl cleaning tablets, and to tampering and replacement. It was the belief of many water conservation practitioners in California that these factors were causing seal failure, leakage, and excessive flush volumes in 1.6-gallons (6 litres) toilets. In addition, there was evidence that consumers may not have been able to locate and install the proper replacement flappers when their original product fails.

These factors could result in a serious decline or "decay" in the water-efficiency of toilet fixtures that purported to be water efficient, thereby negating the water savings that had been predicted by the water utilities subsidising toilet replacements. The above scenario however, has only been partially documented and, as such, water utilities are uncertain as to the magnitude of such failures and resultant water losses.

Out of water utility databases identifying approximately 840,000 toilet replacements, a total of 892 toilet fixtures (1992 to 2002) in California residences were randomly selected and inspected. Of these, flush volumes of 852 fixtures were measured and customers were surveyed as to their past and current actions with respect to the use of bowl cleaning tablets and flapper replacement.

The following are the primary conclusions from the field inspections and surveys:

1. The average flush volume of all 852 toilet fixtures measured was 6.6 litres. 14% of the toilets had a flush volume of < 5.3 litres possibly leading to double flushing. With the assumption that double flushing occurs in these 14% then the average flush volume increases to 7.5 litres.

[5] California Urban Water Conservation Council: Toilet Flapper Study. Koeller & Company, 2004.

2. Only 15% of residences stated that they were using in-tank bowl cleaners. Of the 205 customers using such cleaners, only 17 toilets were found to be leaking. Of the remaining 188 customers, only 40 had ever replaced their flapper valve.

3. Less than 6% of the toilets were found to be leaking through the flapper valve. This equates to 51 toilets out of the 852 sample. In addition there was no apparent correlation of leakage to fixture age. The low leakage rate might also be due to the improved materials used by the manufacturers of the flappers and the low incidence of chlorine based in-tank bowl cleaners within the sample group.

4. Overall, the study findings indicate that leakage through the flush valve seal (flapper) and flush volume increases in aging toilet fixtures are not as detrimental to water savings as might have been expected. The need for water utilities to protect against decay is important however, and so insistence upon flapper durability is ont method of protecting savings.

This study's findings on flapper failure and resultant leakage, recommended that water utilities should carefully consider the costs and benefits of a flapper replacement program before undertaking one. The actual costs and benefits of a subsidised programme of toilet replacement was questioned by this study, mainly on the basis that introducing these water efficient toilets did not in practice represent an obvious delivery of water savings. This in particular is transferrable to the UK, and the true costs and benefits of a toilet valve replacement programme if applied must be fully explored. In addition, the study highlighted that the causes for valve failure are varied and that toilets of the same age and in the same environment one may leak and another may function properly.

3 Call for data

In order to develop an understanding of the full extent of the problem and to gather every bit of existing evidence, a wide range of people, organisations and companies were contacted. This was done in order to collect and gather data, any information and also opinions about the issue, about the scale of the problem and any other comment pertinent to this study.

3.1 Water companies

At the early stages of the project a request for data was made to all participating water companies. Of the eight companies four were able to provide some data, and one company, Bournemouth and West Hants Water, who is not signed up to the project also provided data.

The data was collected from two main sources; from high consumption queries and visits by the Water Regulations teams. More detail about these data sources are given in section 4.1.

In addition to providing data, two water companies were able to send out a questionnaire to a sample of customers to gather information about their toilets and if the users had noticed any leakage. This data is analysed in Section 6 and a sample copy of the questionnaire circulated is contained in Appendix A.

3.2 Manufacturers and Plumbing Retailers

The Bathroom Manufacturers Association (BMA) is the trade association for manufacturers of bathroom products trading in the UK. The BMA represents the interests of over 50 major bathroom manufacturing groups and service providers with over 76 well-known brands and is the collective voice of the bathroom industry. The BMA were contacted to see if the issue of faulty or leaking toilets had been reported to them. They were not able to provide any data, but they did provide some commentary and views;

"…With regard to leaky valves, the experience of our Membership is that drop valves are as reliable as siphons. However, this is assuming that the drop valve has been installed and adjusted correctly. Due to this aspect the higher quality manufacturers actually pre-fit drop valves into the WC cistern to help prevent any installer issues from occurring. This is an on-cost to manufacturers but they believe that it is worthwhile to continue to do this to ensure correct settings are supplied with each WC suite. Obviously where this is not done there is an increasing possibility that errors could occur with the installation. Experience has shown that plumbers often cause leak issues with valves by not ensuring correct installation of components where they are not pre-fitted…"

As things stand the industry does not have any current UK data regarding toilet valve leakage. The last study on this done by industry is at least 18 years old and looked at typical EU product only and at that time only siphons were allowed in the UK.

Regarding the issue generally; the only evidence presented to industry for leaking flush valves has only ever been anecdotal. Where specific cases are known to have occurred there seems to be a lack of information as to who the manufacturer of the flush valve is, how long it may have been installed, if the leak was genuinely the flush valve or if it was actually the inlet valve (was it installed correctly in the first place, has it been maintained, is it a regulatory compliant product etc.) Consequently, the studies to date seem to have failed to identify the manufacturer or to have understood the true cause of the leakage. In the BMA's view, it may well be the case that WC leakage is more often due to the failure of inlet valves rather than the flush mechanism.

The BMA suggest that while there seems to be a deeply held belief by water undertakers that all flush valves "*are bad and prone to leaking*"; they comment that it is worth remembering that all flush valves are required to comply with regulations and have to undergo a series of tests to validate not only the flush performance but also the durability of the product. The BMA state that all types of valve have examples approved by WRAS and on this basis one approved valve type cannot be considered better or worse than any other type of approved valve. Thus they see the real issue for leaky valves is to establish if the leaky valve was actually approved by WRAS in the first place. There is no distinction made for these tests between siphon and flush valve products. It is entirely conceivable that should a study look at failures of flush mechanisms that the evidence may well point to products that were not regulatory compliant in the first place. If this were so then the obvious factor here is to ensure better policing of installations of non-regulatory compliant product to ensure that premature failures of flush mechanisms are kept to a minimum.

3.2.1 Plumbing data

Plumbing retailers were contacted to see if they might be able to provide information about how many replacement parts for toilets have been sold nationally. This information would then be interpreted in order to gauge the scale of the problem as replacement components may highlight the number of faulty toilets. In addition, the data might also indicate the possible reasons of failure within the devices and the type and location of failing toilet mechanisms causing leaks. It is important to try and understand the origin of the leak (and then possible causes) and this data may help to do this. Two of the main market leaders B&Q and Wickes were contacted but were, unfortunately, unable or unwilling to provide any sales data to help with this study.

One company was able to provide some data on a confidential basis. The company is a leading plumbing supplier with 350 national branches whose estimated market share is approximately 20% of the industry and commercial supplies sales. This company represents about 5% of the replacement market sales for household replacement plumbing fittings (including various toilet components) from the sales record as it is thought that many householders would go to a larger store such as B&Q, Wickes etc. rather than a plumber's merchant.

The plumbers' merchant suggested that the sales figures regarding replacement parts from 'high street' retailers rather than the stockists would give a better picture (as a more popular choice for householders) but as stated they were unable to provide any information. Despite this, the data is worth including and is shown in Figure 1.

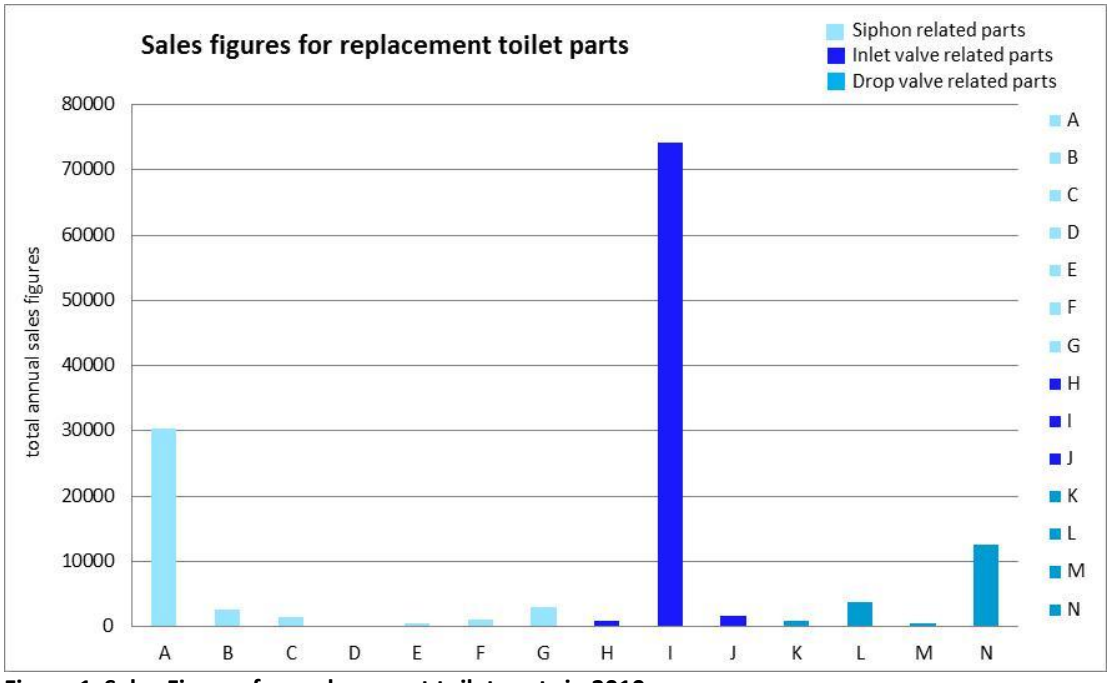

Figure 1 Sales Figures for replacement toilet parts in 2010

KEY:

A - Syphon (229mm)
B - Syphon (203mm)
C - Syphon (50mm)
D - Split syphon (7.5")
H - Inlet valve (1/2")
I - Inlet ball float valve (1/2")
J - Inlet ball float valve (3/4")
K - DF outlet (drop valve) 7.5"

E - Split syphon (8")
F - Split syphon (9")
G - Split syphon (9.5")
[DF – Dual Flush]
L - DF outlet (drop valve) 8"
M - DF outlet (drop valve) 1-1/2"
N - DF top button valve

The data set has been sorted into three categories which include parts relating to siphons, drop valves and inlet valves. Inlet valves covers the issue of water continually flowing into the cistern and then out through the over flow, and as stated in Section 2.1 as these overflows can now be internal, they are less visible and thus a problem may go undetected resulting in water wastage.

Figure 1 shows that a significant number of siphons have been fitted. The product in this data is a dual flush toilet which is retrofitted onto siphon cisterns to convert the single flush into a dual flush. The large volume of these being installed is positive as it suggests that more toilets are being converted into dual flush for the purpose of water saving. It may also indicate that some siphons and drop valves are being replaced with the retrofit products. The data also shows that there are a substantial number of dual flush drop valve buttons being replaced. The reason for this is unknown, but could be replacements due to failing devices.

The largest replacement part is related to the inlet valves, indicating that these could be a significant cause of water wastage from WC cisterns. This interpretation is very subjective but it has been included because but as the company holds a **quarter of the market share** and the trends may be transferrable to an understanding of a national picture.

3.3 Regulators

All the Water Industry Regulators were invited to contribute and be involved in this project. It is important to keep Ofwat, Defra and the Environment Agency informed of this project as it is pertinent to issues affecting the water companies, in terms of their June Return submissions on water savings achieved and in the context of their demand management activities and compliance with the water efficiency targets. All of the Regulators were sent a copy of the interim Report in 2011, but no comments or acknowledgements were received. The lack of interest by the Regulators is disappointing, given the potential scale of the level of water wastage through WC's and their public interest in reducing pcc. Also, it is clear that any shift in policy or regulatory change will have to be led by them.

Defra did show interest initially and were even going to become part of the consortium, but this was not followed through. The Defra Water White Paper "Water for Life" [6] makes two relevant general comments;

"…The White Paper advocates steps such as installing water butts in gardens to collect rainwater, converting toilets to dual flush and addressing domestic leaks[7]…" and, *"…we waste too much of our drinking water, treating it as a limitless resources…a third is flushed down our toilets or used outdoors[8]…"*

[6] Defra Water White Paper: Water for Life, 2011 - http://www.defra.gov.uk/environment/quality/water/legislation/whitepaper/
[7] Defra Water White Paper: Water for Life, 2011 – Page 9
[8] Defra Water White Paper: Water for Life, 2011 – Page 80

These comments are very general and the White Paper does not mention leakage or wastage from domestic appliances or toilets specifically.

3.4 Professional bodies and institutions

The Chartered Institute of Plumbers and Heating Engineering (CIPHE) is the professional body for the UK plumbing and heating industry[9]. The CIPHE has a membership of around 10,000 including approximately 260 manufacturers and distributors. As plumbers are the most likely group to have encountered a faulty or leaking toilet valve, it was felt that they may be able to provide information about this issue. They did provide some information, but all of this was anecdotal, all observations and commentary about what they had encountered whilst working on repairs. Unfortunately data is not routinely collected and there was no quantified data, either about the number of faulty toilets (indicating the scale of the problem) or the amount of water lost (indicating the volume of the water wasted).

Accounts of leakage incidents and further anecdotal evidence from plumbers can be found in Section 7. A summary of possible causes of the problems reported by the plumbers is presented here;

- One plumber suspected that cistern cleaning blocks had degraded the rubber washer which forms the seal on the valve.
- Two plumbers reported instances of the valve jamming open, which allows water to continually pour through into the pan.
- Others report that they have come across the problem, but the cause is not immediately identifiable – two identical WCs installed at the same time and operated in the same way can often perform differently, with one leaking and the other not.
- One reports that 'slime' had built up around the valve, causing it to not seat properly and therefore allowing water to constantly seep through the valve.
- Another plumber had 3 WCs in one house all leaking. Upon disassembly, it was found that one of them had a slimy detritus on the valve, but that the other two, which were also leaking, did not. The plumber therefore could only attribute the cause of the leakage to poor machining of the valve mechanism and finishing. Slimy detritus was also reported by a third plumber, who recommended cleaning the sealing washer regularly, although this is not always easy to access.
- Another plumber had no specific information but he was aware of many that have leaked after installation. He suspects this is due to the poor design of the washer in the valve so that it cannot make a reliable seal and that they easily deform and do not have perfectly flat surfaces.

The evidence from these plumbers suggests that the problem is widespread but the causes can be highly varied. This seems to verify both the observations made by the BMA (Section 3.2) and the possible causes cited in previous UK studies (Section 2.3). These anecdotal accounts are interesting however and are useful in identifying the range of causes that can lead to leaky toilet valves.

[9] http://www.ciphe.org.uk/

3.5 Others

In order to gather information about leaking toilets from different sectors other than in the domestic setting a number of organisations and businesses were contacted to ask for any information.

With a large number of toilets in a considerable daily use, motorway services were thought of as a possible source of information about this issue. The three largest motorway service station providers are; Moto, Roadchef and Welcome Break. The Facilities Managers for these companies were contacted both by phone and email to request any information regarding the maintenance of toilets on their premises, the replacement of any parts and if leakage was considered to be an issue. Unfortunately none of the companies replied or were able to provide information to this request for data.

Similarly to motorway service stations, airports also have a large number of toilets with regular daily use. The Facilities Managers for Heathrow and Gatwick were contacted by email and telephone to request any information about the maintenance and operation of the toilets on their sites, but sadly they did not respond to this request for information.

The reasons for a lack of response may be because;

- In the overall context of their facilities costs the water bill is small and water savings are therefore not a high priority
- The detailed component use would not be measured, rather only the overall site's water use is measured

4 About the data collected

The participating water companies provided any data about leaking toilets which they had collected. Much of this included anecdotal information (i.e. a problem with leaking toilets has been identified, but not quantified) but several companies did have more detailed quantified data. This data was collated and then analysed in order to investigate the quantity of the potential problem relating to leaking toilets and from this to derive a figure for the quantity (scale) of water wasted as a result of leaking toilets. This figure and the evidence gathered will be shared with OFWAT and efforts will be made to allow participating water companies to use this figure for inclusion in their water efficiency targets.

This phase of work did derive a volumetric figure associated with leaking toilets. This figure can then be used for the water efficiency targets to illustrate average water saving per leaking WC and thus volume of water saved by water companies when any WC is fixed.

4.1 Data sources

At the early stages of the project a request for data was made to all participating water companies. Of the eight companies four were able to provide some data, and one company who is not signed up to the project also provided data.

The data was collected from two main sources:

- first, from visits made as a result of high consumption queries. These leaks were identified because customers had flagged higher than expected bills (and therefore water consumption) to the company, see discussion below. The company would then visit and investigate the cause. The data from these investigations tend to be skewed towards the high end of the leakage range because they often rely on the customers to notify the problem and this they would only likely do once the bill had increased sufficiently for water wastage to become a concern.

- The second source of data came from **visits by the Water Regulations teams** of each company. These visits would be made as part of the standard water regulations inspection, and not specifically as a result of a third party identification of a leaking toilet or plumbing loss. During these visits toilets would be inspected and checked for signs of water wastage. It is therefore likely that lower levels of volume leaks would be detected, in addition to any higher volumes. The Water Regulations teams are able to detect and measure leaks down to 10 ml/min. This is important because here leaks that would not be identified by a household meter can be detected and measured.

It is worth including here a short discussion on the way a leak in a WC develops overtime and is detected. Figure 2 shows a leak growth curve (the blue curve). We do not know what shape this curve is (or whether there are different shaped curves for different types of leak) however it is logical to assume that the curve starts at zero and tends to grow to a point where the increase in leak flow rate flattens off.

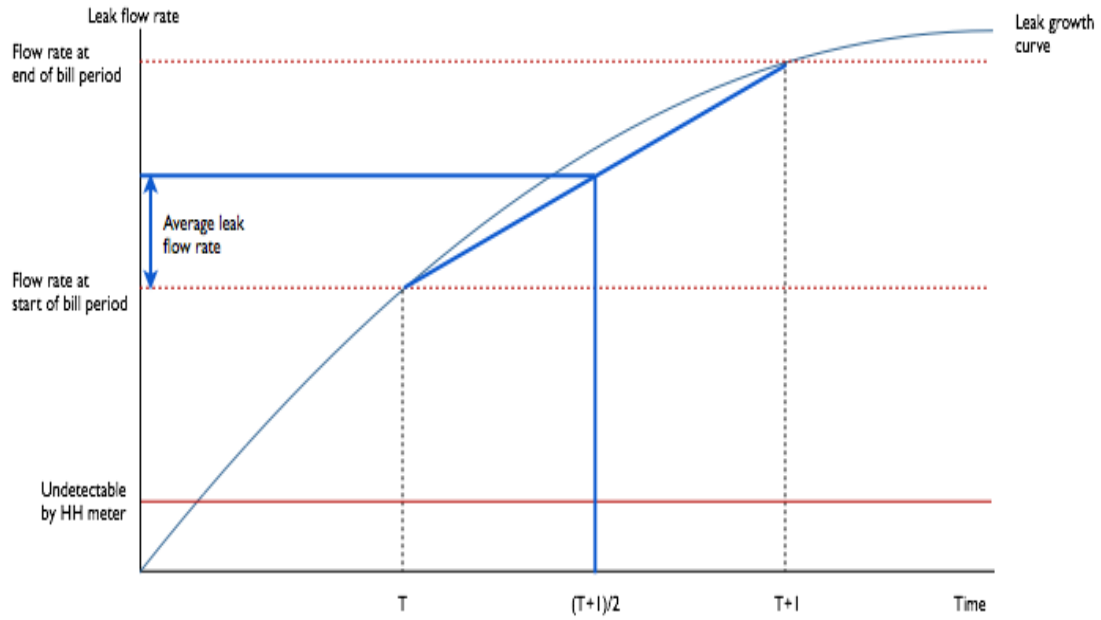

Figure 2 Possible leak growth curve

For toilets inspected randomly (such as during the water regulations visits) the leak could be detected and measured at any point along this curve, and this would be the leak flow rate recorded for the survey.

For leaking toilets detected by increases in measured household bills, the detection will happen when the leak flow rate is above the minimum detection level of the household meter. Household meters normally have a minimum detectable flow rate of somewhere between 1 and 4 litres/hour. At some point in time when the leak is above this flow rate, the householder's bill period (between time T and T+1 on the time axis of the graph) will indicate a higher than expected bill. The water company then has two flow rates:

- at time T, the average consumption flow rate for the property before the leak was identified
- at time T+1, the flow rate for the property with the leak included.

Taking one figure from the other provides an estimate of the leak flow rate. The leak flow rate is often estimated at this point because the householder may be keen to seek a reduction in the bill (or a leak allowance) for this period. However, it should be pointed out that this method of estimating the leak flow rate would nearly always be an underestimate. This is because the leak has probably been running for a time before it is detected and an element of the average consumption for the property before the leak was identified will include leakage. Taking a series of meter readings after the leak is repaired would provide a more accurate estimate.

In total 5 data sets were received which contained suitable data. Two of these data sets were derived as a result of visits made by the companies' Water Regulations teams. The remaining three data sets were derived from high consumption queries i.e. metered customers questioning their bills. The data sets have been anonymised for the purpose of confidentiality as shown in the table below.

Table 1 Derivation of data sets

A	B	C	D	E
High consumption queries	Water Regulations visits	Water Regulations visits	High consumption queries	High consumption queries

Although from different sources, it was considered to be acceptable to analyse the data sets at the same time because both methods measure the leak at a random point in time during the development and growth of the leak.

4.2 Data sorting

1. Initially each data set was analysed individually, and then as a whole data set. Firstly the data set was checked for erroneous data or non-volumetric data and other obvious recording errors.

2. The data from the Water Regulations datasets also contained information about other plumbing losses in addition to leaking toilets, such as leaking overflows from header tanks, not toilet cisterns and underperforming siphons (i.e. under flushing requiring a double flush). These datasets had to be cross referenced to differentiate and then remove these to ensure that the data captured leaking toilet valves and inlets only and the problem was not over represented.

3. The data set was sorted and two ranges of numbers were omitted from each data set:

   - HIGH VALUES > 10 m^3/day. This figure was chosen because it was considered that any leak greater than this volume left unidentified until a bill reading was highly unlikely due to the sheer volume of water passing through the pan. It is likely to have been investigated by the homeowner before a high consumption bill (and subsequent query) was issued. One data point was removed due to this constraint.

   - LOW VALUES < 24 l/day. As mentioned earlier one of the datasets recorded very low leak flow rates due to the method of measurement, and this value was chosen as this reflects the limitations of a meter; a standard household meter would not therefore register values below this. These flows would normally be included in the estimate of general plumbing losses. Therefore are assuming that flow < 1 l/hour is not recorded in most cases where a toilet leak is detected and fixed in a domestic property.

This course of action was taken because this project is about defining a typical value that water companies could reasonably and evidentially claim from a leaky toilet that it has mended, rather than providing an estimation of the contribution of leaky toilets to overall pcc level. This will need to be considered fully in any further research.

5 Presentation of data analysis results

With a sorted data set simple statistics were applied and the outcomes of this data analysis are shown in **Table 2**. It shows the variation between data sets and gives an illustration of the volumes associated with leaking toilet valves. This data is the same as in the interim report as no new quantitative data was received to add to the analysis.

For the purpose of providing guidance on water efficiency target it is rational to assume one toilet per household in the presentation of results.

Table 2: Leakage in litres/WC/day associated with leaking toilet valves

Company	A	B	C	D	E	ALL DATA
Average	881.3	310.7	215.0	1,119.3	537.8	**442.3**
S Deviation	890.8	606.5	234.3	1,533.7	650.4	**812.4**
Minimum	21	28.8	16.7	51.6	20.1	**16.7**
Maximum	3,163	7,200	1,455.9	9,860.0	4,370.1	**9,860.0**
Median	535.5	144	122.3	724.5	357.4	**191.5**
Count	26	480	136	106	114	**862.0**

The dataset is skewed, as can be seen in the histogram in Figure 3, however as discussed in section 4.2, the data collected from bill queries is likely to be an underestimate, therefore it is suggested using the mean as the figure to be claimed for the water efficiency targets when a leaking WC is identified and repaired.

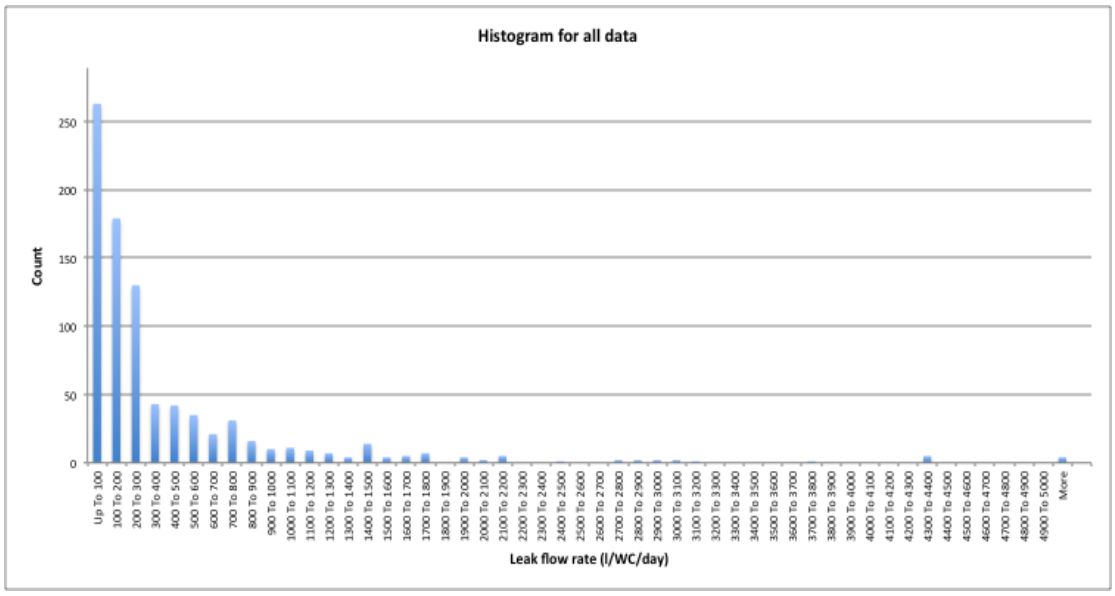

Figure 3 Histogram for all data

In order to derive an estimate of the potential water saving achieved by fixing a leaking toilet, the leakage can be treated in a similar way to pipe leakage. The following is based on the '*burst and background leakage'* method that has been used for pipe leakage.

Conceptually, toilet leaks can fall into 3 categories defined by how they are detected, as follows;

Category A leaks

These are leaks which are likely to be missed by casual inspection, and only detected by someone specifically looking for small leaks. These leaks would probably run continuously, or until the leak flow rate increases to become detectable (analogous to 'background' leakage). The upper leak flow rate is based on two methods;

- an assumption that leaks running at less than 1 ml/s (3.6 l/hour or 86.4 l/day) would be missed by most people
- an assumption that it would require an increase in billed volume of greater than 25% from one bill to the next to identify greater than normal consumption (for average PHC of 360 l/day (pcc 150 * 2.4 occ), this equates to 90 l/day)

Category B leaks

These leaks should be readily detectable either physically by the consumer or through the examination of bills from metered properties. The period that these leaks run for is largely determined by the customer and whether they notice the leak and then are inclined to report or repair it. Metered customers may pick the leak up in sequential bills. The upper leak flow rate is based on;

- an assumption that a WC leak flow rate of > 1 l/min should be obvious, this equates to 1,440 l/day.

Category C leaks

These are leaks which should be obvious and therefore fixed relatively quickly. The upper leak flow rate is based on an upper estimate of the flow through an open inlet valve at high pressure.

The summary statistics for the categories, based on the data provided previously is shown in Table 3.

Table 3 Summary statistics for the leaky valves data.

Category	Description	Min leak flow rate l/day	Max leak flow rate l/day	Number in category	Mean of category l/day	Median of category l/day
A	Small WC leaks which are not readily detectable	0	90	257	55.4	57.6
B	WC leaks which should be detectable	90	1,440	552	398.7	288.0
C	Large WC leaks which should be obvious	1,440	1,4400	53	2,772.7	2,067.6

In terms of estimating the leak flow rate that should be used for the detection of a leak detected through an active water efficiency programme, then category B should be used. The justification for this choice is because leaks in category A are likely to be missed, and leaks in category C are likely to have been detected and fixed by the property owner already.

The distribution of leak flow rates in **Category B** suggests that the mean value can be used for the average flow rate. The average flow rate therefore for the whole data set is **400 litres/toilet/day** and this is the proposed figure to be used for the water efficiency targets.

6 Understanding the scale of the problem

During the project, two water companies distributed a questionnaire to a sample of properties to ask their customers about their toilets. This was based on the toilet survey designed by Bristol Water which is on their website[10]. This was undertaken in the hope that the responses would help to improve the understanding of the problem and to better ascertain the scale of leaking toilet valves.

6.1 Questionnaire: Company X

Company X distributed 841 questionnaires within a target area. 152 questionnaires were returned which equates to a response rate of 18%. Average occupancy is was 2.45 and meter penetration 66.4% (unmetered therefore 33.6%).

Of the leaking toilets, 50% were described as having an intermittent flow and 50% described as a constant flow, but a small trickle. Of the leaks identified 63.6% have been identified for between a week and a month. Some of the leaks, 18.2% have been identified for greater

[10] Bristol Water Toilet Survey:
http://www.bristolwater.co.uk/environment/waterSavingToiletSurvey.asp

than 6 months and an additional 18.2% of leaking toilets have been thought to have leaked for over a year. Of these leaks, 77% have been fixed, but 23% still remain unfixed and thus leaking.

Summary:			
Total number of toilets:	140		
% Siphons:	42%		
% Drop valve:	58%		
Number of toilets leaking:	**12**	**=**	**8.6 %**

6.2 Questionnaire: Company Y

Company Y distributed 2,717 questionnaires within a target area. 559 questionnaires were returned which equates to a response rate of 21%. Average occupancy is was 2.54 in this area. There is no information about meter penetration.

Of the leaking toilets, 50.8% were described as having an intermittent flow, 34.4% described as a constant leak, which is a small trickle and 14.8% were described as a constant leak with which is a steady flow. Of the leaks identified 54.8% have been identified for between a week and a month. Some of the leaks, 9.7% have been identified for greater than 6 months and 35.5% of leaking toilets have been thought to have leaked for over a year which is of concern. Of these leaks however, 90.2% have been fixed, but 9.8% still remain unfixed and thus leaking.

Summary:			
Total number of toilets:	610		
% Siphons:	46.4%		
% Drop valve:	53.6%		
Number of toilets leaking:	**63**	**=**	**10.3 %**

6.3 Summary

One striking feature of the two questionnaire results is how similar the two data sets are. Two completely unrelated surveys have yielded very similar results. When combined, the percentage of toilets which were found to be leaking is **10%**. Both types of flush mechanism are at risk of leaking, but in these two questionnaires drop valves were the leakiest. This might be due to the questionnaire target area which, for both companies, had a higher proportion of new homes in and thus more likely to have a higher proportion of drop valves.

The mean leakage per leaking WC and the proportion of leaking WCs can be used can be used to estimate the scale of the problem. For a sample of 1,000 properties with a pcc of 150 l/person/day and with an occupancy rate of 2.4, the total consumption would be 360,000 l/day. On average we would expect 100 of these to be leaking, with a total leakage of 40,000 l/day. If the leaks from the WCs were all fixed then the total consumption would be 320,000 l/day or a phc of 320 l/property/day or a pcc of 133 l/persons/day. In essence an active programme to educate customers, detect and repair all leaking WCs could potentially

reduce pcc from 150 to 133 l/person/day; a significant step towards the Government's target of 130.

Summary:

Total number of toilets:	140 + 610 = 750
% Siphons:	42%
% Drop valve:	58%
Number of toilets leaking:	12 + 63 = 75

10% of toilets visited were found to be leaking

6.4 Water Regs Data: Company Z

The reasons for Water Regulation visits are twofold, to encourage water efficiency and to ensure that water is used wisely. If undue consumption is detected then this is an enforceable action for the water companies to undertake under the Water Regulations. Company Z provided information which was collected during Water Regulations visits. This information was recorded during standard Water Regs visits and was later collated in a database. The data base was queried for any recorded incidence of leaking toilets and the results were returned after for all flushing mechanisms, whether ball valves or drop valves. The data collected is as follows;

Number of toilets visited	96,994
Number of toilets inspected	92,365
Number of leaking toilets	1,118
Percentage of toilets leaking	1.2%

In the past 10 years, 96,994 toilets have been visited. Of these 92,365 toilets were inspected. The number is less than the total number for two reasons, either the toilet cubicle was in use or the cistern was not accessible i.e. boxed in or out of reach. The number of leaking toilets was only 1,118 out of the 92,365 total toilets. Consequently, the percentage is very low at **1.2%.**

The caveat regarding this data which may account for the low figure is due to how the company's database is operated and how the database formulates and records the data to later be interrogated. The database of Company Z has evolved as a live document over time, designed to capture problems, principally for the Water Regulations. As the needs and requirements of Company Z developed over time this database was merged with another database designed initially for infringements. As consequence, the database has changed over the years and the data logging has not always been inputted in a consistent manner which can later be tracked. The method of interrogating the database means that the precise and specific set of words must be searched for in order for the values to be returned. For example, key words were searched for (such as; drop valve, siphon, cistern, toilet etc.) but unless the data was imputed exactly how the database was queried then the data will not be returned. This may result in an underrepresentation of the number of faulty and leaking toilets as not all the data will have been encapsulated. Similarly, the database doesn't not distinguish between the types of flush mechanism, it is either defective or not.

In addition to leaking toilets, the data also identified cases where the water line was above the design level. As a result more water is delivered into the cistern than is actually required. **Of the total number of 92,365 toilets checked 20,798 were overfilling from their design standard and thus wasting water. This is 22.5%.** The main reason considered for this is that the toilets were set up incorrectly. This data shows that this is more of a problem than leaking valves and would be easier to fix. The volume of water lost from this was not measured or tested as it was deemed counter intuitive and water wasteful to flush every toilet to derive this figure

Case study:
During a Water Regs visit, the same Company Z visited a block of apartments. The reason for this visit was that a number of high consumption queries were received from within the development and so were investigated. **The company visited 225 toilets and of those, 114 were leaking. This equates to 50.7%.** All of these toilets were drop valve cistern types. It transpired that these devices were unapproved components.

This small data set shows just how varied some of the incidences can be, with Company Z data ranging from a failure rate of 1.2% to 50.7%. The problem can be concentrated in a small area (or development) with bathrooms fitted with the same product. Conversely leakage has been shown to occur in a variety of settings and age of properties and type of cistern device. Toilet valve leakage is not the only avenue for wasting water, and the issue of overfilling and over flushing due to improper cistern set up should also be considered as a water efficiency action.

7 Anecdotal evidence

Before this study, much of the evidence regarding the issue of leaking toilets was anecdotal. This evidence is valuable in its own right, for demonstrating the scale of the problem, how the problem was identified and the variation in possible causes documented by a wide range of people from plumbing professionals to homeowners. It is also very helpful to have these views and comments collated so that they can be assessed together rather than isolated views. It would be useful in the future to gather more evidence of this sort in a systematic way in order to ensure that views are representative following a robust research approach.

These comments have been come from a variety of sources. Plumbers have been approached both by direct contact and via the Institute of Plumbing and Heating Engineers. In addition the issue was posted on a number of internet forums for plumbers for discussion and comment. Customer comments have been gathered via plumbers reporting what their customers have said. Water companies also provided some of these comments, which were collected when dealing with either high consumption queries or from the questionnaire which was mailed out as a part of this study.

<u>From Plumbers:</u>

"…I suspect that cistern cleaning blocks have degraded the rubber washer which forms the seal on the valve…"

"…I have seen on two instances the toilet valve jamming open which allows the water to continually pour through into the pan…"

"…I have seen leaking toilet valves but the cause of the problem was not immediately identifiable…."

"…the problem seems massively variable, you can get two identical WCs installed at the same time and operated in the same way can often perform differently, with one leaking and the *other not..."*

"…I have seen a kind of 'slime' which has built up around the valve, causing it to not seat properly and so allowing water to constantly seep through the valve…this was the house which had three toilets in the same house, all of which were leaking…when I disassembled them I found that one of them had a slimy detritus on the valve, but that the other two, which were also leaking, did not…so, I can only attribute the cause of the leakage to poor machining of the valve mechanism and finishing….the slime may be a contributing factor….maybe the seal should be cleaned regularly…"

"…I don't have any specific information, but I've seen toilet valves leak before after installation….I suspect that this is because of the poor design of the washer in the valve so that it cannot make a reliable seal…the washers seem to deform easily and they don't have perfectly flat surfaces…"

"…I have been in the plumbing business now for 34 years, and I have seen many changes in the industry. Ball valves used to be a simple affair made of brass and would last for ever….they were easy to maintain - easy to replace the washer and seating and both high and low pressure systems were very simple and cheap to repair or even replace. Siphons were also very basic in the old 2 gallon cisterns, many then running off cold water storage tanks on low pressure…siphons very rarely passed water, ball valves did sometimes, but as the overflow was external and visible, problems were soon identified…"

"…when I worked through the 1980's I could carry a small box of spares, to cover virtually every type of problem I would attend, the same with taps, I could also have small tray of washers, seatings tap insets and again even a few spare new taps because I knew that these would suffice…In the 1990's the introduction of new taps, ball valves, smaller cisterns and flushing mechanisms – well, that's when the problem started…DIY stores began to sell plumbing materials which was a bad idea, because anyone and everyone could have a go at fixing things…this meant that too many folks were fitting incorrect parts, and fitting correct parts incorrectly and so more leaks and waste occurred…"

"…Due to European trade laws the number of different taps, toilet cisterns and flushing mechanisms runs into the 100's…this means it is impossible to keep the number of spares required…so we have to go back and forth to the plumber merchant which means multiple trips to the same properties, more expensive plumbing rates and the likelihood that people will tray and fix it themselves…"

<u>From Customers:</u>

"…If I noticed the toilet leaking, I would definitely try and fix it myself rather than pay through the nose for a plumber….and I'd buy the stuff from B&G or Wickes rather than a plumber's merchant…"

"…I've got a dual flush drop valve and sometimes the short flush doesn't work. I've tried adjusting the mechanism but I think it is a poor plastic design and not robust enough for the job…"

"…Cowboys built the house, more cowboys refurbished my bathroom and a proper plumber fixed the rubbish leaking toilet with an even more rubbish flexi pipe…"

"…I don't think these new dual flushing systems are good – it seems like there is more to go wrong. I think it's better to try and get the flush quantity to a minimum efficient amount…"

"…Regardless of the cistern, my gripe is with the pan - the new style of pan means that the toilet is always soiled with use and it requires cleaning with a toilet brush on every use - there is never a clean get away!..."

"…we have a problem with our dual flush. On the small flush we always need to flush more than once to clear the waste. The reduced flush is just a trickle and so now we never use it…"

"…Our toilet seemed to work ok, but then the cistern would suddenly start filling over and over again. This resulted in a high water bill. We couldn't repair the cistern so had to replace the toilet, which was a waste and expensive…"

''…I didn't realise this was classed as a leak…"

"…These new European toilets leak all of the time wasting gallons of water every day…"

"….we had a new bathroom had been fitted including a macerating WC. Within 3 weeks I was continuously being awoken in the night by loud noises coming from the bathroom. When we investigated, it was found the toilet valve was already leaking, causing water to enter the pan, and trigger the macerator…"

"…I'd fix the leak if it saved me money…."

"…I think the problem is caused by limescale on the valve – I live in a hard water area and it's a problem…"

"…We often have to double flush, even on the full flush to remove solid waste…"

"…I have already replaced two dual flush toilets within the past two years because of leaks…"

SUMMARY

The anecdotal evidence to support this problem appears to be very compelling. The evidence has come from a variety of sources; and all seem to be consistent in expressing the view that there is a significant problem with water wastage resulting from leaky WCs. This is a problem that cannot be ignored in the context of policy that seeks to deliver lower domestic pcc, and ultimately reduced water abstraction.

It should be noted that from the comments in this section it is both flush mechanisms that were found to be at fault, in addition to internal overflow pipes not making a problem visible. The inlet valve can also be faulty couple with the fact that toilets can be overfilling, or not performing properly thus requiring a 'double flush'. This is also highlighted in Figure 1

which shows replacement toilet components. The largest sales have been for parts relating to inlet valves.

A diverse range of problems and attributed caused have been documented, which makes it difficult to ascertain a main cause and solution to this issue. However, the diversity of potential causes for faults with WCs that the result in water leakage and therefore wastage, does itself give reason to consider the scale of leaky WCs to be a major issue of concern for all those interested in improving water efficiency.

8 Conclusions

Leakage from WCs represents a significant volume of water wastage.

Leak flow rate data from 862 leaking WCs has been collected and analysed. A figure of 400 litres/toilet/day should be used to estimate the losses that should be claimed against the water efficiency target when a leaking toilet is detected and repaired. This figure represents the mean of the data set and is justified as representing a Category B leak which is the leak which is most likely to be identified and fixed.

The questionnaires distributed by two water companies provided valuable information and pointers towards the value of a further study to test if a 10% toilet valve failure rate is realistic. There is a surprising striking similarity between data sets with the result being very comparable. The evidence shows that both types of flushing mechanisms can leak, but that drop valves have a higher incidence of this, but the data set might be skewed to reflect this.

Combining these figures provides an estimate of the scale of the problem of leakage from WCs in the housing stock. This indicates that an active programme to educate consumers to detect and repair all leaking WCs could potentially reduce pcc from 150 to 133 l/person/day; a significant step towards the Government's target of 130. Despite this and concern regarding the issue of leaky WCs there remains a surprising lack of interest in developing knowledge or facts regarding this issue.

Although the study could identify many reasons that might lead to the occurrence of leaky WCs, no empirical evidence to identify the specific causes of leaking WCs; nor the probability that one cause was more likely than another.

The anecdotal evidence however from plumbers suggests that the problem of leaking toilets is widespread and the causes can be highly varied. Causes include;

- Swarf or scale on the valve seat
- Poor seating of valve due to incorrect installation
- Poor seating of valve due to distortion of plastic cisterns during installation
- Jamming of valve mechanism due to lime scale deposits
- Partial opening of the valve due to incorrect adjustment or assembly of button mechanisms
- Cracked plastic components
- Accidental damage caused by curious plumbers and DIY enthusiasts.

Evidence from both the UK and toilet flapper studies in the USA do not demonstrate that valve failure and leakage is correlated with the use of in tank chemical cleaners. The diverse

range of possible causes makes it difficult to ascertain the true cause of the problem and therefore without further research it is not possible here to postulate any recommendations for a long term solution.

This study has drawn attention to the fact that leakage from a failing toilet valve is not the only reason to explain the occurrence of a leaking toilet and the issue of overfilling and over flushing due to improper cistern set up might be significant. This study reports that of 92,365 toilets checked 20,798 (22.5%) were overfilling from their design standard and consequently delivering more water into the cistern than is actually required. The data shows that this is not a trivial problem and should be considered further as an avenue for developing actions to support water efficiency goals.

Finally, a quote from the conclusions in the Regulatory Specification

"These changes are essentially de-regulatory, offering new opportunities to manufacturers of those high quality products which will comply. Low quality products, which previously led the UK to maintain the requirement for valveless mechanisms, will fail the tests. Given the UK's extremely limited water resources and lack of metering, the Government is especially concerned that the objective of water conservation is not compromised by these changes. However, this specification will ensure that these developments are better for the consumer and the environment, and will support the Government's sustainable development strategy."

To what extent the realisation of these goals still apply, and particularly within a context of pressures on freshwater, including increasing drought, will need to be the subject of further investigation, widespread data collection and analysis.

Main recommendations:

- The study has shown that leakage from WCs can represent a significant proportion of average per capita consumption pcc. If leaking toilets could be repaired, or prevented from leaking then this could form a significant part of a strategy to reduce pcc towards the Government's target of 130 l/person/day.

- Collect a larger sample of data to confirm or refine the scale of the issue and to identify if any particular groups of households are more likely to have leaking WCs.

- Research the most efficient methods of detecting and locating leaking WCs for example, through educating customers or analysing bill data.

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APPENDIX A

SAMPLE QUESTIONNAIRE

Property Ref: XXX

Dear Miss XXX,

Did you know that leaking toilets can waste up to 500 litres of water per day, which is the average daily water use of a 4 person household, so we have commissioned a piece of research to see how much of a problem this really is.

The aim of this survey is to gain feedback from customers about how your toilets are performing. We are also interested in gaining an understanding of the number of leaking toilets. If you have more than one toilet in your home, please feel free to indicate this with numbers written in the boxes as necessary. Thank you for taking the time to participate in this survey. Any information provided will remain confidential in accordance with the Data Protection Act.

How many people live in your home? ☐

Do you have a water meter? (Please circle) Yes No

Q1: Do you know what type of flushing mechanism you have in your toilet? If you do not, select the box underneath the picture that corresponds to your cistern.

☐ Traditional siphon with handle flush

☐ Drop valve – either one button or two (dual flush) buttons on front or the top

If you have only ticked the traditional siphon box this is the end of the questionnaire, but please do still return it in the pre-paid envelope provided as it provides useful information for planning water demand into the future.

Q2: Was your toilet installed after December 2000?

☐ Yes ☐ No ☐ Don't know

Q3: Is your toilet dual flush e.g. have the option of a short and long flush either with 2 buttons or by holding the handle down for differing lengths?

☐ Yes ☐ No ☐ Don't know

Q4: Have you experienced any leaking of water into the pan between uses?
(This shows itself as a trickle of water down the back of the pan and is often difficult to see, but can be detected by placing some toilet paper in the pan)

☐ Yes (please continue to Q5)

☐ No (please continue to Q8)

☐ Don't know (please continue to Q8)

Q5: Is this leak;

☐ Intermittent steady flow ☐ Constant – small trickle ☐ Constant –

Q6: How long ago did you notice your toilet was leaking?

☐ Weeks ☐ Months ☐ > 6 months
☐ > Year ☐ Just identified it was leaking

A leaking toilet can waste up to 500 litres of water every day, so why don't you call a plumber today. To find a Water Industry Approved Plumber visit http://www.wras.co.uk/wiaps

Q7: Have you/will you have the leak fixed?

☐ Yes ☐ No

Q8: Do you have any other comments or observations?

