THE 1995 DROUGHT

- *The 1995 drought compared with 1976 and the 1988-92 dry years.*
- *Recent trends in leakage and future potential for reducing leaks.*
- *Overall supply and demand balance.*

POST TECHNICAL REPORT

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POSTreports are intended to give Members an overview of issues arising from science and technology. Members can obtain further details from the PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (extension 2840).

An earlier POST report (1) examined issues related to water shortages during the 1988 to 1992 dry years, which particularly affected the south and east of England. The report looked at the role of meters, leakage control and demand management in reducing demand and wastage, and also the possibility of tackling 'unorthodox supplies' such as ground waters under major cities. The drought faded away in 1993, but in the summer of 1995, very dry conditions reappeared throughout England - this time with water supply problems focused on Yorkshire and NW England.

This note updates the earlier POST study, examines events of 1995, and updates options for avoiding future shortages.

COMPARISONS WITH EARLIER YEARS

The 1995 dry period followed an exceptionally wet winter in England and Wales, with rainfall between October and March nearly 50% higher than the long-term average (LTA). The 'drought' emerged because rainfall between April and October was less than half the LTA, and in some areas, the second driest (after 1921) in 200 years. This meant that despite high groundwater, reservoir and river levels from the previous winter's rain, the areas most dependent on surface run-off for their supply (particularly in the north and south-west of England) suffered more than other regions where river flows and water supplies are maintained to a large extent from groundwater (2, 3).

Similarities and differences during the three worst recent droughts (1995, 1976 and 1988-92) are summarised in **Table 1**. A more detailed comparison between the 1995 and 1976 droughts is given in **Table 2**.

Some key differences between the three droughts were:

- The drought in the spring and summer of 1995[1] has more similarities with that of 1976 than with the 1988/92 dry spell, which was characterised by dry winters and summers with intermittent wet spells.
- The 1995 drought resulted from low river flows and reservoir levels in summer, even though river, groundwater and reservoir levels were high at the start of spring. In contrast, most of the previous events were preceded by dry winters which did not enable resources to recover to normal levels before the onset of the summer.

Table 1 COMPARING THE 1995 AND OTHER 'DROUGHTS'

Water Company	Rainfall (percentage of long-term average)				
	1976 winter~	1976 summer*	1988/92^	1995 winter~	1995 summer*
Northumbrian	64	57	85	131	48
Yorkshire	71	54	83	136	40
North West	82	56	89	130	47
Severn Trent	64	45	87	133	42
Dwr Cymru (Welsh)	63	42	85	140	45
South West	66	32	85	141	47
Wessex	49	33	85	149	43
Thames	48	39	81	140	37
Anglian	59	50	82	124	41
Southern	51	33	80	144	36
Range	*48-82*	*32-57*	*80-89*	*124-149*	*36-48*
England and Wales	63	45	84	138	43

*key: ~ winter: October to March; * summer: April to August average;^ 4-year average*
Source: (1, 2, 3)

Table 2 COMPARISON OF 1995 AND 1976 DROUGHTS

NRA Region	Rainfall	River	Reservoir	Groundwater
Northumbria and Yorkshire	-	-	=	+
North West	-	-	=	=
Severn Trent	-	+	+	+
Welsh	=	+	+	+
South Western	+	+	+	+
Thames	=	+	+	+
Anglian	-	+	+	+
Southern	=	+	+	+

key: + better than 1976; = same as 1976; - worse than 1976
Source: (2)

- Rainfall was lowest in the south and east of England (Table 1), but the 1995 drought **affected** worst the far south-west, Yorkshire and the north-west, where supplies and distribution systems were unable to cope with peak demands. In contrast, previous droughts had affected mainly the south and east of England.
- The 1995 drought was generally no worse than 1976; many parameters showing similar or better conditions across England and Wales (Table 2). However, the worst affected areas had lower rainfall and river flows than in 1976 (although reservoir and groundwater levels were the same or higher).
- Averaged over the 1994/5 winter and the 1995 summer, rainfall was slightly higher (90% of the LTA) compared to the average over the 1988-92 dry spell (84% of the LTA).

1. Despite a wet September, October 1995 also proved to be dry . If the rest of the autumn and winter remains dry, resources will be under pressure again next year.

MANAGING DEMAND

The Role of Meters

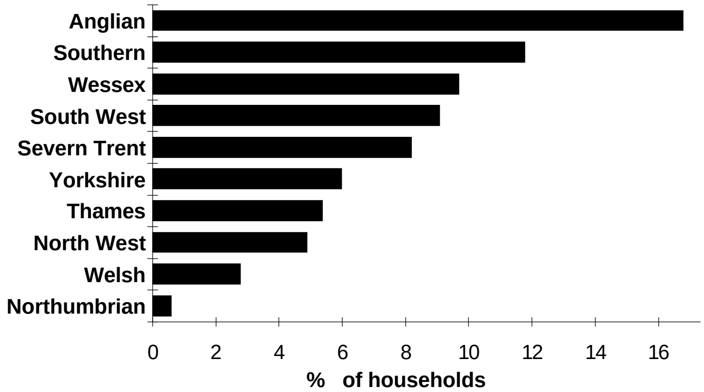
The previous POST report reviewed the role of domestic water meters in managing demand, and presented early results from the National Metering Trials (NMTs) around England. These trials were completed in 1993 (4, 5) and showed that meters caused domestic consumption to fall by 11% on average (slightly more than the 8% figure indicated in 1992), while summer peak demand could drop by up to 30% (9). Installing meters also results in leaks in both water companies' communication pipes and householders' supply pipes being found and repaired, leading to further savings of 5% or so. These average figures conceal variations in the responses within different properties - for instance, one might expect inessential use (e.g. water for gardens) to be reduced in preference to essential uses in the household. The trials suggested however that meters led to similar reductions in all property types, although they did not investigate which uses had been constrained the most, and did not consider longer term effects such as whether demand would 'bounce back' after the initial fall.

The NMTs also brought into focus a number of problems with the technology for metering and meter-reading. Meter reliability could be low from jamming by grit in the water supply. Other problems included air ingress, misting, under-recording at low flows, and a lower level of accuracy than required. The trials showed that 20% of meters failed in the first year, but since the trials ended, installation procedures have been tightened and failure rates have fallen.

These shortcomings are encouraging a search for better systems, and a number of technical innovations are currently being explored, including meters with no moving parts and those with a low pressure drop to reduce the tendency to deposit grit. Meter-reading technology has progressed only slowly in the last few years since the NMTs. Pilot trials for automatic meter reading (AMR) systems (e.g. using radio-read technology) have been underway, and one company is extending these to a larger scale. Nevertheless, these technologies remain unproven (4) and many water companies are not progressing AMR. An additional problem arises from the fact that meters from different manufacturers have non-standard outputs, thereby restricting water companies' freedom to use different types of meter (6).

Despite these difficulties, more meters have been installed across England and Wales since 1992, with 7% of all households (1.4M homes) now metered (7,8). This

Figure 1
PROPORTION OF HOUSEHOLDS WITH WATER METERS, 1995



Source: Hansard, 23.10.95, c410, Written Answers

figure varies significantly between the regions as shown on **Figure 1**, depending on the policies adopted by the companies involved, and it is estimated that 14% of all households in England and Wales will be metered by 1999/2000 and 33% by 2014/15 (9). Information on the anticipated use of meters within individual companies remains confidential.

The merits and demerits of meters are still a matter for debate. As described in POST's earlier report, the arguments were:

- **FOR:** metering is 'fair' in that it enables charges to be related to what the customer uses. It can also provide an incentive to save water and a direct measure of customers' willingness to reduce consumption to save money.
- **AGAINST:** the installation, maintenance and reading costs. The response to metering varies only little with property size and occupancy rate, indicating that there is a basic level of demand that all households require, thus restricting the scope for discretionary cuts. Water charges for large low income families may also exceed their ability to pay.

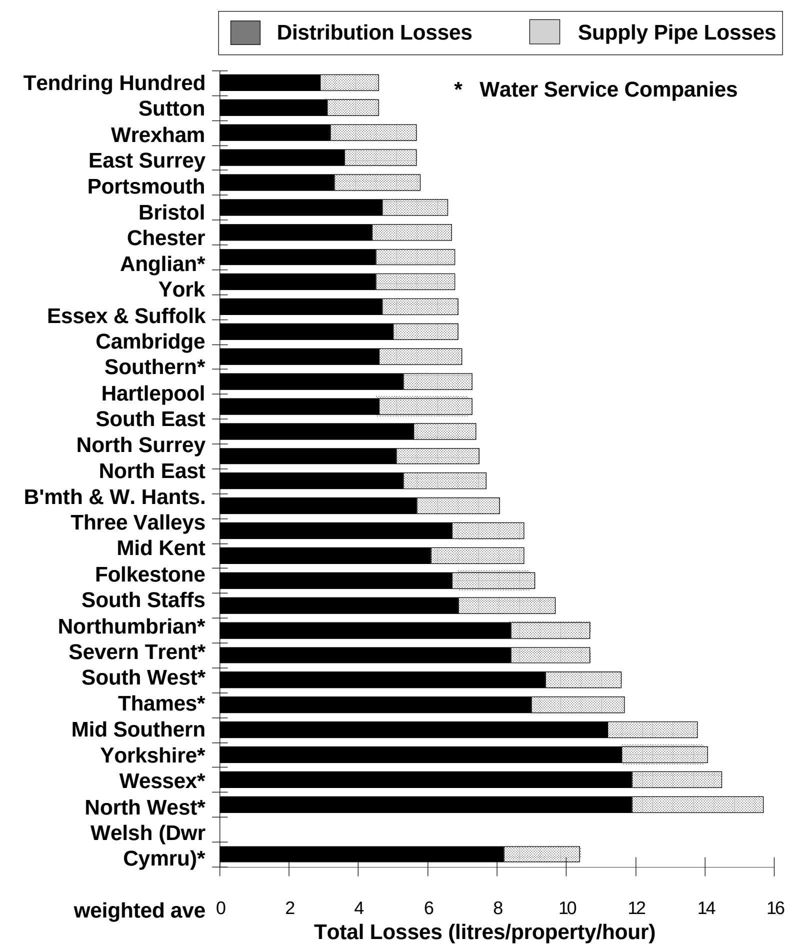
The degree of support for metering can thus depend on individual water company priorities. If the aim is to reduce consumption (especially peak demand), then metering could be cost-effective if limited to larger properties, and policy would be to install meters on new and significantly renovated properties, and other large consumers, rather than aiming to install meters in every household. For instance, Thames Water plc considers that only 30% of households in its area will be metered in the next decade.

Where the emphasis is on meters as the 'fairest' way of paying for the water used, the aim can be **universal metering**. But since installing meters involves additional costs, there can be opposition to water companies imposing meters on customers (10). Anglian Water's policy is to offer free installation followed by two bills based on the actual metered amount of water used **and** the conventional charges based on rateable value. The customer can then choose which charging system to use until the householder changes, when the incoming householder will be charged only on the meter. To date only 1,000 of the 20,000 Anglian Water customers who had meters fitted compulsorily have switched back to charging by rateable value, although 2,300 other customers have been advised by Anglian Water that it may be cheaper to revert to this method of payment. Other arrangements apply to customers in new properties or those who opt to have a meter installed (11).

The current position is that the Government, having consulted on ways of conserving and paying for water (12) published its proposals in August 1995 to move towards metering as the standard method of payment after 2000. Customers will not however be compelled to switch to meters, and charging based on rateable value will be allowed to continue in the short term, thus leaving the final decision on charging methods to the water companies (13). Water companies will also decide how charging by meter will be implemented: for instance, pricing structures could include:

- higher charges for successively greater amounts of water used;
- a low tariff for 'essential' use (i.e. consumption up to a pre-determined ceiling) combined with a higher tariff for any water used beyond this level;
- a uniform pricing structure where each litre consumed costs the same.

Figure 2 WATER COMPANY LEAKAGE RATES, 1994/5



Controlling Leakage

The 1993 POST report reviewed the latest information on leakage which had been estimated by the Office of Water Services (OFWAT) in 1992 to range from 6-36% of distribution input (%DI), with an average of around 22%. These figures related to losses from the water companies' distribution pipes only and thus excluded leakage from customers' supply pipes - possibly accounting for an additional 10% loss. When comparing the performance of different companies, however, it is possible to compare leakage rates relative to the length of main[2] and these figures were given in the previous POST report (page 12).

OFWAT now prefers leakage figures to be expressed in terms of the volume (litres) lost per property per hour (l/property/hr), and these figures are now reported by water companies in OFWAT annual reports (15, 16, 17, 18). The estimates are however subject to large margins of error; principally in estimating unmeasured water delivered to households, possibly **underestimating** leakage rates. With these caveats, the leakage rates for each water company in 1994-5 are shown in **Figure 2**.

The change in practice complicates comparisons across the years, but available data are summarised in **Table 3**. Taken together, Figure 2 and Table 3 suggest that:

- the various methods of reporting affects the ranking of water companies only slightly (8).
- Leakage (as %DI) from water company distribution pipes remains over three times that from customers' supply pipes (typically 22% and 6% respectively), but four times higher when considering l/property/hr (i.e. 8 and 2 l/property/hr respectively).
- On average, distribution losses have not changed significantly in the last few years. There are, however, different trends in different companies - some show slight improvements (e.g. North West is reducing from 34 to 30%); others a worsening (e.g Yorkshire's increase from 28 to 32%). These changes may however reflect changes in assumptions in the procedures for estimating leakage rather than real changes in leakage itself.

2. Measuring leakage in percentage terms is considered by the industry to be a poor means of comparing company performance because of the large differences in the volumes of water delivered, lengths of mains, pressures used, densities of pipe connections, etc.

Table 3 AMOUNT OF WATER LOST THROUGH LEAKS (%)

	Distribution and Supply Pipe Losses		Distribution Losses Only		
WATER SERVICES COMPANIES	**1989***	**1991/2***	**1992/3**	**1993/4**	**1994/5**
North West	29	34	34	33	30
Dwr Cymru	39	34	28	29	29
Yorkshire	24	27	28	29	32
South West	32	29	25	25	24
Wessex	20	25	23	28	27
Thames	25	31	23	23	24
Severn Trent	25	19	21	23	24
Northumbrian	18	26	16	15	17
Southern	28	23	17	16	14
Anglian	21	20	13	12	13
WSC Average	*26*	*27*	*23*	*23*	*23*
WATER SUPPLY-ONLY COMPANIES					
Mid Southern	nd	32	18	22	22
Folkestone	nd	27	20	18	17
Three Valleys	nd	29	20	17	16
Mid Kent	nd	25	19	18	19
North Surrey	nd	25	18	17	17
South Staffs	nd	24	13	17	20
East Surrey	nd	27	16	13	11
York	nd	19	16	17	15
Cambridge	nd	19	16	17	15
North East	nd	18	13	17	16
South East	nd	21	14	15	14
Chester	nd	17	15	16	15
Essex & Suffolk^	nd	17	14	14	14
Sutton	nd	21	12	12	12
Bristol	nd	17	8	11	13
Portsmouth	nd	21	11	11	10
Wrexham	nd	20	13	7	9
Hartlepools	nd	18	7	10	11
B'mouth & W. Hants	nd	11	10	10	12
Tendring Hundred	nd	6	11	12	12
WSOC Average	*nd*	*21*	*14*	*15*	*15*
Industry Average	*26*	*23*	*17*	*18*	*18*

*nd = no data; *figures not directly comparable due to changes in methods.*
^ = data for 1991/2 and 1992/3 as combination of Essex Water Co. and Suffolk WaterCo.

- Distribution losses for water service companies (WSCs) are generally higher than for the industry as a whole, including the smaller water supply-only companies (WSOCs). For instance, total leakage rates within WSC areas are approximately one-third greater than the industry average of 10-12 l/property/hr, while in WSOC areas leakage is 10% below the average. In terms of %DI, WSCs lose between a quarter and a third more than the industry average, while WSOCs lose around a tenth less.
- Water company leakage rates in 1993/4 were greatest (exceeding 10 l/property/hr) in four WSCs:- North West (13.2), Dwr Cymru (Welsh) (12.1), Wessex (11.3) and Yorkshire (10.7).
- In 'bottom-line' terms, when distribution and supply lines are taken into account, the 'best' performance is a loss of ~15%; the 'worst' likely to approach 40% of water supplied. In total, 3664 million litres were lost to leakage each day of 1994/5.

Box 1
FINDINGS OF THE NATIONAL LEAKAGE INITIATIVE

The National Leakage Initiative was established in 1991 by the Water Services Association (WSA) and the Water Companies Association (WCA) in response to the increasing public concern over leakage during the 1988-92 drought. The aim of the programme was to review and update guidance to the water industry on the issues surrounding leakage and its control. The findings of the report included:

- The report recognised that figures on **comparative leakage performance** were of wide interest and thus looked for measures which were "even-handed". No single measure existed, so the NLI recommended that, in addition to presenting leakage as a percentage of the distribution input, measures such as the volume lost per kilometre of the distribution system per day (m^3/km/day) and the volume lost per property per hour (l/property/hr) should be reported.
- Controlling leakage is only pursued so insofar as it is 'cost-effective' and the NLI reviewed methods for setting such **economic leakage targets**. The report recommends that these should be set using a 'bottom-up' approach with locally applicable targets for individual water-supply areas within a company being aggregated into a company-wide target.
- The ability to set economic leakage targets depends on the accuracy and reliability of **estimates of leakage** within local areas and across the wider distribution network. As direct measurement of all leaks is not currently feasible, the NLI reviewed detailed methods for estimating unmeasured water delivered and interpreting and using measured night flows in an effort to improve the estimates of losses.
- One major component of a company's leakage management strategy is expected to be **managing water pressure** as this can reduce the severity of leaks, as well as providing other benefits such as reducing pressure-related consumption (e.g. garden-watering); reducing the frequency of bursts and enabling companies to use cheaper pipes and fittings. However, as reduced pressure can give rise to complaints of poor service, the NLI recommended that this should be accompanied by extensive advertising and education.
- The NLI also reviewed **leakage management techniques**, terminology and training within different water companies to generate a **'best-practice' guide**, and an indication of further developments required. In terms of technology, the NLI considered that specifications were needed for data loggers and leak detection equipment. Similarly, a need for low-cost portable equipment was identified and the report noted a number of promising innovations in leak location, such as sub-surface radar thermography, infra-red photography, long-distance correlation, temperature difference (thermister) monitoring, continuous pressure monitoring and more accurate network analysis. However, leak-noise correlation remains the main method of locating a leak, and novel techniques are only considered in special circumstances, e.g. locating leaks in pipes across agricultural land using helicopter-mounted thermographic imaging.

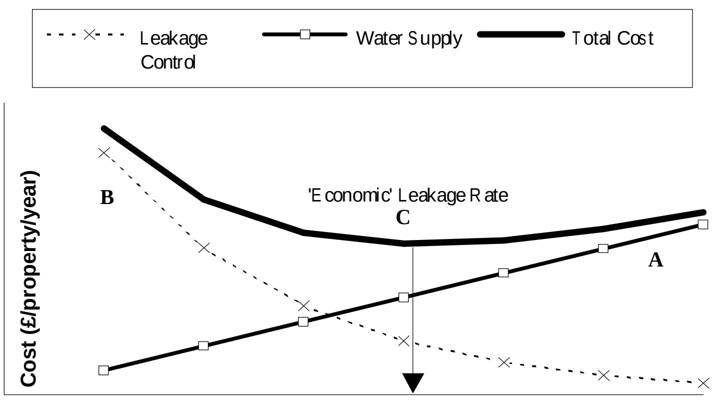
As also mentioned in POST's 1993 report, a **National Leakage Initiative (NLI)** was set up in 1991 by the Water Services Association (WSA) and the Water Companies Association (WCA) (14) to review methods of leak detection and control. The results of the NLI were announced in October 1994 and are described in **Box 1**. The industry had not reached any conclusions on the

Table 4 LEAKAGE REDUCTION TARGETS TO 2005

Company	Current leakage rate (%DI)	Target leakage rate (%DI)	Rate of leakage reduction % per year	Estimated Cost (£M)
North West	30	23*	1.4	nfg
Northumbria	17	nfg	nfg	nfg
Yorkshire	32	nfg^	nfg	nfg^
Severn Trent	24	12*	2.4	125*
Dwr Cymru	29	ncm	ncm	ncm
South West	24	16*	nfg	nfg
Anglian	13	nfg	nfg	nfg
Thames	24	12	1.2	nfg
Southern	14	nfg	nfg	nfg
Wessex	27	15	1.2	nfg
Average	23	16	1.6	id

*nfg = no figure given; ncm = no comittment made; id = insufficient data; * by 2000; ^ £25M pilot scheme to be run over next 12 months to help set target.*
Source: Water Company press releases

Figure 3 THE ECONOMIC COST OF LEAKAGE



implications of the NLI report when, following extensive public and political concern expressed during the 1995 drought, a number of the water service companies (i.e. members of the WSA) announced new commitments to cut leakage over the next ten years (19). To date, targets for reducing leakage have been announced by 5 of the 10 WSCs (**Table 4**). In making these commitments, the WSA stated that companies "*will be seeking to achieve the lowest levels that best practice suggests are both technically feasible and economically sensible*" ; these commitments will require "*major*" investment.

Key to setting and achieving targets are the two issues of determining the cost-effective or 'economic' levels of leakage and the technologies of leakage control.

a) Economic Levels of Leakage

As described in the earlier POST report, water companies have historically claimed to follow a cost-benefit approach to leakage control. The benefits are assumed to be the reduced annual operating costs of having to supply less water, and capital savings through deferment of new schemes to increase supply or install meters. The costs are the amount spent on detecting and repairing the leaks. This philosophy means that there is an **'economic level of leakage'** below which it costs more to save water than the water itself costs; this level varies between water supply areas[3]. In the Pennines, with its gravity-fed supply, the cost of supplying extra water is relatively low. This makes the economic level of leakage higher than in areas such as east Anglia, where more pumping is required, and extra water is more expensive.

The NLI report (14) looked more closely at methods for calculating the 'optimum' or 'economic' level of leakage. As shown in **Figure 3,** the total cost of leakage is the sum of the costs of supplying the leaked water and the costs of detecting, locating and repairing leaks. Where little is spent on leakage detection and control (point A), leakage rates will be greater. At low leakage rates, it is much more difficult to make further progress and costs rise swiftly (point B). Between these points, there is a level of leakage at which the sum of the two costs is minimised, and this defines the 'economic' level of leakage (point C).

Although the costs of detecting, locating and repairing a leak vary across the country, the main factor influencing the economic level of leakage will be the cost assumed for the leaking water - the lower value assigned to the water, the less economic incentive there is to stop it leaking. The NLI recommends that the cost of water be assumed to be the marginal cost only - i.e. the pumping and treatment costs - typically 2-10 p / m^3 and, where capital investment is planned, the marginal capital costs - typically 10-20 p / m^3 (3). Exact figures are commercially confidential, and not therefore available but they are clearly considerably below the typical prices charged to customers (44-109 p / m^3 (18)) which *inter alia* include returns on investment already made by the companies.

In the absence of specific data, it is not possible to illustrate the effect on the economic level of leakage (ELL) of different water cost scenarios. Nor is it possible to judge how close different companies' leakage rates are to their respective ELL. However, initial studies using the NLI method suggest **the ELL is highly sensitive to the assumed water cost** - a 1% increase in the value assumed for the 'lost' water could lead to the ELL falling by 10% (3).

The NLI approach is not yet widely adopted by the water industry and does not therefore provide a standard formula for setting targets across the industry. A method similar to that described by the NLI has, how-

3. In some respects the terms 'optimal' or 'economic' in reference to leakage are unfortunate in that they infer that leakage is to some extent a desirable commodity, but this derives from the terms used in economics to define cost-effectiveness.

ever recently, been applied by the Water Research Centre (WRc) (20) to review the leakage costs and performance of Sutton District Water (SDW). SDW already operates at low levels of leakage (3.2 l / property / hr for company pipes and 6.04 l / property / hr for total leakage in 1993 / 4) and the study found that the ELL was 3-5 l / property / hr for total leakage, suggesting that current leakage in SDW is near the economic level[4]. This study thus encourages those who believe that methods for determining the economic level of leakage can be applied in the 'real world'.

In the absence of wider use of this approach, regional guidelines may have a role. For instance, the Southern Region of the National Rivers Authority (NRA) has advised water companies in the region that it expects total leakage rates to be reduced below 6 l / property / hr before it will consider any applications for new abstraction licences or variations to existing licences. This value is approximately half the industry average (10-12 l / property / hr) and the NRA believes (8) this to represent a realistic initial estimate of the ELL for many companies in the Southern Region.

b) Implementation of Leakage Control

Clearly, leak control would be greatly facilitated, and the cost-benefit balance shifted, if technological breakthroughs occurred in leak detection and repairs[5]. As described in the previous POST report, available methods for detecting, locating and repairing leaks include leak noise correlation, placing collars around leaks, replacing or relining pipes and reducing mains pressure; these were also reviewed in the NLI report. However, there have been few significant developments in the techniques of leakage control in the last few years, although the use of remote video cameras for inspecting pipes is becoming more widespread, and some innovative methods of detection and location are being developed (Box 1).

Some current trends may affect leakage rates, even though not targeted at leak control. One is the replacement or relining of pipes carried out to meet water quality standards under the EC Drinking Water Directive (DWD). Here, since relining does not always cure leaks (and can even exacerbate them), many in the water industry consider that replacement is the most effective solution - for instance, Thames Water predicts that one-sixth of its mains will be replaced in the next 5 years. Across the whole industry replacements are currently being undertaken at a rate of less than 1.5% per year.

Figure 4 EXPENDITURE ON WATER SERVICES, 1989/90 TO 1994/5

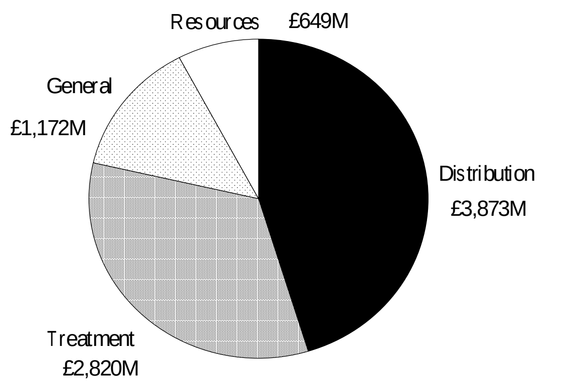
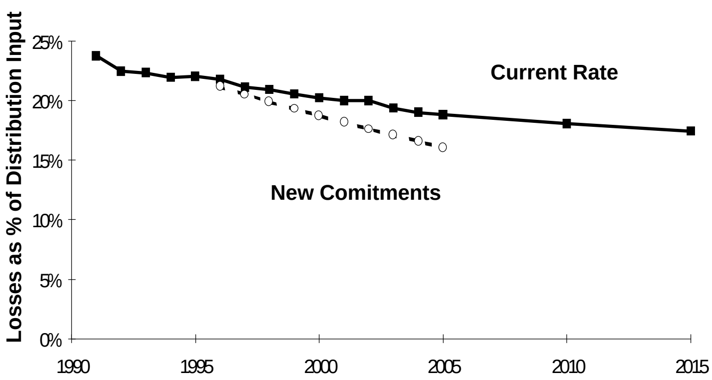


Figure 5 FORECAST DECREASE IN COMPANIES'LEAKAGE RATES



OFWAT suggests however, that mains replacement or relining is an expensive strategy for reducing leakage. Moreover, where replacement and relining does succeed in reducing leakage however, the water pressure may rise, leading to increased use, offsetting some of the gains of the leakage programme. OFWAT thus suggests that replacement and relining should be combined with replacement of householders' supply pipes, and the NRA suggests more could be made of the water companies' powers to require householders to repair supply pipe leaks.

No figures are available for expenditure by the industry on leakage controls specifically, although an average of £80M was spent each year by the industry on dealing with 'supply interruptions' between 1989 and 1994, representing about 5% of total expenditure in water services, and 10% of expenditure in water distribution (**Figure 4**) (21). Continuation of current trends would be expected to reduce companies' leakage rates as shown in **Figure 5**- on average, leakage would decrease from 24% in 1991 to 17% by 2015 - a rate of reduction of 1.2% per year (9).

More recent developments may now increase the rate of improvement. Firstly the European Commission has proposed a revision to the DWD reducing the permit-

4. The total cost of leakage to SDW is about £7.60 per property each year, including the cost of lost water, leakage controls and repairs.

5. Leakage within a distribution system depends on many factors including the age of the infrastructure, the density of connections, the chemistry and mobility of the surrounding soil, the chemistry of the water, the topography of the terrain and the magnitude and variability of water pressure required for pumping (15).

ted lead concentration from 50 µg / l to 10 µg / l over the next 15 years. These standards would require the replacement of lead pipes in both water companies' communications pipes and householders' supply pipes, and up to 8M houses (i.e. approximately one-third of connected homes) could require some pipes to be replaced, with the side-effect of reducing leakage by perhaps a tenth of its present level.

Secondly, the new commitments from some of the water service companies to tackle leakage (Table 4) indicate that leakage will be reduced, on average, from 23% to 16% over the next 10 years, i.e. an average rate of reduction of 3% per year - more than double the rate of improvement currently underway.

On the other hand, other factors (e.g. proposed standards in the revised DWD which could require the replacement of sound coal-tar lined mains pipes because of their low levels of fluoranthene) may serve to divert resources into replacing leak-free pipes, thus slowing the rate of leakage reductions.

BALANCING SUPPLY AND DEMAND

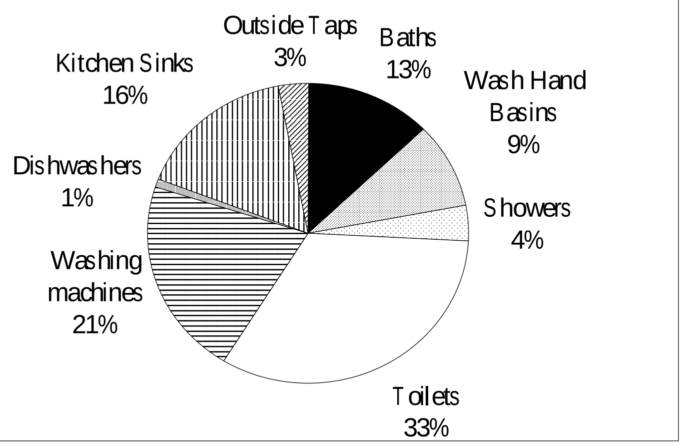
Short-term droughts also bring into focus the issue of balancing supply and demand in the longer-term, as discussed in detail in the earlier POST report. On the supply side, the NRA produced a national strategy for water resources development in 1994 (22) which considered many of the previously reviewed options:

- Water transfer.
- Urban groundwater utilisation.
- Barrages and reservoirs in estuaries.
- Artificial recharge of groundwater.
- Effluent re-use.
- Desalination.
- Undersea pipelines.
- Flexible tankers and flexible water sacs.

The NRA strategy excluded all but the first two on grounds of economic viability and environmental impact, and went on to consider in more detail four **river transfers** (Wye / Severn, Severn / Trent, Severn / Thames, Trent / Ely Ouse-Essex), plus a pipeline linking the Severn to London as well as developing the rising groundwater under Birmingham. Spare yields of up to 500 Ml / d from Kielder reservoir in the north-east were also considered. For the south-east this was uneconomic, but a more viable possibility was for transfers to meet marginal deficits in parts of Yorkshire.

Overall, the NRA concluded that "*there is a real possibility that no strategic resources will need to be completed in England and Wales for perhaps 20 years or more*" and that large-scale water transfers should not be considered as 'front-runners'. Only the Severn / Thames transfer could

Figure 6 DOMESTIC USE OF WATER



be worth further consideration in the longer-term. Notwithstanding the overall national position, the NRA acknowledges that **local** developments will be required to meet demonstrated need, and these might comprise small inter-regional transfers, local groundwater schemes, small abstractions and small reservoirs. However, the NRA does not propose to allow new supplies **unless** it can be demonstrated that leaks have been reduced to economic levels and that water companies have implemented demand management measures to the best of their ability.

The NRA is currently consulting on its approach to demand management and water conservation (8) until the end of December 1995 and the water companies have not yet made public their responses to this. Early indications are that some companies regard large-scale 'strategic' supplies as a higher priority than the NRA.

Turning to methods of **reducing consumption**, there are many examples of water-saving technology - e.g. low-flush WCs and urinals; mixer, spring-loaded and spray-head taps; more efficient washing machines and dishwashers. Since the earlier POST report, uptake of domestic water-saving devices has been limited - the Eco-labelling Scheme has been applied to only one brand of washing machine, and there is little evidence that customers are choosing water-saving devices on the basis of their 'environmental friendliness'. Manufacturers see such features as only one of many factors in consumers' choices (23).

There is however, now a better understanding of domestic water usage patterns (**Figure 6**), as a result of a study by Anglian Water of consumption in 2000 homes (24). The greatest uses are for personal hygiene (baths, basins, showers and toilets, 59%), followed by clothes washing (21%) and the use of the kitchen sink (16%) for cooking, drinking, washing-up, etc.

In terms of their potential for savings, most WCs use 9 litres during a flush. Water bylaws introduced in 1994 confined new appliances to 6.5- 7.5 litres, and low-flush WCs are available that use 6 litres or less per flush. Were all WCs to be converted to reduce flushing volumes, national domestic usage could be reduced by around 10%[6]. In terms of personal washing, it is estimated that if all households had showers instead of baths, a further 10% of water used could be saved. A similar saving would result if all washing machines met the criteria of the eco-label.

While these measures together could theoretically reduce domestic consumption considerably, they are not cost-effective in the short term for a number of reasons. Firstly, appliances can not generally be converted to save water, and they are expensive to replace. Secondly, where domestic water is charged by rateable value, the cost to customers of using extra water is zero, and there is thus no financial reward for switching to water-saving appliances. Meters provide some incentive to householders (8, 12, 13), but even here, the economics are not favourable - if water costs were reduced by a quarter on a water bill of £200 (i.e. £50) per year - the pay-back period could well be in excess of the lifetime of the water-saving appliances! Although appliance manufacturers consider that there is much scope for growth in this market in the next decade (23), people are most likely to consider water-saving devices when they have to renew their existing appliances, making the spread of such appliances slow and thus contributing to water conservation in only the long term.

In **industry** (approximately 18% of water use (1)) the trend towards waste minimisation has affected both the use of raw water and the discharge of effluent, and three notable successes since 1993 have demonstrated the potential for water savings in this sector (8). The Aire and Calder Project in Yorkshire, Project Catalyst in Merseyside and the Leicester Waste Minimisation Initiative have between them identified total cost savings worth about £20M per year, with reductions in water consumption of 20-50%. Savings were also identified in effluent discharges, solid waste disposal and energy consumption (see POST Report No. 58, Waste Recycling).

Agriculture presently accounts for around 1-2% of total water demand (1), and in dry years, nearly 70% of agricultural water is used for spray irrigation, mainly in the east of England where it can represent a major source of demand in critical years. The non-irrigation demand is small and can normally be satisfied with mains supplies or from local sources. Spray irrigation has become, however, of such importance to agriculture that the NRA considers some sectors of production would not take place unless a continuous supply of water was available (8). Moreover, the demand for spray irrigation is greatest at times when river flows and groundwater levels are at their lowest, thus putting additional pressures on resources in drought-prone areas. However, the NRA has powers to restrict spray irrigation during periods of exceptional shortage of rain in order to protect flora and fauna, and also points to a number of other options for meeting agricultural demand in local areas. These include: investing in new resources (especially where there is little spare capacity in existing supplies); improving management of existing resources (through pooling or sharing arrangements) and improving the efficiency of using resources (through improved irrigation techniques and optimal timing of irrigation).

6. Contrary to popular belief, it has been shown that placing a brick in the cistern is not effective in clearing the WC pan, as the bowl must be designed to complement the available flushing volume.

OVERVIEW AND ISSUES

The 1995 Drought in Context

From the earlier discussion, it is clear that the '95 drought has more in common with the 1976 drought than with the extended 1988-92 dry period. There are differences, however, in that the '95 drought followed a wet winter, and thus the spring started with groundwater and reservoir levels higher than in 1976. It thus affected those areas most dependent on spring and summer run-off - the SW, Yorkshire and NW areas.

During the 1995 drought, water supplies have been restricted in a number of areas through statutory measures:-

- Hosepipe bans in many parts of England (particularly the north-west, south-west and Yorkshire).
- Drought orders restricting both supplies and abstractions in Yorkshire.
- Garden watering bans in localised areas in Southern England.

Analogous data are not available for the 1976 drought, so it is not possible to compare the effectiveness of water companies in meeting demand between the two droughts. Similarly, data are not yet available on aggregate demand for 1995 compared with 1976, although long-term trends indicate a general increase over the past 20 years. Water companies suggest however, that the 1995 drought was accompanied by unprecedented peak demands, particularly for gardens.

Following the end of the hot weather, restrictions have been lifted in many areas, although hosepipe bans and drought orders remain in place in Yorkshire. Due to modest rainfall in November however, a recent application to introduce rota cuts in West Yorkshire has been postponed until January 1996.

However, despite the wet September, October also proved to be unusually dry, particularly in the north, and water has started to be shipped from Northumbria (where no resource or supply problems were reported) to Yorkshire in an attempt to maintain supplies. It also appears likely that a temporary pipeline will be installed between the Tees and the Swale to alleviate the local shortages. With the limited rainfall and reduced compensation flows into rivers, reservoir levels have started to recover. However, if the dry autumn so far is followed by a dry winter, the areas currently affected will be starting to face peak seasonal demand from a much worse position than in 1995, with consequently more serious implications for supply.

Is the Potential of Leakage Control being Realised?

The preceding discussion suggests that leakage rates across the water industry have changed little in recent years - perhaps reflecting a view prevalent both before and after privatisation, that leakage could be tolerated because new supplies could always be provided to make up the short-fall created by wasted water. Nevertheless, on a company basis, different trends do emerge, with those areas most affected by the '95 drought among those with the highest (and in the case of Yorkshire, worsening) leakage rates. In the worst areas, close to 40% of the water supplied fails to reach the customer.

Measures initiated by the water industry following the 88-92 drought have moved slowly and as yet have had limited impact (e.g. the NLI). The current position is that:-

- There is no commonly accepted approach to assessing the priority to be attached to leakage control across the industry.
- Data are not available to assess how close companies are to their economic level of leakage.
- Current guidance assigns a very low value to water loss, tending to lead to economic justifications for high leakage rates.
- On the basis of current spends, leakage is only expected to be reduced by around 1.2% per annum, due to routine replacements of mains and other routine work.

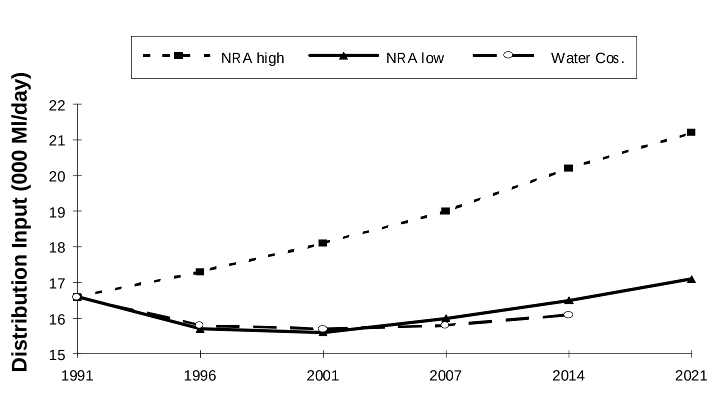
The water service companies have now committed themselves to an accelerated leakage control programme, which would have the effect of more than doubling the current rate of improvement. The water industry and OFWAT argue that this is the most efficient approach, since it leaves it to water companies to take measures to minimise their total costs (including those of leakage) under the regulatory regime applied by OFWAT and the NRA. In this way, full account can be taken of local circumstances within each water supply zone which will determine the relative priorities to be assigned to leakage.

Others (including the NRA and members of the Public Utilities Access Forum - PUAF), while welcoming any moves to reduce wastage, argue that the revised priorities assigned to leakage control on a voluntary basis do not adequately safeguard future supplies, and would argue for a more rigorous approach. Options in this area include:-

- An accelerated application of the NLI methodology throughout the water industry and urgent measures to reduce leakage to current economic rates.
- Review of the methodology to see if the costs of water take into account all relevant factors, (e.g., environmental costs of the increased supplies necessary). In this context, the water industry is currently attempting to assign an economic value to water which takes into account environmental and drought factors.
- Review by OFWAT of the duties placed on the water industry in this area.
- Mandatory leakage targets - in the Government's consultation exercise on water conservation recently, the vast majority of comments received supported setting mandatory leakage targets, especially in the short- to medium-term where there is an existing or anticipated shortage of supply (13). Such targets, as put forward in the Water Conservation Bill (26), are opposed by some (e.g. OFWAT (27)) who focus on concerns that they would lead to increased prices for consumers and distort company priorities. The Government has stated however that it would review the case for mandatory leakage targets where it could be shown that voluntary targets were not being achieved.
- Placing customers' supply pipes under the responsibility of the water companies to enable supply pipe leakage to be controlled as part of the companies' programmes, rather than relying on householders to find and control leaks. This was rejected however by the Government before privatisation on the grounds of cost and an inadequate case for transferring the responsibility.

The above options can be considered against the new statutory duty to ensure the efficient use of water introduced in the 1995 Environment Act. It is not yet clear how this will affect the policy of the regulatory bodies, and some questions remain over whether the onus falls on the water companies themselves or their customers to use water efficiently. Conceivably, the powers and responsibilities of OFWAT and NRA could be affected in a number of areas, e.g. in :-

Figure 7 WATER DEMAND FORECASTS



- providing guidance (e.g. on how to determine the economic level of leakage);
- setting regional guideline levels of leakage (e.g. along the lines of the NRA Southern Region figure of 6 l / property / hr);
- providing regulatory support for voluntary targets (e.g. through restrictions on price rises and reviews of abstraction licences against their achievement);
- requiring companies to declare the cost figures they use in determining the economic level of leakage.

Balancing Longer Term Demand and Supply

The Role of Meters

As discussed earlier, many still see charging for the actual amount used as the fairest way to pay for water, and the only way to provide a financial incentive to reduce consumption. Others express misgivings over universal metering - particularly because of the pressures it might place on those with lower incomes to reduce frequency of washing, toilet flushing, etc. with potential implications for health and hygiene. Combined with technical difficulties in meter operation and reading, many water companies have become more sceptical of the potential savings available through metering. The position has therefore changed since 1992 where water companies were being encouraged to introduce compulsory metering, and the Government now seeks for *"companies to extend the use of meters as far and as quickly as possible"*, recognising that this will take time and may need to be selective, concentrating on areas of potential water shortage, high-volume users and in supplies to new or refurbished properties. Since there is now no intention of making universal metering compulsory, the possibility is retained of continuing to charge for water on the basis of the rateable value of the property.

Even though the National Metering Trials are now complete, there remain a number of unresolved detailed issues, and areas where further information could help define the best role for meters, for instance:-

- Identifying where savings are made in household consumption as a result of metering (i.e. how far essential or luxury uses are constrained).
- The effect of different tariff structures on the use of water.
- Comparing the cost-effectiveness of metering relative to other methods of demand management such as public education, leakage controls and the wider use of water-saving devices. In this context, the NRA suggests that leakage control is more cost-effective than meters in saving water (13 and 89 pence per cubic metre saved respectively)
- Longer term studies to quantify possible' bounce back' of demand following initial reductions.

As already discussed, technical limitations are also a factor limiting meter use. Meters can be unreliable, there is no standard output across the industry (complicating the task of automatic reading) and there could thus be scope for collaboration between companies with the assistance of the Department of Trade and Industry to overcome these problems.

The Need for New Supplies

The earlier POST report looked at the estimated increase in demand over the next ten years for different areas, and the potential contribution to meeting that demand of metering, leakage control and more efficient use. Since then the Government has issued a consultation paper on the management of water resources (12) which, together with the 1994 strategy for sustainable development (25) shifted the emphasis more on to balancing demand and supply, rather than providing new sources of supply.

Most recently, the NRA has published its own strategy for the development of water resources (21). As shown in **Figure 7**, this presents a low-demand scenario to 2021 (8, 9) which coincides with the water companies' own low demand scenario. It predicts that demand will fall until around 1997 / 8 and then slowly rise, returning to the 1991 level around 2016 / 17. On these forecasts, no new resources would be needed for 20-30 years (allowing for some small local schemes), and in a 1995 policy document (13), the Government stated that *"existing resources should be used to the fullest possible extent, taking into account economic and environmental considerations, before additional resources are developed"*. This principle of managing demand to match supply has now been placed on a statutory basis through the duty on OFWAT and the water companies to promote the efficient use of water.

Under the high demand scenario, however, shortfalls for different regions are predicted as shown in **Table 5**,

Table 5 FORECAST DEMAND AND SHORTFALL

NRA Region/Area	1993/4 Demand (Ml/d)	NRA Demand Forecast Scenario					
		Low			High		
		Demand increase by 2021	Shortfall (Ml/d)	Shortfall as % of demand	Demand increase by 2021	Shortfall (Ml/d)	Shortfall as % of demand
Anglian	1663	18%	35	2.1%	37%	195	12%
Southern	1394	6%	21	1.5%	31%	152	11%
Thames	3521	-2%	56	1.6%	28%	867	25%
South West Area*	477	19%	3	0.6%	43%	124	26%
Wessex Area*	870	6%	20	2.3%	32%	201	23%
Severn Trent	2434	3%	41	1.7%	28%	577	24%
Welsh	1096	-1%	12	1.1%	18%	133	12%
North West	2397	-6%	0	0.0%	15%	164	7%
Northumbria Area =	828	6%	0	0.0%	16%	14	2%
Yorkshire Area =	1476	0%	0	0.0%	23%	261	18%
TOTAL	16156	2%	188	1.2%	40%	2688	17%

Table 6 POTENTIAL SAVINGS FROM DEMAND MANAGEMENT MEASURES (8)

OPTION	POTENTIAL SAVINGS (Ml/d) South & West	North & West	Total	Cost Effectiveness (p/m3)
Leakage control	900	1440	2340	13
Domestic recycling	820	460	1280	321-493
Domestic metering	650	410	1060	89
Low-flush WCs	550	300	850	18-172
Showers	390	220	610	94
Efficient washing machines	280	160	440	0
Urinal controls	90	50	140	9
Low-volume showers	25	15	40	102
Total Potential Saving	3705	3055	6760	-
1993/4 Distribution Input	9881	6274	16155	-
Potential Saving as % of Input	37%	49%	42%	-

leading to an excess of demand over supply, ranging from 2-26% by 2021. However, some regions (particularly the South) have greater shortfalls than others, and within regions different water companies face different problems. Under the high demand scenario there would need to be much greater success in reducing demand if significant new sources of supply are not to be required.

The scope for savings in water resources by a range of measures has been explored by the NRA (8), and is summarised in **Table 6**. Theoretically at least, the **potential** savings exceed the projected shortfalls. For instance, introducing just the three most cost-effective measures (washing machines, urinal controls and leakage controls) could save 2930 Ml/d, compared with the anticipated high-demand shortfall of 2688 Ml/d.

Such measures are, however, unlikely to be implemented *en masse* across the country, given the market failures and obstacles described earlier in this report, and some have suggested that there is a role for national schemes to encourage switching to water saving appliances. For example, some (10) have proposed a Water Savings Trust (akin to the Energy Savings Trust), which would provide grants to householders to switch to water-saving devices, with the money coming partly from a levy on existing bills and partly from investment by the water companies themselves (paid for through deferment of costs of providing new supplies and installing meters). However, the Government has stated that it has no intention of making the fitting of showers compulsory, nor of providing financial support for the installation of water-saving devices and appliances (13).

The previous POST report also noted that groundwaters in some cities were rising as the result of a decline in heavy water-using industries, and considered whether these waters could provide cost-effective new supplies, while providing other benefits such as reducing pumping costs and damage to buildings and tunnels. The Construction Industry Research and Information Association (CIRIA) has estimated that the costs of damage to buildings in London amounts to tens of millions of pounds, and London Underground estimates that it spends £1M each year in pumping and controlling groundwaters. Thames Water is working in conjunction with LUL and insurance and building firms to look at the feasibility of pumping to control rising groundwater, but the latest research indicates that for London this source of water would not provide a viable supply due to high treatment costs. However, if the full environmental costs could be considered together with savings through deferment of new capital projects, the financial viability may improve.

In Birmingham, the NRA concludes (22) that rising groundwaters could provide a viable source of up to 50 Ml/d to augment the River Trent or the canal system (at a capital cost of £4.4M). Other benefits of the scheme include improving water quality in rivers and canals around the city and avoiding pollution from groundwaters entering contaminated land. There are however, no plans at present to progress this scheme because of concerns over possibly high treatment costs if the groundwater is contaminated.

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GLOSSARY

%DI	Leakage as percent of distribution input
CIRIA	Construction Industry Research and Information Association
DWD	Drinking Water Directive
ELL	Economic level of leakage
LTA	Long-term average
LUL	London Underground Ltd.
NLI	National Leakage Initiative
NMT	National Metering Trials
NRA	National Rivers Authority
NW	North-west
OFWAT	Office of Water Services
PUAF	Public Utilities Access Forum
SDW	Sutton District Water Company
SW	South-west
WCA	Water Companies Association
WRc	Water Research Centre
WSA	Water Services Association
WSC	Water Service Company
WSOC	Water Supply Only Company