Water Management

Response from The Royal Academy of Engineering to the House of Lords Select Committee on Science and Technology

September 2005

1. Defining the problem

1a) *What are the causes of the current problems of water supply, and how serious are they?*

1.1 A major problem of water supply is caused by the rising demand associated with the increase in population in the South East of England. The number of households in this region has risen without a concomitant increase in water supply. This is especially problematic since the South East is the area of England with the driest climate. Problems will undoubtedly be exacerbated if housing development proceeds in areas that are already subject to water supply stress, e.g. Ashford and Thames Gateway.

1.2 There has also been a general increase in the demand on water supply from households. This demand increase is due to changing socioeconomic conditions which have led to greater ownership and usage of water using appliances such as washing machines and dishwashers. The nature of the demand from households has also changed, becoming increasingly 'peaky', with much higher demand in the Summer than the Winter months.

1.3 This pattern of demand is obviously in negative correlation to the pattern of rainfall, which is greater in the Winter than in the Summer. This seasonal discrepancy in rainfall is becoming more dramatic due to the effects of climate change, since climate change has led to wetter Winters and drier Summers, and to increasingly frequent occurrences of extreme weather. These effects are likely to become more severe in the future and will lead to problems of lack of raw water availability in the summer months, and to a strain on the treatment works and distribution systems during periods of high demand.

1.4 Climate change is therefore leading to general, long term problems of water supply, but there is also the more immediate problem of a recent sustained period of below average rainfall (9 months) which has depleted ground water resources, depleted stocks in reservoirs and led to low flow in rivers. Such problems of localised periods of low rainfall can and should be dealt with by restrictions on water use. However, since privatisation restrictions on water supply such as hosepipe bans have been treated as less acceptable by the media and the public.

1.5 Leakage has been a problem in the past and, as a result, it has received a great deal of attention by water companies. The improvements in this area are such that we are now at a point where further improvements would be too costly in comparison with the savings that they would deliver

1.6. Tougher legal safeguards to protect environmentally important sites have reduced the availability of natural supplies from which water can be drawn. Standards for drinking water have also risen but, the creeping contamination of water resources (such as increases in levels of nitrates in the water which is expected to worsen over the next 5-10 years) means that such restrictions have led to a reduction in deployable resources.

1b) *What are the projections for future water supply, and what factors will influence these projections? Where, and over what timescales, may problems emerge?*

1.7 Projections for future water supply are prepared by the Environment Agency and by water companies. These projections are generally taken to be quite adequate predictions of future water supply. However, some projections are based on plans produced by water companies in the south east which include figures for housing growth that are 20% lower than given in the Office of the Deputy Prime Minister's Sustainable Communities plan. Furthermore, these projections do not factor in increases in non-household use that will arise from the creation of employment for the members of these extra households

1.8 Reliable supply is likely to reduce in all parts of the country, due to a number factors. First there are the broadly social factors of growth in the number of households (significant housing growth being projected for both the south east and the south west regions), economic growth, socioeconomic changes and changes in behaviour (behaviour is likely to change as a result of increasing awareness of water supply issues, and potentially as a result of the implementation of water metering).

Environmental factors that will influence projections are higher quantities of wastewater effluent, depleting groundwater resources, future rainfall, eutrophication of reservoirs due to agricultural practices (which is expected to worsen over the next 5-10 years), and increases in nitrates in the water. Supply is also forecast to reduce over the next 5-15 years as a consequence of environmental legislation such as the Habitats and Water Framework Directives, and the Environment Agency's abstraction management policy requiring reductions to company abstraction licences.

1.9 Climate change is also a significant factor, and will affect future water supply in a number of ways. Higher temperatures will lead to higher levels of evapotranspiration. There will be reduced river flows in summer, meaning less and poorer quality water, and these lower river and groundwater levels are likely to lead to pressure to reduce abstraction. Lower dilution in reservoirs will result in water needing more treatment, and will exacerbate the problems of eutrophication. There will be more severe and frequent droughts, and hotter summers will tend to give rise to higher demand in the summer months.

1.10 Problems of future water supply will be most acute in the south east of England, where demand will outstrip supply in this region unless planned new resources are developed. Problems in this region will be much more prominent over the next decade.

1.11 There exists potential for much greater supply, but any increase will incur environmental and economic costs. A problem that threatens water companies' plans to increase supply is that many of those plans are dominated by major resource development, but implementation of such developments is lengthy (15-20 years) and fraught with uncertainties.

1c) *Is sufficient research being devoted to predicting, and handling, possible future scenarios?*

1.12 Research carried out by the Environment Agency and by UKWIR (UK Water Industry Research) is largely accepted as substantial and useful, especially as it involves input from the water companies, and therefore addresses real, live problems. The Met Office's Hadley Centre also carries out useful research into predicting future climate change. The research pursued in the shape of the Foresight scenarios produced by the Office of Science and Technology has some value, but its strategy of looking into all possible scenarios means that it tends to be too broad to be of practical use. Since it is not possible to plan for all eventualities, it is more valuable to focus on most likely scenarios.

1.13 However, there are still a number of uncertainties affecting possible future scenarios. These include both climate change and changing behaviour in the face of climate change, future housing growth, and the effects of metering. There is also insufficient research on the impact of the EU framework on the future water supply of the UK. There would be value in carrying out careful research on water transfer between companies, especially investigating whether it can be done without adverse impact on the supply-demand balance of the transferring company. Generally, there needs to be more collaborative work between water companies, focusing on issues of national interest and sustainability rather than common industry issues.

1.14 Research in this area is hampered by the fact that the UK does not have the state-of-the-art planning technologies of other countries. The hydrological models currently used for planning are based on limited data and solution techniques.

1d) *Is the response of the Government, the EU, regulators and the industry adequate?*

1.15 The 'twin track' model, focusing on managing demand, and on implementing new resources to meet demand, is generally appropriate. However, there is room for improvement in that, since the Environment Agency and Ofwat both tend to resist new development, the twin track approach has so far focused much more on decreasing demand than on building more resources. This is diminishing the 'slack' or 'headroom' in the system between available resources and demand, and means that in times of drought it becomes apparent that demand has outstripped drought-reliable resources. There is need, therefore, for an advocate for pro-development work, to establish a better balance between the two 'tracks'. In addition, the long planning times associated with implementing new resources

means that, although the water companies and regulators are aware of problems, they face difficulties in addressing them.

1.16 On the part of the regulators, Ofwat's role in developing a common framework for asset management planning centred on service quality has led to an improvement in asset planning. However, Ofwat's focus on keeping down prices inhibits actions that could prevent leakage, and its five-year regulatory period is too short for it to deal with the development of new resources. A clear and unified policy from Ofwat and the Environment Agency on issues such as metering and water conservation would be of benefit to public water supply.

1.17 Government could improve its response in a number of ways. Possibilities include amending building regulations to ensure that new houses have water efficiency incorporated into their design; exploring means of implementing water metering more swiftly; introducing financial incentives for grey-water re-use and sustainable drainage systems; and constructing innovative tariff structures to drive down demand in non-household sectors.

2. Supply and demand

2a) *What are the options for increasing water supply, and what are the arguments for and against?*

2.1 The following is a list of some of the options for increasing water supply, with brief comments on their respective benefits and drawbacks. Each of the options shares the drawback of incurring some environmental damage. A more extensive list is included as Appendix A

New reservoirs: this is the classical and most obvious response to water supply issues, as reservoirs provide a reliable resource, and can be used to capture the extra rainfall at times of low demand. However, they tend to meet resistance on environmental grounds, and there is a long period of time between initial planning and completion (up to 20 years). The capacity of some reservoirs may be extended by raising their dam/water levels, reducing the need to develop new reservoirs. Where available, a related option is to employ redundant quarries as a way of putting retired resources to good use presenting environmental benefits, but it would provide a low yield.
Desalination: the costs of this technology are falling, but plants are still expensive, consume a great deal of energy, and can be damaging to the coastal environment. Reverse Osmosis (the subject of proposals by Thames Water) presents an interesting option – the technology is improving, though again it is costly to run, requiring high levels of energy. However, plants could be used only when the need was felt – such as in times of high demand during the summer. The real costs of desalination depend of course on the salinity of the abstracted water – they are more cost-effective in estuaries than in coastal regions.

Groundwater development: this can be done at a relatively low cost, but will lead to low river flows and affect the riverine habitat.

Leakage control: much has already been done to stem water leakage, and further work in this area is likely to be uneconomic, especially as it is improbable that leakage can be eliminated entirely.

Licence changes: changes to current licensing restrictions could be carried out at no financial cost, but would be potentially costly in environmental terms. However, it is questionable whether all river abstraction restrictions are appropriate, and there may be value in examining current restrictions on abstraction licences.

Bulk transfers: this is an option in regions where adjacent areas have enough water to donate. However a national water grid, while it would even out geographical imbalances, is made infeasible by the costs of transporting water.

Water re-use: there needs to be more research into effective water recapture, recycling and re-use. Recycling of sewage works effluent is also a favourable option where the geographic setup is appropriate.

2b) *What are the likely future trends in water demand, and what can be done to manage demand more effectively, and to influence the behaviour of consumers and others?*

2.2 Household demand has risen steadily over the last 70 years and is likely to continue to rise into the immediate future. Household demand is also likely to become 'peakier' given climate change. However, it is also likely that increases in household use will slow after 10 years due to ownership of water using devices reaching 100%, appliances with greater water efficiency being introduced, and the increased penetration of metering. Non-household demand is likely to decrease then stabilise over the next ten years, due to the shift away from heavy industry and industry's recognition of the benefits of water re-use. It is possible that the rise in domestic per capita use coupled with increases in leakage control, reaction to climate change, and declining use by industry might lead to an overall decrease in demand by about 2030.

2.3 Metering represents the greatest opportunity for managing demand. It will be especially effective if introduced alongside sophisticated pricing structures such as: rising block tariffs; high season excess surcharges; volumetric charges for excessive users; special charges for owners of sprinklers and swimming pools; and special tariffs for industries with seasonal variations in use, such as the tourist industry. Even if the evidence is not clear that metering drives down overall consumption, it tends to lessen the phenomenon of high seasonal demand. To address the issues of costs involved in introducing metering, it may be helpful to introduce a programme of placing meters in areas of high demand, only bringing them into commission when house owners change. Installing meters in bulk like this, rather than only in response to individual demand, will mean a drop in unit price. However, there is a need for more sophisticated meters than those currently available if variable tariffs are to be implemented.

2.4 If metering is implemented the Government must takes steps to protect lower income families. It will also be necessary to ensure that water companies do not abandon their obligation to improve efficiency levels in order to maximise revenue, and to guard against the opinion amongst consumers that if they pay for their water, they can use as much as they choose to pay for.

2.5 There is a general need to raise awareness amongst the public of the value of water and to encourage them to be more responsible consumers. For example, it is important to promote public acceptance of hosepipe bans – which should be accepted as necessary during extended periods of dry weather. Water companies can play a role by giving more advice on saving water, including information about the water consumption of household appliances. For example, Water UK announced the launch of the 'WaterWise' initiative in 2005, building links between affordability and water efficiency and promoting the benefits of water efficiency to customers.

2.6 Demand can be further managed by introducing water saving appliances such as low water-consuming washing machines, dishwashers, low flush toilets, spray taps and push-taps which automatically stop, low-volume showers, trigger-gun hosepipes and so on. Central and Local government can also take action by making sure new public and private developments incorporate water efficiency into their design.

See Appendix B for an extended list of measures for managing demand.

2c) *What contribution can science, engineering and technology make towards reducing water use or waste by households, businesses and the public sector?*

2.7 Science, engineering and technology can play a useful role by developing the next generation of software tools to refine the distribution of water, and to gain greater accuracy in understanding the ways that water resource availability fluctuates seasonally and yearly. There is also room for

technological developments for managing abstraction, treatment, distribution and collection so as to avoid wastage and damage to the environment. This could include increasing the efficacy of wastewater treatment works to allow the use of recycled water, and the development of Reverse Osmosis technology.

2.8 There is also a contribution to be made via refinements to household commodities that use water to make them more water efficient – though they must also be cheap to fit and aesthetically acceptable. However, the demand for such items will only become sufficient to motivate such developments when household metering is made compulsory. The major issue concerning managing demand is that of changing people's habits and perceptions, and this is a political or social matter rather than an issue that can be addressed directly by science, engineering and technology.

3. Infrastructure

3a) *What is the current state of the water supply and drainage infrastructure? Is there sufficient investment in its improvement?*

3.1 Unlike in the past, there is now good awareness of the condition and performance of the water supply network. The network is reasonably well-maintained, generally stable, and its performance broadly optimal. The condition of the infrastructure has improved significantly since privatisation, after which there was significant investment by water companies. However, far less is known about the condition of the drainage structure, since Ofwat adopted the strategy of gathering information on only 15% of the network, and dealing with the remainder on a reactive basis.

3.2 There are nevertheless some threats to the water supply and drainage infrastructure. The system is working closer to capacity for more of the time than it has had to in the past. More frequent storms due to climate change might damage existing assets, for example, severe storms might highlight the under capacity of the storm sewer systems. Therefore, there is a need for further investment in the infrastructure, especially given the nature of past investment. For whilst water companies invested heavily in the infrastructure, the investments since privatisation were in short and medium life assets which need replacing more often, and hence investment in longer life assets will be necessary for them to be modernised and replaced in the medium to long term.

3.3 The infrastructure is currently managed via the concept of serviceability – according to current level of performance, rather than actual condition. However, serviceability is something that can only be assessed over the long term, which is at odds with the 5 year financing cycle of the water industry. Furthermore Ofwat's policy is to take as a benchmark for investment what has been spent historically, and this will mean stability in expenditure on renewing the infrastructure. But it is bound to be the case that the scale of investment will have to rise significantly in the future, since the scale and complexity of the infrastructure has risen vastly in the last 70 years. Hence, instead of seeking to suppress expenditure, it would be beneficial to identify those parts of the infrastructure that could be replaced now. There is a need for investment in the integration of drainage and water use – leading to more sustainable water management.

4. Context

4a) *The Water Act 2003 amended previous legislation in order to promote sustainability and water conservation. Is the legislative and regulatory framework, at national and European levels, adequate?*

4.1 The legislation is largely adequate, and it is appropriate that a duty of care should be placed on the water companies and Defra for the efficient use of water. However, the government should do more to raise public awareness of the challenges regarding water supply, and to explain the need for higher water charges. Government should do more to accelerate the introduction of metering, and should revisit legislation on banning disconnection as penalty for non-payment of bills, to ensure that the public are prudent users of the water supply.

4.2 There is a need to encourage Ofwat to pay more attention to the adequacy of water supplies, rather than focusing on keeping water prices down. Healthy competition between the Environment Agency and Ofwat could be encouraged to combat the general resistance to improvement.

4b) *How does water figure in the development of Government policy in areas such as housing, land use planning and industry?*

4.3 Water management appears to figure very little in the development of Government policy on housing, land use planning and industry. Water companies are not, but should be, statutory consultees in the planning process. Specifically, there is a real problem with the development of new homes in the south east. The developments are inadequately thought through in terms of the converse problems of flood risk (too much water) and water supply (too little). The Sustainable Communities plan should feature water more highly than it appears to, having directed housing growth to the area with the driest climate. Once involved in the policy process, water companies should also be given the means to implement the appropriate policy: financially; in terms of timely granting of planning permission; and by the acceptance of some degree of environmental damage.

4.4 There is a strong need for joined-up policy in relation to supply and demand from water companies, central and local government, and the regulators (Ofwat, Drinking Water Inspectorate and the Environment Agency). We must learn from New Orleans the dangers of becoming complacent in the face of the non-occurrence of predicted climatic risks, and hence being unprepared when disasters occur.

4c) *What can the UK learn from the experience of other countries?*

4.5 It is widely accepted that the UK is a world leader in the area of water planning and management but, there are lessons to be learnt from other countries. Metering is the norm in most developed countries, as are intelligent tariff structures, and penalties for non-payment of bills – Singapore and Holland are good examples for their use of meters, tariffs and itemised billing. Lessons can be learnt from countries such as Singapore that reuse water efficiently, and countries that use minimally treated seawater for toilet flushing.

4.6 Benefits may be gained from making water company resource plans public documents, giving the opportunity to open public debate about water as a valued resource. Exemplary countries with regard to water and land management policy are Holland, France, Germany, and other parts of the EU, Singapore, Australia, Japan, South Africa and the US. The situation in the UK might be improved if the more streamlined planning timescales of Singapore, France and other European countries were employed. Opportunities also exist to learn the value of research into water management as pursued in Australia and the US.

4.7 Following privatisation of the UK water industry, many of the UK water companies are now owned by non-UK organisations. This should ease the transfer of knowledge and experience gained in other countries.

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Appendix A: Options for increasing water supply

Option	For	Against
New reservoirs	• Reliable yield • Relatively low operating cost	• High capital costs • Planning issues • Environmental concerns • Loss of land • Lead time
Dam raising	• Low operating costs	• Dams not always suitable • Yield may not necessarily increase • Further land loss • Environmental concerns
Pumped storage	• Relatively low capital cost • Better use of existing storage • Low environmental impact • No loss of land	• High operating costs • Not all reservoirs are suitable
River intakes	• Little or no summer yield • Low capital costs	• Low capital cost • Poor water quality • Possible environmental concerns
Licence changes	• Virtually no costs	• Environmental concerns
Boreholes	• Usually good quality water • Incremental developments possible • Low environmental impact • Relatively low capital costs • Relatively low operating costs	• Not all areas suitable geologically
Aquifer recharge	• Low environmental impact • Relatively low capital costs	• Not all geology suitable • Mixed results from trials
Conjunctive use	• Effective use of existing system • Low environmental impact	• Complexity of operation • Water transfer costs high
Bulk transfers	• Effective use of resources	• Adjacent areas may not have surplus
Water grid	• Evens out surplus/deficit areas • Low environmental impact	• High operating costs • High capital costs
Desalination	• Reliable and unlimited yield	• High operating costs • High capital costs • Environmental costs
Redundant quarries	• Effective use of redundant workings • Environmental benefits • Low capital costs	• Low yield

Appendix B: Options for the effective management of demand

Option	Comments
Compulsory metering • Industrial premises • Commercial and public sector premises • Swimming pool owners • Sprinkler/hosepipe users • Households with an outside tap • Households in water-shortage areas • Households where a meter or meter box already exits	There are very few non-domestic properties in most areas which are not metered. Owners of swimming pools, sprinklers and power showers are required to register with the Company which retains the right to meter them.
Meter installation policy • Installation meters/meter boxes when premises change ownership - industrial - commercial and public sector - households	
Introduction of special fees • Introduction of separate additional fees for: - sprinkler users - hosepipe users - outside tap users - swimming pools	
Changes to existing measured tariffs • Discontinued declining block rate tariffs • Discontinued “neutral” charges • Increasing the volumetric charge • Introducing rising block volumetric charges • Introducing Summer/Winter or other seasonal tariffs • Introducing daily/peak/off-peak tariffs for at least some seasons • Charge only above a defined “subsistence” level of use (to protect low income families)	Some tariff structures require more intelligent meters than are currently installed.
Introduction of special tariffs for specific users • Introducing “interruptible” industrial supplies • Introducing lower charges for major users with significant storage • Introducing higher-cost “ban-free”	

sprinkler or hose pipe licences • Introducing spot pricing for selected customers	
Targeted water conservation information (advice on appliance water usage) • Industrial customers/bodies • Commercial customers • Households • Public sector (e.g. schools, hospitals, community groups) • Recreation facilities (parks and gardens, golf courses) • Designers of hot water systems, taps and water using appliances • Purchasers of water-using appliance (i.e. in showrooms) • Labelling water consumptions of appliances	This information is usually provided by water companies as part of their water conservation strategies but perhaps would be better if nationally coordinated.
Advice & information on direct abstraction and irrigation techniques • Drip vs. spray irrigation • Direct abstraction • Other techniques for reducing evaporation	Most water companies provide a lot of advice on the use of water in gardens and on irrigation techniques.
Advice & information on leakage detection and fixing techniques • Industrial • Commercial & public sector • Household • Agricultural	This type of advice and information is already given as part of companies' water conservation strategies.
Water saving devices • Appliance exchange programmes - washing machine - dishwasher - WCs - other • Company subsidy to appliance manufacturers • Company subsidy to consumers for the purchase of water saving appliances • Encouraging or requiring greater use of water saving technology in new and/or existing buildings (industrial, commercial, public sector and household) - fitting of showers - low volume shower heads - limiting purchase/use of	These devices are constantly being trialled and assessed by the water industry.

"power showers" - low flush toilets - dual flush toilets - fitting new toilets - composting toilets - waterless urinals - retrofitting existing toilets - shallow trap toilets - flush controller for urinals - timing devices - "people detectors" - self-closing taps (i.e. push operation taps that cut off the supply after a short time - spray taps - toilet bags cistern dams (by displacing part of the cistern volume, reduce the flush volume - hose activated by a spring loaded trigger mechanism - limited purchase/use of instantaneous water heaters/boilers - research and development into water saving technology	
Recycling and re-use • Encouraging or requiring indirect waste water re-use (i.e. abstraction downstream from the discharge of treated waste water e.g. for agricultural irrigation and industrial cooling) • Encouraging or requiring direct waste water re-use (i.e. use of treated waste water via pipes or other conveyance) • Encouraging or requiring water recycling (i.e. direct use of untreated "grey water") - industrial - commercial and public sector - household (e.g. using water from bath/showers/ basins for toilet use - fitting recycling systems in new houses - fitting recycling systems to existing houses	Where appropriate water companies encourage the use of recycling and "grey water". However it is essential that there is absolutely no risk of cross contamination with consequent risks to public health.