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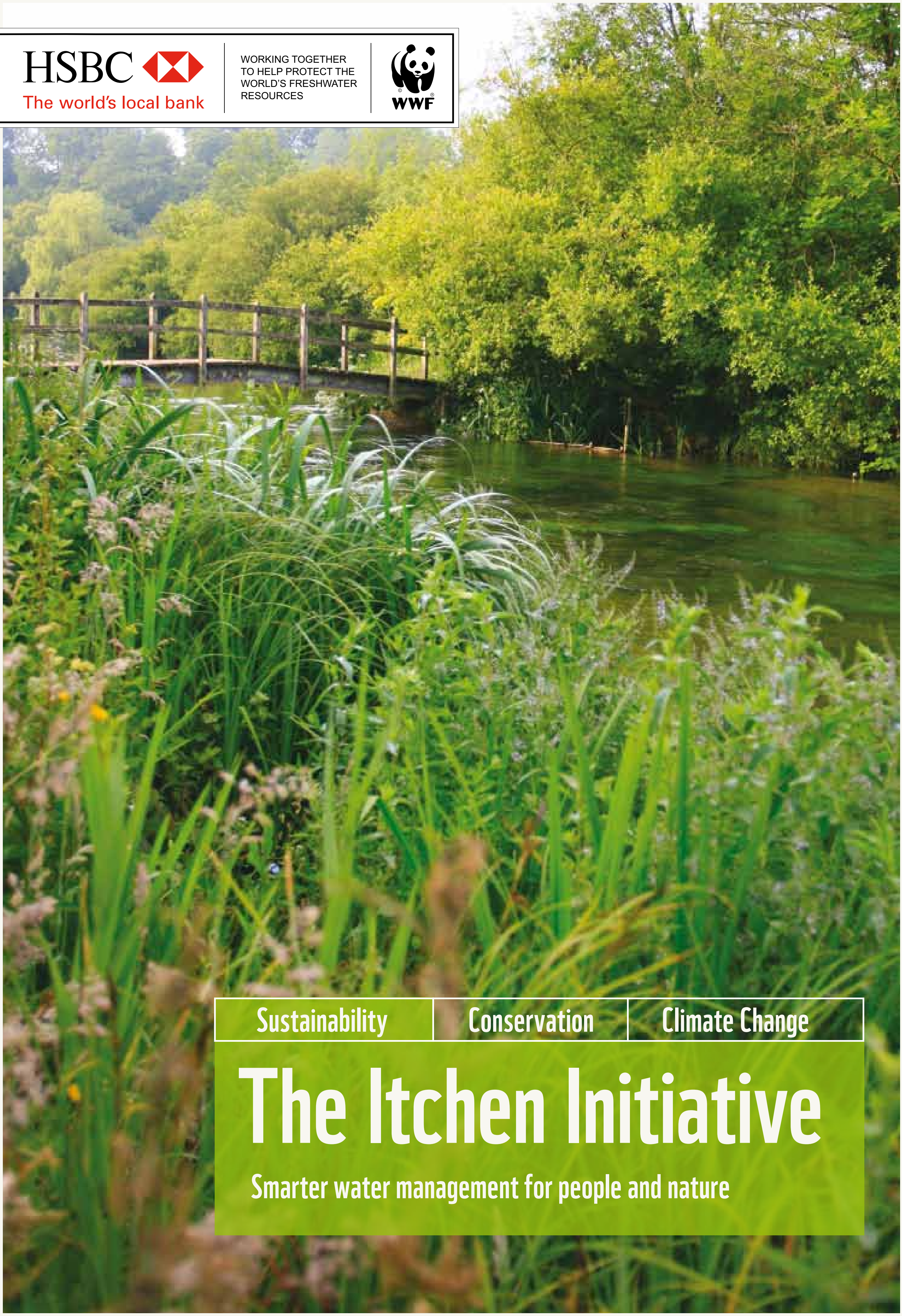

Sustainability | Conservation | Climate Change

The Itchen Initiative

Smarter water management for people and nature

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CONTENTS

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Rivers in the UK are home to an amazing array of wildlife that need full flowing rivers to survive. Protecting wildlife ranging from ducks and other birds through to increasingly rare species such as white clawed crayfish and water vole is just one of the reasons to reform the way we manage water in this country.

FOREWORD

Some time ago, I was walking with my wife near our home in the Chilterns. The path on which we were walking seemed particularly splendid in its design: wide, level, well maintained, with elegant trees on either side and comfortable gravel underfoot. After some time we came upon a bridge over the path, and it became apparent we were in fact not walking on a path at all, but the dried up bed of a chalk stream.

The Defra White Paper on the water industry provides an unmissable opportunity for delivering reforms that benefit people and nature.

David Nussbaum, chief executive, WWF-UK

This report sets out the reforms that are necessary if we are to restore this river, and the many other rivers and wetlands in our country that currently have too much water taken from them, and if we are to safeguard our natural heritage and water supplies in the face of climate variability and a rising local population. The reforms we propose here are based on a smarter approach to water: more flexible, cost-effective, and in tune with water's natural variability.

If these reforms are to be successful, they need to be substantive: the introduction of a selection of marginal initiatives resulting in limited incentives is unlikely to lead to the change in approach and mindset that is called for. Regulatory and policy leadership will be required. Yet, the costs of inaction and 'muddling through' are rising. We see this, for example, in the unnecessary costs associated with the piecemeal approach to metering or reducing over-abstraction, or the increasing inequities of a charging system that is still mostly based on property rateable value.

The forthcoming Defra White Paper on the water industry provides an unmissable opportunity for clear guidance on the pathway to delivering these reforms. This may include the need for legislation. But any changes that do not require legislative interventions should be adopted promptly. There is much that can be achieved in the 2014 periodic review, but we will need quickly to develop plans for action if we're to grasp this opportunity.

As well as developing policy and legislation, the government has an important on going role in providing leadership on the value of water. A clear, overarching narrative, that sets firm goals for the government, regulators, businesses and individuals, is vital.

Moving to 'smarter' water will require action by many people. There are clear opportunities for the separate economic and environmental water regulators to move in close step together to design smarter regulatory mechanisms for addressing environmental challenges.

Leadership is required not only from government. Much of the responsibility lies with the adoption of a different approach by abstractors and water companies. This involves companies developing and trialling innovative approaches, and being prepared to adopt a more proactive role towards their environmental responsibilities. Relying on regulators alone to set standards for sustainability is not compatible with modern corporate responsibility. There's a real opportunity for progressive water companies to take a lead in developing and trialling new, more sustainable and smarter approaches to water management, and for individuals and communities to value water and use it more carefully.

BACKGROUND TO THE ITCHEN INITIATIVE

The Itchen Initiative was launched to provide recommendations for the future of water management and regulation, in particular the reviews to be completed in 2011 by OFWAT and Defra.

The Initiative is named after the River Itchen, one of the world's most beautiful and iconic rivers, now threatened with over-abstraction of water to meet the needs of a growing population in the context of climate variability and change. The Initiative has brought together leading water industry and policy experts to develop a compelling and coherent response to these challenges. The Initiative is intended to inform, in particular, Defra's forthcoming White Paper on the water industry and Ofwat's review of the regulatory arrangements for the water industry in England and Wales.

We've brought together leading water industry and policy experts to develop a compelling and coherent response to the water abstraction challenge.

The Initiative has been based on a series of background discussion papers prepared by Colin Fenn, Rob Wilby, Waterwise, WWF-UK and an independent research report paper prepared by Policy Exchange[1]. Southern Water and South West Water have very kindly co-operated in testing some of the approaches proposed in this paper with their water resource system models. We extend our warmest gratitude to them both.

The Initiative has benefited from the advice and guidance of an Advisory Group composed of Lord Deben, Jonathon Porritt, Sir Graham Wynne, Tim Keyworth (Ofwat), Neil Whiter (South West Water), Meyrick Gough (Southern Water) and Professor George Yarrow. We'd like to express our thanks to the members of this group. The views and recommendations expressed are, however, those of WWF, and not the advisory group.

THE SCOPE OF THE ITCHEN INITIATIVE

We established the Itchen Initiative to identify solutions to the challenge of over-abstraction and its impacts on our natural environment, now and into the future.

As is now well recognised, these are already significant challenges, and both climate variability and an increasing population will make them more so. It is our vision that the water management policies, regulations and systems in this country should ensure that the water needs of the environment and people can be met, in a way that involves the least cost. In safeguarding our natural environment, these systems must be robust to climate variability and change, and ensure that the water needs of vulnerable customers are met.

RESTORING FLOWS TO RIVERS WILL REQUIRE CHANGE TO THE WAY WE MANAGE WATER. NEW ECONOMIC REGULATION AND CHANGES TO WATER LICENSING AND CHARGES ARE NEEDED TO CHANGE THE WAY INDIVIDUALS AND COMMUNITIES USE WATER.

Meeting this challenge will not be straightforward. It will have implications right across the way in which we manage water, including reforms to economic regulation, abstraction licensing, the basis on which abstractors and customers are charged for water, and the way in which individuals and communities use water. The inter-connected nature of these problems has, however, created challenges for the scope of our work. While it's clearly beyond this initiative to identify in detail reforms across all of these areas, nevertheless sustainable water use cannot be taken in isolation from these wider issues. While we believe that our recommendations encompass all abstractors, much of the discussion has focused on public water supply companies, as these constitute a very significant proportion of the challenge.

In response to this challenge, we have attempted to keep a focus on those issues that are central to ensuring environmental water needs are met with the least cost. This has meant, for example, a particular focus on the way in which environmental risks are recognised in the abstraction and regulatory regimes. We have also identified those areas where we believe supportive policy reforms are necessary to create the right conditions for more sustainable approaches. For example, we have noted the importance of developing social tariffs for water customers, and changes to the incentives around operational and capital expenditure in the economic regulatory regime. In these cases, however, it hasn't been the Itchen Initiative's role to develop recommendations in detail. Instead, we have identified the direction of reform that we believe to be required.

One important final point must be made about the scope of this report. Healthy freshwater ecosystems depend on a great deal more than simply adequate flows of water. We can put as much water as we like down a river, but if the quality is poor, the channel is a concrete trapezoidal box and the bed is obscured by contaminated sediment, then we are wasting our efforts. The Itchen Initiative has focused on one part of the overall needs of our freshwater systems: the challenge of water quantity. However, ensuring that investments in restoring and protecting healthy flows of water in our rivers are not to be money wasted will require that the other pressures on our rivers, lakes and wetlands are addressed at the same time. The implementation of the Water Framework Directive provides a wonderful opportunity to take just such an integrated view.

SUMMARY

Coping with water scarcity is recognised as an increasing challenge in England and Wales, threatening both our natural environment and the security of water supply for customers.

The challenge

Maintaining security of water supply represents a significant cost for water customers in the context of increasing concerns over affordability. The challenges associated with water scarcity are projected to increase very substantially over the course of the coming decades. We believe that a new approach is needed: an approach based around flexibility and incentives, and a clearer link between our use of water and the environment that provides it.

Limitations in the current system

Some important steps have already been taken in the direction of smarter water management, for example the development of Catchment Abstraction Management Strategies (CAMS), the initiation of the Restoring Sustainable Abstraction programme and significant progress on demand management in Ofwat's 2009 periodic review of water company business plans (PR09). These provide the basis on which further reforms can be built. However, there remain a number of important limitations to the current approach:

- There is huge uncertainty over environmental requirements. This uncertainty is inflating costs, hindering longer-term water resources planning, acting as a barrier to water sharing and trading, and acting as a constraint to resolving over-abstraction.
- At the rate of progress possible under the current mechanism for ending existing over-abstraction, it could take between three centuries and two millennia to reach sustainable levels of abstraction across England and Wales.
- In many places, basic environmental protections for rivers against abstraction are not in place. There are currently no incentives for companies and other licence holders to account for environmental impacts of the operation of existing licences, even in cases where such impacts are well recognised.
- Company plans to introduce demand management in areas suffering chronic over-abstraction have been turned down by Ofwat on the (legally justifiable but hydro-ecologically illusory) basis that these areas are in licensed water surplus. Unsustainable licences give the illusion of a healthy water surplus, when in fact rivers are running dry because of over-abstraction. This can result in Ofwat declining company plans to introduce demand management programmes in areas where the highest rates of water use in the country are drying out rivers.

- Current water planning methods significantly disguise the true costs of meeting peak water demand in dry years.
- The majority of water customers do not know or pay for how much water they use, and pay the same amount regardless of whether that water is scarce.
- There remain cultural barriers to the introduction of more widespread demand management.
- Water companies have tended to favour capital-intensive new supply solutions over alternatives such as demand management, trading water with neighbouring companies, and other operational expenditure solutions.

Beyond the average: understanding variability

Understanding variability is central to many of the concepts underpinning 'smarter water management'. A better understanding of the variability in both natural freshwater systems and the way in which people use water will allow us to identify more precise, targeted and cost-effective solutions to reducing environmental impact, reconciling supply and demand under increasing pressure, and maximising the value that we derive from the water that we use.

In many water supply areas, the costs of ensuring security of supply are driven in large part by peak water demand in dry summers. The construction of expensive, new infrastructure may not be the most cost-effective response to rare episodes of shortfall. Rough, back-of-the-envelope calculations suggest that in some cases the true cost of providing the water to run a sprinkler for an hour under peak conditions in dry years might be as much as £50. A series of alternative responses may be more attractive, including targeted demand management, tailored tariff setting, sharing of water between companies, spot trading arrangements, interruptible supply tariffs for bulk water users and, generally, solutions with low capital costs and high, but infrequently incurred, operating costs.

A significant proportion of peak water demand is driven by outdoor water use, implying a very significant cross-subsidy from less affluent to more affluent homes under current water supply tariffs. In the absence of smart meters and tariffs, this cross-subsidy cannot be addressed.

Given the spare capacity that exists in company supply systems most of the time, significant scope exists for water companies to modify the operation of their existing systems to reduce environmental risk. No incentives currently exist to encourage companies to factor environmental risk into the way in they operate their systems, with minimising operating costs being the chief driver of operating practice between (infrequent) times of shortage.

Modelling work undertaken by this Initiative on the Dart and the Itchen has demonstrated the potential for reductions in environmental impact through flexible network operations based on environmental risk and the use of variable abstraction quantities tied to the prevailing flow or level. While this modelling work is only preliminary, it indicates that some reductions in environmentally damaging abstraction may be achievable through either or both of these mechanisms, at low cost.

On this basis, we identify two major opportunities that can be realised through a move to a smarter water management system:

1. Innovative and flexible approaches to ending damaging abstraction have the potential to deliver environmental benefits at significantly lower cost than the approaches currently adopted.
2. A range of flexible solutions to reconciling supply and demand remain available and under-utilised, due to a range of regulatory, methodological and cultural barriers.

Realising these benefits will require reforms to our water management regulations and incentives so that environmental values and risks are better and more accurately reflected; signals over scarcity and the value of water are given to abstractors and water users; and, regulatory and planning biases towards fixed, capital intensive solutions are removed. We set out below the recommendations that are required to achieve these reforms.

1 **Abstraction licences should permit different volumes of abstraction at different levels of water scarcity, with increasing restrictions on water withdrawals as river and groundwater levels decrease. More widespread use should be made of 'security of supply' licences to be used only under certain conditions.** The levels of these 'smart' restrictions will need to vary in different systems, depending on the nature of environmental risks. Smarter approaches using hands-off flows and seasonally varying limits on abstraction quantities are already in use in a number of places across England and Wales, and some water resources systems have operating rules involving flow-related variable abstraction permissions. However, there is significant opportunity to bring these approaches into the mainstream, implementing smarter conditions on the majority of licences.

2 **Incentive mechanisms need to be developed to indicate where abstraction of water is subject to higher environmental risk, in particular to influence the day to day operational decisions of water abstractors.** One of the key opportunities to emerge from the discussions undertaken through the Itchen Initiative is the potential for significant, low-cost environmental improvements through changes to the operational procedures of abstractors and water companies. This may not always require changes to licences. The development of a mechanism to signal these opportunities is a high priority for achieving cost-effective environmental improvements. A number of mechanisms could achieve this objective, for example the use of price signals or the development of a mechanism through the price review process.

3 **The existing CAMS process should be developed to establish long-term, catchment-based abstraction targets in time for these to be incorporated in planning ahead of the next periodic review in 2014. Scientific assessments of abstraction risks and targets should be separated from decisions over licence changes and compensation.** There is an urgent need for clarity over future environmental limits on abstraction to enable long-term planning and a smooth transition to sustainable abstraction. Such an approach to a broader assessment of damaging abstraction should reflect differing levels of risk, rather than simply identifying sustainable or unsustainable abstraction. This would enable a more sophisticated investment response in the context of inevitable uncertainty. It would also provide companies and other regulators with a basis on which to develop more flexible, operationally-based responses. The process of establishing clear, national environmental objectives for abstraction is likely to require increased resources for the Environment Agency during the transition, which could be funded by a temporary increase in the abstraction charge.

4 **An incentivised, step-wise approach should be developed to end current damaging abstractions.** Given the very high total costs that are potentially involved in addressing the legacy of historical licences, it is essential that the costs associated with the transition from unsustainable to sustainable abstraction are minimised. This requires a process that is incentivised, long-term, broad-scale and smart. A number of mechanisms are possible and, in particular, Ofwat needs to consider these as part of developing its approach to the 2014 price review.

5 **The government should set out a strategy to implement near-universal smart water metering by 2020, coupled with a national policy on social tariffs. Smarter tariffs that better reflect scarcity and the marginal cost of providing water should also be developed.** Evidence suggests that households with meters reduce consumption by 10% to 15%, with up to 30% reduction in peak week water use. The information a smart meter provides makes a vital contribution to smarter demand management and, supported by development of social tariffs, can help address current affordability issues. Better signalling through smarter tariffs of the high cost (financial and environmental) of providing water to meet peak demand during dry periods will further reduce demand and remove the existing cross-subsidies from low ‘peak’ water users to (typically more affluent) high ‘peak’ water users, while providing the choice to those who do wish to pay a high cost to use water under these circumstances.

6 **Companies should develop a more targeted approach to demand management. Ofwat should reform its water efficiency target to support this, and agree a mechanism to allow cold water efficiency to be delivered through the Green Deal.** Targeted demand management can achieve more significant impacts by focusing both on those times when water is scarce and those users who offer the greatest scope for saving.

All the water we use – flowing freely from taps in our homes, schools and businesses – is taken from the natural environment. This action of taking water from our rivers, chalk aquifers or reservoirs means there is less for our precious native plants and animals that need it to survive.

7 **Companies should develop smarter demand responses to below average rainfall and peak demand.** While water companies already make use of responsive demand management during and in anticipation of droughts, there are significant opportunities to extend (non-mandatory) management of demand in periods of below average rainfall in normal years, dry years and peak demand periods. There is also scope to target better and enhance demand-side responses during drought events.

8 **Ofwat should change regulatory incentives to mitigate against bias towards capital-intensive solutions.** It is likely that the water companies' bias towards capital expenditure arises in part as a consequence of incentives in the price regulation regime. But there may also be important cultural drivers. As part of its current review of regulation, Ofwat should identify ways to mitigate companies' bias towards capital-intensive supply-side solutions. One approach would be for Ofwat to capitalise a fixed percentage of certain costs across both capital and operational expenditure in the Regulatory Capital Value, so that incentives would be equalised between capital and operational solutions.

9 **Reforms should be introduced to provide incentives to increase innovation in the water sector and to encourage the identification of a greater diversity of approaches to matching supply and demand.** A number of reviews, including that by Professor Martin Cave, have identified lack of innovation as a challenge for the water sector. In this context, innovation need not be confined to technical improvements that allow the same activities (for example leakage repair) to be delivered at a cheaper cost; it also encompasses new ways of meeting objectives, including approaches requiring more cooperation between companies. A number of market and regulatory mechanisms have been proposed that are designed to stimulate innovation and the development of alternative approaches. The chief challenge appears to lie in innovation (adoption and take-up of new ideas and technologies) rather than in invention (the development of new ideas and technologies).

10 **Reforms to the water resources planning process should be introduced to provide greater transparency and consistency over costs and options, and to ensure that environmental values are better recognised.** Water resource planning provides the basis by which options are identified and investments are selected. There are significant opportunities to improve the transparency and consistency of the current approach. Taken together, we believe that they would provide a fairer treatment of demand-side measures; remove the potential for bias towards over-investment in capital-intensive solutions; factor the environmental value of water into decision-making; and increase the transparency associated with the costs of new investments, and who pays for them.

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Looking to the future for water security in the UK, it is essential that we implement smarter water management to keep our rivers full flowing and supporting a strong ecosystem.

FIT FOR THE CHALLENGE?

The current arrangements for the management and regulation of the water industry were designed at a time when we faced different challenges.

WE NEED SMARTER APPROACHES TO MANAGE WATER RESOURCES IF WE ARE TO MEET THE GROWING CHALLENGE ASSOCIATED WITH WATER SCARCITY AND ITS VARIABILITY.

In the era leading up to and following privatisation of the water industry, concern over the water quality impacts of poorly treated sewage effluent was the predominant environmental water management issue in England and Wales. The combination of the appallingly polluted state of many rivers and near-shore waters in England and the introduction of a series of European water quality directives led to a significant investment programme to address these issues. This was accompanied by the development of a robust process for identifying and selecting water quality investments. There has, however, been less focus on the environmental issues associated with water scarcity until comparatively recently. As a consequence, the approach to managing scarcity in a sustainable way is less well evolved.

We need new approaches to the management of our water resources if we are to meet the growing challenge associated with water scarcity and its variability without continuing and exacerbating unacceptable environmental impacts. We call this new approach ‘smarter water management’: an approach based around flexibility and incentives and a clearer link between our use of water and the environment that provides it.

This chapter sets out briefly the main challenges associated with water scarcity and variability in England and Wales, and the future trends that are likely to exacerbate these challenges. It concludes with an introduction to some of the most significant anomalies in the current water management framework.

Current challenges

Environmental damage from over-abstraction

The negative impacts of water abstraction on freshwater ecosystems are increasingly being recognised. The majority of the current water abstraction licences were issued in the 1960s when concerns about over-abstraction were not as significant as they are now. As a consequence, suitable safeguards were not included in these licences[2].

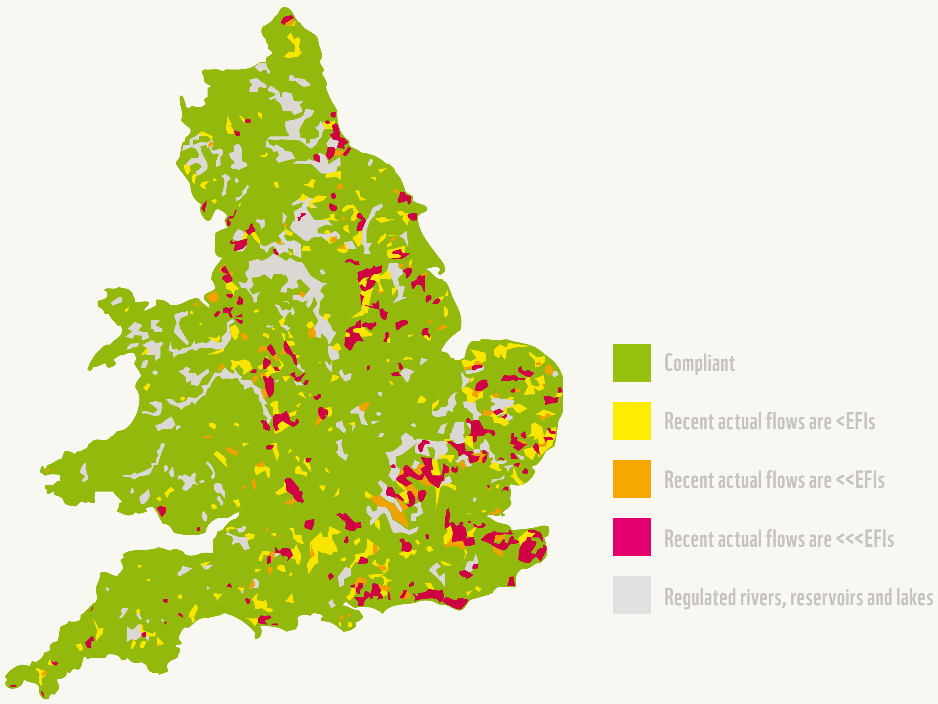
3.3 BILLION

THE ENVIRONMENT AGENCY ESTIMATES THAT UP TO 3.3 BILLION LITRES OF WATER IS ABSTRACTED EVERY DAY OVER AND ABOVE THE SUSTAINABLE LEVEL.

Depicting the overall extent of the environmental problem due to over-abstraction is not straightforward. The impacts of abstraction on freshwater ecosystems can be complex and can vary significantly between freshwater systems. Importantly, as we will consider later in this report, these impacts are variable in time, with environmental damage being more likely to occur under conditions of water scarcity, i.e. during periods of low rainfall and/or high water demand. A number of attempts have been made to provide an overall characterisation of the problem. For example, the Environment Agency has estimated that in England and Wales on average between 1,100 and 3,300 million litres more per day is abstracted than the environment can sustain; this is equivalent to between 5% and 15% of the total water supplied[3].

The Environment Agency has made a number of efforts to represent the spatial distribution of the over-abstraction problem. While there are challenges with any such effort, they can provide a preliminary indication of the extent of the problem. In 2010, the Environment Agency published a map (Figure 1.1) based on actual abstraction volumes. Abstraction volumes were compared against indicators of sustainable levels of abstraction developed as part of the Water Framework Directive (WFD) implementation process. The result provides an indication, albeit imperfect, of the current geography of over-abstraction. This depiction may, however, hide over-abstraction impacts in 'flashy' (rain-fed) catchments in the north and west of the country during short dry periods (for example, in the summer of 2010 in the north-west of England); and it gives little indication of the temporal variability of damage.

Figure 1.1: The over-abstraction challenge in England and Wales.



Source: Recreated from Environment Agency, Managing Abstraction, June 2010

Case study: the River Beane

The river Beane springs from the Hertfordshire chalk before winding its way, for 12 miles or so, to meet the river Lee. The Beane was once a chalk stream. Gin-clear water flowed through watercress farms and a watermill in the headwaters and locals enjoyed fishing, swimming and boating on the upper parts of the river. But in the 1950s boreholes were sunk beneath the Beane to provide Stevenage with water. Contemporary accounts report that river levels fell noticeably, milling and local watercress farming ceased and good fishing virtually disappeared[4].

The major pumping station on the Beane at Whitehall abstracts up to 22.7 million litres a day (Ml/d). This causes the middle section of the river to be heavily depleted. The river is regularly dry in its upper reaches (some five miles from the source), and often the dry stretches of river extend for long periods and distances. In summer months, the lower reaches of the river are heavily supported by urban water run-off from Stevenage. The Environment Agency's CAMS assessed the Beane to be 'over-abstracted with insufficient flows to meet the environmental need at all times, even at times of high flows[5]'. It found that actual abstraction (from the chalk) was equivalent to 76% of the natural low flow that would normally be exceeded 95% of the time. This results in a large deficit between current river levels and those the environment needs to be healthy.

Water availability and pollution

Pollution of water resources, in particular groundwater resources, places further constraints on water availability for use. Almost half of the groundwater used for public water supply requires blending with water from other sources because of the level of pollutants. Over 140 groundwater sources have had to be closed because of water quality problems since 1975, resulting in a loss of 425 million litres per day in available output[6].

Affordability and cost

Maintaining security of supply for customers represents a significant cost for water customers. In PR09, the water companies of England and Wales committed to new capital investment of £1.4 billion in order to meet security of water supply for customers[7]. This investment is in addition to a significant capital maintenance programme.

Average household water bills in England will be £340 per year in the period from 2010-2014, with much higher bills in some areas[8]. Water and sewerage bills have risen by 44% above inflation since privatisation in 1989. While Ofwat has largely constrained price rises from 2010 to 2015, the plans to 2015 contain relatively little progress to address over-abstraction, which will be further exacerbated by trends discussed below. Nor do the plans address the potential impacts of climate variability and change. There are therefore ongoing concerns over the ability of vulnerable customers to afford to pay their water bills.

60.7M

THE POPULATION OF ENGLAND IS ESTIMATED TO INCREASE FROM 51.5 MILLION IN 2008 TO 60.7 MILLION IN 2033.

Future trends

The challenges associated with water scarcity are projected to increase very substantially over the course of the coming decades, owing to a number of factors: increasing demand, climate variability and change, the increasing cost of meeting the supply/demand balance, and the cost of addressing the legacy of environmental impact bequeathed by our current water management systems and infrastructure.

Increasing demand

Increasing demand for water is being driven by a growing population, coupled with the potential for increased demand for water per user if this is unmanaged. Latest projections from the Office for National Statistics estimate that the population of England will increase from 51.5 million in 2008 to 60.7 million in 2033[9]. Much of this growth will be focused in the already water-stressed south and east of the country. If this increased population were to consume water at current national averages, this could be an increase of around 1,500 Ml/d – equivalent to 10% of current water company abstraction across England and Wales.

Deriving reliable estimates of future changes to levels of per capita demand is problematic. Per capita demand varies considerably between water company areas, from as high as 178 litres per day (l/d) in some (unmetered) areas to as low as 110 l/d in other (metered) areas[10]. Notably, demand is highest in the south and east of England, where population growth is expected to be the greatest. Future per capita demand will be determined by the extent and success of demand reduction technologies, incentives and programmes, and, critically, by individual awareness and behaviour. As a consequence, the Environment Agency postulated that the current national average dry-year per capita consumption of 150 l/d could range between 130 l/d in some areas, to as high as 160 l/d in others, by the early 2030s[11]. Bringing population, economic growth, lifestyle and demand projections together, the Environment Agency estimated four scenarios for future water use by the 2050s which ranged from an increase of 35% to a decrease of 10%[12]. The latter is predicated on the introduction of widespread and effective demand management measures, and their committed uptake by water users, particularly in domestic households.

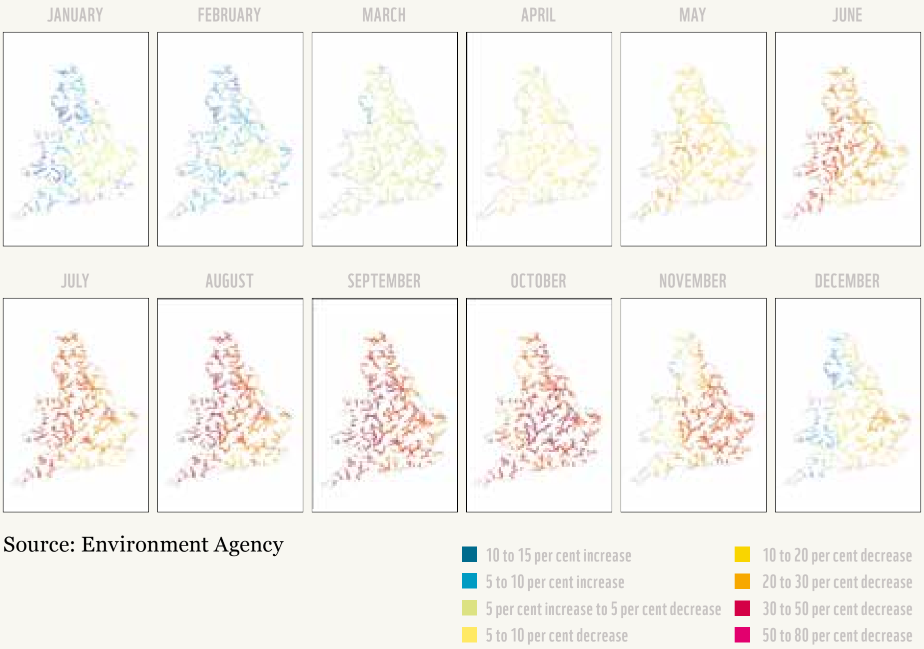
CLIMATE MODELS SUGGEST MORE VARIABILITY AS WELL AS A SHIFT TO WARMER, WETTER WINTERS AND WARMER, DRIER SUMMERS.

Climate variability and change

One of the key impacts of climate variability and change on the UK will be through changes to the hydrological cycle. While these impacts are difficult to predict with accuracy, the UK Climate Impacts Programme (UKCIP) models in 2002 and 2009 projected a future in which England experiences wetter winters and drier summers on average, with rainfall events becoming more intense. Both of these trends are likely to place an increased pressure on water resources and the freshwater environment, with less water available when water is scarce in the summer, and reduced recharge of groundwater aquifers as a result of more intense rainfall events. Current predictions also indicate increases in the frequency and intensity of events that are now considered to be extreme: flood flows, droughts and heatwaves of a given severity are predicted to occur more often. The forecast is for more variability as well as a shift to warmer, wetter winters and warmer, drier summers. If these projections are realised, the challenge for water resources management is getting greater.

On the basis of the UKCIP 2002 assessments, the Environment Agency calculated impacts on monthly average river flows in England and Wales (see Figure 1.2). Even given the uncertainties inherent in such projections, these estimates give a sense of the scale of the problem.

Figure 1.2: Percentage change in the mean monthly flow between now and the 2050s using the medium high UKCIP02 scenario.



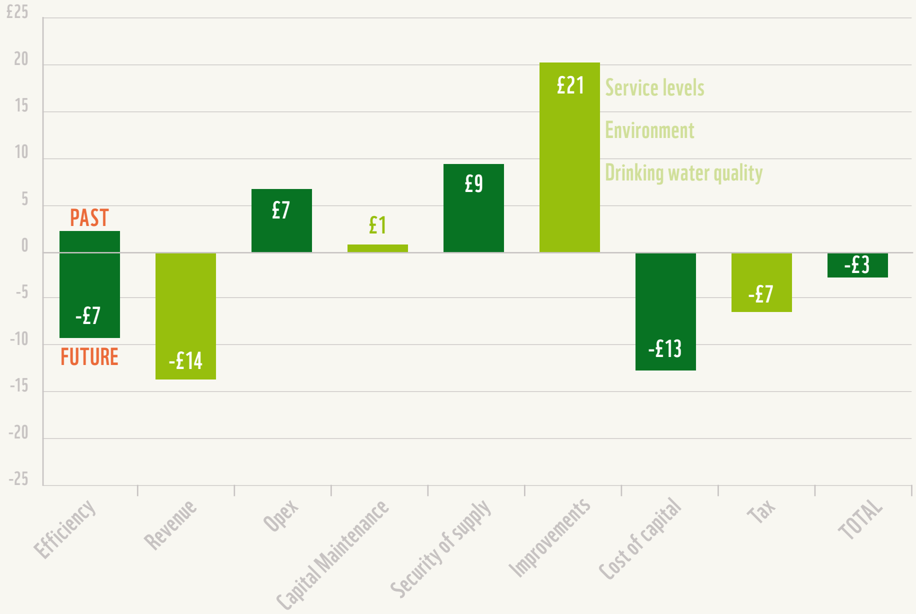
Source: Environment Agency

The increasing cost of security of supply

The cost of meeting increasing demand for water will, in general, rise over time in the absence of innovation. The lowest cost options for meeting supply have been and will continue to be utilised first, meaning that increasingly more expensive options are required as subsequent demand rises. The regulatory regime in England and Wales is actively designed to pursue this outcome. It requires companies to select the least cost options to balance supply and demand. With each subsequent planning cycle, more expensive options will be required unless innovative new options can be identified.

This trend was reflected in PR09. Figure 1.3 shows that, while many factors were driving a decrease in water bills, these were offset by other factors driving increases. The increasing cost of maintaining security of supply is second only to a group of 'improvements' (service levels, environment and drinking water quality) in driving prices up. In other words, ensuring security of supply is the most costly element of maintaining the current service to customers.

Fig 1.3: Factors driving change in average bills 2009-10 (£343) to 2014-15 (£340).



Source: Ofwat, Media Briefing – Final Determinations, presentation, 26 November 2009

Addressing the environmental legacy

Patterns of abstraction resulting from historical water resources management, infrastructure and regulatory systems are causing significant environmental damage. Legislation in the last 20 years has driven a significant programme of investment to address the water quality legacy. The more holistic approach introduced under the WFD will now broaden the focus so that historical abstraction and water quantity issues will need to be addressed. This is likely to require new measures that will reduce the amount of water that abstractors can take from some existing sources of supply. This will add a further constraint to the ever-tightening balance between supply and demand.

First steps in the right direction

A number of important steps have already been taken in the direction of smarter water management. These provide the foundation on which a further round of reform can be built. In many cases, the reforms that we propose in this report do not require the development of entirely new approaches, but instead the broader and more consistent implementation of existing innovative approaches.

Catchment Abstraction Management Strategies (CAMS)

The CAMS process was the first attempt to take a catchment approach to managing abstraction – identifying available resources and the location of potential over-abstraction problems. This has provided the basis for capping the issuing of new licences in fully or over-abstracted catchments. However, the CAMS assessments haven't provided enough information with a suitable degree of confidence to enable regulators and companies to make decisions about measures to reduce existing over-abstraction, nor have they removed the uncertainty over future environmental requirements.

The Restoring Sustainable Abstraction scheme (RSA)

The current RSA programme has started the process of addressing existing over-abstraction. It has completed over 300 investigations into the environmental impact of abstraction across the country, and 148 schemes are being further 'examined to identify the most effective restoration solution'[13]. There has been agreement to fund (through water bills) 61 schemes to implement reductions in abstraction licences for Habitats Directive sites by 2015, and there has also been agreement to compensate a water company for two licence reductions through the Environment Agency's compensation scheme (relating to abstractions by United Utilities from the Brennand and Whitendale rivers)[14]. As explained in section 1 below, however, this scheme would take over three centuries to address the scale of the problem that has been identified by the Environment Agency, and is currently confined to site-by-site approaches rather than comprehensive, catchment-based ones.

The development of 'hands-off flows' and smarter licence conditions

31%
OF SURFACE WATER LICENCES AND 1% OF GROUNDWATER LICENCES NOW INCLUDE 'HANDS-OFF' FLOW CONDITIONS.

In general, water licences do not include conditions to protect environmental water needs beyond annual, daily and (sometimes) hourly abstraction limits. However, licences that have been issued more recently by the Environment Agency have included conditions designed more specifically to protect the environment, including the use of seasonally varying licensed quantities and 'hands-off' flow conditions that identify the flows in the river below which abstraction must cease. Some 31% of surface water licences and 1% of groundwater licences now include 'hands-off' flow conditions[15]. There are also examples of smarter approaches to licensing that seek to balance environmental requirements and security of supply in a more sophisticated way. These include the dynamic operating rules in the Lower Thames Operating Agreement, where security of supply is balanced against the environmental requirements of the river such that at times of severe low flow increased abstraction is only permitted with the progressive imposition of more intensive customer water use restrictions. Some water licences also exist that may only be used under conditions of scarcity. A good example of the latter is the West Berkshire Groundwater Scheme which contributes approximately 70 Ml/d of the London Water Resource Zone deployable output, but the scheme may only be used when a hosepipe ban has been imposed.

Progress on demand management in PR09

In PR09, Ofwat approved plans from six companies for large-scale water efficiency retrofit projects and proposals for more water meters from a number of companies, including Southern Water's Universal Metering Programme.

Case study: Southern Water's Universal Metering Programme

Southern Water is installing half a million meters over the five years to 2015. This will increase the proportion of metered households in its supply area from 40% to 92%, help reduce water consumption and, in turn, reduce abstraction from the environment. The new 'automated meter reading' meters are smart meter compatible, and will be supported by informative bills, customer feedback devices, home water audits and a water efficiency campaign. New tariffs, developed in consultation with customers and Ofwat, will ease the switchover to paying by meter and help to protect vulnerable customers. Significantly, the new meters will help Southern Water better manage its resource network, understand consumption and identify and fix water leaks. For example, the meter will alert the company to leaks in the supply pipe of the property itself (e.g. leaking toilet cisterns or dripping taps) enabling its leakage response team to fix supply pipe leaks and feed back information to customers. It will also enable an improved understanding of water use. WWF is working with Southern Water to help communicate the benefits of metering to customers, focusing on the benefits to the natural environment.

Emerging anomalies in the current system

Even though progress has been made to date, more needs to be done to address the growing pressures identified above. We set out here some of the most significant current challenges and anomalies that need to be tackled.

1 **There is huge uncertainty about environmental requirements. This uncertainty is inflating costs, hindering longer-term water resources planning, acting as a barrier to water sharing and trading, and acting as a constraint to resolving over-abstraction.**

The current programme for ending unsustainable abstraction has not yet provided clarity on the overall scale of reductions in abstraction that will be required. The RSA programme has been driven by a number of different pieces of legislation. It focuses on particular sites, rather than being a process to reach a comprehensive view on future abstraction limits across whole catchments. As such, it provides only piecemeal guidance on the extent to which over-abstraction will need to be redressed. Some broader, catchment-scale assessments of flow requirements are now being undertaken.

This lack of clarity is currently hindering the ability of water companies to develop sustainable long-term water resource plans. For example, water companies were told that they should not incorporate any reductions in abstraction to meet WFD objectives into the 25-year Water Resource Management Plans that they published in 2009. Similarly, the current piecemeal approach to reducing damaging abstraction means that companies are unable to develop optimal, longer-term solutions to matching demand and supply across their networks. The cost of meeting environmental requirements is being driven up as a consequence.

Uncertainty over future environmental requirements is acting as one of the primary constraints to increasing water trading and sharing as a mechanism for reducing the cost of meeting demand. In the context of uncertainty over the sustainability of existing water rights, water trades need to be subject to an intensive application-based assessment by the Environment Agency. The volume of water licensed is often significantly reduced in the process[16]. The lack of long-term clarity is also a significant constraint to long-term water sharing arrangements between abstractors.

Case study: Uncertainty over future sustainability requirements is driving up customer costs

The types of costs associated with uncertainty over future environmental requirements are well illustrated by a case from the 2009 price review. In the lead-up to the review, one water company facing significant challenges in meeting a supply-demand shortfall identified a redundant groundwater licence in the region that was available for trade. The licences were for a significant volume of water (in excess of 20 Ml/day), and were available for a price several times less than would have been required to develop alternatives to meet demand. However, the area has a number of sites subject to ongoing investigation under the RSA programme, and investigations on the status of current abstraction levels are not due to be completed until 2012-13. Due to this uncertainty over the sustainability of the existing regime, the Environment Agency was unable to provide approval for the trade in time for it to be included in the company's PR09 business plan. The more expensive options had to be used instead. The additional cost of investment required that could have been avoided by the trade may have been as high as £50 million in this case.

2 The current mechanism for ending existing over-abstraction could take between three centuries and two millennia to achieve sustainable levels of abstraction.

The RSA programme is the current mechanism for ending over-abstraction. This focuses on a number of specific sites of higher conservation value, including Habitats Directive sites and Sites of Special Scientific Interest (SSSIs). At present, it does not focus on all river catchments at risk and subject to the WFD.

TWO
IT COULD TAKE UP TO TWO MILLENNIA TO REACH SUSTAINABLE LEVELS OF ABSTRACTION IF WE PURSUE THE CURRENT MECHANISM.

Through the RSA programme, compensation is paid to licence holders in return for amending or revoking an abstraction licence[17]. This allows water companies to invest in replacing any lost resources through new demand management and/or new supply schemes. For other abstractors, it offsets any lost revenues. Under current arrangements, costs for resolving over-abstraction of Habitats Directive sites by water companies are funded through the periodic review process. All other costs, including remaining non-Habitats Directive water company abstractions identified under the RSA programme, and all non-water company abstractions, are met through the Environment Improvement Unit Charge (EIUC) compensation scheme.

The EIUC is a supplementary levy raised through the abstraction charging regime. It is designed to develop a fund that can be used to provide compensation for the revocation of licences identified under the RSA programme. In total, the funding for water companies to redress over-abstraction of Habitats Directive sites through the periodic review totals £350 million. In addition to this, the EIUC scheme is expected to raise and spend around £100m over 10 years to compensate other water company and non-water company RSA sites.

In addition to the sites already identified under RSA, the eventual task of meeting the requirements of the WFD must be considered. This requires addressing all the natural environments at risk from over-abstraction. While no final guidance was provided in the 2009 River Basin Management Plans as to the changes to abstraction that would be required to meet the WFD, some preliminary indications of the scale and cost were provided. The total cost was indicated at between £3.6 billion and £25 billion[18]. Under current policy arrangements these costs would need to be met through the EIUC. On the basis that the EIUC has generated £100 million over the last 10 years, it would take between 350 and 2,500 years to achieve the reductions in unsustainable abstraction indicated in the WFD River Basin Management Plans.

3 There are currently no incentives for companies and other licence holders to account for the environmental impacts of the operation of existing licences, even in cases where such impacts are well recognised. In many places, basic environmental protections for rivers against abstraction are not in place.

The most basic protection that may be included in water abstraction licences to prevent damage to freshwater ecosystems is a hands-off flow condition, which requires abstraction to cease when river flows reach a stage at which the environment is at risk. Other than hands-off flow conditions, which are only in place on a minority of licences, the current regulatory and licensing systems provide no other incentives or signals to abstractors with respect to the negative environmental impacts that their existing abstraction licences may be having, even in cases where the occurrence of such impacts is well recognised. Abstraction charges are levied on the total licensed abstraction rather the amount of water used, meaning that abstractors pay the same regardless of how much is used – a marginal charge of zero. Outside Habitats Directive sites, the current periodic review process has no mechanism for considering the environmental impacts of existing abstraction licences: environmental risk is not incorporated into assessments of water availability or the evaluation of demand management proposals. In cases where companies include proposals for ending damaging abstraction in their draft business plans, these have been disallowed by Ofwat, whose statutory remit is to protect customers, because the Environment Agency does not require a reduction in the licensed abstraction.

Case study: paying more for water where it's abundant and less where it's scarce

Current abstraction charges are paid on the basis of licensed volume rather than volume of water used – abstractors face no incentive to use less than the maximum licensed volume. Charges comprise a standard charge to cover the costs of administration of the water management system and an additional EIUC. Each of these is set regionally. A comparison of these charges between Northumbria and Thames regions is shown below. This shows that, perversely, significantly more is paid to in abstraction charging per unit of licensed volume in the water-abundant north-east than in the water-scarce south. The higher standard charge in the Northumbria region derives from a historical agreement to cover the costs of the development of Kielder reservoir. The fact that the resources which this scheme provides are well above the previously (mis)forecast demand it was built to meet is another story.

Abstraction charges, £/1000m3, 2010/11

	Standard Charge	Environmental Improvement Unit Charge	Total
Thames	13.84	2.75	16.69
Northumbria	25.98	0.00	25.98

Source: Environment Agency Scheme of Abstraction Charges, 2010/11

4 **Company plans to introduce demand management in areas suffering chronic over-abstraction are turned down by Ofwat on the (legally justifiable but hydro-ecologically illusory) basis that these areas are in licensed water surplus.**

The mismatch between actual water availability (accounting for environmental needs) and licensed limits is leading to perverse outcomes in the water resource planning process. Unsustainable licences give the illusion of healthy water surplus, when in fact rivers are running dry because of over-abstraction. This can result in Ofwat declining company plans to introduce demand management programmes in areas where there is environmental damage. Ofwat does this on the basis that replacing the yield from over-abstracted sources is inevitably more costly than to continue to exploit the current licence, and would thus lead to higher charges to customers. To approve these measures would require Ofwat to take a view on environmental priorities beyond the abstraction licensing regime.

177

DEMAND MANAGEMENT IS MUCH NEEDED IN THE MIMRAM CATCHMENT – THE RIVER IS OVER-ABSTRACTED AND PER CAPITA CONSUMPTION IS AT ONE OF THE HIGHEST LEVELS IN THE COUNTRY: 177 L/D.

The Mimram is one catchment where demand management is much needed. Per capita consumption from this source is at one of the highest levels in the country: 177 l/d, which is 18% higher than the national average[19]. Environment Agency investigations have determined that abstraction is having a detrimental impact on the Mimram[20]. In 2008, it advised the water company that the licence would be revoked. However, this has yet to be implemented. The water company included plans for metering in its 2009 draft business plan to reduce demand. These were declined by Ofwat, as the Water Resource Zone is in water resources 'surplus'. In declining these proposals, Ofwat took account only of the licences held by the company to abstract water, with no regard to the series of assessments demonstrating the unsustainability of these abstractions[21]. The result: stalemate.

5 **The process for reducing damaging abstraction may not identify the least cost solutions, resulting in unnecessarily high compensation costs and water bill increases, and slower progress on reducing over-abstraction.**

We are concerned that there are significant risks that the current process for compensating licence holders may lead to higher than necessary costs being paid – particularly if there is a step change in the speed at which reductions in damaging abstraction takes place. As we discuss throughout this report, there may be a range of lower-cost opportunities for addressing damaging abstraction than the typical approaches that rely largely on capital expenditure to develop replacement resources. Alternatives include more use of demand measures, operational changes to reduce the impacts of abstraction and more trading and sharing of water between companies. The implementation of these least-cost solutions poses significant regulatory challenges, in particular because, in the case of water companies, the identification of these solutions will often require a very detailed understanding of company operations, networks, resources and costs. At the very least, this will require close cooperation between the environmental and economic regulators. Even then, there are limits to the extent to which regulators themselves are able to identify least-cost solutions, with such solutions more likely to emerge through a mechanism that provides incentives for abstractors to identify least-cost solutions themselves.

Under the current RSA scheme, the process for determining costs is based on a negotiation between the Environment Agency and the licence holder. There are no incentives at all on the licence holder to identify lower-cost solutions. This places a very significant burden on the Environment Agency to understand the cost structures facing abstractors and to negotiate a realistic fee with the licence holder. The Environment Agency has had some success in negotiating lower-cost solutions. However, identifying least-cost options to balance supply and demand represents a problem for all regulators, and may be even more challenging where complex environmental risks are concerned. If the scale and pace of abstraction modification increases, a process entirely dependent on regulatory scrutiny may become highly resource-intensive and increasingly inadequate to the task of revealing the true costs to licence holders of licence reductions.

£58M

THE COST OF RESTORING SUSTAINABLE ABSTRACTION TO THE ITCHEN IS ANTICIPATED TO BE £58M.

Case study: negotiating the cost of solutions

Southern Water's initial estimates of the cost of restoring sustainable abstraction on the Itchen at Otterbourne were in excess of £100m. By the end of the price review process, the company had agreed a solution costing £58m with Ofwat and the Environment Agency, which was included in its final 2010-2015 business plan[22].

During the Itchen Initiative process, we've heard anecdotal evidence of at least two other companies where initially high cost (capital intensive) solutions were tabled, only for significantly lower cost (more operations intensive) solutions to be found through the negotiation process. In these cases the cost differential was reported to be a factor of 10 between the initial high cost 'capex'-weighted solutions and the final 'opex'-weighted ones. However, these examples have not been included here because the data is not available in the public domain and has been redacted in the companies' published business plans.

6 **Current water planning methods significantly disguise the true costs of meeting peak water demand in dry years.**

In developing Water Resource Management Plans, companies assess and report the costs of developing new supplies on the basis of the cost of the increased capacity that will be provided, i.e. £x million per additional Ml/d. This presentation disguises the frequency with which this additional resource may, or may not, be required. On occasions, this new resource may be mostly (or even solely) required to meet peak water demand in dry periods, meaning that it will be required only on an infrequent basis. The cost of providing water on these occasions is likely, therefore, to be exceptionally high, but this is not revealed under current approaches.

7 The majority of water customers don't know or pay for how much water they use, and pay the same amount regardless of whether that water is scarce.

The UK remains one of the few European countries where people do not pay for water on the basis of the amount that they use. Ireland and Norway are the only other European countries that do not have universal or near-universal metering. In 2010, just 35% homes in England and Wales paid for water on the basis of volume, using a water meter. Water company plans suggest this will rise to 50% by 2015[23]. Some regions have much higher proportions of metered customers. For example, by 2015, Southern Water will have 92% households with a meter, whereas neighbouring Portsmouth Water will have just 24%[24]. The Walker Review into Household Metering and Charging recommended that the government revise its current approach to metering to deliver 80% metering in England and Wales by 2020. It also recognised the importance of mitigating and managing affordability issues[25].

Even among those customers who are metered, the majority pay a flat rate per unit of water they use, regardless of how scarce it is, or how expensive it is to provide. While there have been a number of trials of alternative tariffs, there is currently little use of sophisticated tariffs that aim to reduce consumption or target times of particular water scarcity.

8 The current, piecemeal transition to metering is leading to higher costs, and the installation of equipment that may not be able to realise the full potential of metering.

The Walker Review and the Environment Agency agree that the current piecemeal approach to metering, driven by people opting for a meter, is not as cost-effective as systematic compulsory metering[26]. A street-by-street approach (for example, Southern Water's 'Pit Stop' metering) accompanied by comprehensive communications can significantly reduce costs and 'normalise' having a meter. The Walker Review concluded that installation costs could be reduced by between 20% and 50% if the remaining 14 million unmetered households were metered in a systematic way.

20-50%
INSTALLATION COSTS COULD BE REDUCED BY BETWEEN 20% AND 50% IF THE REMAINING 14 MILLION UNMETERED HOUSEHOLDS WERE METERED IN A SYSTEMATIC WAY.

Of the 10 million or so meters already in place, the large majority are 'dumb' meters which clock up water consumption as water flows past the mechanism. These meters have to be manually inspected in order to collect data, and are often read just once or twice a year. Increasingly, water companies are installing automated meter read (AMR) meters, which transmit consumption data via radio frequency. The meters themselves are equipped with a memory, to record time series data (such as daily consumption). Data can be transmitted to a central hub, or collected by a passing vehicle. AMR 'smart' meters are less resource-intensive in terms of meter reading, can provide more data, and can be fitted with leak alarms.

Despite AMR technology being available, and the potential to offset higher capital costs associated with purchasing the devices with lower long-term operational costs, many water companies are continuing to install 'dumb' meters. In 2009, South East Water submitted proposals to install smart meters[27]. Ofwat refused to fund these on the basis that they were not cost-effective for customers and, as a result, the company is planning to install a significant number of dumb meters[28]. This could mean that for many customers, innovative tariffs are at least a decade away, as these would be difficult to operate using dumb meters.

9 **There remain cultural barriers to the introduction of more widespread demand management.**

There is little confidence in many demand management measures, for a variety of reasons relating to culture, experience, professional skill set, delivery and simply the nature of relying on millions of people instead of a solid piece of infrastructure. This often results in estimations for savings associated with demand management being offset against associated large headroom (uncertainty margins) in water company supply-demand planning, and is one of the reasons why options are not selected. This can lead to a vicious circle where companies do not select demand management schemes – so they do not trial them and develop data on their effectiveness, and therefore do not increase their confidence in the approach.

10 **Water companies have tended to favour capital intensive new supply solutions over alternatives such as demand management, trading water with neighbouring companies, and other operational expenditure solutions.**

A number of drivers appear to contribute to companies' preferring new capital supply solutions, sited in their appointed area. First, the regime for price regulation tends to give incentives to capital rather than operational expenditure, with particular regulatory incentives for companies to reduce operational expenditure. At the same time, companies have been able to profit from an increased Regulatory Capital Value (RCV). They have achieved this through financial engineering which has enabled them to secure a lower financing cost than the cost of capital assumed by Ofwat in its price limits.

Second, there are likely to be cultural reasons for companies' preferences. Building new infrastructure is what companies are familiar with doing, and this may be reflected consciously or unconsciously in internal processes such as business plans. Investors may also be very focused on the size of the RCV as the key measure of a company's attractiveness.

Third, as discussed earlier, companies have relatively little experience of demand-side measures. Therefore, they have lower confidence in what would be delivered, particularly over the long term. The projected benefits of demand-side measures are correspondingly discounted in options appraisals and the estimates of anticipated savings reduced accordingly. The need for confidence in the ability of measures to deliver security of supply is reinforced by the regulatory regime, where failure to deliver security of supply can lead to the imposition of financial penalties. Taken together, this leads to fewer demand-side schemes being selected, and a vicious circle inevitably ensues.

Lastly, companies are familiar with having ownership of most of their water resources, and may be uncomfortable with the process of contracting for secure supplies in the way most other sectors do. This may explain why, though there is bulk water trading between companies, this is at a low level and has seen little increase in the last decade or so, despite the large differences in costs between neighbouring companies.

BEYOND THE AVERAGE: UNDERSTANDING VARIABILITY AND ITS IMPLICATIONS

Variability is at the core of water systems. Understanding and responding to this is central to 'smarter water management', allowing us to identify more precise, targeted and cost-effective solutions to reducing environmental impact, and reconciling supply and demand under increasing pressure.

Understanding variability in freshwater systems

Water resources are characterised by variability, in both time and space. Figure 2.1 (see page 30) shows a series of hydrographs of the daily gauged flows in the River Dart in South Devon over a 50-year period. The 'envelope' of the lowest (dark grey) and highest (light grey) gauged flows on each day of the year in the record from 1958 to 2009 is also shown. Both the intra- and inter- year variability is substantial; extreme summer flow volumes have historically ranged from as low as 0.6 m3/s to as high as 100 m3/s. Understanding such variability and its implications is at the core of designing smart solutions to the water challenge.

Taking climate variability and change into account is part of this challenge. The impacts of climate variability and change on freshwater systems are often portrayed in terms of changes to the average (as in the case of figure 1.2). This, however, provides an insufficient portrayal of how climatic unsteadiness is likely to impact on water resources systems.

FOR FRESHWATER SYSTEMS, THINKING IN TERMS OF AVERAGE CLIMATE CHANGE IMPACTS IS INSUFFICIENT - WE NEED TO THINK ABOUT SHIFTS IN EXTREMES.

In figure 2.2 (see page 31), a number of modes of climate transition are illustrated. The top picture represents one of the most common ways we think about climate change – a steady change in the mean climate. In freshwater systems, the middle picture (showing a change in variance around some mean value) is also likely to be experienced, with climate change manifest as a shift in the frequency and degree of extreme weather – with more droughts and floods, often with longer duration and greater intensity. Most climate models are not able to predict with confidence changes in climate variability. The bottom picture illustrates another form of change, where the state of the system changes abruptly, in steps, as thresholds or tipping points are reached. There is plenty of international evidence of such abrupt changes in precipitation. Real change may combine each of the types shown.

Increases in variability are likely to be crucial for understanding the impacts of climate on freshwater systems. Figure 2.3 (see page 32) shows long-term rainfall anomalies for England and Wales for May, June and July, dating back to 1761, alongside a 30-year moving average. This indicates that while there has been a long-term decline in average precipitation over the last two centuries, this long-term change is small compared with short-term variability.

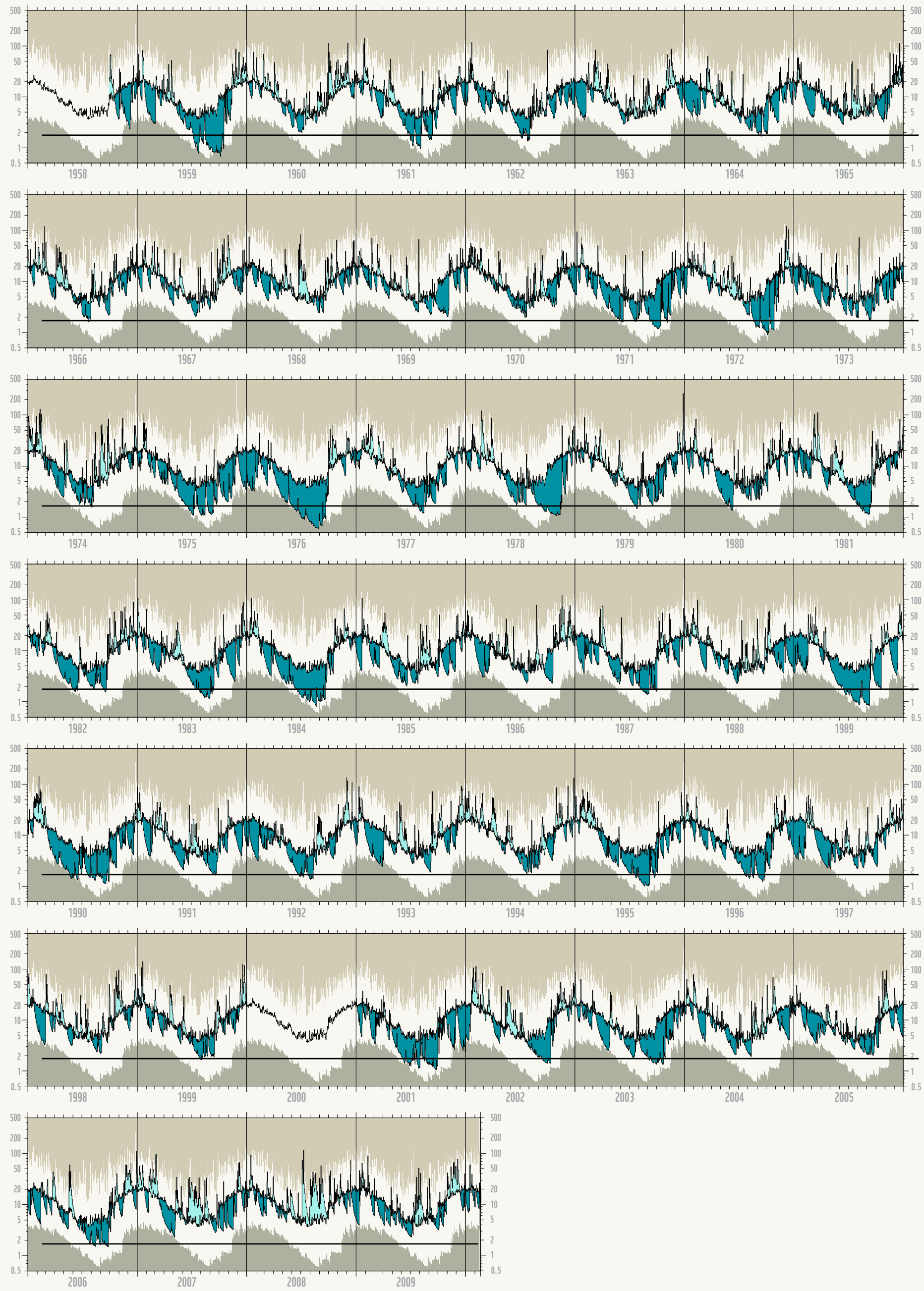
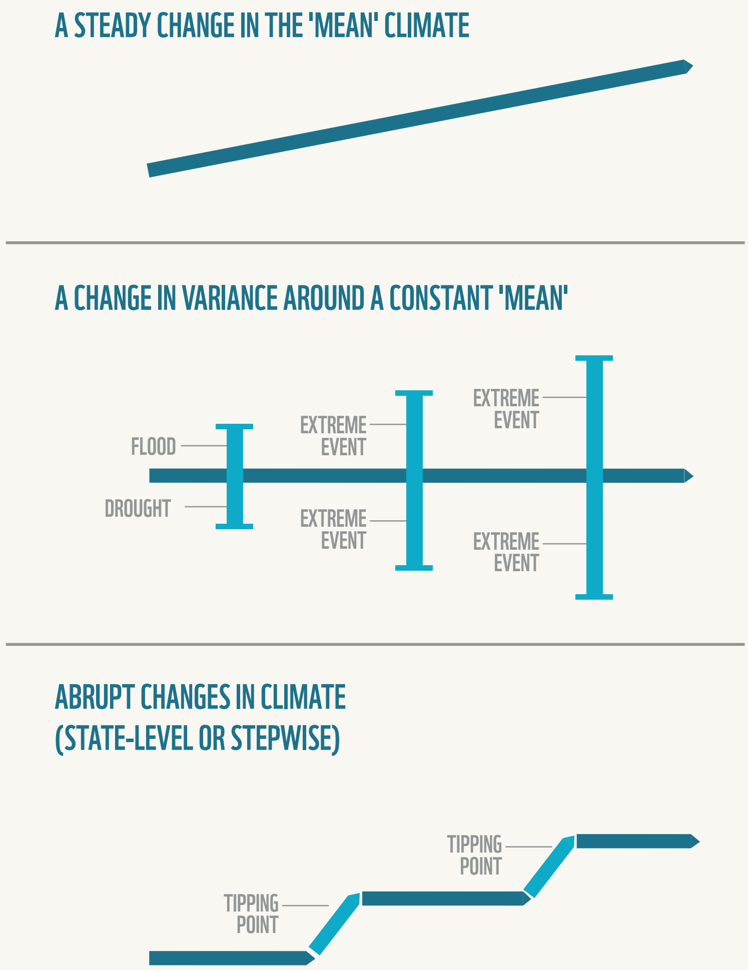


Figure 2.1: Gauged daily mean flows of the river Dart at Austin's Bridge, 1958-2009.

The areas shaded in dark blue show flow periods below the long term mean flow. The areas shaded in light blue show flow periods above the long term mean flow. Note the use of the logarithmic scale on the vertical axis. The line across the hydrograph represents the Q95, or flow exceeded in the river for 95% of the time, an indication of the level below which the environmental risk from abstraction increases.

Source: Hydrograph provided by the National River Flow Archive. River flow data comes from the Environment Agency.

Figure 2.2: Different models of the impact of climate variability and change on freshwater ecosystems.



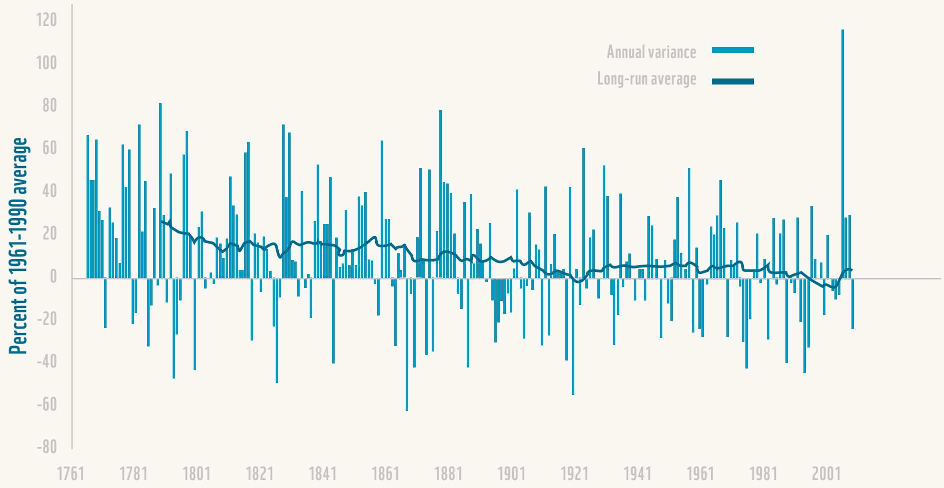
Source: WWF-UK, Flowing Forward, 2010

For our water supplies and our freshwater environment, it is these extremes and any changes to them that will be at the heart of the climate adaptation challenge. These extremes are very hard to model. Given the huge uncertainties, we need to develop a flexible and dynamic approach to water resources management that allows us to continuously adapt and respond to new information. Understanding variability, and how it relates to supply, demand and environmental impact, is at the core of designing a smarter water management system, and one that is resilient to climate change.

Variability and environmental impact

Modification of natural flow regimes can result in a range of negative impacts on freshwater ecosystems. While modification to the timing and volume of peak river flows is a localised issue on a few regulated rivers in England and Wales, the majority of the impacts of abstraction and river regulation in this country are a result of low flows and water stress*. Impacts can include loss of river and wetland habitat due either to absolute loss in wetted area or insufficient water depth, increased sediment accumulation, increased temperature, increased vulnerability to pollutants and predation, and impacts on some plant and invertebrate species that are dependent on certain water velocities.

Figure 2.3: Annual variance from long-run average precipitation, England and Wales, May-July, 1766-2010.



Note in particular the very wet summer of 2007.

Source: Professor Rob Wilby

FOR THE MAJORITY OF FRESHWATER SYSTEMS IN ENGLAND AND WALES, THE IMPACTS OF ABSTRACTION ARE LIKELY TO OCCUR AT TIMES OF WATER SCARCITY AND LOW FLOW.

While there are important exceptions, in the majority of freshwater systems in England and Wales this means that the impacts of abstraction are likely to occur at times of water scarcity and low flows, in particular during periods of low rainfall. This is illustrated in figure 2.1, where a black line has been drawn on the gauged flow record for the River Dart to indicate the flow at which increasing risk to the system from abstraction is likely to occur. In wetter years, abstraction at currently licensed levels from the River Dart at this point may pose little to no risk. However, it is in drier summers that the risk to the river and ecosystem it supports is greater.

The extent to which abstraction impacts on flows are episodic depends to a significant degree on the nature of the freshwater system. Groundwater-fed systems such as chalk streams are less flashy and have more constant flows than rain-fed systems such as the Dart. This means that over-abstraction problems are, in general, likely to occur for briefer episodes in rain-fed systems than in chalk streams. By the same token, abstraction can have more sustained impacts in chalk systems when groundwater levels are drawn down.

There will be some important systems where abstraction is likely to have an impact at most times – in particular, systems that depend on a relative abundance of water. This can include certain wetland systems, and headwaters of chalk streams, where abstraction from aquifers can exacerbate the drying of rivers downstream from the natural perennial head.

*A number of important functions of freshwater ecosystems are dependent on peak or flood flows, including species migration for spawning, movement of sediments, gravel cleaning, and inundation of wetlands. In many parts of the world, alterations to these peak flows as a result of the construction of major infrastructure are responsible for serious environmental impacts. In the majority of freshwater systems in England and Wales, however, reservoir storage is comparatively small and not typically on the main stem of rivers. As a consequence, ecologically important peak and flood flows are largely undisturbed, and, where they are, this is a localised issue confined to regulated tributaries.

Variability and demand management

Demand management practice to date has tended to deal with aggregate data. This has been driven mainly by the fact that companies have limited data on individual household consumption, because only 35% of domestic households are metered and because aggregate data is useful (if imperfect) when forecasting how demand may change for the purposes of water resources planning. All too often, demand and consumption are characterised in terms of averages. For example, current per capita consumption is frequently defined in terms of the national average value of 150 litres per person per day[29] and Defra's aspiration for reduced future consumption across England and Wales by 2030 is defined as a blanket 130 litres per person per day[30].

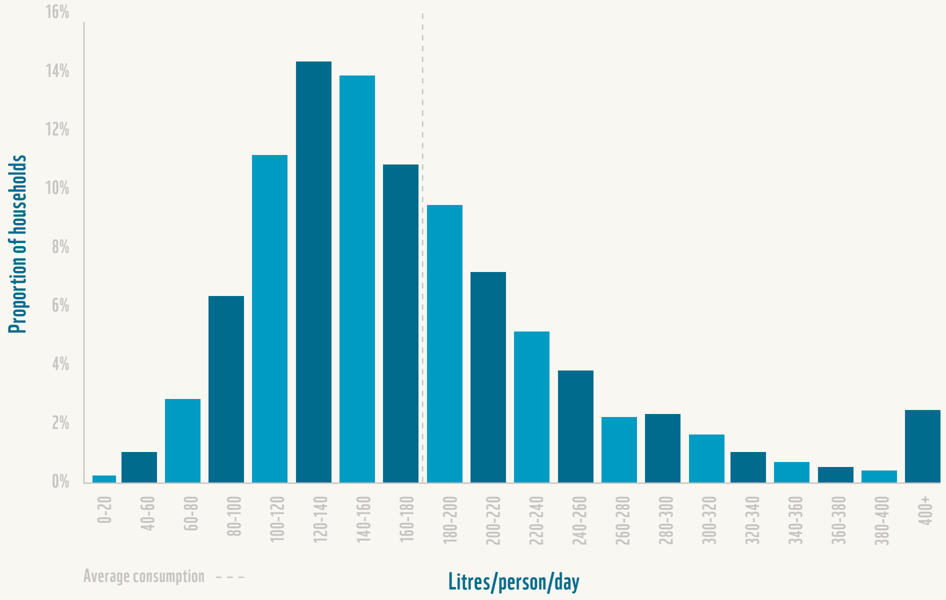
400 LITRES
INDIVIDUAL CONSUMPTION VARIES SIGNIFICANTLY, FROM BELOW 20 TO OVER 400 LITRES PER PERSON PER DAY

Current demand management and forecasting methods tend to consider the factors driving average consumption, seeking to break down average water use into component parts (such as taps, toilets, etc) before assessing how these may change over time (according to technology, policy and behaviour change) [31]. For the purposes of water resources planning this is a sensible approach. But for the purposes of developing a programme of interventions to reduce demand, it may be more suitable to consider different questions – for example, thinking in terms of the huge variability in water use, or asking who is using how much and when.

Aggregating and averaging individual use obscures the diversity, variety and temporality of individual water consumption. For example, average per capita consumption of Thames Water's demand monitor households* is 171 litres per day [32]. However, as figure 2.4 shows, individual consumption varies significantly, from below 20 to over 400 litres per person per day. In this sample, the range of consumption shows that the majority of people use below the average amount, with the most common consumption being 120-140. Average consumption is higher, as the distribution is skewed by a tail of people using very high levels of water, in particular over 5% of the population who are using over 300 l/p/d.

* A representative sample of 2000 households who do not have a water meter and pay by rateable value. Thames Water measures water use in these households to inform demand forecasting for its 'unmeasured' customer base.

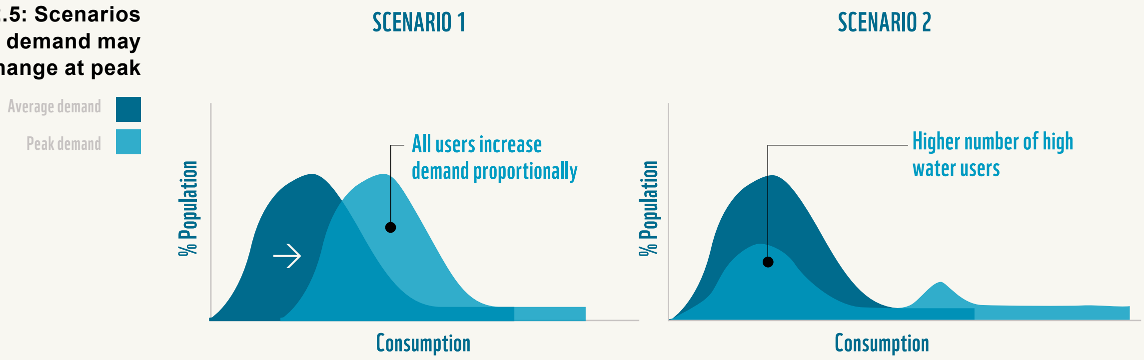
Figure 2.4: Distribution of per capita consumption in a sample of 2000 households in Thames Water's consumption sample (measured consumption of households who pay by rateable value).



Source: Thames Water

In addition, it is likely that the shape of the consumption distribution will shift at different times, with a marked difference between the annual average condition and the peak demand condition. This is illustrated in figure 2.5, showing that increases in demand at peak times may be driven not by an average across the board increase, but by a substantial increase by a minority of users.

Figure 2.5: Scenarios showing how demand may change at peak



Source: WWF-UK, Itchen Initiative, 2011

We tend to assume that peak summer water use is a result of everyone using more water. But it may well be that higher peak demand is a result of some people using more, while most people use approximately the same.

Scenario 1 shows how the distribution of water use changes from average (dark blue) to peak (light blue), with everyone increasing their water use by the same per cent.

Scenario 2 shows the change from average (dark blue) to peak (light blue) demand, with the change driven by a small group of people use significantly more water, while the majority of people use the same or a fraction more water.

Understanding and reflecting the variability in demand could help water companies to target interventions where they can be most effective – either at high users where there is more potential for reduction, or as demand rises. A more detailed understanding of demand could also help to determine which uses of water are essential and which are more negotiable, and therefore where consumers might be more amenable to making reduction at times of scarcity. This is discussed on page 47.

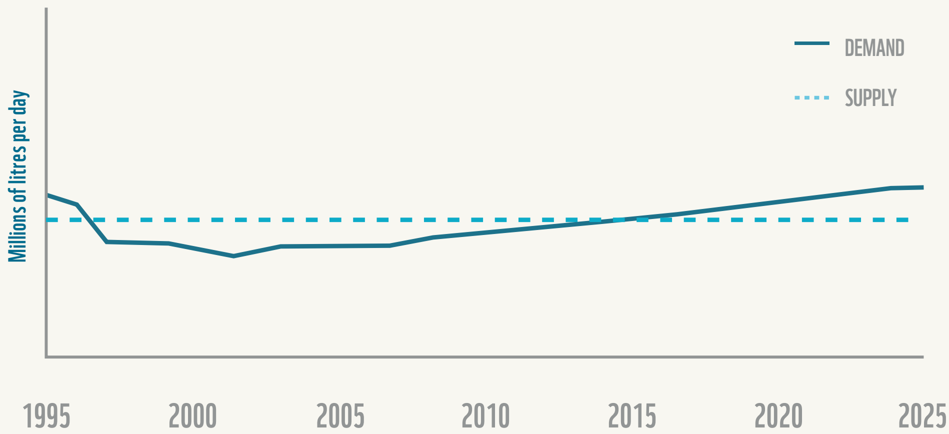
Variability and water resources planning

Water companies are required by their regulators to produce Water Resource Management Plans that provide security of supply against shortfalls of supply-demand at least total cost, to a stated level of service. That level of service defines the target frequency with which restrictions are needed to reduce demand, in order to ensure that the supply-demand balance remains positive even when supplies are reduced in drier years. Each company determines its own preferred level of service, in consultation with its customers. Most companies set a level of service that involves the use of hosepipe bans at a target frequency of no more than once in 10 years or 20 years.

Drought Management Plans define the measures a company will take to reduce demand (by imposing restrictions of progressively increasing severity) and increase supply (by securing permits and orders to relax conditions on abstraction licences), in order to maintain a supply-demand balance in drought events of increasing severity. Taken together, a water company's Water Resource Management Plan and Drought Management Plan show how it plans to provide security of supply to customers in wet, normal, dry, drought and extreme drought years of increasing severity.

Because it is not possible to know in advance when a dry or drought year will occur, in producing their Water Resources Management Plans water companies must regard each year of the 25-year planning period as a 'design dry year' in which demand can only just be met without the need for restrictions. Companies seek to ensure that the water available for use is sufficient to meet unrestricted demand, plus a margin of safety (target headroom) to cover unavoidable uncertainties, in each and every year of the planning period. Figure 2.6 depicts the planning problem defined in this way, with annual minimum water available for use – shown as the light blue, dashed line – and annual average demand (plus target headroom) – shown as the dark blue line. In the example shown, water available for use remains constant across the time period, while demand initially declines (due to leakage reduction, in this particular case), and then increases. On the basis of the data shown, forecast demand exceeds forecast supply around 20 years into the planning period, implying the need for new demand management and/or supply schemes to be developed by that date to prevent a shortfall in supply.

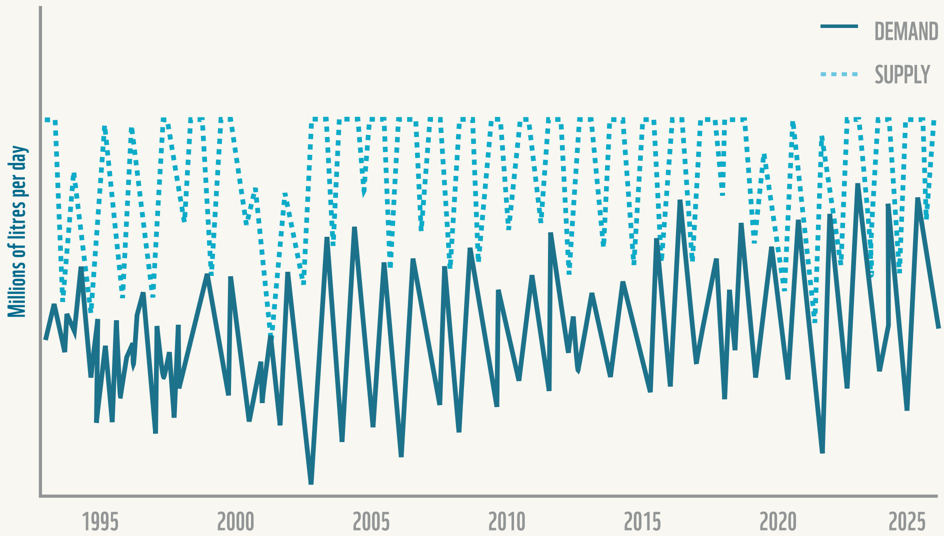
Figure 2.6: Annual supply and demand forecasts for supply-demand planning.



Source: Fenn and Piper, 1999[34]

In reality, of course, every year in the planning period is not a 'design dry year'. Rather, the 25-year period is likely to be composed of wet, normal, dry and, potentially, drought years. In most years in the planning period, demand will be lower that the forecast 'design year' demand; and in most years, supply will be greater than the forecast 'design year' supply. As a result the supply-demand balance in most years will be considerably greater than in the 'design year'. In other words, in most years there will be a significant surplus of available water over demand. A possible representation of actual supply and demand over a 25-year period is shown in figure 2.7, with supply varying from year to year but mostly being greater than the design supply, and with demand varying within and between years around the design demand. In this case, while annual demand peaks exceed annual supply minimums on a number of occasions, the two curves do not coincide such that demand exceeds supply on any occasion.

Figure 2.7: A more detailed representation of supply and demand variability as it might occur in reality, as opposed to in planning terms.



Source: Fenn and Piper, 1998

The fact that the planned scenario is much different to the actuality, should not reflect badly on the planning methods – water companies need to plan on the basis that the 'worst-case' design event could happen in any (and every) year if security of supply is to be achieved.

However a number of important implications follow from variability in supply and demand. First, in many water supply areas the costs of ensuring security of supply are driven in large part by peak water demand. Projected shortfalls in supply can occur where reduced availability in dry summers coincides with peak water demand. Much of this peak demand is driven by outdoor water use. Given the costs associated with developing (otherwise redundant) additional supply to meet these episodic, peak demands, this means that the additional cost of providing outdoor water in dry summers may be exceptionally high. Rough calculations suggest that the true cost might be in the region of £50 to provide the water to run a sprinkler for an hour under peak conditions in dry years*. Because water charges at peak times do not reflect the costs associated with providing that peak water, individual customers do not have a choice about whether or not they want to pay more for the investment necessary to support garden watering in dry periods. As outdoor water use tends to be more prevalent in more affluent households, this implies a significant cross-subsidy in the current water payment arrangements from less wealthy households to wealthier ones.

BUILDING NEW INFRASTRUCTURE THAT'S NOT NEEDED MOST OF THE TIME MAY NOT BE THE MOST COST-EFFECTIVE RESPONSE TO RARE EPISODES WHEN SUPPLY DOES NOT MEET DEMAND.

Second, the construction of expensive new infrastructure may not be the most cost-effective response to rare episodes of shortfall. Constructing capital-intensive new infrastructure that is not needed for the vast majority of the time might be a highly expensive response. When shortfall is understood as a rare and episodic event, a series of alternative responses become more attractive, including targeted demand management, tariff responses, sharing of water between companies, spot trading arrangements, interruptible supply tariffs for bulk water users and, generally, solutions with low capital costs and high, but infrequently incurred, operating costs. While these may not be attractive responses to a perennial shortfall in supply, they may be significantly cheaper responses than infrastructure-based approaches to shortages occurring for a few weeks or months each decade or quarter of a century.

Third, the trade-offs inherent in these decisions are largely hidden in current water resources management planning and decision-making. The ways in which water availability, demand and costs are presented means that the true costs of meeting peak water demand in dry summers are not revealed transparently in the decision-making process.

Lastly, this reality constitutes a huge opportunity for managing resources in an environmentally sensitive way. The extra resources in most years when compared to the planning scenario may be used in a number of ways, to meet a number of different goals. In non-drought and non-design dry years – which constitute the majority of years – water companies generally seek to meet managed demand at least operating cost, subject to staying within licensed conditions and limits and keeping sufficient resources in stock to cater for the possibility of 'drought tomorrow'. Since licence charges are a fixed cost, irrespective of the amount taken, minimising operating costs means minimising pumping and treatment costs.

* This rough calculation is based on the following assumptions: cost of new supply resource is £3 million per Ml/d; the resource is used to make up a shortfall in peak demand experienced for two months in average across a decade; a sprinkler uses 1,000 litres an hour; and 20 years of benefits are included (undiscounted) as an approximation to a full present value calculation of benefits. A range of marginal calculations such as transmission losses and maintenance costs have not been included.

AT PRESENT, THERE ARE NO INCENTIVES FOR COMPANIES TO TAKE LESS WATER FROM SENSITIVE RIVER AND GROUNDWATER SOURCES, OR TO TAKE LESS FROM THOSE SENSITIVE SOURCES WHEN WATER IS SCARCE.

This generally means that 'cheap' sources like groundwater and river sources are used more than more expensive sources. At present, there are no incentives for companies to take less water from sensitive river and groundwater sources, or (except as licence terms require) to take less from those sensitive sources when water is scarce.
A smarter and more environmentally sensitive way of managing the surplus of resource that exists over demand in most years might easily be achieved, with the right mechanisms and incentives in place to take less water from sensitive sources, not just in drought events, but between drought events too. This would achieve the desirable outcomes of protecting ecosystems in normal and dry years, and allowing ecosystems to build resilience between droughts.

Case study: Thames Water desalination to meet demand in droughts and peak demand periods

Thames Water's desalination plant was built to meet London's demand for water in dry and drought periods, and in periods of peak demand. The desalination plant made good an assessed planning shortfall in drought deployable output of 140 Ml/d, at a capital cost of £200 million. Thames Water deemed that the water was needed to ensure security of supply to meet its preferred level of service for restrictions on demand including hosepipe bans at no more than once in 20 years, and the elimination of need for rota cuts, from a frequency of use assessed by Thames Water to be once in 25 years, without the plant. The economic and social cost of the desalination plant was justified on the basis of the need to meet demand in drought years, and peak demand in dry years, perhaps, so as to avoid the risk of emergency drought orders and consequent effects on the environment and London's economy. The desalination plant was also built to enhance the robustness of London's supply against terrorist activity. Given the relative infrequency with which the plant would be operated, the water supplied would come at a high cost per litre actually supplied.

SMARTER WATER MANAGEMENT

If the right reforms to regulation and incentives for water abstractors and users are put in place, addressing the social and environmental impacts of water scarcity can be achieved at lower costs than previous estimates.

We believe that understanding and responding to variability, in both water scarcity and water use, is central to the challenge of water management now and under an uncertain future. On this basis, we identify two major opportunities that can be realised through a move to a smarter water management system:

1. Innovative and flexible approaches to ending damaging abstraction have the potential to deliver environmental benefits at significantly lower cost than the approaches currently adopted.
2. A range of flexible solutions to reconciling supply and demand remain available and under-utilised, due to a range of regulatory, methodological and cultural barriers.

Realising these benefits will require reforms to our water management regulations and incentives so that environmental values and risks are better and more accurately reflected; signals over scarcity and the value of water are given to abstractors and water users; and regulatory and planning biases against fixed, capital intensive solutions are removed. We set out below the objectives and recommendations that are required to achieve these reforms.

Smarter environmental water management

The abstraction licensing and water rights regime is the key mechanism by which sophisticated environmental requirements can be recognised in water management and the concept of the 'value of water' placed at the core of our water management systems. Smarter water management must therefore start with a smart abstraction licensing system.

ENDING CURRENT OVER-ABSTRACTION ISSUES IS LIKELY TO REQUIRE INVESTMENT IN ALTERNATIVE MECHANISMS FOR ENSURING SECURITY OF SUPPLY, WHETHER THROUGH DEMAND OR SUPPLY-SIDE INTERVENTIONS.

Barriers to a smarter abstraction licensing system

- The backlog of historical licences is the major barrier to the implementation of a smarter licensing regime. This is exacerbated by the lack of legal clarity over the ability of the government and regulators to revoke or amend damaging licences; very significant shortcoming in the funding available through the current RSA programme to address historical over-abstraction; and outstanding issues over the extent to which compensation should be paid to holders of existing licences as and when these are reformed.
- There are no mechanisms to indicate environmental risk to abstractors who hold licences.
- There remains a lack of clarity over future environmental limits.
- Ending current over-abstraction issues is likely to require investment in alternative mechanisms for ensuring security of supply, whether through demand or supply-side interventions. This would incur costs to the abstractors concerned and/or to government if compensation is required.

We suggest that a smarter licensing system needs to have a number of core characteristics.

First, it needs to be able to provide underpinning protection of freshwater ecosystems under differing natural conditions, including future climate variability and change. Central to achieving environmental sustainability is recognising that less water should be abstracted from the environment as flow levels in rivers fall. In many freshwater systems, preventing environmental damage requires a focus on low-flow and below-average rainfall episodes. This requires that increasingly stringent limitations be placed on abstraction as flow levels in rivers decline (with alternative mechanisms for balancing supply and demand available). In extremis, this is likely to require an absolute prohibition on abstraction at certain water levels. This may, potentially, be accompanied by allowing increased abstraction from some sources at higher flows.

DIFFERENT SOURCES OF WATER ARE ASSOCIATED WITH DIFFERENT LEVELS OF ENVIRONMENTAL RISK.

Second, the management of water resources should recognise that different sources of water are associated with different levels of environmental risk. Some sources of water – for example, groundwater sources linked to the headwaters of chalk streams, or water sources impacting on important wetlands – may be associated with higher levels of risk at all times. This higher level of risk should be reflected to abstractors.

Third, protection of environmental water needs does not have to be based only around absolute threshold values. There are a number of reasons why a single quantity limit alone may be inappropriate. Quantity limits may not be able to reflect a smooth environmental damage curve rather than an abrupt threshold, scientific uncertainty, and the circumstances in which the value of water to people is much higher than to the environment. We therefore believe that the absolute under-pinning protection afforded by differing quantity restrictions on abstraction at differing flow levels should be complemented with mechanisms to signal increasing levels of risk as water availability declines. This is likely to be particularly important in reducing the impact of abstraction on ecology during in years which are not ‘design dry years’, when there is resource headroom to allow greater flexibility in operations.

Lastly, many of our rivers rely on return flows from abstraction to sustain downstream abstractions and a thriving ecology. These return flows may be from industrial purposes, mills, hydro-electric power generation, fish farms, or effluent treated to a high standard. Incentives should be provided for these flows to be as large in volume, high quality, and as close to the point of abstraction as possible, in order to minimise impacts on ecosystems and maximise the water available for us by other abstractors. Enabling return flows to be recognised in the licensing regime is also likely to be an important part of moves to liberalise the mechanisms for trading water.

A number of different levels of sophistication are possible under a smart licensing approach. These range from a simple set of tiered permissible levels of abstraction as river levels fall, through to complex combinations of permissible levels, prices, and accompanying conditions on the use of water under different circumstances. There will be greater operational challenges to more complex systems and therefore a trade-off between complexity and performance of the system, with more complex approaches appropriate in only a few contexts.

£75,000

MODELLING ON THE RIVER DART SUGGESTS THAT ENVIRONMENTAL BENEFITS COULD BE ACHIEVED BY SPENDING £75,000 ON OPERATIONS IN A DRY YEAR, COMPARED TO UP TO £100 MILLION CAPITAL EXPENDITURE ON NEW RESOURCES.

As part of the Itchen Initiative, we undertook modelling work on the Itchen and Dart rivers to explore the potential for two forms of smarter abstraction licences.

- In the Itchen catchment, we tested the performance of a rising block abstraction scheme at Southern Water's Otterbourne abstraction source. Here, we modelled the potential to deliver specified environmental and yield goals by allowing the permitted rate of abstraction (above a hands-off flow level) to increase in line with increasing flow in the river.
- In the Dart model, we tested the overall costs and benefits of changing the operating rules to offer greater protection to the more scarcity-sensitive river Dart. Currently, the unit cost of abstracting from the Dart is cheap compared to neighbouring groundwater and reservoir schemes in South West Water's Roadford Strategic Supply Zone. We modelled different scenarios, so that the Dart river abstraction was comparatively expensive at low river flows (when the river needs the water) and cheaper at high flows.

While this modelling work is only preliminary, it indicates that some reductions in environmentally damaging abstraction may be achievable through either or both of these mechanisms, at low cost. For example, the river Dart modelling showed that a source prioritisation approach would provide significant improvements for the environment at a much lower cost than the traditional approach (£75,000 in operating costs in a dry year, compared to up to £100 million for resource replacement). A summary of the river Itchen and river Dart case studies is presented in the Appendix. Full details are included in supporting Itchen Initiative discussion papers[35,36].

1 **Abstraction licences should permit different volumes of abstraction at different levels of water scarcity, with increasing restrictions on water withdrawals as river and groundwater levels decrease. More widespread use should be made of 'security of supply' licences to be used only under certain conditions.**

All abstraction licences should have conditions to limit the amount of water that can be abstracted as water levels in the river and/or groundwater table are reduced, while permitting higher levels of abstraction when water is abundant. This could include a 'hands-off' flow condition, specifying levels below which no abstraction is permitted from the source. Restrictions of different complexity could be introduced, depending on the risks to the environment and the requirements of local water management. The levels of these restrictions will need to vary in different systems, depending on the nature of environmental risk in those systems.

To maintain security of supply, companies require access to sufficient supplies so they can satisfy rising demand under a range of conditions, including those of significant water shortage. This means that certain licences may be necessary to meet demand only very rarely. Under conditions specified on the majority of licences, and subject to a few exceptions, companies are free to use the licensed volume for the majority of time, even when these licences may be responsible for significant environmental risk.

Commercial realities and regulatory pressures often mean that water companies prioritise sources in order of cost, and cheaper sources tend to be river or groundwater that pose higher levels of environmental risk. To minimise environmental risk in the majority of years, but to maintain security of supply, new licence conditions could permit water to be abstracted only on a limited set of pre-defined conditions, which are expected to be infrequent. For example, a licence could specify that it can only be used once other resources and responsive demand management measures are in operation. In some cases, such conditions might apply to the whole licence (e.g. in highly sensitive wetland or headwater systems). In other cases, they might apply to only some parts of the licence (e.g. at flow levels below Q95).

Smarter approaches of this type are already in use in a number of places across England and Wales:

- hands-off flow conditions are now included in all new and varied abstraction licences;
- examples exist of licences that can only be used under certain circumstances, for example the West Berkshire Groundwater Scheme in the Thames area; and
- the Lower Thames Operating Agreement includes a range of conditions under which different abstraction levels are permitted across the lower Thames supply system, and stringent demand management measures are imposed in order for the company to abstract more water at times of severe low flow.

However, there are significant opportunities to bring these approaches into the mainstream, implementing smarter conditions on the majority of licences.

2 **Incentive mechanisms need to be developed to indicate where abstraction of water is subject to higher environmental risk, in particular to influence water abstractors' operational decisions. Options include a system based on risk or scarcity charges, and 'outcomes based' mechanisms as part of the price review process.**

THERE IS HUGE POTENTIAL FOR LOW-COST ENVIRONMENTAL IMPROVEMENTS, THROUGH CHANGES TO WATER COMPANY OPERATIONAL PROCEDURES.

One of the key opportunities to emerge from the discussions undertaken through the Itchen Initiative is the potential for significant, low-cost environmental improvements through changes to the operational procedures of abstractors and water companies. This approach is discussed in detail in relation to the river Dart case study presented in the Appendix. Closely associated with the opportunities available through these operational changes are changes to encourage abstractors to maximise the quality and quantity of return flows, as close as possible to the point of abstraction.

There is currently no mechanism or signal to encourage or support the adoption of these approaches. Where abstractors hold a licence, there is no indication of whether and when that licence may be associated with different levels of environmental risk. The development of such a mechanism is therefore a high priority for achieving cost-effective environmental improvements. A number of mechanisms are possible for achieving this objective, in particular the use of price signals or the development of an 'outcome based' mechanism through the price review process. These mechanisms could be mutually supportive. First, the use of pricing of some form may be well suited to the task of signalling higher levels of risk. It provides a mechanism to provide incentives to water companies to reduce use of environmentally risky abstraction where water companies have alternative supplies of water, or where water is being used for low value activities.

Conversely, signalling risk through pricing would ensure that some abstraction can continue in those situations where water use is of high value. In order to be effective, the use of price as a mechanism in signalling risk needs to be based around actual abstraction from water in the environment under identified conditions of risk. The existing abstraction charging system includes a number of weighting factors, including factors based on the source of water (i.e. supported, unsupported or tidal). It would be possible to extend this approach to include a source factor based on environmental risk. The conversion of abstraction charges so that part or all of them are assessed on a volumetric basis could be achieved by basing annual licence charges on water use over the previous period. This would enable the charging scheme to reflect actual use, while ensuring a stable source of revenue to support the management of abstraction.

If a charge over and above the current total generated through the standard charge and the EIUC were to be raised, issues would need to be considered over the use of monies generated. However, we believe that meaningful incentives could be developed by sharper focusing of some or all of even the existing charge to a risk-based, volumetric basis. The more tightly the scarcity charge could be defined, the greater the incentive effect that could be achieved while keeping overall charges constant. Options to prevent companies from passing the scarcity component of the charge on to customers should be examined to increase the incentive effect.

MEANINGFUL INCENTIVES COULD BE DEVELOPED BY SHARPER FOCUSING OF EXISTING CHARGES TO A RISK-BASED, VOLUMETRIC BASIS.

While there are advantages to a scarcity-charge based approach, it is unlikely to be sufficient on its own to secure sustainable abstraction, in particular because the impacts of abstraction can be very time and place specific. Even a well-designed scarcity charging scheme is likely to be relatively blunt, and require supplement by mechanisms that can allow for highly targeted responses.

A second mechanism for encouraging approaches based around operational flexibility could be developed as part of Ofwat's current thinking around 'outcomes based' regulation. Under outcomes based approaches, water companies would be encouraged to develop programmes based not on a series of activity based requirements and targets, but based on achieving desired outcomes. In the context of abstraction, this would mean that the current focus on the development of new 'schemes' to replace unsustainable resources, accompanied by changes to licences, could be complemented by company proposals to reduce environmental risk based around flexible operational approaches and demand management. This would require companies to develop, and Ofwat to approve, these proposals through the price review process. As part of its work on Future Regulation, Ofwat is currently considering a range of options to reward companies that demonstrate effective delivery against outcomes.

Case study: Flexible approaches to reducing damaging abstraction: Cotswold groundwater

The operation of the Upper Thames Swindon and Oxfordshire Water Resource Zone is a good example of how flexible approaches to both licence conditions and water resource operating systems can be used to reduce damaging abstraction. A number of groundwater licences in the Cotswolds have been surrendered by Thames Water because of the impact that the abstractions were having on river flows. Instead, water is now pumped upstream and put into supply from groundwater and surface water abstractions in Oxfordshire, and this water is subsequently returned back into the river through effluent returns. The Cotswold groundwater schemes can now only be used as Drought Permit sources with a frequency of not more than one year in 20[37].

3 **The existing CAMS process should be developed to establish long-term, catchment-based abstraction targets in time to be incorporated in planning ahead of the next periodic review, with associated assessments of levels of environmental risk. Scientific assessments of abstraction risks and targets should be separated from decisions over licence changes and compensation.**

There is an urgent need for clarity over future environmental limits on abstraction to enable long-term planning and a smooth transition to sustainable abstraction. The ability of companies and abstractors to develop cost-effective, flexible and long-term responses to damaging abstractions is only possible where a long-term view can be provided of what these objectives should be. If companies are to develop low-cost solutions based on water network optimisation, they will require clarity over sustainability reductions based not on single sites, but across whole catchments and water resource zones.

PR14

THERE IS AN URGENT NEED FOR THE ENVIRONMENT AGENCY TO CONFIRM THE STATUS OF DAMAGING ABSTRACTION FOR EVERY CATCHMENT IF SOLUTIONS ARE TO BE INCORPORATED INTO PR14 COMPANY PLANS AND THE WFD PLANS IN 2015.

The existing CAMS process has provided a good first view of the extent of damaging abstraction. However, the assessments undertaken as part of the first round of CAMS development have not provided the evidence that the economic and environmental regulators consider robust enough to identify required changes to current abstraction. While some catchment-based assessments are currently being undertaken by the Environment Agency, a view of damaging abstractions across all catchments needs to be developed in time for companies to incorporate these recommendations into the next water company periodic review in 2014 (PR14), and WFD plans in 2015.

If companies are to incorporate reductions in abstraction in time for incorporation into PR14, there is a high degree of urgency to resolving these issues. The assessment undertaken ahead of PR14 need not, however, offer a final view on all situations: where there are particularly high costs or uncertainties, more detailed assessments could subsequently be undertaken.

Such an approach to a broader assessment of damaging abstraction should build on the concept of differing levels of risk, rather than simply identifying sustainable or unsustainable abstraction. This would enable a more sophisticated investment and management response in the context of inevitable uncertainty, and provide guidance to the development of any scarcity or risk based pricing mechanism. It would also provide companies and other regulators with a basis on which to develop more flexible, operational based responses.

There are also significant opportunities to separate the process of scientific assessment of environmental water needs from judgements over trade-offs between environment and other social and economic objectives. The functions of environmental assessment and the management of the water abstraction and licensing system are both currently undertaken by the Environment Agency, which creates procedural challenges. In particular, the current RSA programme could be improved by the Environment Agency making a clear public declaration of its the view on the desired outcomes from an environmental perspective, prior to the identification of solutions and agreement with licence holders over any necessary changes to licences. Without this, it is difficult for stakeholders to participate in the process. Development of a clear process for publication of environmental objectives for abstraction, ahead of discussions with licence holders over solutions, is essential. There may also be benefit in some form of functional separation of an environmental water management function.

The process of establishing clear, national environmental objectives for abstraction is likely to require increased investment by the Environment Agency in undertaking scientific assessments. This could be funded by a temporary increase in the abstraction charge (either the standard charge or the EIUC) for the period of transition while this new approach is established.

4 An incentivised, step-wise approach should be developed to end current damaging abstractions.

A key obstacle to achieving environmentally sustainable water management is the current level of over-abstraction, which is a legacy of licences that do not contain the conditions necessary to protect the environment. Uncertainty over how this legacy will be addressed is now having negative impacts beyond the continuing impact on ecosystems, for example creating significant uncertainty over future water resources planning.

Given the very high total costs that are potentially involved in addressing this legacy, it will be essential to ensure that the costs associated with the transition from unsustainable to sustainable abstraction are minimised. We believe that four conditions need to be met if these legacy issues are to be addressed in a least-cost way:

- *Incentivised:* the approach needs to include ways in which water abstractors are given incentives to bring forward the most cost-effective solutions, with benefits for those that are able to identify least-cost solutions and costs for those that do not. Regulators are unlikely to have the information or capacity to identify least-cost solutions themselves through simple scrutiny. This requires both carrots and sticks.
- *Long-term:* costs will be reduced if the process of transition can be achieved over a period of time, with several implementation and investment cycles. This will allow abstractors to incorporate changes into longer-term planning exercises rather than develop high-cost, short-term solutions. It will also support innovation and learning.
- *Broad-scale:* the broader the geographic scale on which over-abstraction issues can be addressed, the greater the opportunity there is for abstractors to optimise their own operations to meet these objectives at low cost. This cannot be achieved on a site-by-site approach.
- *Smart:* Changes should be limited to those required to achieve sustainable abstraction. This can be achieved by using smart licensing to protect water sources at the key times and places where environmental risk is greatest, while not limiting low-risk abstraction.

We propose a process based largely on voluntary licence reform, with funds to support abstractors who choose to make changes to damaging licences, and incentives to encourage abstractors to participate in this voluntary process.

The key incentive that we propose is the establishment of a clear end-point at which remaining unsustainable abstraction licences will be amended without funding. Legislation should be reviewed to ensure that the government and its agencies are in a position to amend or revoke damaging licences without compensation where required. It is important that early, clear indication is given by the government of its intentions to use these powers at a specified point in the future for those abstractors who have not voluntarily reformed their licences before this time. This will provide a strong incentive for abstractors to secure a funded, voluntary alteration to their licences. As part of this, a mechanism will need to be developed to identify those licences where the imposition of these conditions will pose genuinely unacceptable costs – for example, where the costs of ensuring security of supply through alternative sources are very high and the environmental benefits low.

Providing clarity over a deadline by when licence changes will be introduced could be complemented by the use of price as an incentive mechanism. Where a scarcity charge is levied on the use of water under circumstances of environmental risk, this will provide a further incentive to abstractors to seek to secure funded, voluntary changes to environmentally damaging licences. This scarcity charge could rise over time to provide an increasing incentive.

Accompanying these incentives is the need to develop a mechanism to fund voluntary licence changes. For water companies, this funding will be required to ensure that security of supply can be maintained if some water resources are unavailable for some or all of the time. For other abstractors, funding will be required by way of compensation for lost income.

Under the current RSA programme, there is a split between the funding mechanisms for company and non-company abstractions, and it is likely that this will need to be maintained. For non-company abstractions, we favour an expanded RSA programme that allocates funding through a 'reverse auction' process. Under this approach, abstractors would submit bids as to the sums of money they would be prepared to accept for alterations to licence conditions. The abstractors offering the greatest reductions in environmental impact at the lowest cost would be awarded funding in return for voluntarily amending their licences. This would create a competition to identify least-cost way of achieving sustainability reductions. The reverse auction should be run through several rounds so that innovation can be copied. An increase in the non-company EIUC may be required to provide sufficient funds for such a process.

OFWAT SHOULD DEVELOP A FUNDING MECHANISM THAT ALLOWS THE MOST INNOVATIVE COMPANIES TO REDUCE DAMAGING ABSTRACTION VOLUNTARILY.

A mechanism similar to this should be developed for companies. At its simplest, this would also involve an expansion of the RSA programme and an increase in the EIUC to generate sufficient funding to operate a reverse auction process for water company abstractions. If the EIUC was converted to a volumetric-based scarcity charge, this would also have the advantage of greatly increasing the incentive for companies to participate.

Despite the elegance of this approach, there are challenges. In particular, it would require a significant increase in the current level of the EIUC, likely to be in the order of 10 times the current level (even assuming that the costs of ending damaging abstraction could be achieved for less than current estimates). For the most affected regions, this would see the combined abstraction and EIUC charge tripling or more. This would generate issues of regional cross-subsidy that would need to be considered. There may also be concerns, political or otherwise, within some parts of government over such an increase in the charge applied to water companies, and the retention of it for these purposes.

An alternative to this approach would be to develop a mechanism through the price review that was able to mimic this incentive without either the cross-subsidy challenges or the need to levy a significant additional charge. Under this approach, companies would be able to seek approval to end damaging abstraction through the price review process. However, a national limit would be set on the amount that Ofwat would permit to be spent on reducing damaging abstraction in any given price review. Only the most cost-effective solutions would therefore be approved. This would generate competition between companies to produce the least-cost reductions to damaging abstraction. Not only would this provide incentives for a low-cost transition to sustainable abstraction, it would also reveal important information about efficient ways of closing the gap between supply and demand.

Refinements to this approach could include a negotiated approach with companies within the context of the overall funding cap, and a repeat of this mechanism within price review cycles to increase the number of times in which the mechanism was used and learning was possible. Such approaches are, of course, dependent on the existence of sufficient incentives for companies to participate in the process.

Smarter demand management

Smarter demand management recognises the spectrum of water use in different places and times. It requires an understanding of when water is being used, and by whom, in order to benchmark use and identify the greatest potential for savings. With this information, interventions can be targeted in order to maximise effectiveness, increase confidence in the approach and reduce cost of delivery. A range of different interventions are available, including:

SMARTER DEMAND MANAGEMENT REQUIRES AN UNDERSTANDING OF WHEN WATER IS BEING USED, AND BY WHOM.

- *Information interventions:* such as smart metering, that reveal information and help develop targeted demand managment.
- *Persistent interventions:* such as water efficiency and leakage control that seek to reduce everyday demand.
- *Responsive interventions:* focused on reducing demand when water is scarce.

Demand management is increasingly used to reconcile supply and demand and to reduce energy consumption. Demand-side savings, realised predominantly through further leakage reduction, will slightly outweigh supply-side enhancements in the 2010-2015 investment period[38]. The evidence for the effectiveness of water efficiency retrofitting has shown that it can consistently deliver savings[39], and, through the Drought Plans and actions when a drought is in prospect, water companies have demonstrated that responsive interventions can reduce demand when water is scarce[40].

Demand management linked to the time and place that water is scarce has the opportunity to play a greater role in delivering sustainable levels of abstraction. This implies a much greater focus on responsive demand management to address peak water use in dry episodes, bridging between the 'normal' demand management activities that are currently included in Water Resource Management Plans and the 'event' measures that are included in Drought Management Plans.

Barriers to smarter demand management

- Lack of smart metering precludes a coherent understanding of who is using water when, where and for what purposes, and hinders the development of targeted responses and the implementation of smart tariffs.
- Cultural barriers remain among water companies and customers.
- There is a perceived bias in water companies towards capital-expensive solutions.
- Clear government policy and leadership is still lacking on affordability and the role of demand management.

5 The government should set out a strategy to implement near-universal smart water metering by 2020, coupled with a national policy on social tariffs. Smarter tariffs that better reflect scarcity and the marginal value of providing water should also be developed.

By 2015 half of households in England and Wales will have a water meter, with some areas reaching near-universal metering[41]. There is broad consensus that the current method of charging for water is unfair and that, over time, there will need to be near-universal metering across England and Wales[42]. Cost benefit analysis suggests that a strategic roll out of meters, as opposed to an 'opt in' approach, is cheaper in the long term[43].

10-30%

WATER SAVINGS RESULTING FROM INSTALLING HOUSEHOLD WATER METERS HAVE BEEN DEMONSTRATED TO BE IN THE REGION OF 10% AND 15%, WITH UP TO 30% REDUCTION IN PEAK WEEK WATER USE ACHIEVABLE.

Water savings resulting from installing household water meters have been demonstrated to be in the region of 10% and 15%, with up to 30% reduction in peak week water use achievable[44]. A meter alone, however, will not change behaviour: it is the metering package that counts, including use of communications, tariffs, and support to reduce water use. Installation can also act as a trigger, presenting an opportunity for wider behaviour change.

Smart meters provide information that can make a vital contribution to smarter demand management. They allow a detailed understanding of actual water use, enabling water companies to develop targeted reduction interventions. Time series information can help companies to optimise networks, reduce waste in the system, and help to identify and reduce the 25% of leakage that is deemed to occur within the boundaries of properties. Smart meters also permit the introduction of real-time customer feedback and smart tariffs linked to scarcity. Put simply, smart metering provides the information to enable a smarter approach to demand management to succeed. Guidelines for water company business plans should therefore include a minimum standard for smart meters (having at least AMR capability, with the facility to link to customer/in-home displays). Cost-benefit analysis for metering should include the additional demand reduction benefits that smart meters can create.

The move to near-universal metering provides the opportunity to introduce tariffs that better reflect the value of water. The cost (financial and environmental) of providing water to meet peak demand during dry periods is high. Better signalling of this to customers through smarter tariffs will help to reduce demand and remove the existing cross-subsidies from low peak water users to high peak water users (who are typically more affluent). It will also provide the choice to those who do wish to pay a high cost to use water under these circumstances. Water bills linked to scarcity are fundamental to reflecting the value of water (including the true cost of its provision) during times of hydrological and environmental stress. Over time, companies should therefore be required to develop smarter tariffs that reflect scarcity and remove cross-subsidies.

Government must give clear guidance regarding the development of social tariffs. The average burden of unpaid bills adds £12 annually to every bill[45]. By enabling companies to distinguish between those who can't pay and those who won't pay, social tariffs may enable this burden to be reduced. Near-universal metering can also help address affordability, as a greater understanding of consumption can help target support and ensure that subsidies are going to those high user/low income households that need them.

Smarter tariffs can be designed to reflect changes in season, increasing scarcity and increasing consumption. They can mitigate adverse impacts on affordability for high user/low income households, for example high occupancy households or those needing high volumes of water for medical purposes. A rising block tariff represents one such smart approach, providing essential water at lower cost, with the price increasing as the volume rises. The size of the blocks can be set based on per capita consumption (if occupancy data is available) or by benchmarking against historic water use for that household (e.g. reliable winter consumption), or household consumption (based on property type). These tariff structures can be accompanied by concessional tariffs for particular groups of customers.

For smarter tariffs to work, it is essential that customers have frequent information on their consumption, fully understand the tariff structure and have the opportunity to respond (can choose alternatives). It is therefore unlikely that tariffs implemented without 'smart' meters, supported by in-home display and/or frequent bills, will work effectively.

6 **Companies should develop a more targeted approach to demand management. Ofwat should reform its water efficiency target to support this, and agree a mechanism to allow cold water efficiency to be delivered through the Green Deal.**

Demand management can achieve more by focusing on those times when water is scarce and those users who offer the greatest scope for saving. By targeting demand interventions at high users more water savings can be achieved at lower cost. Understanding which households are responsible for driving up average and peak demand is important for targeting interventions. For example, appeals relating to outdoor water use should be targeted at high users, which would be more cost-effective than a blanket approach. Water companies should consider how they can work with local stakeholders (e.g. local authorities, gardening groups and centres and NGOs) to use different channels to communicate with their target households.

GOVERNMENT'S WATER EFFICIENCY TARGET SHOULD REQUIRE COMPANIES TO PROVIDE EVIDENCE OF THE EFFECTIVENESS OF THEIR ACTIVITIES, AND TO FOCUS ON TIMES AND PLACES WHERE WATER IS SCARCE.

Ofwat requires water companies to meet a water efficiency target – reducing household consumption by one litre per property per day, each year over 2010-2015. While this is a good first step, there are concerns that it is limited in its effectiveness for changing company attitudes or delivering actual water savings. Significantly, the current target is assessed on the basis of input activities and does not require companies to demonstrate the effectiveness of measures. Nor is it focused on reducing consumption when and where interventions will yield the maximum benefit.

The water efficiency target should be reformed to require companies to evaluate and provide evidence on the effectiveness of their measures. In addition, companies could be encouraged to focus interventions on those times and places where water supply is in deficit and/or there is environmental risk from abstraction. The 'sustainable economic level of water efficiency' introduced in PR09 allowed companies to deliver water efficiency in areas with supply-demand deficits. This approach could be extended in PR14 to allow companies to trial innovative, large-scale demand management in areas where there is environmental risk from abstraction (even if current licensed surplus means there is not currently an identified supply deficit). This would be analogous to the funding of catchment management activities under the National Environment Programme, wherein companies were able to trial innovative land management approaches to improving drinking water quality.

The regulatory changes proposed in this report include a package of incentives for demand management (including the use of shadow pricing, scarcity charging, targets and various approaches to address the capex bias). At the same time, there is a need to overcome cultural barriers to greater use of demand management. One way would be to require a minimum commitment to demand management, proportional to the forecast baseline supply-demand deficit in each resource zone in the final year of the planning period. This would provide an impetus – and a funding justification to Ofwat – for greater demand management efforts in areas of greatest water shortage.

14M

OFWAT SHOULD ALLOW COMPANIES TO DELIVER WATER EFFICIENCY TO 14 MILLION HOMES THROUGH THE GREEN DEAL.

To increase opportunity and reduce the costs of demand management, water regulation could be better linked to that for housing and energy. For example, the government's Green Deal aims to deliver energy efficiency retrofits to 14 million homes by 2020. Hot water efficiency measures will be included in the Green Deal delivery and payment mechanism, as they save energy as well as water[46]. Although cold water efficiency measures will not deliver household energy savings, including cold water efficiency in the Green Deal presents a simplified message. It also enables delivery at a significantly reduced cost (compared to a separate retrofit scheme solely for water). Ofwat should approve a mechanism that enables water companies to fund the marginal cost associated with providing and installing cold water efficiency measures, so that they are offered free to customers as part of the Green Deal package.

More details on our approach to more target demand management is included in a supporting Itchen Initiative discussion paper produced by Waterwise[47].

7 **Companies should develop smarter demand responses to below average rainfall and peak demand.**

Water companies already make use of responsive demand management. When a drought is foreseeable, companies begin appeals for voluntary restraint in water use, before implementing their Drought Management Plan that sets out a communications strategy and imposition of increasingly severe restrictions.

There is, however, a significant opportunity to develop more extensive use of smarter demand responses to periods of below average rainfall. Softer measures can be extended to the management of demand in periods of below average rainfall in normal years, dry years and peak demand periods which are more frequent than the 'design dry year' or drought events that currently provoke a demand-side response. There is also some scope to better target and enhance demand responses during drought events. Appeals to reduce waste, voluntary restrictions and information to nudge households to reduce water use should be used widely in response to increasing environmental water scarcity.

Awareness of water scarcity and the need for reduction in use is important to encourage behaviour change. Increased understanding about the way companies manage water and changing water availability can help address negative perceptions (relating to poor management of resources). For example in Queensland, Australia, water resource and per capita consumption levels are communicated to customers on a monthly basis[48]. In the UK, drought warnings (informed by low rainfall) could be a feature of the local weather forecast, similar to how flood warnings are communicated.

While smart tariffs play an important role in responsive demand management, additional incentives and penalties could be applied during dry and drought periods. These could include rewards for installing water efficiency devices or penalties for using water above some high consumption cap[49,50].

29% PHASED RESTRICTIONS ON WATER USE HELPED TO DELIVER DEMAND SAVINGS OF 29% IN CALIFORNIA.

For commercial customers, there is also the option of interruptible tariffs, where customers who are prepared to be subjected to phased restrictions at times of drought pay a discount charge when compared to customers who need a high security of supply. In the UK, mandatory restrictions (such as hosepipe bans) accompanied by communications about the need for urgent action can result in ~10% reduction in demand during a drought period[51]. In countries experiencing long-term drought, phased mandatory restrictions, supported by appeals, tariffs and water efficiency, can deliver enhanced reductions in demand. In California, for example, these measures delivered savings of 29%[52]. While phased mandatory restrictions are used in the UK, there may be scope for these to be further developed. In Queensland, mandatory restrictions include bans at certain times and/or on certain days; more discrimination and phasing of bans on particular uses e.g. hosing hard surfaces, sprinklers, drip irrigation, using a hose pipe for garden watering, topping up pools, washing boats and cars; various concessions e.g. for those with newly landscaped gardens; and also enforceable penalties for breaches[53].

Current use of demand-side response is determined by trigger points related to water resources status (commonly reservoir water levels). There is an opportunity to 'smarten' triggers by replacing sharp transitions with risk-based bands, including indicators to understand when demand is rising, and environmental risk. If the legacy of unsustainable abstraction licences is not addressed, rivers will feel the impact of water scarcity long before customers are asked to respond. Developing smart licences also presents the opportunity to develop trigger curves for river catchments, linked to flow threshold conditions.

Finally, the evidence base for responsive demand management is less developed than that for water efficiency. Water companies should share evidence of the effectiveness of demand-response and drought measures.

Smarter regulation

In this report we have outlined proposals for reducing the cost of tackling over-abstraction. These include smarter licensing to minimise the restriction on abstraction while protecting the environment, structured abstraction charges and customer tariffs to discourage peak water usage and smarter demand management to increase the effectiveness of demand-side response when water is scarce.

In addition to these reforms, it is important that the water supply regulatory system encourages (through incentives) least-cost solutions to matching water demand and supply – thus making it cheaper and easier to tackle over-abstraction. The strategy proposed in this report does not intend to address over-abstraction through unnecessarily high capital expenditure, which would be added to water companies' Regulatory Capital Value at customers' expense. That outcome would also limit the environmental gains that could be achieved. Addressing over-abstraction across the country will require significant spending, and, because of this, it is essential that there is maximum pressure on water companies and others to bring forward the best and cheapest solutions to match demand and supply.

Regulatory processes should be designed to provide incentives to encourage the widest possible range of options for matching demand and supply. These will include demand-side measures and trading of water and sharing of reserves between water company areas, as well as more traditional capital-intensive supply enhancements. Regulatory processes should also ensure selection of the most cost-effective options, on a level playing field.

Barriers to smarter solutions for meeting demand and reducing damaging abstraction

- Drivers in the regulatory system and cultural factors that contribute to a perceived bias by companies towards capital-intensive new supply enhancements built in their own areas.
- Appearance of insufficient incentives – and disincentives – within the regulatory arrangements for encouraging innovation. The Cave Review of competition and innovation in the water sector found very low levels of spending on innovation.[54]
- Legislative, regulatory and cultural barriers to neighbouring water companies (and other new entrants) being able to trade water across company boundaries and generally offer competing demand or supply options.

8 **Ofwat should change regulatory incentives to mitigate against bias towards capital supply solutions.**

Water companies' bias towards capital expenditure is likely to arise in part as a consequence of incentives in the price regulation regime, but it may also have important cultural drivers. As part of its current review of regulation, Ofwat should identify ways to mitigate companies' bias towards capital-intensive supply-side solutions.

OFWAT COULD HELP TO SHIFT COMPANY CULTURE BY REQUIRING THAT A MINIMUM PROPORTION OF INVESTMENT TO RECONCILE SUPPLY AND DEMAND CONSIST OF DEMAND MANAGEMENT AND OTHER OPERATIONAL MEASURES.

One approach would be for Ofwat to capitalise a fixed percentage of costs across both capital and operational expenditure in the Regulatory Capital Value, so that incentives are equalised between capital and operational expenditure solutions. Such an approach has, for example, been used by Ofgem in its fifth electricity distribution price control. This mechanism could be applied across all water company activities, or only certain categories of operational expenditure – for example, expenditure designed to ensure the supply and demand balance. This would remove disincentives to operational expenditure based solutions to meeting water needs, while generally maintaining existing incentives for efficiencies in operational expenditure.

Alternatively, or in addition, and particularly if cultural factors are considered important in the current bias towards capital, Ofwat should consider regulatory incentives to countervail cultural biases. For example, Ofwat could require a minimum proportion of companies' programmes for matching demand and supply to consist of demand-side measures and interconnection. Such incentives would be appropriate for a time-limited period only, in order to help shift culture.

9 Reforms should be introduced to provide incentives to increase innovation in the water sector and encourage the identification of a greater diversity of approaches to matching supply and demand.

Reducing unsustainable abstraction is likely to require a range of innovative approaches to meeting the supply and demand balance in the water sector. A number of reviews, including that undertaken by Professor Martin Cave, have identified lack of innovation as a challenge for the water sector. In this context, innovation need not be confined to technical improvements that allow the same activities (for example leakage repair) to be delivered at a cheaper cost. It also encompasses new ways of meeting objectives, including approaches that require more cooperation between companies. A number of mechanisms have been proposed that are designed to stimulate innovation and the development of alternative approaches.

INNOVATION SHOULD BE MORE THAN TECHNICAL IMPROVEMENTS – IT SHOULD ENCOMPASS NEW WAYS OF MEETING OBJECTIVES AND NEW APPROACHES.

First, in his 2009 review, Professor Martin Cave proposed steps for market opening in the water sector, designed to allow new entrants and competition in the sector, with the intention of stimulating new and cost-effective approaches. Cave supported the introduction of greater competition as a way of stimulating innovation both 'upstream' and 'downstream' – including both supply-side and demand-side measures. Both Cave and Ofwat have proposed separation of water companies' retail services businesses, and enabling non-household customers to choose their retail supplier. This would be designed to create a new set of businesses which are more focused on delivering services that customers want, including water efficiency and demand-side response services. In Scotland, where non-household customers are already able to choose their water supplier, there has been significant growth in the non-household water efficiency services market.

Second, there may be scope for increased trading and sharing of water across company boundaries. Ofwat has estimated significant potential for this approach as an alternative to more traditional supply proposals, and Severn Trent Water has done work to demonstrate how it could supply neighbouring water companies' demand forecasts more cheaply than its neighbours' plans[55,56]. Ofwat, Cave and Severn Trent Water have argued that regulatory, and probably legislative, changes are needed to enable companies to trade and compete in this way[57].

Third, Ofwat should consider as part of its review of regulation whether the price review process itself could be more contestable, so that neighbouring companies or entrants were able to offer competing proposals for matching supply and demand. For example, there could be opportunities in the price review process for a water company to propose that they sell water to a neighbouring company at peak times, as an alternative to the latter company's proposals for investing in its own new supply infrastructure. Alternatively, a separated water retailer might propose alternative demand-side approaches – for example a programme of water efficiency installations or aggregating interruptible contracts.

Lastly, it is likely that even where market-based reforms are introduced, these will be insufficient on their own to identify all potential gains from innovation. Ofwat should therefore consider new and specific regulatory incentives for innovation. Ofwat could consider an approach based on the Low Carbon Innovation Fund, which was introduced by Ofgem to provide incentives for innovation in energy networks. If necessary, the government should include in legislation the ability for Ofwat to set up such a challenge fund across companies. Any such fund should provide incentives for innovation by offering rewards for innovation outputs, rather than simply paying for research and development. It should also be open to bidders beyond the monopoly water companies. Innovation rewards could include increasing the allowed period, under price regulation, during which a company could earn excess returns on a successful innovation output.

10 **Reforms to the water resources planning process should be introduced to provide greater transparency over costs and options, and ensure that environmental values are better recognised.**

Company Water Resource Management Plans provide the basis by which options are identified and investments are selected to reconcile supply and demand. There are significant opportunities to improve the transparency and consistency of the current approach. In particular, some current approaches appear to support the existence of a general bias towards capital-intensive supply-side solutions. We believe that a number of reforms to the planning process would provide a fairer treatment of demand-side measures, remove the potential for bias towards over-investment in capital intensive solutions, factor the environmental value of water into decision-making, and increase the transparency of the real cost of new investments, and who pays for them.

More detail on each of our proposed reforms is provided in a supporting Itchen Initiative discussion paper[58]. In summary, we propose:

1. A consistent basis should be introduced for estimating supply, demand and the gains from different options. There should be consistency across the country to the way deployable output is estimated. In particular, there needs to be consistency over the stated frequency of droughts for which companies need to achieve security of supply. Where this is set too conservatively, it can result in over-investment in infrastructure that is required on exceptionally infrequent occasions. The supply gains and the costs of new supply-side options should be stated at the point of consumption rather than at the point of abstraction. Because the gains from supply-side options are currently calculated at the point of abstraction, they do not factor in losses and the costs of treatment and distribution (including leakage). Demand-side measures, applied at the point of consumption, do not suffer from these costs and losses. In this respect, the playing field is not level.

£ COMPANIES SHOULD USE A SHADOW ENVIRONMENTAL VALUE OF WATER WHEN PLANNING TO INCORPORATE ENVIRONMENTAL RISK.

2. A shadow environmental value of water should be included in water company investment planning, which would incorporate environmental risk into the options assessment. These values should be adjusted for different levels of environmental risk. The current mechanisms for incorporating environmental values into options assessments fall short of providing an appropriate value, thereby overvaluing supply-side rather than demand-side options.

3. Options to alter levels of service should be included within companies' options assessment and optimisation processes, where this is not already done. A companies' target level of service sets out how often it aims to use restrictions on water use, and depend upon relaxations of abstraction licence conditions, to meet demand. For example, a company may opt for a level of service target of no more than four hosepipe bans per century (1 in 25 years). Investment is then required to enable this level of service to be met. If, on the other hand, a company aimed to achieve a level of service of restrictions once in every 50 years, this would require greater investment in the development of alternative sources of water. At the moment, the level of service is determined (taking account of customer preferences and willingness to pay) ahead of the options appraisal process, and without formal consideration of the costs that might be associated with the selection of different levels of service. Instead, the level of service should be determined as one of the options in the assessment process, with level of service being an outcome of that process rather than a predetermined parameter.

LEAKAGE CONTROL MUST BE INCLUDED IN OPTIONS ASSESSMENT, WITH REDUCTIONS OVER AND ABOVE THE 'ECONOMIC LEVEL OF LEAKAGE' PURSUED WHEN THIS IS A COST-EFFECTIVE WAY OF MEETING DEMAND.

4. Similarly, options to reduce leakage should be included within the options assessment where not already done. While some companies include future levels of leakage as one of the options to be determined on comparative cost-benefit grounds through optimisation modelling, others predetermine their 'economic level of leakage' and do not consider them as options to meet the supply and demand balance. This may result in leakage not being reduced, even when it might be the cheapest option to address a supply-demand shortfall. We recommend that different rates (and costs) of leakage control be included in optimisation analysis, with reductions in leakage over and above the 'economic level of leakage' being pursued where this is the most cost-beneficial approach to meeting demand.
5. Companies should calculate the cost of providing water at peak times in dry years, and the cross-subsidies between different users associated with the provision of this water. As we have already emphasised, a significant component of the cost of providing water is to meet peak demands during dry periods. This means that there may be investments that are needed only for periods of time as short as a few weeks, or as infrequently as once in a quarter of a century. In assessing these investment options, companies should calculate and report the costs associated with providing peak water at this time. Technically, companies should calculate not only the capacity-based costs of each proposed option (using the volume of water that could be deployed, irrespective of the frequency of its use), but also the output-based costs (i.e. the cost per litre of water actually planned to be delivered over 25 years). This will indicate the true cost of providing this water, which may be very high. Companies should also be required to undertake and report an assessment of the cross-subsidies between different customer groups associated with low and high water users at times of peak demand. It is likely that much of the water used at peak times is for outdoor purposes and could therefore represent a cross-subsidy from poorer households to more affluent households with gardens. Such assessments should inform the structure of smarter tariffs.

Conclusion

The recommendations set out in this review provide the basis for a transition to smarter water management in England and Wales, which relies on flexible responses and an understanding of the value of water. Since launching our Rivers on the Edge project in 2009, we have developed these recommendations in discussion with government, regulators, water companies and other interested people. We thank all those who have been involved for their valuable contributions. We believe that our recommendations are practical and implementable and we hope to work with people across the water sector to bring them into effect, to the benefit of water customers and rivers across the country.

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River plant species – such as watercrowfoot – also rely on the ecosystem provided by the river for their survival. As rivers run dry, these plants and flowers, which bring extra colour and vibrance to our country, are also at risk of dying out.

APPENDIX: PRACTICAL MODELLING OF SMART ABSTRACTION

As part of the Itchen Initiative, we have considered smart abstraction approaches on two rivers: the Dart and the Itchen.

The preliminary results of these two tests have been encouraging, indicating that environmentally improved abstraction regimes may be possible at little cost. At the same time, given time constraints, we have not been able to model the full implications of these changes on resource availability under all conditions.

River Dart: Optimising the use of available resources from vulnerable and less vulnerable sources

Under the current approach to ending unsustainable abstraction, licences that are judged as damaging to the environment are revoked or amended. This typically results in a reduction in the available resource (or deployable output) available to a water company. In order to ensure security of supply, this reduction needs to be offset by the development of a new resource, estimated at a cost of between £1.5 million and £7 million per Ml/d. The lost resource could instead be 'made good' by a demand management scheme but such schemes tend to be of limited 'yield' and of too high a cost (under prevailing approaches). Therefore, new resource supply schemes tend to fill the void created by sustainability reductions. It can therefore be thought of as a 'resource replacement' approach. While there will always be a need for such 'resource replacement', in many cases there is the opportunity to complement them with the development of 'source prioritisation' approaches.

Source prioritisation was illustrated in a modelling exercise undertaken by South West Water, on the River Dart. The surface water abstraction from the River Dart at Littlehempston has been identified as a potentially damaging abstraction for some time. The daily maximum licensed volume in the existing licence is 27.28 Ml/d. This represents more than 20% of the river flow at the Q95, and more than 30% of the Q99 flow. This level of abstraction is significantly in excess of environmental flow indicators.

The supply area serviced from the Littlehempston abstraction can also be serviced by a number of alternative sources (see figure A1, overleaf):

- Dart Boreholes and Rannies groundwater source.
- Burrator Reservoir (a single season reservoir with net storage of 4210 Ml).
- Pumped abstractions from the River Tamar at Gunnislake supported by augmentation releases from Roadford Reservoir (a multi-season strategic reservoir with net storage of 34500 Ml).

Figure A1: Dart system schematic map.

At times of low flows, the principal alternative to the use of water from the Dart is water released from Roadford reservoir and pumped from the Tamar catchment. More limited supplies are available from Burrator reservoir.

In current practice, sources are prioritised on the basis of least cost at periods of higher water availability, and on the basis of maximising yield as scarcity increases. As water abstracted from the Dart is cheap, this is used in priority to the Roadford source. In point of fact, abstraction from the Dart source is greater under low flow conditions (when demand is high) than it is under high flow conditions (when demand tends to be low). In our model, the cost of Dart water was increased at times of low flow to reflect environmental risk, so that Dart water costs more at these times than water from Roadford and Burrator.

The model was tested for the drought of 1995/1996. Under a scenario where flows below the Q95 were protected, the total additional costs as a result of the use of water pumped from Roadford would have been in the region of £75,000 (including carbon costs), with a very small reduction in storage at Roadford over a two-year cycle. Under a second scenario where flows below the Q70 were protected, the total cost was £315,000. However, under this latter scenario, there was a more significant (13%) reduction in stored water in Roadford over the two-year drought cycle.

A number of conclusions follow from these results:

- The ‘source prioritisation’ approach modelled in this case suggests that environmental benefits could be achieved for a fraction of the costs of ‘resource replacement’ approaches. While replacement of a 27 Ml/d resource would be likely to cost up to £100 million, the source prioritisation approach was able to provide significant improvements for £75,000 in operating costs in a dry year. It is important to note that these costs would only be required in dry years where the Dart levels fall significantly. On the basis of extrapolation, the total costs for pumping water from Roadford when flow levels in the Dart fall below the Q95 would be in the region of £285,000 over a decade, a fraction of the cost of the ‘resource replacement’ option. It should be noted that the modelling work conducted did not evaluate the costs of the scheme in reduced deployable output elsewhere in the supply zone, as a result of the greater drawdown of Roadford reservoir stocks to lower abstraction from the Dart. But the initial results are encouraging that the all-in cost of this approach would be significantly lower than that required to replace the entire licensed volume.
- The principal drawback of this approach is that it may not provide protection in the case of the most severe droughts, when all available sources of water may be required. These events are likely to be rare, although potentially becoming less so under climate change. There are likely to be potentially increasing situations in which investment in resource replacement to ensure protection for critical resources is required.
- The potential for a source prioritisation approach to be effective is dependent, by definition, on a range of available sources to meet supply. The extent to which this is the case will vary between supply zones.
- The modelled tests were rapid and preliminary. More sophisticated development of alternative operating rules is likely to be able to identify optimal environmental options with least impact on cost and deployable output.
- The annual charge paid by South West Water to the Environment Agency for the abstraction at Littlehempston in 2010/11 was £119,531. This is more that the additional cost that would have resulted from the use of Roadford water rather than Dart water under the 1995/96 model. This implies that, in this case at least, a ‘scarcity charge’ on the use of water from the Dart set at the same level as the current abstraction charge would have the potential to modify behaviour to achieve some environmental outcomes.

If such ‘source prioritisation’ approaches are to be successful, they depend on the availability and assessment of a range of options across networks. This type of approach is, therefore, significantly more likely to be successful if applied in ‘whole of catchment’ or ‘whole of network’ approaches, rather than on the current site-by-site approaches.

The Dart case study indicates that pricing is a potentially effective means of signalling the sensitivity of water sources, one against another, and of avoiding damage to the most vulnerable sources, by source substitution.

River Itchen: Going with the flow – balancing authorised abstraction quantities with source status

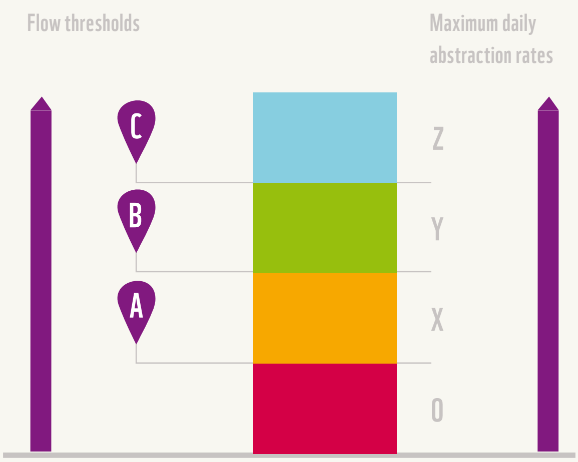
One way in which environmental sensitivity may be signalled, and abstraction from sensitive sources controlled, is to use a flow-based permitting approach. Here, the volume of water that may be taken from a source is tied to the water available from that source: as the flow in a river or the level in an aquifer falls, the permitted abstraction quantity falls, and (importantly for maintaining overall yield quantities) vice versa. The approach is more sophisticated than a simple hands-off flow condition, which prohibits abstraction when flow (or level) falls to a prescribed value. Instead, there is a graduated set of higher flow tiers to limit abstraction to sustainable quantities, protecting low flows from excessive abstraction while allowing higher rates of abstraction at higher flow levels, and at all times recognising environmental limits. We modelled a preliminary test of this approach, using abstraction from the river and groundwater sources at Southern Water's Otterbourne site, in the River Itchen catchment.

The underlying principle of the approach is that abstraction from a source (or group of sources) should be:

- prohibited when upstream flow is below some defined hands-off flow value (A);
- limited to a low rate (of X Ml/d) when flow is above A but is less than some higher flow value (B);
- limited to an increased rate (of Y Ml/d) when flow is greater than B but less than some higher value (C);
- increased to a maximum permitted rate of Z Ml/d when flow is above some sufficiently high flow threshold value (C).

Figure A2 illustrates this concept, showing the arrangement of the three flow thresholds (A, B, C) and the red, amber, green and blue bands of no, low, medium and high abstraction rates (of X, Y, Z Ml/d, for the amber, green and blue bands, respectively).

Figure A2: The rising block abstraction concept.



For the Itchen case study, a well-calibrated and tested catchment flow model (CATCHMOD) was used to simulate flow in the river under different abstraction regimes. Optimal values for the flow thresholds A, B, C and the abstraction rates X, Y, Z were identified as those best able to deliver defined environmental goals with minimum possible impact on total abstraction quantities over various 30-year simulation periods (including a climate change affected future period, as well as past periods). The environmental goals were to minimise the number of days of low flow posing harm to macro-invertebrates and impeding salmon migration and, most critically, attainment of a target environmental flow regime, particularly at low flows. The flow regime recently determined by the Environment Agency during its Review of Consents for the Habitats Directive was adopted as the target for this purpose.

Different values for the flow thresholds and abstraction rates were found according to the weighting attached to minimising the number of failure days and to maximising sustainable abstraction (above the target flow regime) during low flow periods. Figure A3 (see page 62) illustrates the key results for five different abstraction scenarios:

1. no abstraction ('zero');
2. average abstraction over the baseline period 1961-1990 ('historic');
3. maximum levels of abstraction permitted by the current licence ('licence');
4. licensed volumes proposed by the Environment Agency following it's Review of Consents ('ROC');
5. the smart licence developed through this modelling exercise* ('smart').

The results show that the smart licensing design delivers fewer of the low flow days that harm macro-invertebrates and limit salmon migration, without loss of total yield available for abstraction when compared to the ROC licence conditions in all but the driest scenarios. It would appear from these results that the tiered licensing approach has some merit, insofar as delivering both environmental and total abstraction goals.

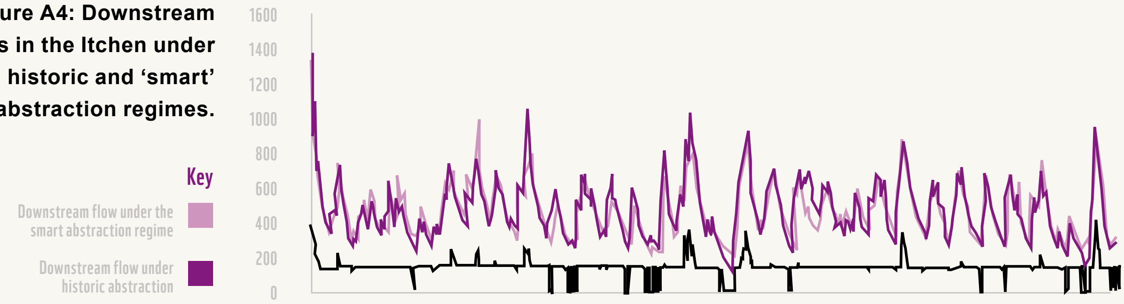
Whether the smart licence conditions also deliver acceptable yields in dry and drought periods (i.e. deployable output) remains to be seen. Time series of simulated abstraction under the smart licence regime shows a number of instances when abstraction falls to zero over the 1961-1990 period, indicating impact on deployable output (figure A4, see page 63). Whilst such zero-abstraction episodes occur under the smart licence regime, they also occur under the proposed ROC regime. It remains important to evaluate the deployable output impacts of the smart abstraction regime to make a rounded assessment of the merits of the smart approach. WWF and Southern Water intend to test this issue as an extension to the work done to date. Notwithstanding the outcome of this further modelling, there remains scope to make better use of water taken from vulnerable sources like the Itchen at times of plenty (taking water from vulnerable sources when it is available, and resting other sources for use at times when vulnerable sources are under pressure) and environmentally-benign winter storage schemes. Furthermore, water-saving measures could be invoked long before flows in the river drop to such critical levels.

*with values of 270 Ml/d for A, 320 Ml/d for B, 675 Ml/d for C and with values of 130 Ml/d for X, 140 Ml/d for Y and 140 + (Qt-1 -675) Ml/d for Z.

Figure A3: Results from the 'smart abstraction licensing' approach compared to other licensing approaches.

The top diagram shows the number of low flow days posing harm to macro-invertebrates, under the various abstraction regimes. The middle diagram shows the number of low flow days hindering salmon migration. The bottom diagram shows the annual average of the long run 'abstractable' volume attainable under the various regimes. Each set of bars shows the results for different historical periods and for 'dry' and 'wet' variants of plausible future climate for the 2020s.

Figure A4: Downstream flows in the Itchen under historic and 'smart' abstraction regimes.



Total abstraction (from surface and groundwater sources) series associated with the 'smart' licensing regime shown in black.

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WWF-UK Freshwater in numbers

100% RECYCLED

WWF · THE ITCHEN INITIATIVE

THREE

English chalk streams – the Itchen, the Kennet and the upper Lee – where we are working to highlight the pressure on our rivers from abstraction, made worse by increasing demand for water, a growing population and the effects of climate change.

36%

The proportion of people who make the connection between domestic water use and damage to river ecosystems in the UK.

500,000

homes will have water meters fitted by Southern Water by 2015. WWF is working with the water company to help people make the connection between the water they use at home and the water in their local river, with water metering a way to protect rivers and wildlife.

1,500

homes have been made more water efficient as part of Save Water Swindon – a WWF, Thames Water and Waterwise large-scale water efficiency retrofit project.

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

wwf.org.uk

HSBC
The world's local bank

The HSBC Climate Partnership is a 5 year global partnership between HSBC, The Climate Group, Earthwatch Institute, The Smithsonian Tropical Research Institute and WWF to reduce the impacts of climate change for people, forests, water and cities.

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