Water resources for the future

A STRATEGY FOR SOUTHERN REGION

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ENVIRONMENT AGENCY

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Foreword

Water is vital for life – we all use it in our homes and gardens, farming and industry needs it, the wildlife of rivers and wetlands depend on it. Yet much of the time we take our water for granted. Only extremes make us realise its impact. In the early and mid-1990's we had serious droughts. More recently rainfall and flooding. Both have undesirable impacts on our environment and quality of life.

A recent study of the impact of climate change says, 'while the recent pattern of extreme weather events cannot be directly attributed to climate change, they are consistent with what modellers expect to happen under climate change'. Rainfall patterns of the last decade emphasise the need for a robust, long-term water resources strategy.

The Environment Agency's vision of proper water management in the Southern Region of the Environment Agency is, *abstraction of water that is environmentally and economically sustainable, providing the right amount of water for people, agriculture, commerce, and industry, and an improved water – related environment*. This strategy sets out how we believe this vision can be achieved. We advocate a dual approach, within which managing water demand and careful use of water play an important role alongside the improvement of existing supply systems and development of some future resources.

We recognise the magnitude of the challenge facing us to achieve this. Our region is amongst the driest in the country. There are pressures from continued economic growth and new housing developments, personal consumption of water, irrigation of crops as well as the potential future impacts of climate change. We have valuable diverse water environments with many national and international conservation sites that need protection and, in some cases, restoration or enhancement. This region is home to many of the 'priority species' identified in the national Biodiversity Action Plan: three of the five 'special habitats' are also found in the region.

Public water supply must remain under close scrutiny in the region. We believe good progress was made by the 'Water Resources in the South East Study' that we conducted with the region's water companies and OFWAT, reporting recommendations to the DETR in July 1999. These recommendations have since been adopted in water company water resources plans and business plans. They also form part of our strategy, but our strategy demonstrates that there is still much to do if we are to achieve our vision. There are significant choices to make between alternative options if we are to secure the long-term outcomes we want.

This strategy sets out a framework that requires actions by many different organisations and individuals to achieve it: water companies, planning authorities, farmers, environmental organisations and many others. Indeed everyone plays a part – all of us are consumers of water. The publication of this strategy is another important step in a continual process, and we look forward to working with others to deliver together the actions required to make our vision reality.

David Jordan
Regional Director, Environment Agency Southern Region

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Summary

Introduction

Water is essential for natural life and for human use. We use it in our homes and gardens, in commerce and industry, and in agriculture. The way that we use water has a direct impact on the natural environment. This means that it is essential that there is a secure framework for the management of water that protects the long-term future of the water environment while encouraging sustainable development.

The Environment Agency is the statutory body with a duty to secure the proper use of water resources in England and Wales. In accordance with this duty, we have prepared this water resources strategy for the Agency's Southern Region, which covers the Isle of Wight and the majority of the counties of Hampshire, East Sussex, West Sussex and Kent. This strategy forms part of a suite of eight strategies that are consolidated in the Agency's national strategy for England and Wales. This strategy looks some 25 years ahead. It considers the needs for water both for the environment and for society, examining the uncertainties about future demand for water and its availability.

This strategy is part of a framework of integrated water resources planning carried out by the Agency and water users. Water companies play an important part in this framework, each having a published plan for the next 25 years that is kept under annual review. Our strategy sets a structure within which these plans can be refined, allowing them to meet the wider objectives of society.

Of the total water abstracted and consumed in the region, some 15 % is by agriculture and industry, with 85% abstracted by water companies for 'public water supply', which is why this receives most attention. But the Agency will continue to be active across all sectors of water use, encouraging initiatives that contribute to sustainable development.

Our strategy concludes that:

- In Southern Region, water is a scarce and often over-committed resource. The variety of demands present serious challenges to water resource management.

Resolving environmental problems presents one challenge. In many places, further improvements to the water environment are necessary. We believe this will require recovering between 80 and 180 Ml/d of abstraction: around 10 % of current abstraction across the region and a lot considering the reliable yield of Bewl reservoir is about 80 Ml/d. We also need to recover up to 500 Ml/d of licensed but unused abstraction - 'paper' licensing - across the region to prevent more unsustainable abstraction developing.

- A reliable public water supply is vital but, even in the short term let alone the long-term, parts of the public supply network can't meet reliability standards and there are few opportunities for conventional resource development which are acceptable.

- Forecast economic growth, housing growth and climate change present a greater challenge to the south east than elsewhere in the country.

- In Southern Region, reliable supply has to be achieved from a less-integrated water supply infrastructure than exists in much of the rest of the country. The region is also prone to peak demand problems: four out of five Southern Region water companies regard planning and investing for the peak period to be at least as necessary as for the annual average supply-demand situation. Greater integration of the south's supply infrastructure is essential.

- Resource development proposals should be promoted jointly by water companies.

- Doing nothing is not an option. Total water resource management must be exercised: licence alterations, demand management, metering, leakage control, efficient use of water, infrastructure strengthening, bulk supplies between companies and resource development. All are required and feature within this strategy.

- We recommend enhancing public water supply by improving existing schemes, sharing existing water supply resources and developing some new resources. But, efficient water use is also vital. We recommend that water efficiency should be promoted actively and that over the next 25 years, we should expect household water metering to become widespread, albeit with the continued protection of vulnerable groups. More attention to leakage control will also be needed.

- Agriculture must continue to use available water to best effect. In most agricultural areas, no further summer water is available. Farmers should consider crop suitability and 'winter storage' of water.

- Commerce and industry should pay more attention to water efficiency. In many cases, water saving initiatives can pay for themselves in less than a year. Active promotion of opportunities is essential.

- Working together will be the key to delivering the sustainable development of water resources. We will work to ensure that institutional structures and legislation assist effective water management.

Basis of the strategy

The Agency's vision for water resources for the next 25 years is:

Abstraction of water that is environmentally and economically sustainable, providing the right amount of water for people, agriculture, commerce and industry, and an improved water-related environment.

In preparing this strategy, we have considered the needs of public water supply, agriculture, and industry, as well as the environment. We have taken into account population growth and housing projections.

We have looked at the present resource situation, identifying areas where abstraction needs to be reduced to correct damage and improve the environment. In Southern Region, there are large areas where no more water is available during summer, where damage is already occurring or where damage could occur if existing licences were ever used more fully. We estimate that, in total, further reductions in abstraction will amount to 80 to 180 Ml/d by 2025 and 'paper' licensing of up to 500 Ml/d may also need to be recovered.

In developing this strategy, we have taken a new approach, basing our forecasts on socio-economic scenarios developed as part of the Department of Trade and Industry's Foresight programme. The Foresight scenarios define a broad framework of possible social, economic, political and technological change. They are presented as four different pictures that represent different ways in which our society could change. We have used these scenarios to consider how the demand for water could develop.

The scenarios show that demand for water is highly dependent on societal choice and governance. In two of the scenarios, total demand for water rises over the next 25 years, while in the other two it falls. Changes

are driven by economic pressures, people's desire to use water in different ways, and technological innovation.

Climate change is an important issue facing water resources management over this century. The latest climate change scenarios suggest that temperatures will rise across England and Wales. In the southern half of England, summers will be drier, while winters will be wetter throughout England and Wales.

Climate change will affect not only water availability but also demand. Over the next 25 years, we believe the effects can be managed within the twin-track strategy that we propose. However, there is at present insufficient information about extreme events to allow detailed assessment of the probability of longer or more intense droughts. This is an area that we will keep under review. In facing climate change, adaptation strategies are the key, and our recommendations prefer options that are flexible to the range of possibilities encompassed in present climate change scenarios.

In choosing a way forward, we have considered costs and benefits, risks and uncertainties, and the contribution to sustainable development. The contribution to sustainable development has been tested using sustainability appraisal. This is a process that considers policies and plans against the four key strands of sustainable development: economic growth and employment, protection of the environment, making wise use of natural resources, and social progress that considers the needs of all.

Conclusions

We recommend developing resources that total some 100 Ml/d by 2010 and anticipate up to a further 75 Ml/d by 2025. Much of this can be achieved by enhancing existing resource systems and developing water transfer schemes within the region. However, our strategy includes enlarging existing reservoirs at Darwell and/or Bewl in East Sussex. Further reservoir storage, the potential reuse of coastal effluent discharges and potential transfers into the region should all be explored in case they are needed. Some of the resource development is expected to help replace existing resource use that is damaging the environment. All resource development schemes will need careful investigation to ensure their environmental impacts are acceptable.

The development of schemes to enhance water resource availability will be the responsibility of those who will own or benefit from the schemes. We expect them to take action to investigate such schemes and to promote their development at an appropriate time.

Our strategy aims to improve the state of catchments degraded or potentially degraded by abstraction, by recovering damaging abstraction and 'paper' licensing. We expect to achieve this by implementing the National Environment Programme and the Habitats Directive, through future water company charging reviews and using Catchment Abstraction Management Strategies that we are to develop.

Continued attention to leakage control will be essential in public water supply. We believe that the continued application of best practice techniques can contribute significantly to the management of water resources. The achievements of recent years have been driven by Government and regulatory attention; in this area, continued regulation is essential.

Metering domestic customers can contribute greatly to managing water resources. The Agency advocates more use of household metering within the context of the Government's broader social and environmental policies including the protection of vulnerable households. Further metering must be accompanied by appropriate tariffs that provide social safeguards

Water efficiency will be essential if we are to achieve our vision of sustainable water resource development. We believe that water efficiency needs active promotion and that the best way to achieve this is through an independent organisation specifically funded for this purpose. The Agency will seek views on this proposal, and if we find support, will encourage its further development.

Our strategy anticipates overall household savings of up to 75 Ml/d by 2025 from metering and water efficiency measures, but the potential savings could be greater than this.

Commerce and industry could save water and money by taking simple actions. However, uptake has been disappointing and it is clear that work is needed to facilitate the uptake of these actions.

Agriculture should also work to make effective use of existing supplies, while considering opportunities to work with others to develop new sources of water. Trading of licences may prove fruitful. The Agency will seek discussion with supermarkets and food processors whose requirements may influence the use of water.

We have identified a number of areas in need of further research. The Agency will work with others to define the needs and enhance knowledge of these areas.

Future review

We have considered the risks that may arise from following this strategy. Our approach accommodates the range of demands that may arise in the future. It also allows for current scenarios of the effects of climate change. As new scenarios of climate change are developed, we will review the timing of the actions that we propose. It is possible that further investigation could disqualify some of our preferred options. For this reason, we believe that the appropriate studies should be started in good time. Similarly, the demand management options carry some risks. Some may require support or facilitation by Government and regulators, as well as activity from water users; we will review progress.

We will report on progress against this strategy annually. We plan to review the strategy completely in a few years. This strategy provides an appropriate framework for long-term water resources planning in Southern Region and contributes directly to the Agency's water resources strategy for England and Wales.

Actions

Our recommended national actions are summarised in Table 8.1 and reproduced opposite. In many cases, we seek co-operation across sectors and between different organisations. We will work to facilitate such activities. More details for Southern Region can be found in chapters 7 and 8 of this strategy.

Table 8.1 Actions

Action Ref	Action	Agency	Water companies	Agriculture	Industry	UK Government and NAW	Ofwat	Planning bodies	NGOs and others
A1	Where new or existing developments are not fully utilised water companies should consider sharing this water with others.		✓						
A2	Government should keep the Water Supply (Water Fittings) Regulations under active review to ensure that they make the best possible contribution to efficient use of water and that water companies enforce them actively		✓			✓			
A3	Water companies should actively promote waste minimisation schemes among their industrial and commercial customers in compliance with their statutory duty to promote the efficient use of water.		✓		✓				
A4	Ofwat, Government, water companies, trade associations and the Agency should vigorously promote water efficiency to all sectors and monitor the results of this work.	✓	✓			✓	✓		✓
A5	The Agency will work nationally and locally with water users and water companies to ensure that water efficiency is delivered.	✓							
A6	Government should ensure that any steps towards competition and restructuring maintain and encourage the efficient use of water resources.					✓			
A7	The Agency will seek better access to information on leakage and leakage-control.	✓							
A8	The water industry should continue to develop and implement new and better methods of leakage control.		✓						
A9	The system for setting annual leakage targets should be maintained and developed.	✓				✓	✓		
A10	The Agency will explore with Government, Ofwat and others how the current regulatory framework and the new legislation proposed in the draft Water Bill can assist in achieving good leakage control.	✓				✓	✓		
A11	The Agency will work with Ofwat, Government and the water industry in the provision of accessible information to householders about metering and in the development of tariffs that encourage water efficiency while having regard to the Government's broader social and environmental policies.	✓	✓			✓	✓		
A12	Water companies should take a positive attitude towards targeted household water metering where this is appropriate and where opportunities arise.		✓						
A13	The Agency will seek to identify opportunities to make water available for agricultural purposes from existing and new developments.	✓		✓					
A14	The Agency will encourage farmers to adopt good practice in water use around the farm.	✓		✓					
A15	The Agency will work with agriculture to continue to develop indicators of good practice in water use.	✓		✓					
A16	Farmers should actively seek ways of minimising their water use.			✓					
A17	Farmers should consider working together to develop schemes that can be shared by several farms.			✓					
A18	The Agency will assist trading of abstraction licences between abstractors, provided the trade is not doing any harm to the environment.	✓							
A19	Farmers should consider the possibility of trading abstraction licences to meet their needs.			✓					
A20	The Agency will seek dialogue with supermarkets and food processors to encourage greater understanding and consideration of the impact of their crop requirements on farmers' use and management of water and of the consequences for the water environment.	✓							✓

Table 8.1 **Actions** *continued*

Action Ref	Action	Agency	Water companies	Agriculture	Industry	UK Government and NAW	Ofwat	Planning bodies	NGOs and others
A21	The Agency will approach proposals for hydropower schemes positively and work constructively with the developers to achieve viable schemes.	✓							
A22	The Agency will seek the co-operation of others, including environmental organisations and abstractors, in identifying the actions that are needed to improve the water-related environment in relevant areas.	✓	✓	✓	✓		✓		✓
A23	The Agency will promote greater understanding of the value of the water environment, by providing clear information to the public on how water use affects the natural environment.	✓							
A24	Navigation authorities should consider whether boating demand will increase their need for reliable water resources. If it will they should prepare to identify and justify schemes to provide more water within the expected new legislative framework.								✓
A25	The Agency will encourage the development of more local transfers of raw or treated water to meet particular circumstances, provided that they take account of the needs of the environment and other users.	✓							
A26	The Agency will work with Ofwat towards further rationalisation of the ways that we each seek water resources information from water companies.	✓					✓		
A27	The Agency will work with planners to identify opportunities for water efficiency in new developments.	✓						✓	
A28	The Agency will work with Government to identify opportunities for streamlining the process of approval for essential water resources development while maintaining full public accountability.	✓				✓			
A29	The Agency will explore with others the idea of an independent water efficiency body; if we find support, we will encourage its further development.	✓							
A30	The Agency will work with others to prioritise and take forward appropriate research and development.	✓							

1 Introduction

Water is essential for natural life and human use. We use it in our homes and gardens, in industry, and in agriculture. Of our natural resources, water is unique in that it is renewable but its use has a direct impact on the natural environment. Water in rivers and wetlands supports plant and animal life, and plays a great part in defining the essential character of the landscape and countryside. Reconciling the needs of the environment with the demands of society is becoming an increasingly difficult challenge. Now more than ever, we must plan our long-term use of water so that there is a secure framework for its management.

1.1 The need for a strategy

The Environment Agency is the statutory body with a duty for strategic water resources planning in England and Wales.

This document sets out the Environment Agency Southern Region water resources strategy.

The Southern Region of the Agency covers the Isle of Wight and the majority of the counties of Hampshire, East Sussex, West Sussex and Kent: a total regional population of over 7 million people. A map of the Southern Region area is shown in Figure 1.1

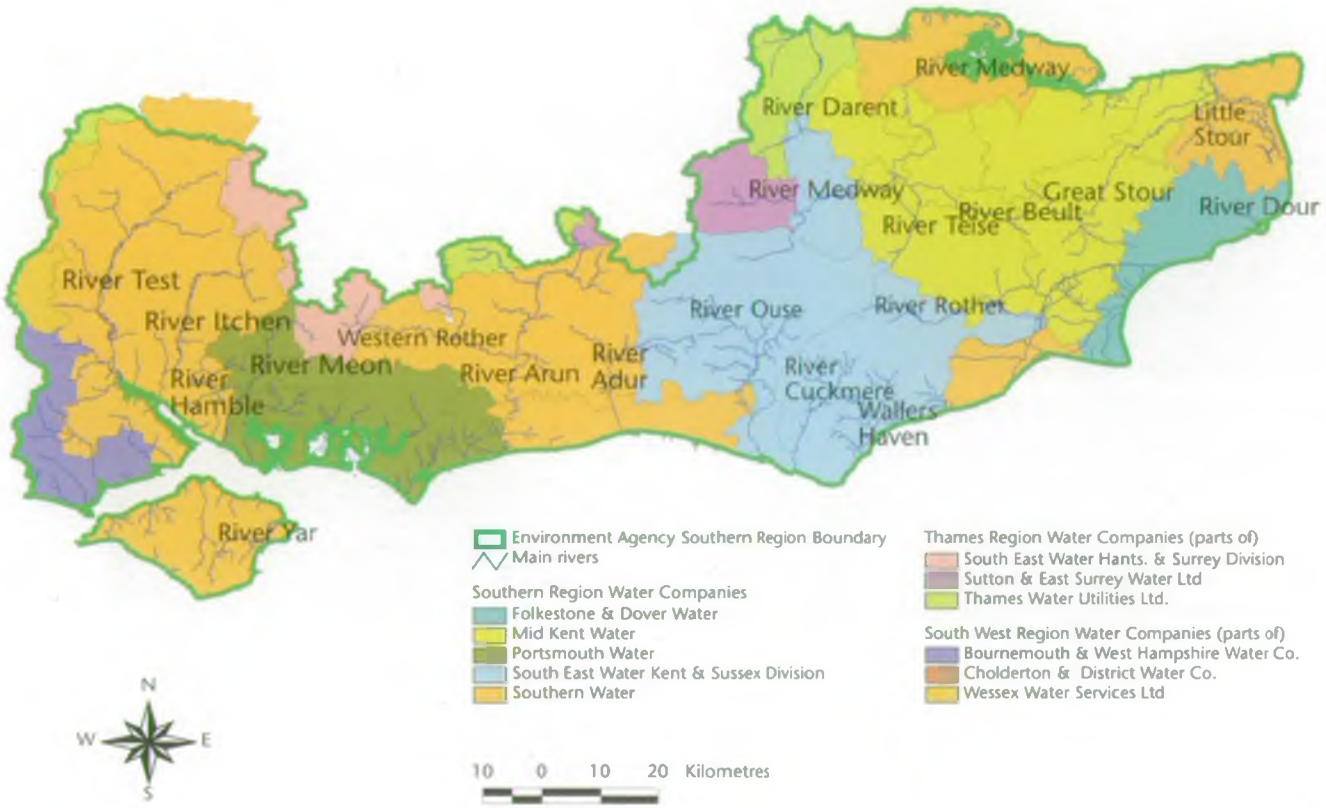
This strategy looks 25 years ahead and:

- builds on a long tradition of water resources planning
- considers water resources needs for the next generation
- adopts a flexible approach which reflects the many uncertainties that face water resources
- provides a broad framework for the management of water resources
- includes a secure way forward that protects the water environment
- contributes to sustainable development
- provides guidance for other strategies and plans, both within and outside the Agency.

As well as managing water resources, the Environment Agency has responsibility for water quality, flood defence, fisheries, navigation, and other ecological and recreational uses of water. This water resources strategy is part of an integrated approach to the management of the water cycle that is brought together by the Agency's Environmental Vision.

This document is one of a suite representing the water resources strategy for England and Wales. The national water resources strategy deals with overarching policy, approaches and techniques. It considers national issues and an overview of the seven English regional strategies and the strategy for Wales. The regional water resources strategies apply the national approach, but focus on the current state of local water resources and explore options for their long-term sustainable management.

Figure 1.1 Environment Agency Southern Region, showing water companies and rivers.



1.2

Vision and objectives

The Environment Agency is the statutory body with a duty for strategic water resources planning. Our role is to protect the long-term future of the water environment while encouraging sustainable development. Our vision for water resources in the next 25 years is:

Abstraction of water that is environmentally and economically sustainable, providing the right amount of water for people, agriculture, commerce and industry, and an improved water-related environment.

This strategy will help us achieve the following objectives, to:

- manage water resources in a way that causes no long-term degradation of the environment;
- improve the state of existing degraded catchments;
- ensure that water is available to those who need it, and that it is used wisely by all;
- indicate the present state of water resources;
- illustrate the impact of different social and economic choices on future water use;
- cater robustly for risks and uncertainties;
- promote the value of water to society and the environment;
- review feasible water management options including innovative solutions where appropriate;
- provide a framework for logical decisions to be taken at the right time;
- identify actions and opportunities for the Agency and others to work together to achieve our vision.

This strategy contributes to various themes of the Agency's new *Environmental Vision* (Environment Agency, 2000d) including:

- a better quality of life;
- enhanced environment for wildlife;
- a greener business world;
- wiser, sustainable use of natural resources;
- improved and protected inland and coastal waters;
- limiting and adapting to climate change.

The long-term approach that we have taken complements the Vision.

1.3

Consultation

While the Agency has statutory responsibilities for long-term water resources planning in England and Wales, there are many others with an interest in water resources. For this reason, in October 1999 we published a national consultation document ("Water resources for the future - values and challenges") seeking the views of groups and individuals on a variety of issues. There were some 270 replies nationally.

A national consultation response report was published at the end of September 2000.(Environment Agency, 2000c).

1.3.1 Regional consultation

In Southern Region, we conducted a two-stage consultation exercise. A preliminary paper was distributed in December 1999. This was followed by our full consultation document "Water for growth - a fair share?" in May 2000. Both were supplementary to the national consultation and were circulated to some 120 external stakeholders across the region, including environmental organisations, local authorities and water companies. On May 18th 2000 we held a seminar, "Water for growth - a fair share?" in Brighton, attended by 50 of the stakeholder organisations.

Regional consultation on water resources strategy "water for growth – a fair share?"

We received a total of 65 detailed responses to the regional consultation. Common concerns were:

- the impact of climate change;
- the implications of economic development and housing development;
- more consideration of the commercial demand for water that might go hand-in-hand with housing growth;
- securing the environment's need for water;
- recreational use of natural and man-made water features;
- the role of the Agency in educating the community to use water wisely;
- how to balance guidance on potential water savings with their costs.

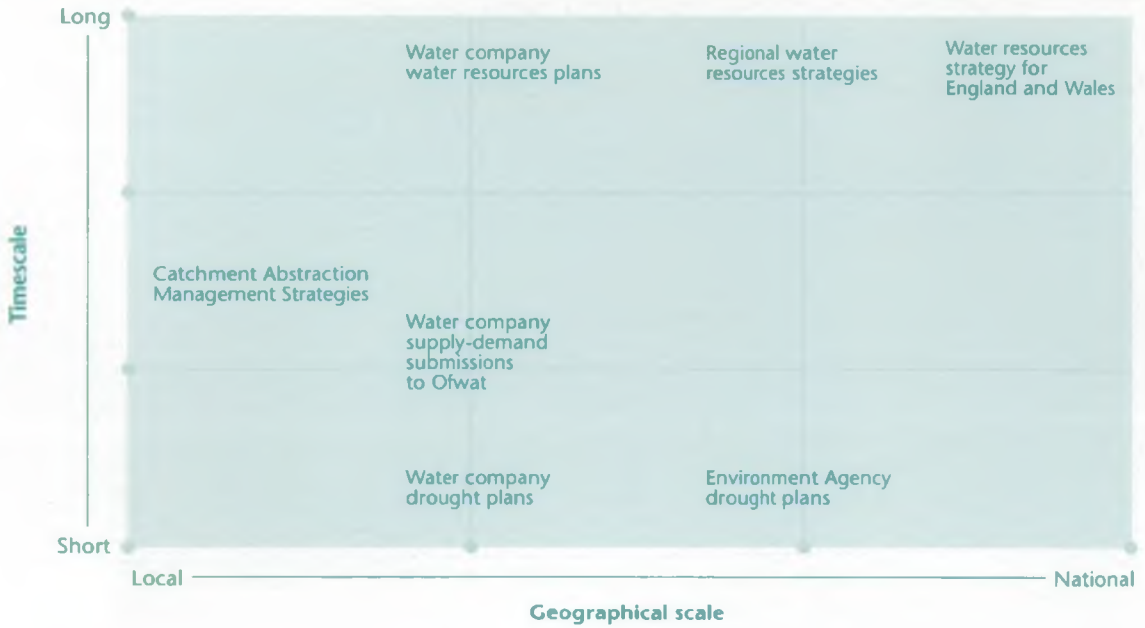
The following aims met with general approval and will help us fulfil the national objectives:

- make the best use of existing water supply resources, managing them within our statutory duties;
- implement the current National Environment Programme (NEP) and consider future environmental objectives;
- establish realistic aims for further leakage control and water efficiency measures;
- provide a framework in which future detailed work will be added, such as Catchment Abstractions Management Strategies (CAMS);
- provide a sound basis for clear guidance to planners and developers and foster relationships to minimise the adverse impacts of socio-economic development.

In October 2000 a regional consultation response report summarising the views received, with some Agency reaction to them, was issued to respondents.

We have tried to take the overall consultation responses into account as we have formulated our strategies, but communication should not end with this publication. We welcome views on the contents of this document or on any other aspects of water resources management that are of interest. If you wish to comment, please write to the Regional Water Resources Manager at our Guildbourne House, Worthing address or email: **southern.water.resources@environment-agency.gov.uk**

Figure 1.2 Scales of water resources planning activities



1.4

Links with other water resources planning initiatives

The Agency's water resources strategies are part of a framework of integrated water resources planning carried out both by the Agency and by water companies. These cover different timescales and different areas. (Figure 1.2)

This strategy looks 10 to 25 years ahead, and covers Environment Agency Southern Region. It covers all aspects of water resources management, including public water supply. This is always prominent in national and regional water resources strategies, because it is such an important part of water use. Each water company has its own water resources plan, setting out its view of how it will manage water resources over the next 25 years. These plans complement the supply – demand balance submissions that water companies make to Ofwat every five years. Annual updates to water company plans are submitted to the Environment Agency for review. The plans detail the actions that water companies intend to take, and are an important part of the water resources planning process. This strategy has used water company plans as the basis for the consideration of future public water supply. Further updates of water company plans will in turn be informed by this strategy.

The Agency's role in this strategy is to set the bounds within which decisions will be reasonable. This means that we must develop a good understanding of the values of society and government, and combine these with a rigorous assessment of future demands and pressures to provide a framework for decision-making. In some cases, these values will mean that there is an obvious course of action. In others, limited time will mean that a single course of action will have to be chosen and acted upon. Our approach must be sufficiently robust to deal with all sorts of uncertainty and still meet the objectives that we have identified for our strategies. In providing strategies, it is not our intention to constrain the commercial decisions of water companies and other abstractors, but to provide a way forward that ensures that decisions meet the wider objectives of society as a whole, and any statutory obligations in the process. This strategy sets a broad framework within which detailed plans for action by water companies and other abstractors can be drawn up.

In preparing this strategy, we have:

- considered the issues summarised in *LEAPs* (Local Environment Agency Plans) and borne in mind the coming programme of work on *CAMS*. This regional water resources strategy sets out the broad problems and offers possible solutions; but in future, CAMS work will provide more detail. There will be 12 CAMS in Southern Region.
- reflected on *previous national and regional water resources strategies*. The previous national strategy, "Water: Nature's Precious Resource" and the previous regional strategy "Sustaining Our Resources - the way forward" were published by the National Rivers Authority (NRA) in 1994, although Environment

Agency Southern Region published "Sustaining Our Resources - update" in 1997, incorporating the NRA regional strategy into the Agency. The 1994 strategies instilled the concepts of sustainable development, water demand management and the precautionary principle.

- used the *water resources plans* (WRPs) submitted to the Agency by water companies in 1999. These provide a valuable, consistently-produced, detailed review and forecast of public water supply resources, supplies and demands. Our consideration of this information is presented in chapters 4 and 6. WRPs also include the outcome of the 'Water Resources in the South East' review which we summarise in section 3.2.3
- followed the revision of *Regional Planning Guidance* (RPG9). This has raised the profile of the sustainable development issues surrounding future regional housing and economic development. In section 4.5 we summarise our view of the water demand of economic development and housing growth which might affect strategic water resources issues. This strategy considers the uncertain future scale of such growth.
- been party to the *Regional Sustainable Development Framework* prepared by the South East England Regional Assembly (SEERA). This follows the principles set out in the UK strategy for sustainable development, "A better quality of life" (DETR 1999). The framework's objectives include sustainable management of water resources.
- considered the South East England Development Agency's (SEEDA) *Regional Economic Strategy for the South East of England.* SEEDA have recognised that one of the most acute environmental pressures in the region is the high and increasing demand on water resources.

1.5

Structure of the report

In this document we describe the framework for water resources management and we set out the principles that underpin the strategy (Chapter 2). We summarise the current state of water resources (Chapter 3) and the pressures that we expect to develop on water resources in the future (Chapter 4). We move on to quantify these pressures (Chapter 5). We describe the options that could be used to meet these pressures, discuss the tools that have been used to assess these options and describe how we have used the outcome of this assessment to build the strategy (Chapter 6). Our results and conclusions are presented in Chapter 7 while Chapter 8 sets out the actions and recommendations that are needed to deliver the strategy.

2 Frameworks and principles

This chapter sets out the institutional and regulatory framework within which our water resources are managed. It looks at the changes that may result from the introduction of competition and economic instruments, and sets out the principles that underlie this strategy.

2.1 Institutional and regulatory framework

The management of water resources in England and Wales is carried out by several institutions.

2.1.1 The Environment Agency

The Environment Agency has the duty to conserve, augment, redistribute and secure the proper use of water resources in England and Wales. It is the central body with responsibility for long-term water resources planning in England and Wales. Other relevant responsibilities of the Agency include:

- flood defence on main rivers;
- water quality;
- waste minimisation in certain regulated industries (including water waste);
- fisheries; and
- navigation on some rivers.

The management of abstraction to fulfil our duties is achieved through the licensing system. This was originally introduced by the Water Resources Act 1963 and subsequently amended by several pieces of legislation that have been consolidated by the Water Resources Act 1991. In November 2000 the Government published a draft Water Bill outlining legislation, that it intends to introduce when there is time in the parliamentary timetable (DETR 2000e). This will strengthen the Agency's role and powers in respect of water resources management.

Our water resources duties extend to all abstractors, including water suppliers, agriculture industry, commerce and those who abstract for amenity, sports or leisure uses. With a few exceptions, any organisation that or individual who wants to abstract water in England or Wales needs an abstraction licence from the Environment Agency. This authorises the abstraction of a given volume of water. In exercising this regulatory role the Agency has additional duties under the Environment Act 1995 to contribute to sustainable development and to promote the conservation and enhancement of the natural environment. It also has a duty to take account of costs and benefits in the exercise of its functions, and to have regard to the economic and social well-being of rural communities.

Our primary duties are set down in legislation; policies describe the way that we fulfil these duties. The Environment Agency has developed a number of policies that inform the way that we manage and plan water resources. These water resources policies are endorsed by the Agency's Board and therefore represent a public statement of how the Agency will act. A copy of these policies is available from the Environment Agency at the Bristol address.

The Environment Agency is responsible for:

- Reporting on the state of the environment: a report on the "State of the Environment" for the South East was published in June 2000;
- Local Environment Agency Plans (LEAPs) describing the range of issues that influence the environment, economy and social well-being of different catchments and including problem-solving actions;

- Catchment Abstraction Management Strategies (CAMS), setting out the Agency's plan for managing the abstraction regime of each catchment. This is a new initiative, starting in 2001. CAMS will be reviewed every six years in a rolling programme. The relationships between CAMS, LEAPS and regional and national strategy are shown in figure 2.1;
- drought plans, setting out the Agency's role in managing droughts;
- regular review of water company water resources plans and drought plans;
- national and regional water resources strategy, setting out the Agency's vision for the long-term management of water resources.

The legislation, principles and information that guide the water resource management actions of the Agency and others are still developing. This strategy aims to be flexible and adaptable in relation to water resource and water supply management developments. Strategically important recent or pending developments are listed below. Most are outlined in this document:

- The Abstraction Licensing Review (ALR) and draft Water Bill (December 2000)
- Catchment Abstraction Management Strategies (CAMS)
- The Competition Act 1998
- Economic Instruments
- Drought Management Plans
- Water company Water Resources Plans (WRPs)
- The Habitats Directive
- the National Environment Programme (NEP)
- the Agency's initiative on Restoring Sustainable Abstraction (RSA)
- The Water Framework Directive
- Updated groundwater protection zones
- The Water Industry Act 1999
- The Water Supply (Water Fittings) Regulations, 1999

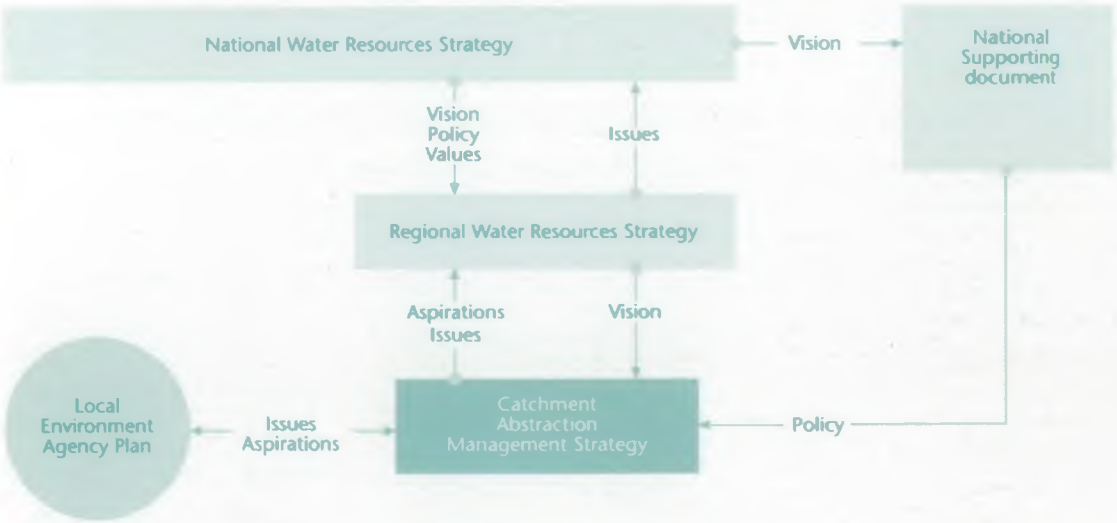
2.1.2 UK Government

In England, the Secretary of State for the Environment, Transport and the Regions determines drought orders and deals with appeals against the Agency's abstraction licensing decisions.

2.1.3 Water companies

Almost all public water supply in England and Wales is provided by private water companies. Their water abstractions and effluent discharges are regulated by the Environment Agency. The Agency is under a duty to have regard to their water supply and sewerage services duties when it exercises its powers. Each water company has the statutory duty to develop and maintain an efficient and economical system for wholesome water supply to customers, and the Agency's duties in respect of water resources management do not relieve the companies of that obligation. The five companies operating within Southern Region are Folkestone and Dover Water, Mid Kent Water, Portsmouth Water, South East Water and

Figure 2.1 Links between water resources strategies, CAMS and LEAPS



Southern Water. Several others, including Thames Water and Sutton and East Surrey Water, operate around or partially inside the Southern Region boundary. (See Figure 1.1)

Water companies are responsible for:

- Providing a clean and reliable supply of water;
- Promoting the efficient use of water by their customers;
- Water resources plans, submitted to the Environment Agency, setting out each company's view of how it will manage water resources over the next 25 years. These are reviewed annually;
- Drought plans, setting out responses to different types of drought;
- Proposing and justifying water resources schemes for incorporation into Ofwat's periodic reviews of water charges;
- Promoting the efficient use of water on behalf of customers; and
- Maintaining an economical and efficient supply system.

Water companies make decisions about the way they want to manage their supply – demand balance according to the values of the company and their understanding of the needs of their customers. In many areas of water resources planning, several different courses of action are equally effective. Water companies legitimately make commercial decisions about how they wish to manage these areas.

2.1.4 Ofwat

Economic regulation of the water companies of England and Wales is carried out by the Director General of Water Services through his Office of Water Services (Ofwat). The Director General reviews water company prices to customers in his five-yearly price review (see Ofwat 1999a). Water companies produce plans showing how they intend to manage and develop their supply systems. The Director General determines prices to customers so that companies have sufficient income to carry out the parts of these plans that he considers to be justified.

2.1.5 Drinking Water Inspectorate

The quality of the water delivered by water companies to their customers is regulated by the Drinking Water Inspectorate.

2.1.6 Planning and local authorities

Strategic planning authorities and local authorities are responsible for the land use planning framework and planning decisions. Water resources has been the subject of much interest and concern in the recent round of revisions to Regional Planning Guidance. We anticipate a need to work increasingly closely with planning authorities to ensure that the water resources implications of new developments in the region are understood and managed sustainably. This not only covers the impact on water resources of new housing, but also mineral winning activities that dewater and affect local rivers and streams. The location, scale and pace of housing and economic development must consider water resource and water supply provision issues, amongst others. Local authorities also regulate the quality of private drinking water supplies through their environmental health duties.

2.2 Competition and economic instruments

In April 2000, the Government published a consultation document on competition in the water industry in England and Wales (DETR 2000b). The government believes that the extension of competition is desirable, as it should lead to greater efficiencies, lower prices, innovation and better services, to the benefit of customers. The government is clear that this should be achieved without compromising public health, safety, the environment or wider social policy.

Different modes of competition are being considered. In this strategy we are concerned with the long-term future of water supply. We base much of our analysis on data related to present water companies. However, this does not mean that we assume that present water company structures will continue for the next 25 years. Our interest is in the people who use water in their homes and industry, and not in the commercial structure of the supplying company. However, the structure of the water industry could have serious effects on the ability to deliver our strategy.

We take the view that introduction of competition, and possible restructuring of water companies, must be controlled so that it encompasses good practice and innovation, without putting at risk environmental protection or delivery of water efficiency. We consider that accountabilities for promoting water efficiency, currently a duty of water undertakers, could become dissipated and therefore even harder to deliver. Water efficiency is of great importance, and we trust that

government will ensure that its delivery is not compromised by structural changes to the public water supply industry.

The government also consulted on economic instruments in April 2000 (DETR 2000c). The paper considered:

- The case for raising abstraction charges above the cost recovery level, either to make abstractors bear the environmental cost of the effects of their abstraction, or to reduce the amount of water abstracted for economically low-value uses
- The potential for the trading of abstraction licences as an effective means of achieving the optimal distribution of water resources within and between different sectors of water use, hence contributing to sustainable development.

The paper invited comments on the government's view that increasing charges beyond cost recovery would be unlikely to be the best way to reduce abstractions. Comments were also invited on the government's view that licence trading should be promoted within a strong regulatory regime that provides a framework to protect the environment and other water users. The government will produce a further document on economic instruments in relation to water abstraction early in 2001.

We consider the role of abstraction licence trading further in section 7.3.

2.3 Principles underpinning the Agency's approach to water resources planning

The Agency's approach to water resources planning is based on four main principles.

2.3.1 Sustainable development

The Environment Agency has a legal duty to contribute to sustainable development. In May 1999, the government published "A better quality of life: a strategy for sustainable development for the United Kingdom" (DETR 1999a). It says that at the heart of sustainable development is the simple idea of ensuring a better quality of life for everyone, now and for generations to come. It means meeting four objectives simultaneously:

- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources;
- Maintenance of high and stable levels of economic growth and employment.

The concept of sustainable development provides a framework against which strategies can be tested. We have used a technique known as 'sustainability appraisal' to measure the contribution of our strategies to sustainable development. This is discussed further in Chapter 6.

2.3.2 The 'twin-track' approach

The 'twin-track' approach takes a balanced view, seeking the efficient use of water while bringing forward timely proposals for resource development where appropriate. The twin-track approach recognises the value of water in the environment, and therefore seeks the efficient use of existing water resources. However, it recognises also that development of new water resources may be necessary, and that such development must be planned in advance so that it is ready when the water is needed. The approach implies that as more resource development is required, increasing effort must be applied to the efficient use of water.

2.3.3 Robustness to uncertainty and change

In looking ahead, we must acknowledge explicitly the uncertainties that are associated with many of the factors that affect water resources management. This means that we must identify a way forward that is flexible and robust to a range of possible futures. To do this, we need to understand the implications of the different changes that could happen. For this reason, we have taken a scenario approach, looking at the different ways that society may use and value water in the future. Uncertainties include specifically social values and systems of governance, and climate change. We explain in Chapter 5 how we have allowed for them.

Adoption of a scenario-based approach also makes it easier to discard the old 'predict and provide' doctrine that involved developing resources to meet all possible future demands. By considering different possible futures, we can develop an approach that involves managing water use and expectations to produce a strategy that is robust and flexible.

2.3.4 The precautionary principle

The 'precautionary principle' says that where there is uncertainty about the consequences, decisions should be cautious and should seek to clarify the source of the uncertainty. In water resources management, this principle means that if there is a serious risk of environmental damage because of a proposed abstraction, the decision about the abstraction should ensure that the environment is protected. It also applies to a serious risk of failure of public water supply, which would be unacceptable in terms of its social and perhaps economic impacts.

3 State of water resources

This part of the report looks briefly at how water is taken from the environment, distributed and then used. It also discusses the environmental demand for water and its importance in terms of recreation.

England and Wales are commonly perceived as wet and everywhere in the country can have very wet periods. It is, of course, not always so and in parts of the south and east rainfall can be very limited. Also, population density is high, so the water available for each person can be surprisingly low: providing water and protecting the environment can often be in conflict.

Pevensey Levels, East Sussex: An internationally designated wetland fed by waters also used for public water supply

3.1 The water resource: groundwater, rivers, wetlands and rainfall

Groundwater held within aquifers is an important source of water within Southern Region both for consumption and for the environment. Chalk is the dominant aquifer, typically used for around 60% of public water supplies and contributing spring-flow and base-flow to many rivers and streams enabling them to continue flowing during dry periods. Other aquifers account for about another 20 % of public water supplies. Directly or indirectly, groundwater can also support our wetlands.

River Itchen – Internationally renowned Chalk stream....just one of the many valuable and sensitive water environments across Southern Region

Southern Region also has rivers that are predominantly dependent on surface drainage, with little support from groundwater, so their flows can be more variable and perhaps less reliable: many of the rivers and streams of East Sussex have this characteristic.

Wetlands and rivers, including winterbournes, are important habitats supporting diverse species of flora and fauna. The Agency's Thames and Southern Regions are contact points for 14 of 39 'Priority Species' and 3 of 5 special habitats under the Convention on

Biodiversity and the DETR Biodiversity Action Plan. Chalk river habitat is one of the identified special habitats. Southern Regions important wildlife habitats are discussed in chapters 3 and 5.

In managing our use of water resources we must ensure that river flow and groundwater regimes can support river and wetland ecosystems and sustain their use for fisheries, navigation, dilution of effluent discharges and existing licensed abstraction.

Rainfall

Water is abstracted from the region's rivers, aquifers and reservoirs for public water supply, and for use in industry and agriculture. These abstractions and our water environments are ultimately dependent on rainfall and its movement over and through the ground. Average annual rainfall varies across the region from 800 to 1000 mm in the west or on higher ground, to 550 to 650 mm in parts of Kent. But much rainfall is evaporated or used by plants, so that useful or 'effective' rainfall is far less, especially in summer. Only 20 to 50 % of rainfall may be effective in recharging resources. In a dry year, effective rainfall may be even lower, comparable to some Middle Eastern countries. Year to year variability in rainfall and dry periods that span several years can also be significant. Dry winters can limit groundwater recharge and reservoir storage recovery.

3.1.1 Drought and drought management

Droughts are natural phenomena caused by long periods of low effective rainfall. Dry periods may continue over several years, creating a cumulative deficit in water resources, particularly in groundwater. River flows can fall to very low volumes when there is no rainfall for long periods because there will be no surface runoff and reduced contributions from groundwater. Low river flows affect water quality through higher temperatures, less dilution of effluent and lower oxygen levels. They can expose areas of the river channel, such as fish spawning grounds, causing damage or disruption.

The first rainfall following a dry period is not the end of a drought. Dry soils soak up the rain and it may take many weeks before giving a sustained rise in groundwater and river levels. Conversely, wet winters do not preclude drought developing the following summer. For example, the winter of 1994/95 was quite wet, but the hot dry summer of 1995 and dry winter of 1995/96 produced water supply and water environment problems through to the spring of 1997.

Drought Management Plans

In "Maintaining Public Water Supplies", (January 1999), Ministers confirmed that water companies should maintain Environment Agency-agreed drought management plans. Agreed plans were produced in May 2000. The plans set out the drought situations that a company may face and their proposals to avoid the need for additional abstraction in all but the most exceptional circumstances. The full range and sequence of drought management measures include the imposition first of hosepipe bans and then of restrictions on inessential use. Baseline monitoring expectations are also to be included and implemented for sites where additional abstraction might be sought in a drought.

In turn, the Environment Agency has produced its own drought management plans, expanding this approach to include all water uses. The Agency plans identify measures to monitor and assess the impact severe droughts may have on the water environment. In future, the Agency may apply for Drought Orders to restrict abstraction during droughts to protect the environment.

3.2 Distributing water

3.2.1 Abstraction

To ensure sufficient water is available for us to use, we need to ensure that water is available at the right place at the right time, whilst minimising the impact on the water environment.

Water is abstracted from surface and groundwater sources for use directly by agricultural and industrial users, but public water supply accounts for the majority of abstraction. Water is abstracted from rivers, reservoirs and groundwater sources by water companies, treated and distributed to domestic, business and industrial customers as public water supply. Supplies must be available to satisfy peak period needs and average annual needs in dry years.

3.2.2 Transfers

In Southern Region, the distribution, scale and type of abstraction is the result of many factors, including hydrology, geology, historical settlement, water demand growth and development of water company businesses in response to demands, economic pressures, privatisation and regulation. Similarly the way supply systems have developed is a result of these factors. Some involve transfer of water, either by pipeline or

aqueduct or within rivers and canals. While there are some 'bulk supplies' from one company to another and there are proposals for more, Southern Region has a complex, but less integrated water supply infrastructure than much of the rest of the country.

In 1999 around 1400 Ml/d was abstracted for public water supply: about the same as the reliable yield of Kielder reservoir in Northumberland. Southern Region relies on a complex mixture of small sources. The region is also groundwater dependent, with only around 10% of public water supply provided from six reservoirs and less than 10 % from direct river abstraction: groundwater abstraction accounts for the rest.

Water companies assess their ability to match supplies with demand within water resource zones, defined as areas in which all customers experience the same security of supply. Water company water resources plans (WRPs) submitted in 1999 show 85 water resource zones in England and 42 in Wales. Environment Agency Southern Region has 28 zones, with others falling partly inside the regional boundary.

There are resource zones with surplus resources and others with existing or forecast deficits. At present, the infrastructure does not allow the surpluses to satisfy the deficits. This can be apparent for annual average demands, peak demand periods, or both. We describe resource zone surpluses and deficits in chapter 4.

At a strategic level, distributing water can involve transfer of raw (abstracted) water or treated water. Southern Region's existing and proposed treated water pipeline transfers are shown in figure 3.1, while raw water transfers are listed below. The proposals are included in water company WRPs. Transfer of water is discussed in chapter 6.

Raw water transfers in Southern Region, include:

- The Candover scheme: groundwater pumped from the upper river Itchen catchment and discharged to the river to regulate low flows.
- The Ardingly-Ouse scheme: releases from Ardingly reservoir to the river Ouse, mainly for re-abstraction at Barcombe.
- The Medway scheme: releases from Bewl reservoir to support abstractions at Springfield on the Medway; abstraction from the upper Medway to help winter refill of Bewl reservoir; transfers from Bewl reservoir to Darwell reservoir.
- The Wallers Haven scheme: groundwater abstraction discharged to river tributaries to support abstractions at Boreham Bridge on the Wallers Haven.

3.2.3 Water Resources in the South East Group

Much of the resource development proposed by Southern Region water companies in WRPs is to facilitate treated water transfers (bulk supplies) and the sharing of resources between neighbouring water companies to meet supply-demand shortfalls. In principle, the Agency thinks these proposals do make better use of existing resources. The proposed bulk supply agreements shown on figure 3.1 have been achieved through the Water Resources in the South East Group (WRSE) formed in July 1997 by the Southern Region water companies, the Agency, Ofwat, and Thames Water. The WRSE Group was established following the Monopoly and Mergers Commission report on the proposed bid for Mid Kent Holdings plc by General Utilities PLC and SAUR Water Services plc in January 1997. The Group has developed water resource planning for the South East of England. The conclusions of the review were reported to the DETR in July 1999 by the Agency, Ofwat and the companies.

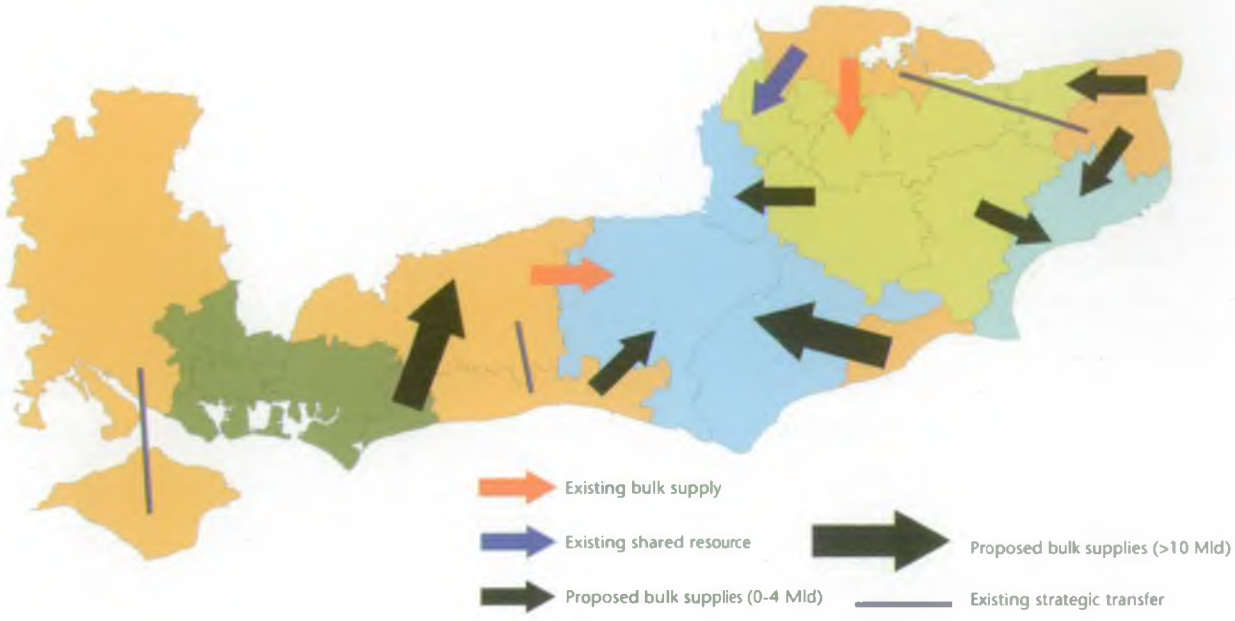
3.2.4 Leakage

A significant portion of water abstracted for public water supply is lost through leakage from the distribution system and supply pipes on customers premises. Losses vary from water company to water company as a result of differing historical investment in leakage control, the differing nature of the companies' systems, topography and geography.

Over the last 10 years there has been a significant change in the perception of leakage by government and the general public. This has prompted a change in leakage control policy. After the 1997 Water Summit, mandatory leakage control targets were introduced and this has resulted in a marked reduction in total levels of leakage. Current targets are set by Ofwat based either on the company's assessment of the economics of leakage control or where this is not considered to be robust on the company's relative resource position and existing levels of leakage. Those companies with greater water stress are expected to have lower levels of leakage. A joint DETR, Environment Agency and Ofwat project has been instigated to explore opportunities to determine a future approach to leakage target setting.

The regional total leakage level is set to be around 190 Ml/d in 2000/01, down by one third from the 1992/93 figure of 281 Ml/d. This represents a saving of some 90 Ml/d, equivalent to around 2-3 times the daily supply for Brighton and Hove. The current level of leakage within our region represents around 106 litres for each property each day (l/prop/d) or around 17%

Figure 3.1 Strategic links, shared resources and 'Water Resources in the South East Group' bulk supply negotiations



of all treated water entering the supply network. Four out of the five Southern Region water companies maintain that their current mandatory targets set by Ofwat are at, or already below, their economic level, where the cost of reducing leakage becomes more expensive than providing water from other sources.

Leakage is discussed further in chapter 6.

3.3 Uses of abstracted water

Water is used for many different things. An understanding of existing water use is essential in helping to develop our view on the scale and scope of future changes.

25% of water abstracted from our rivers and aquifers is for direct use by agriculture and industry; regionally, some 50Ml/d is taken for agricultural use and 400Ml/d for industrial purposes. However much of this is returned to the environment near the point of abstraction, so consumption is low. The majority of consumptive abstraction is taken for public water supply, as illustrated in the pie charts (Figure 3.2).

Below we consider both public water supply and direct abstraction under the following broad headings:

- Household water use;
- Industry (considering both mains water and direct abstraction);
- Agriculture;
- Power generation.

These categories cover the most important uses of water.

3.3.1 Household water use

The estimation of an individual's daily water use in terms of litres per head per day (l/h/d), otherwise known as per capita consumption (pcc), is a key element of water companies' water balance calculations and demand forecasts. 'Unmeasured' pcc is calculated from general water supply statistics and customer information, but 'measured' pcc is calculated more directly from household meter readings. Pcc can be calculated and forecast for dry years or normal years and expressed in relation to 'annual average' consumption or 'critical period' consumption.

Figure 3.3 shows a regional aggregation of the water companies' forecasts of demand growth for public water supply to 2024/25 (dry year annual average demand), taken from the 1999 WRPs.

Figure 3.4 (a and b) shows the make-up of the forecast growth in dry year demand. (Note, the vertical scales of the two figures are different). The majority is growth in consumption from within existing households and their population, although in the 1999 WRPs, water companies allowed for only some 295,000 new homes, somewhat fewer than later government indications (See section 4.5 below). Non-household (industrial) demand falls 25 Ml/d by 2010 in the 1999 water company forecasts, but this is not shown in figure 3.4 (a or b).

Figure 3.2 **Licensed and consumptive abstraction by sector, excluding tidal licences**

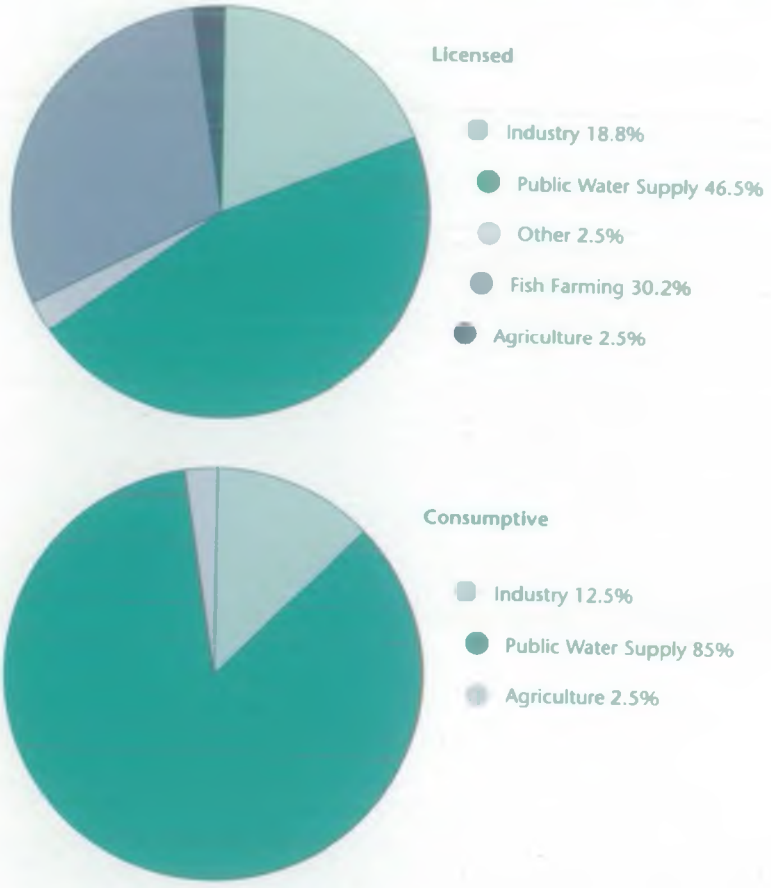


Figure 3.3 **Regional demand forecast 1997/98 to 2024/25 based on water company 1999 water resources plans (dry year annual average demand)**

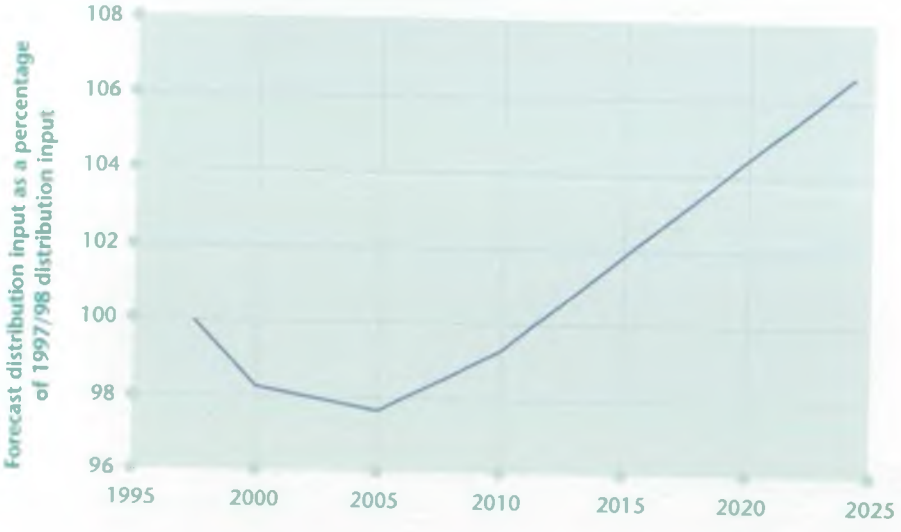


Figure 3.4a Main components of 1999 WRP forecast water demand growth, 2010

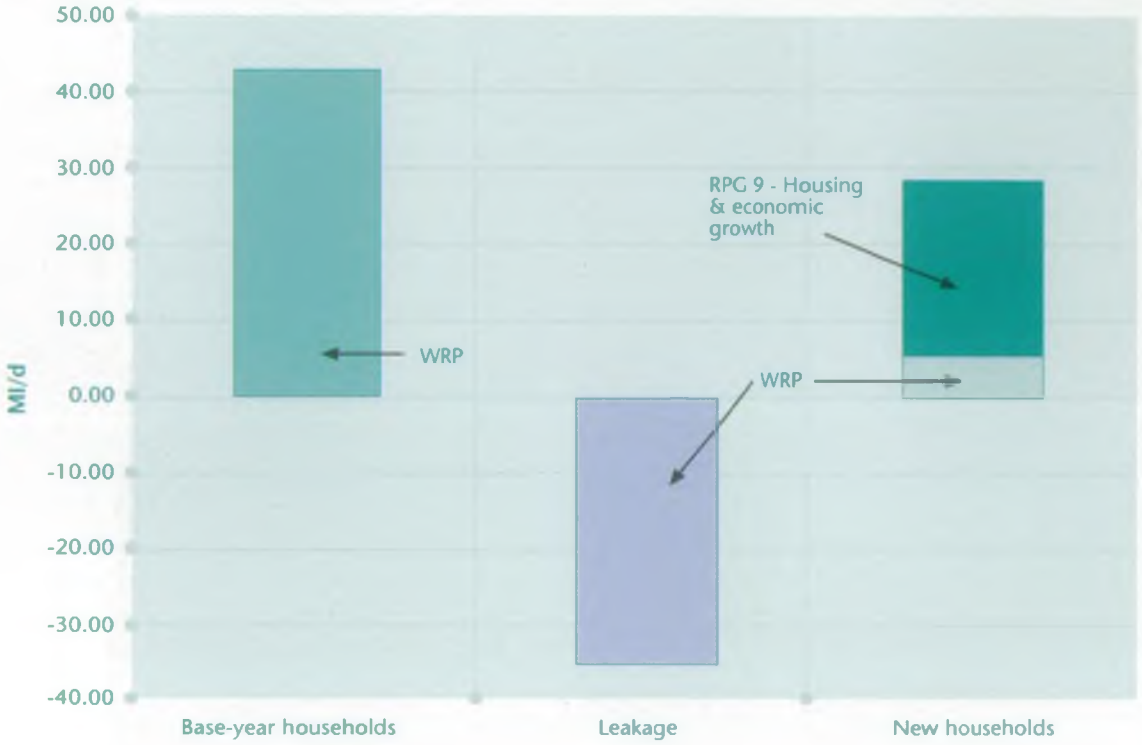
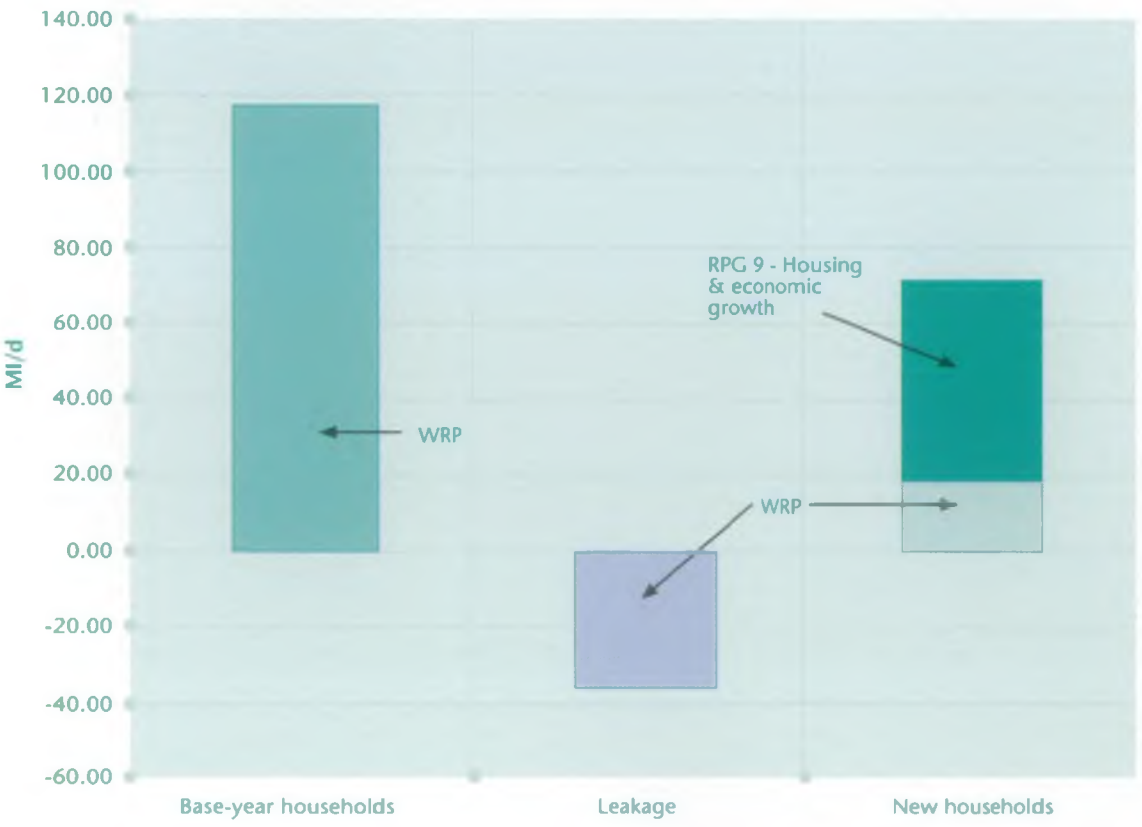


Figure 3.4b Main components of 1999 WRP forecast water demand growth, 2025



The growth in water demand from the occupants of new housing may be closer to that of existing households if the housing increases suggested in Regional Planning Guidance (RPG9) are implemented. This is demonstrated on figures 3.4 (a and b) and discussed in section 4.6.

Figure 3.5 shows the volume of water put into public supply across Southern Region in the drought year of 1995. The seasonal pattern of water use is fairly typical, with peak demands occurring during the summer months largely as a result of increased domestic use such as personal washing and garden watering. In the hot dry summer of 1995 peak demands were high relative to the average.

Within Southern Region, there is a wide variation in pcc figures. Company forecasts of pcc is summarised in Table 3.1, while recent annual average values are summarised in Table 3.2

Whilst some variation in pcc is to be expected due to different housing type, the socio-economic distribution of the population and climate patterns, the Agency would like to see the water companies continue their research to improve current estimates and future projections. At present all water companies within Southern Region are predicting a steady rise in pcc over the next 25 years. If pcc growth cannot be contained, there will be further stress on the environment, unless leakage control saves an equivalent amount of abstraction. Efficient use of water and further leakage control are discussed in chapter 6.

3.3.2 Industry

There are a variety of direct abstractions for industrial water use within the region ranging from non-consumptive uses such as mineral washing and power station cooling, to highly consumptive uses such as evaporative cooling. Main water consuming industries in the region include paper milling, pharmaceuticals, petro-chemicals and food and drink. Consumptive industry accounts for 10 % of the consumptive abstracted volume. Demand for industrial water has

Figure 3.5 Public water supplied, 1995 (Southern Region)

Table 3.1 **Summary of unmeasured and measured per capita consumption (pcc) within Southern Region for supply-demand scenarios, based on water company forecasts. (Figures in litres per head per day (l/h/d), critical period relating to 'peak week').**

Scenario		Description	2000/01	2009/10	2024/25
Normal Year Annual Average (Baseline)	Unmeasured	Maximum	190.6	203.7	228.2
	Unmeasured	Minimum	155.9	159.2	168.5
	Measured	Maximum	183.1	193.4	210.0
	Measured	Minimum	145.8	150.9	159.2
Dry Year Annual Average (Final Planning)	Unmeasured	Maximum	199.2	210.1	230.7
	Unmeasured	Minimum	162.6	169.7	178.3
	Measured	Maximum	191.4	199.4	212.4
	Measured	Minimum	148.8	154.0	161.0
Dry Year Critical Period (Final Planning)	Unmeasured	Maximum	325.9	408.3	550.5
	Unmeasured	Minimum	200.5	214.3	239.4
	Measured	Maximum	259.5	266.2	284.8
	Measured	Minimum	181.4	192.4	219.8
Southern Region Averages (Mean)					
Normal Year Annual Average (Baseline)	Unmeasured	Mean	162.3	169.9	186.4
	Measured	Mean	155.0	161.0	174.3
Dry Year Annual Average (Final Planning)	Unmeasured	Mean	171.6	179.0	196.0
	Measured	Mean	162.3	168.3	182.7
Dry Year Critical Period (Final Planning)	Unmeasured	Mean	243.9	255.9	280.7
	Measured	Mean	218.4	226.3	244.4

Table 3.2 **Annual average per capita consumption based on figures reported by water companies**

County (approx.)	Property Type	Per Capita Consumption (l/h/d)					
		1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Hampshire	Unmeasured Households	156	154	156	173	163	160
	Measured Households	-	-	140	148	141	148
West Sussex	Unmeasured Households	151	152	154	167	161	159
	Measured Households	-	-	133	139	135	143
East Sussex	Unmeasured Households	147	153	160	170	163	161
	Measured Households	-	-	141	149	146	150
Kent	Unmeasured Households	148	152	158	168	160	161
	Measured Households	-	-	140	143	144	148
Mean for Southern Region (without Isle of Wight)	Unmeasured Households	151	153	157	170	162	160
	Measured Households	-	-	139	145	142	148

stabilised in recent years, following declines throughout the 1970s and 1980s. The reasons for this decline can be attributed to the general fall in industrial production, increased recycling and efficiency, the down-sizing of military bases and the shift away from primary industries which were major water users.

For industry, direct abstraction represents a relatively cheap source of supply, while public water supply is more costly, but can be the most economic source of high quality water. Business, service and leisure sector premises can be large users of public water supply for employee or customer use.

The Environmental Technology Best Practice Programme (now Envirowise) and the Agency's "Optimum use of water for industry and agriculture dependent on direct abstraction" (Environment Agency,

1998d) project have both shown clearly that there is significant scope for reducing water consumption in industry and business, with considerable cost savings.

3.3.3 Agriculture

Farmers draw on both public water supplies and direct abstraction from rivers and groundwater.

Direct abstraction can support general farming activities, such as diluting chemicals, washing down, livestock drinking, and irrigation for farm crops; direct abstraction for such agriculture accounts for around 3% of total abstraction in the region.

Horticulture uses water from public water supply, as well as direct abstraction and there is growth in water required from public supply as back-up for direct abstraction. This back-up may typically be called upon during periods of peak demand in other sectors of public water supply.

Other direct agricultural water abstractions include fish farms, which can require large throughput. Careful siting of the intake and discharge locations is required as these large abstractions can severely affect the river reach inbetween; nearly all water taken is returned after use.

The biggest use of water by the agricultural sector is spray irrigation. This is a highly consumptive use of water with virtually no return discharges to the river system.

Over the last five to ten years, supermarkets and food processing firms have extended their influence over all areas of on-farm decision making, through the development of farm assurance schemes and integrated crop management protocols. Within the context of these schemes and protocols, farmers may be limited in the way they incorporate efficiency measures into their farm management practices. Only when these specifications change might it prove economically viable for farmers to implement medium-term water efficiency measures.

Spray irrigation and trickle irrigation

Irrigation is usually applied through spray guns, but trickle irrigation is now becoming more widespread, particularly on the Isle of Wight, in parts of East and West Sussex and in Kent, particularly around the Medway estuary. The Abstraction Licensing Review proposes that existing and proposed trickle irrigation abstractions will be brought into the licensing system. Existing trickle irrigation may prove to be an additional, perhaps unacceptable, stress on the resource balance, but at present quantities of water taken for this purpose are uncertain. If existing abstractions are causing harm to the environment, mitigation measures such as winter storage will be required before new licences are granted. In some applications, trickle irrigation can be an efficient means of applying water, but the Agency will expect suitable apparatus, maintenance, scheduling, controls, and monitoring within overall best practice.

3.3.4 Power Generation

Power generation is by far the largest non-consumptive use of water from direct abstraction in England and Wales. Southern Region's largest abstractions are in tidal waters. New power stations generally use less water, with some being air-cooled.

There is no hydropower in Southern Region and potential is limited, although interest in small-scale hydropower generation may increase following initiatives to promote alternative means of producing energy.

3.4 Recreational and other uses of water

3.4.1 Navigation

The rivers and canals of England and Wales have a long history of navigation, but use is now mainly recreational. On rivers, it may be necessary to maintain levels to allow boats to pass. Canals can move water from one catchment to another, through the use of locks. The restoration of disused canals, new navigational agreements or increases in boat traffic can present challenges for water resource management. The Agency has a Navigation Restoration Policy and works with those considering restorations to determine whether sufficient water will be available without detrimental impact on the environment or other abstractors. In Southern Region, there are formal navigation agreements on the River Medway in Kent and Rye Harbour in East Sussex.

3.4.2 Angling

Fish are an integral part of the aquatic environment and often provide the best indicators of a well-balanced ecosystem due to their position towards the top of the food chain. Of particular importance is the effect of water flow on the migrations of salmon and sea trout, both downstream as smolts and upstream as adults from the sea. Seasonal or occasional increases in river flow, stimulate these movements and are important in enabling adult fish to negotiate obstructions.

Angling for both coarse and game fish is an important and hugely popular use of rivers, lakes and canals. The fish populations, as well as having a significant conservation value, support important rod and net fisheries.

3.4.3 Wildlife conservation

As the main organisation with responsibility for pollution control and water management in England and Wales, the Agency is an important contributor to wildlife conservation, especially in wetland and river habitats. Wildlife conservation generally aims to maintain or enhance natural biodiversity. Its success depends on understanding the environmental requirements of habitats and species and how plants and animals interact.

The Environment Act 1995 gives the Agency a duty to promote the conservation and enhancement of the natural beauty and flora and fauna of inland and coastal waters and associated land. England and Wales have a relatively rich biodiversity, although between 10 and 20% of our native species are considered to be threatened in some way. The Agency has lead responsibility for 39 species and five habitats of wetland character under the UK Biodiversity Action Plan (UKBAP) (UK Government, 1994). Chalk river habitat, predominant in Southern Region, is one of the five special habitats. The UKBAP identifies the need to take opportunities for enhancing wetland habitats. In its lead role, the Agency will need to explore with others how such opportunities can be supported.

The way that we manage water resources plays an important part in maintaining or enhancing biodiversity. In setting conditions on abstraction licences, we carefully consider the needs of wildlife, and where there is doubt, we make decisions based on the precautionary principle. The Agency is also a competent authority under The Conservation Regulations 1994 which implement the Habitats Directive, which is designed to protect sites of international importance to specified flora and fauna. This means that we must ensure that designated sites and associated wildlife are not harmed by current or proposed abstractions. Environmental needs are discussed in section 4.2

3.4.4 Other recreation and amenity

Water is an important resource for a variety of sports and recreation, including angling, canoeing, sailing and rowing. It has an important value as a landscape and amenity feature enjoyed by the millions who visit rivers, canals and lakes for relaxation. The requirements often conflict, calling for careful management, especially in areas dependent on tourism where growth may be desirable to sustain local communities but where there is a risk of damaging the essential nature of the environment on which tourism is built.

3.5 Water resources and the environment

The present environment of Southern Region is the result of many factors, including climate, geology and topography. Water is an essential part of our natural environment, because of the way that it supports plant and animal life and shapes the landscape.

To summarise the current position, we have produced three maps. (Figures 3.6, 3.7 and 3.8). They cover summer surface water availability, winter surface water availability and groundwater availability. It is not appropriate to separate an assessment of groundwater availability between summer and winter, because the characteristics of most aquifers mean that rainfall stored in the winter is released to rivers and wetlands gradually throughout the year. The maps are based on hydrological records representing dry weather conditions: as far as possible we have tried to represent the scale of dry weather that might occur about once in every ten years.

Each water resource map has the following categories, shown as red, yellow and green, respectively:

- Unsustainable or unacceptable abstraction: current actual abstraction is causing definite or probable environmental problems, or problems are anticipated if abstraction reaches full licence volumes.
- No additional water available: licensed abstraction does not pose a threat to the environment, but it is considered that there is little scope for further abstraction.
- Additional water available: additional water may be available, although at any specific site volumes available may be small and reliability may be low.

The maps indicate both where opportunities for further reliable abstraction might exist and where existing licences or abstractions might reduce river flows or

groundwater levels to environmentally-unacceptable levels: our method assumes that abstraction should not cause river flows to reduce below the levels necessary to protect the environment. The flow conditions set within existing abstraction licences to control abstraction were assumed to offer the protection necessary. Of course, many flow conditions were set on licences some time ago and there are many initiatives underway to improve determination of environmental flow requirements. We expect CAMS to review existing flow conditions against the latest knowledge and best practice.

These maps represent the strategic position across Southern Region, based on the broad conditions across large areas, and reflect our current understanding of the relevant issues. Subject to more detailed examination, we believe any areas classified "red" on the maps need some re-balancing, either in 'paper licensing', actual abstraction or both. In time, we should be able to reclassify "red" areas "yellow". But the maps are not intended to pre-judge licensing decisions. Individual licence issues or new applications will be considered on their merits against specific local analysis. This assessment does not rule out scope for further small scale licensing in some locations. CAMS will make detailed assessments for each catchment in a six-year programme starting later in 2001. We have published the results of our consultation on the CAMS process and later in 2001 we will present our proposed process.

Surface water

To determine whether a catchment has more water available for abstraction, the reliability of the resource was considered: the river flow should be sufficient to meet the needs of the abstractor over time without damaging the environment.

The surface water resource maps were generated from hydrological flow records, licensed and actual abstraction data, dry weather flow effluent discharge estimates and environmental protection assumptions. Maps were produced for dry summer and dry winter flow conditions for actual and licensed abstraction volumes.

A numerical approach was used in reviewing large surface water catchments. But for small surface water catchments, small groundwater-fed streams and marshes, we inferred results from: upstream surface water; contributing groundwater resource; the presence of designated environmental sites; water quality considerations and subjective assessment. Inferred areas are shown hatched on the maps.

Figures 3.6 and 3.7 show surface water resources across Southern Region. Figure 3.6 shows the situation assuming existing licences are fully-used in a dry summer. The map indicates that our rivers and streams are already over-licensed in relation to dry summer conditions.

Figure 3.6 **Surface water availability – based on licensed abstraction, during a dry summer**

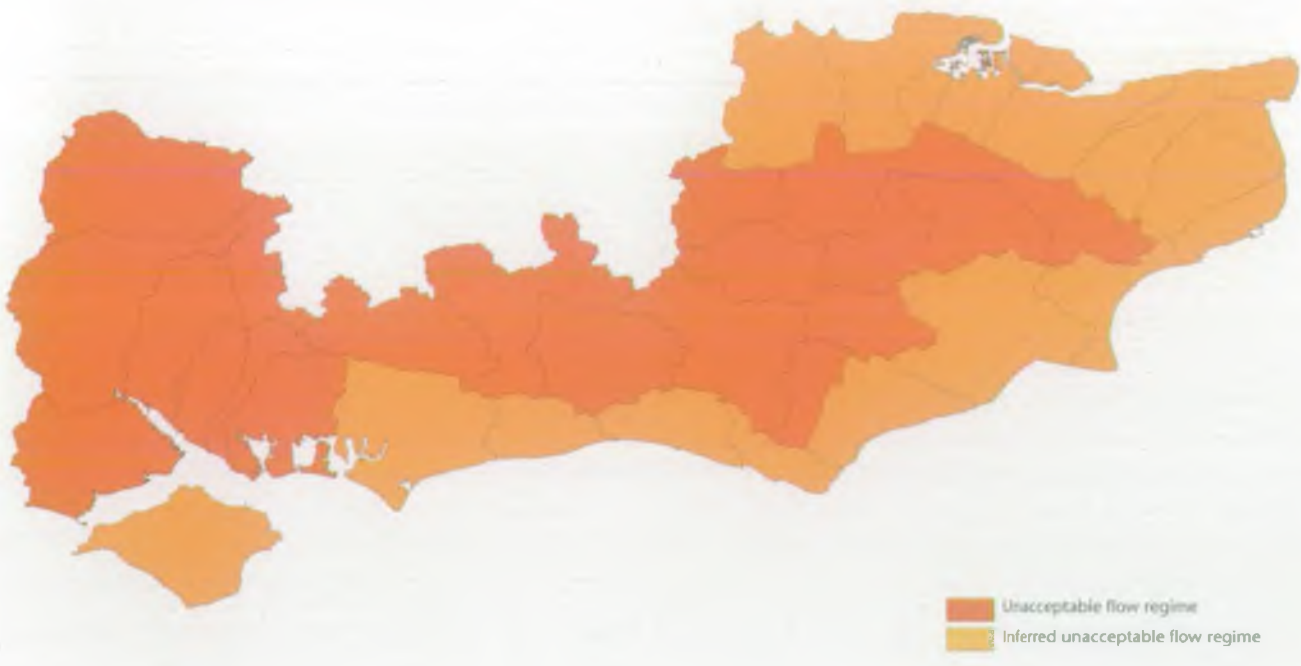


Figure 3.7 Surface water availability – based on licensed abstraction, during a dry winter

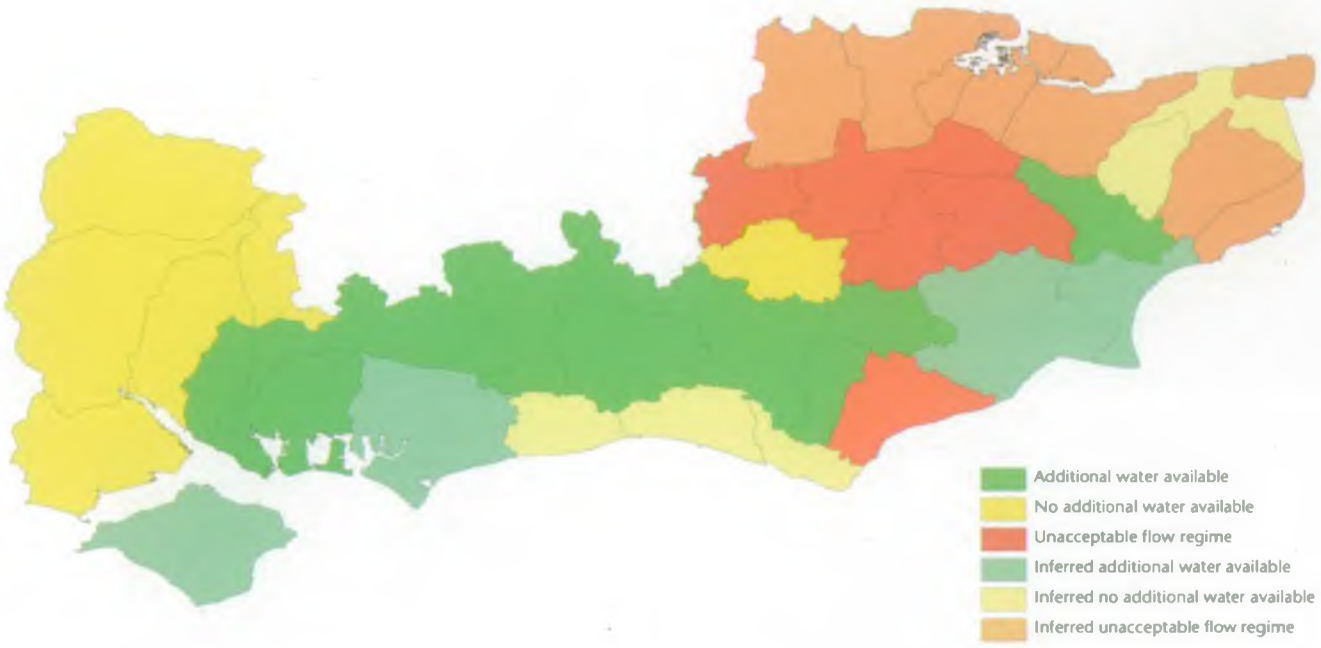


Figure 3.8 Groundwater availability – based on licensed abstraction, during a dry year (water year)

Figure 3.7 shows the surface water resources situation based on licensed abstraction for a dry winter. The map indicates that much of Kent is potentially over-licensed during a dry winter. Hampshire, the Isle of Wight and East and West Sussex are either broadly at the abstraction limit or have additional water available. In East Sussex, the Wallers Haven and Pevensey Levels are a concern.

The conclusion from figures 3.6 and 3.7 is that there is very little scope for further summer surface water licences in Southern Region and that there is reason to be concerned about potential over-abstraction in many catchments. However, there is scope for further winter abstraction associated with winter storage schemes.

Groundwater

The groundwater resource map is derived from effective rainfall, licensed abstraction data, information on groundwater-fed spring flows and environmental protection assumptions. We have produced annual (water-year) maps for dry weather recharge conditions for licensed abstraction volumes.

Groundwater resource was determined as the difference between the effective recharge and the required resource (licensed abstraction plus environmental protection) over a water-year. Aquifers with a negative difference (required resource is greater than the effective recharge) were classified as having an "unacceptable flow regime"; those with a small positive balance were classified as having "no additional water available" while the remainder were deemed to have "additional water available".

The allocation to environmental protection is particularly uncertain in the groundwater balance, partly due to the complexity of groundwater – surface water interactions. The groundwater map relies on the Environment Agency's experience of groundwater levels, spring flows, abstraction patterns and water quality impacts in dry and drought years to support the water balance calculations.

Figure 3.8 shows the groundwater resource of Southern Region for a dry year based on licensed abstraction volumes: the majority of the region's aquifers are already over-licensed.

Turning the "red" areas on our water resources maps to "yellow" by recovering paper licensing and actual abstraction is a necessary and fundamental goal of our strategy.

4 Pressures on water resources

Many factors need to be considered in planning water resources. We need to understand the current demands placed on water supplies and the environment by society and the future demands that are likely to arise. Water companies forecast demand for public water supply to grow and plan to ensure they have resources at their disposal to balance demands with supplies. But there are many aspects of the future that are uncertain. These include, for example, population growth, housing, land use, effects of climate change and how society might change. How society values the environment and chooses to use water in future will determine the demands placed on water resources.

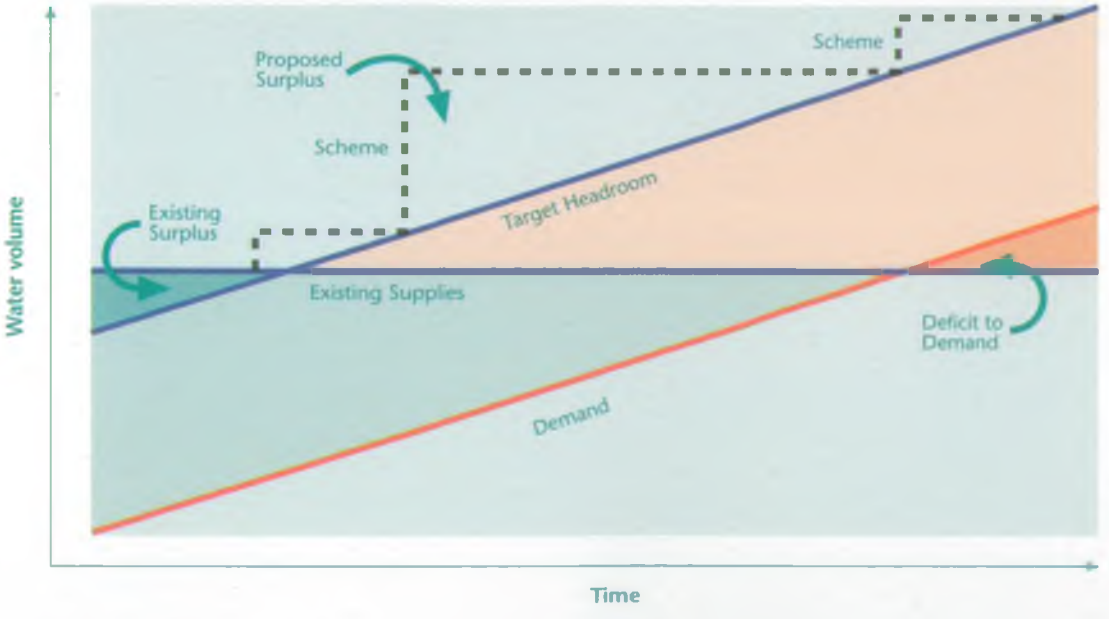
4.1 Public water supply

As it is the largest component of consumptive abstraction across the region, maintaining reliable public water supplies to agreed standards represents a significant pressure on water resources. Current and forecast public water supply requirements place some immediate pressures on the Southern Region environment through supply enhancement proposals. These arise from the water resources planning round that culminated in the 1999 water resources plans (WRPs) submitted by water companies, with supporting investment plans largely approved in Ofwat's 1999 charging review. A variety of proposals have been outlined in these plans. These address the supply reliability standards to be met, a review of existing supplies and forecast demands, their geographic distribution and the infrastructure available to distribute water from sources to demand.

Water company water resources planning

Water resource plans explore the public water supply-

Figure 4.1 Conceptual supply–demand balance diagram



demand balance in relation to normal years and dry years, although dry year demand forecasts and drought-reliable source outputs are the basis of assessing the reliability of water supplies. All companies assess the dry year, annual average, supply-demand balance and those prone to peak demand problems also assess the critical period balance. Four out of five Southern Region water companies regard planning and investing for the critical period to be at least as necessary as for the annual average balance. The critical period is typically the peak-week demand. For example, a hot dry week in August, perhaps including the bank-holiday.

The Water Resources Planning Guidelines expect water companies to plan to achieve and maintain a balance between available supplies and forecast demands, looking 25 years ahead. A planning margin called 'target headroom' is also expected to be included; typically a margin of between 5 % and 10 % of available supplies over demands, increasing the further ahead the estimate. Figure 4.1 shows a conceptual supply-demand balance. At different times a company might have a deficit waiting to be solved, could be in balance or might have a surplus, because many supply-demand options can't be phased in to match the forecast demands perfectly. In the context of the WRPs, a true surplus implies spare supplies over and above forecast demands *and* target headroom.

The companies assess the supply-demand balance for each of their resource zones and their WRP should cover the complete range and scope of options available to the company to balance supplies and demands.

This range of 'total water management' has four principal categories of options:

- Customer side management, including domestic metering, education and recycling
- Distribution management, including reducing leakage
- Production management, covering activities between abstraction and distribution
- Resource management, including new resource development, expanding existing resource capacity, resource transfers, aquifer storage recovery and effluent re-use

The Agency expects water companies to discuss their options in their water resources plans and include preliminary justification of the preferred options.

Together with company business plan submissions to Ofwat, WRPs also consider the implications of the National Environment Programme.

Water companies are required to review their plans each year. Any new information that could affect the future supply-demand balance should be considered, such as new housing growth projections. The Agency will continue to work closely with the companies in the annual review and periodic update of these plans.

Existing public water supply situation and forecast demand growth

Figure 4.2 shows the 2000/01 'dry year annual average' supply-demand balance for each water company water

Figure 4.2 **Dry year, annual average demand, initial balance, 2000/01**

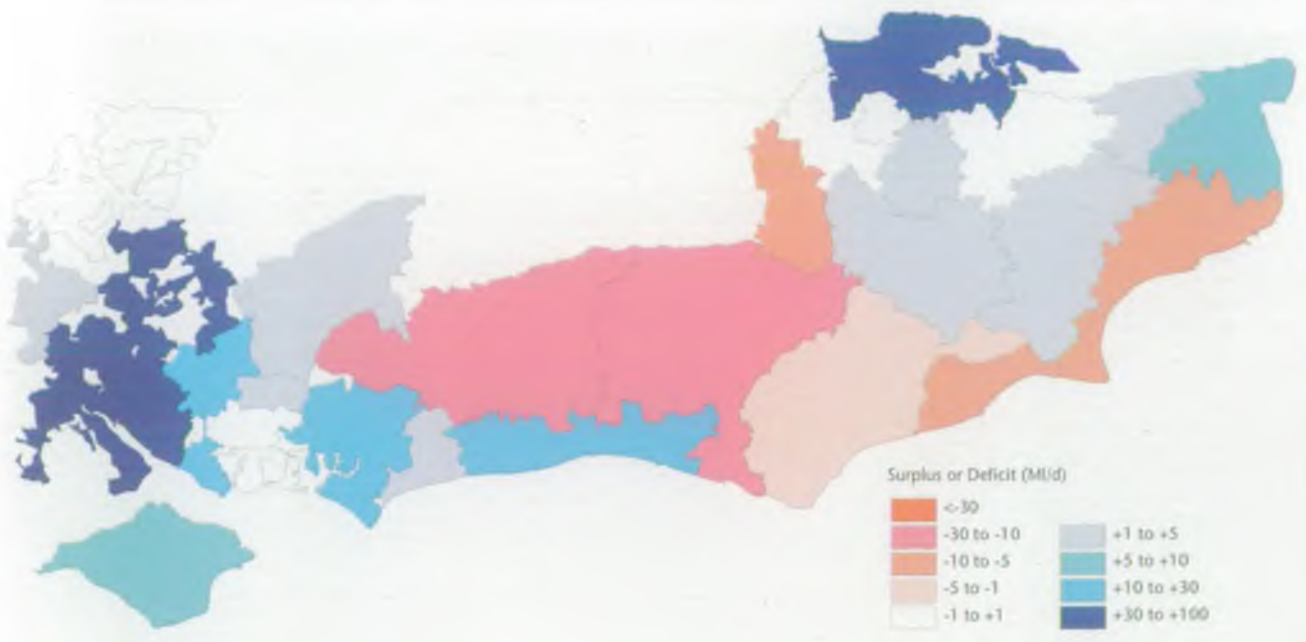
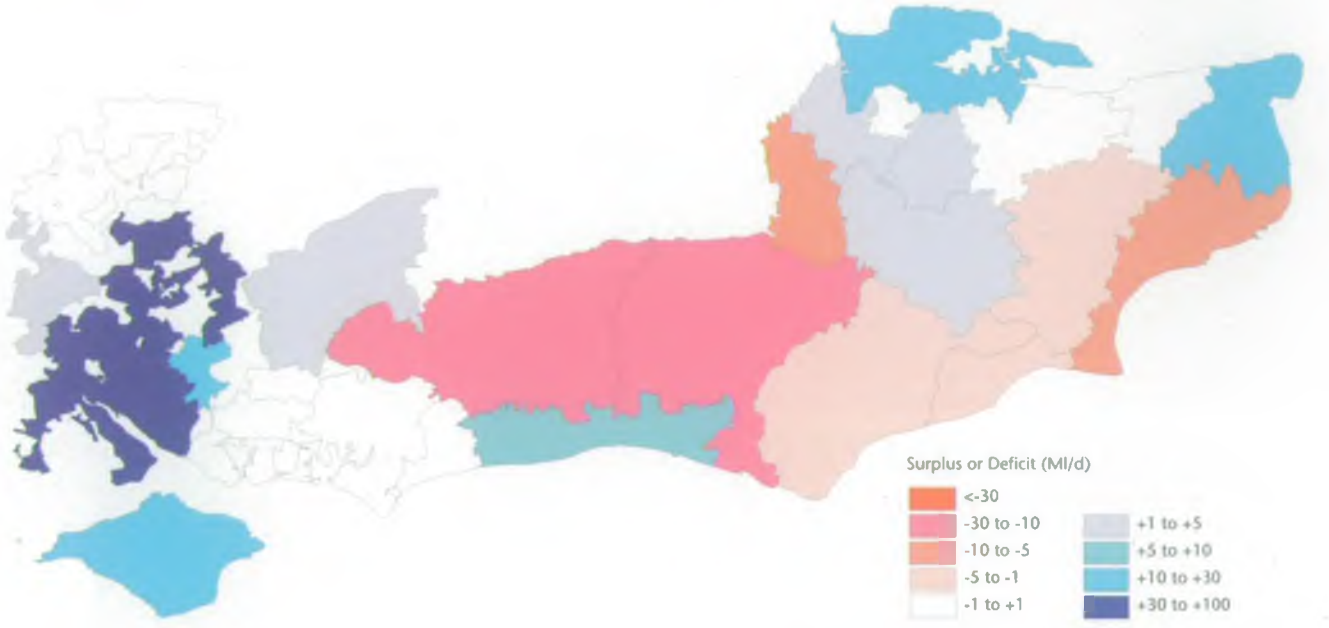


Figure 4.3 Dry year critical period demand, initial balance, 2000/01



resource zone as forecast by the companies in their 1999 WRP, based on reliable resources, leakage control and water efficiency intentions, as at 1997/98. Some resource zones have a shortfall (deficit) between their supplies and forecast demands, while other zones have a surplus. Figure 4.3 represents the equivalent 'critical period' (peak week) situation. Water companies could struggle to satisfy customer demand in resource zones with shortfalls should the dry year scenario actually occur.

Companies must plan to balance supplies and demands and so achieve the required levels of service to their customers; the assumptions within the dry year scenario build in more security of supply than previous standards. This is why some of the resource zones show shortfalls at 2000/01. To satisfy the agreed standards, further leakage control, demand management, supply enhancement or resource development is required.

Figure 4.4 shows the dry year public water supply demand forecasts to 2024/25, company by company, including the main changes in them between June 1998 and October 2000. We have shown available supplies constant at 1997-98 levels, but in future they will increase if new supply schemes are implemented, or decrease if we have to reduce abstractions to protect the environment.

Figures 4.5 and 4.6 represent the year 2010 equivalent of figures 4.2 and 4.3 if demands grow as forecast in the 1999 WRPs and no further 'total water management options' are developed.

Some water company plans have shown difficulties in achieving or maintaining a 'dry year' supply-demand balance in the short to medium term because of either the existing dry-year supply-demand shortfalls or projected demand growth. The resource zones with most difficulty are listed below.

South East Water, in Kent and East Sussex.

- Forecast overall deficits of 22 Ml/d in 2000/01 and 4 Ml/d in 2009/10.
- In the Mid-Sussex resource zone, forecast deficits range from 19 Ml/d in 2000/01 to 10 Ml/d in 2019/20.
- Forecast dependency on new resource development beyond 2015.

Folkestone and Dover Water

- Forecast deficit of 8 Ml/d against demand of around 50 Ml/d in 2000/01, but reducing to nearly in balance by 2009/10
- Projected water resources concerns beyond 2005 as the company has limited options and could not identify a clear preferred solution for its 1999 WRP
- May be ultimately dependent on a regional strategic solution.

Southern Water

- Immediate and short term water resource deficits (to 2005), particularly in Sussex North resource zone (nearly 30 Ml/d for 2000/01), but also Sussex East (Hastings)
- Further investigation of the potential of the Bewl-Darwell reservoir system is essential beyond 2005, both for Southern Water's supplies and for support to other companies.

Figure 4.4 Water company water demand forecasts

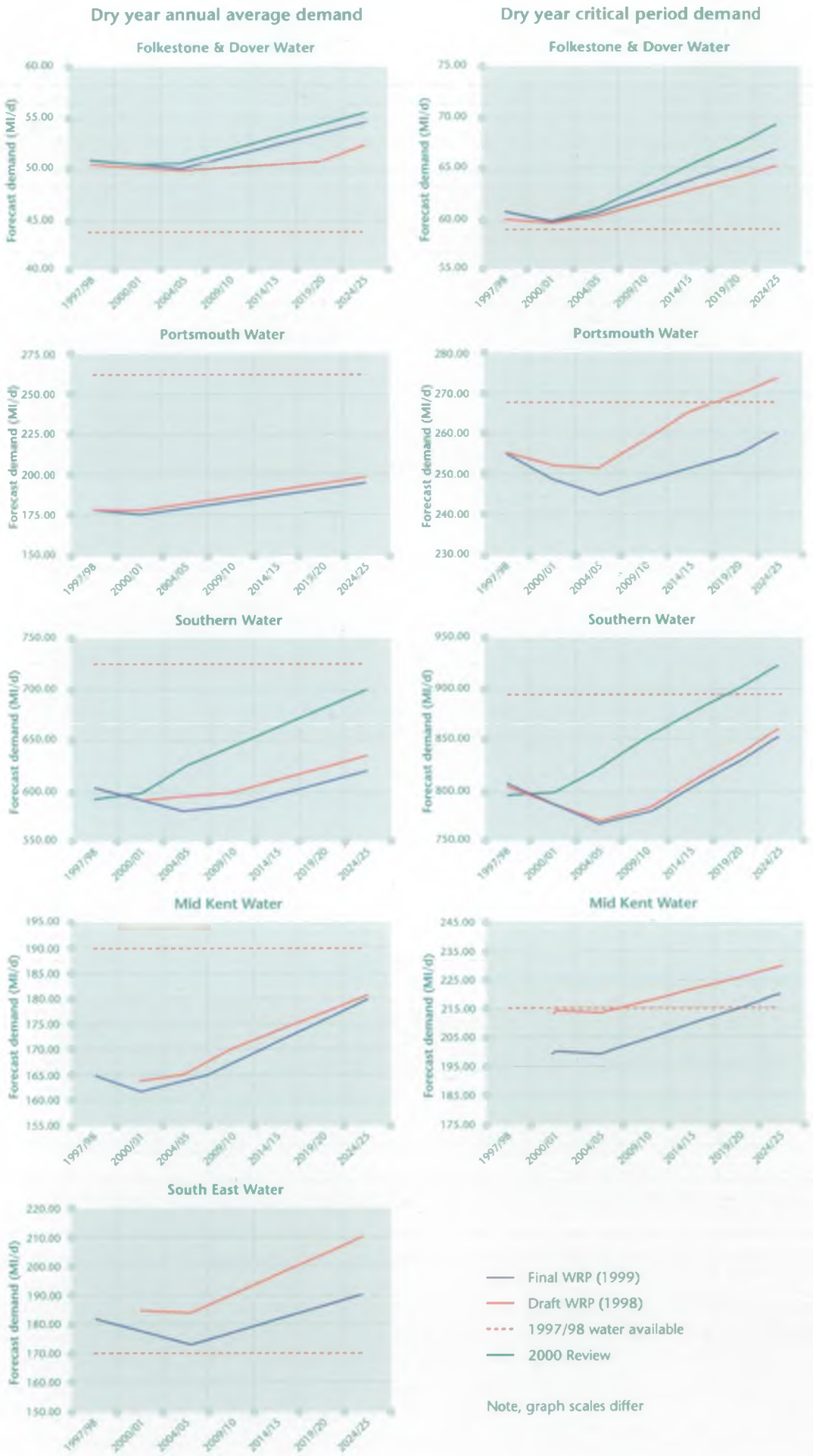


Figure 4.5 Dry year, annual average demand, initial balance, 2009/10

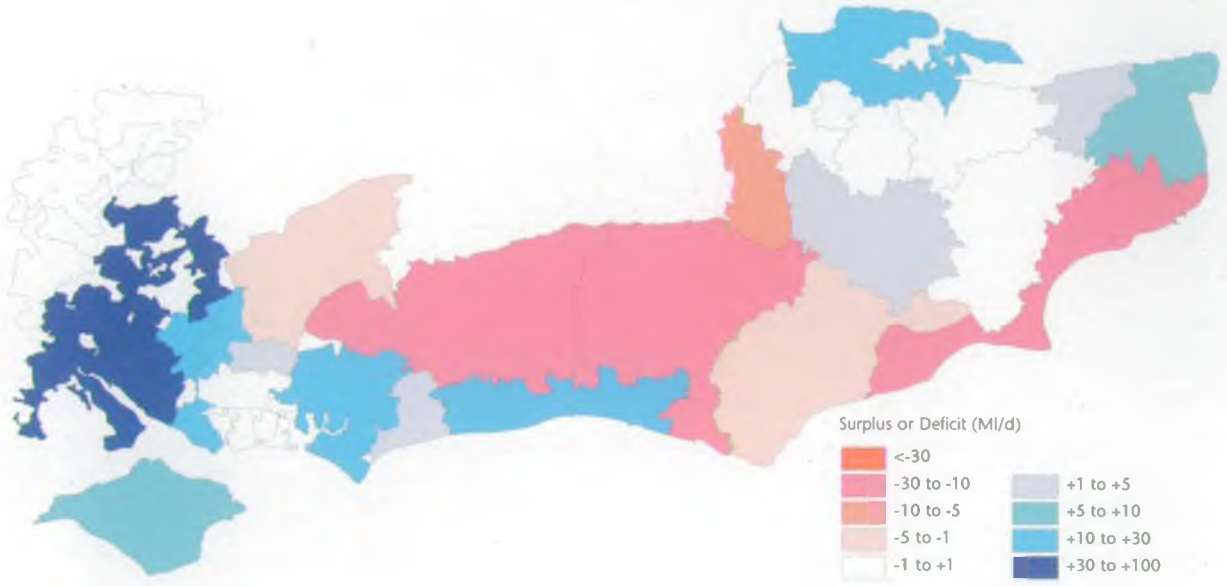
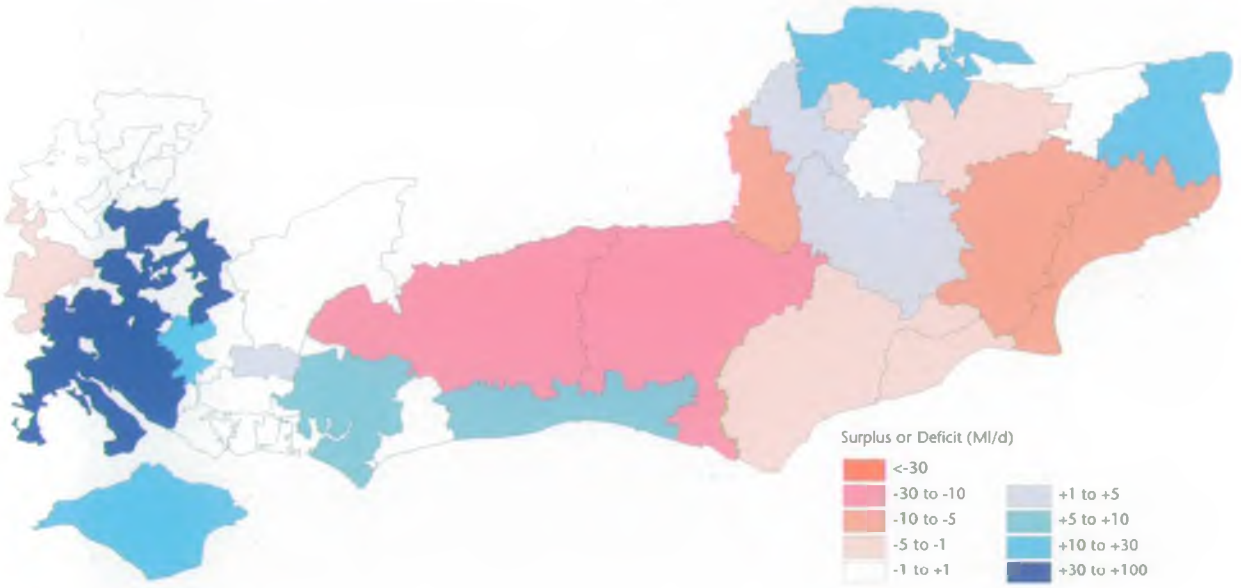


Figure 4.6 Dry year, critical period demand, initial balance, 2009/10



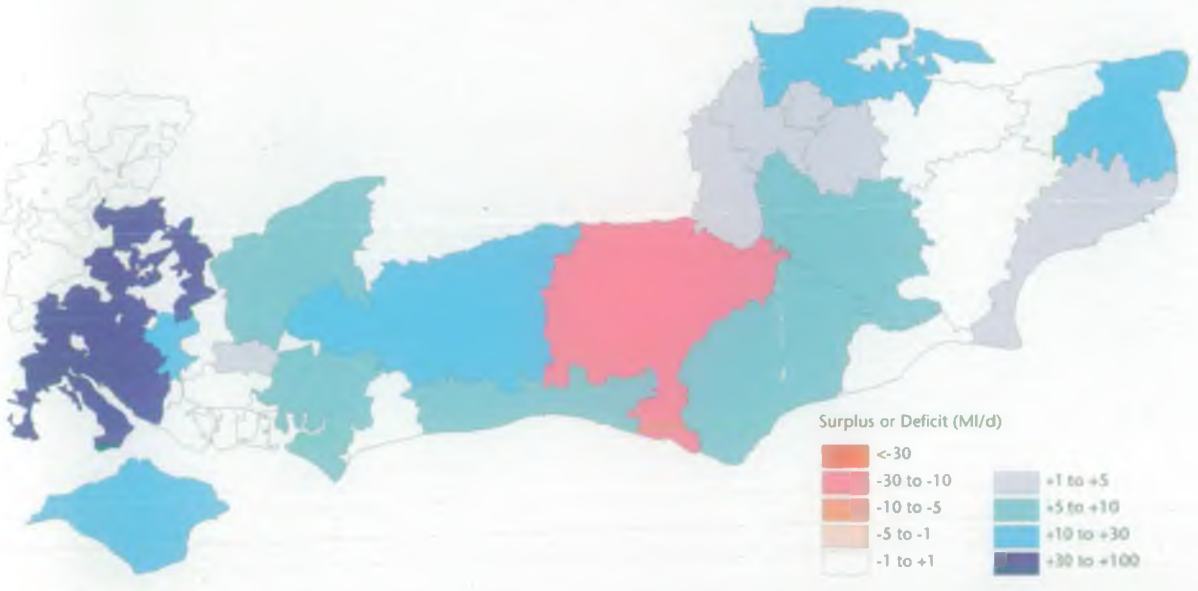
The distribution of surpluses and deficits on figures 4.2, 4.3, 4.5, and 4.6 highlights the uneven distribution of water resources and public water supply demands across our region. Clearly there is a need to co-ordinate the approach to planning and sharing new and existing resources.

In their WRP, each company proposes their solution to their forecast supply-demand balance. This draws on the company's appraisal of the available 'total water management options'. In Table 4.1 we have summarised the Southern Region water companies' resource development proposals by county, showing the proposed increase in available supplies over the next 25 years. The WRP options have featured heavily in the Agency considerations in forming this strategy. A significant portion of the options proposed by companies to 2010 are actually due to be implemented by 2005, funded by the third (1999) Ofwat determination of water company charges to customers between 2000 and 2005. In WRPs the selection of options is least-cost based and developed from resource zone level to address the geographic distribution of the supply-demand balance.

Figures 4.7 and 4.8 represent the year 2010 equivalent of figures 4.5 and 4.6 with the Table 4.1 'total water management options' to 2010 applied. The majority of resource zones will either be in balance or have a healthy surplus if the proposals are implemented as intended and demand grows as forecast in the 1999 WRPs.

Figure 4.7 Dry year, annual average demand, final balance, 2009/10

Figure 4.8 Dry year, critical period demand, final balance, 2009/10



4.2

Environmental needs

In section 3.5, we presented a review of water resources. Much of the problem portrayed on the resource maps (figures 3.6, 3.7 and 3.8) stems from the many licences issued as Licences of Right or Entitlement following the Water Resources Act, 1963. However, as scientific assessment has advanced, so too have the expected levels of environmental protection. The necessary protection may increase in the future, perhaps through the Habitats Directive review or the Water Framework Directive.

Over the last decade in Southern Region we have followed three policies to protect the environment when determining abstraction licences:

- Where there has been uncertainty, the Agency has refused licences, or issued them with time limits, on the grounds of the 'precautionary principle';
- There has been a policy of presumption against further consumptive abstraction from most of the chalk aquifers of the region (and some of the lower greensand aquifers);
- For most surface water catchments there is also a 'presumption against' further summer consumptive

Table 4.1 **Summary of resource development and other supply-side options proposed in water companies water resources plans**

Scheme category	County	Option Yield (Ml/d)					
		2000-2005		2005-2010		2010-2025	
		Average	Peak	Average	Peak	Average	Peak
Surface water enhancement within existing licence	IOW	5	0	-	-	-	-
	Sussex	13	5	-	-	-	-
Groundwater enhancement within existing licence	Hants	2	3	-	-	4	4
	Kent	8	17	1	1	3	7
	Sussex	7	4	-	-	-	-
Operational improvement, e.g. outage risk reduction, operational waste recovery	Hants	8	6	-	-	-	-
	Kent	4	3	-	2	-	-
	Sussex	8	36	-	-	5	4
Operational improvement - conjunctive use	Kent	1	1	-	-	-	-
	E.Sussex	1	1	-	-	-	-
Surface water developments - including licence variations	E.Sussex	20	-	-	-	6	6
Groundwater developments - including licence variations	W.Sussex	0	15	-	-	-	-
Resevoir enlargements	E.Sussex	-	-	-	-	10	0
New reservoirs	E.Sussex	-	-	-	-	9	9
Bulk supplies	Kent	7	10	-	-	-	2
	Sussex	23	15	-	-	7	7
Aquifer storage and recovery (ASR)	Sussex	-	-	21	21	5	5
Totals	Hants	10	9	0	0	4	0
	IOW	5	0	0	0	0	0
	Kent	13	21	1	3	3	7
	Sussex	49	61	21	21	35	24
	Region	77	91	22	24	45	31

Notes:
1. Other ASR, some effluent reuse and some desalination options are discussed in plans, but without 'selection' or any indication of output potential.
2. Bulk supplies excluded from totals.
3. 'Sussex' is East and West combined.

abstraction. Where possible, potential abstractors are encouraged to apply to take water in the winter and provide reservoir storage from which they can use water in the summer.

Our review has confirmed that these policies must be continued, but our strategy must go further to ensure that environmental need is allowed for, including resolution of established problems.

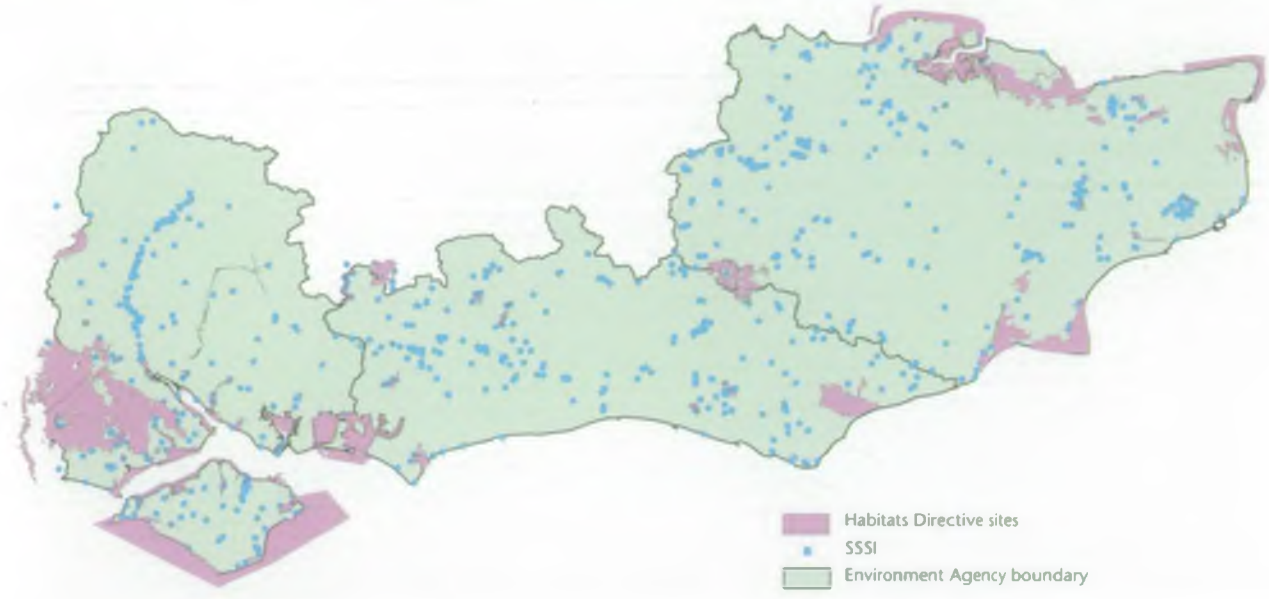
We have begun addressing these problems: the Habitats Directive review is underway and the Environment Agency's current National Environment Programme is a five-year plan to resolve problems at sites where water company abstractions are known or thought to be causing an unacceptable impact on their immediate environment (Environment Agency, 1998b).

Our assessments of the changes to abstractions that may be needed will be refined in coming years, not only by our Catchment Abstraction Management Strategies but also through River Basin Management Plans developed under the Water Framework Directive. These plans must identify the changes needed to water quantity and quality to achieve suitable ecology everywhere.

4.2.1 The Habitats Directive

The purpose of the EC Habitats Directive and the UK Conservation (Natural Habitats) Regulation 1994 is to protect our most important wildlife sites, ensuring the long-term conservation of biodiversity. A network of protected areas should be established across the European Community: the Natura 2000 network includes Special Protection Areas (SPAs) for wild birds and Special Areas of Conservation (SACs) for other types of animal, plant and habitat.

Figure 4.9 Habitats Directive sites and Sites of Special Scientific Interest in Southern Region



The Regulations require the Agency, as a competent authority, to review all existing abstraction licences and discharge consents in isolation and combination, including those for agriculture and industry as well as public water supply, to identify those that could be adversely affecting the designated wildlife sites. This statutory obligation also extends to all applications for new licences and consents. Several hundred existing licences are involved.

Southern Region has numerous European wildlife sites, many being wetlands; it has 34 SPAs and candidate SACs, as well as over 390 nationally-important Sites of Special Scientific Interest (SSSIs) as classified by English Nature. Over 80% of the Hampshire and Isle of Wight coastline is covered by SPAs or candidate SACs. Extensive stretches of the Sussex and Kent coasts are similarly classified together with several inland wetlands. Figure 4.9 shows the extent of European wildlife sites and SSSIs within the Southern Region.

From 2000 to 2004, the Agency, in conjunction with licence holders, will investigate the nature and extent of any adverse effects on the integrity of designated sites. Where existing licences and consents are considered to be having an adverse effect, the Agency is required to modify or revoke them to mitigate that effect. The Agency will be consulting those who hold relevant licences or consents, and applicants for new permissions will also be urged to discuss their proposals with us as early as possible so that the potential affects can be assessed.

This strategy explores possible outcomes of the Habitats Review from section 5.4 onwards.

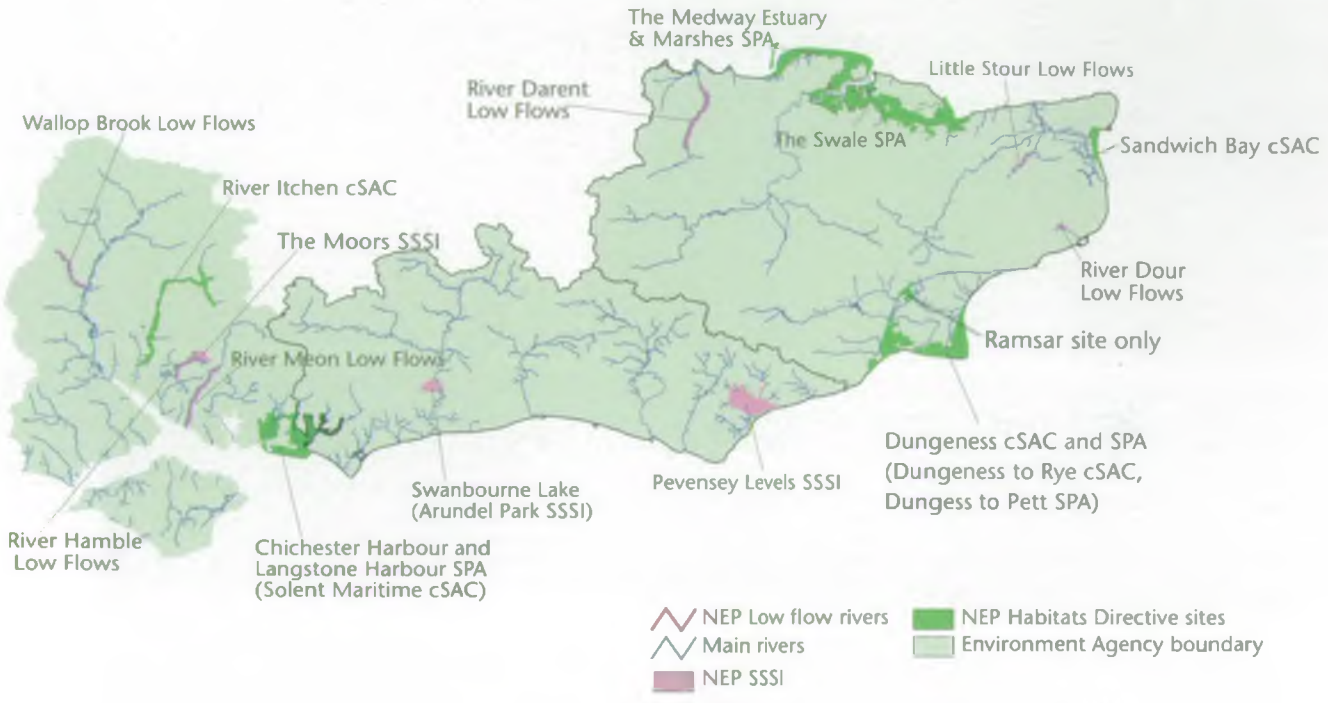
4.2.2 National Environment Programme

In the Third Periodic Review (1999) of water company asset management planning (AMP3), Ofwat set out revised price limits for water company charges to customers for the next five years. The review embraced the entire financial framework of the companies and ensures they can cover the costs of meeting new environmental obligations. As part of the 1999 Periodic Review, the Agency advised government on the environmental improvements that needed to be investigated by water companies in England and Wales to comply with European Directives, UK legislation, and non-statutory Agency objectives.

This programme of environmental investigation and improvement for 2000-2005 is known as the National Environmental Programme (NEP). The NEP sites associated with abstraction problems within Southern Region are listed in Table 4.2, and include Habitats

Swanbourne Lake, West Sussex: protection from abstraction is to be implemented by March 2003 within the National Environment Programme

Figure 4.10 The National Environment Programme –Southern Region sites



Directive sites, SSSIs, and Low Flow alleviation sites. The sites are also shown on Figure 4.10

Many of the NEP sites are also designated wetlands of international importance (Ramsar sites), including Chichester and Langstone harbours, Dungeness, Sandwich Bay & Hacklinge Marshes, Medway Estuary and Marshes, the Swale and the Pevensey Levels.

Water companies must investigate the impacts of their abstractions on the NEP sites and this work should progress to the completion dates in Table 4.2. The Agency will consider the best information available at these dates and take action as necessary.

This strategy explores potential outcomes of the NEP programme from section 5.4 onwards.

4.2.3 Restoring Sustainable Abstraction (RSA)

As part of our work to protect and enhance valuable water environments, we are developing a list of sites where abstraction may be causing damage. We expect the RSA programme to influence future need to find and implement solutions at further sites, beyond Habitats Directive and current NEP sites.

4.2.4 Biodiversity Action Plans

The government has signed the Convention on Biological Diversity and is committed to conserving and, where possible, enhancing biological diversity. The Agency is committed to enhancing biodiversity, and in all of our work we consider opportunities to contribute to the success of the UK Biodiversity Action Plan (UK Government, 1994).

4.2.5 The Water Framework Directive

The EU Water Framework Directive, which came into force in December 2000, is due to be incorporated into UK legislation by 2003. It is intended to integrate existing European water legislation, implementing a system of "River Basin Management Planning". Achievement of good ecological status for surface water and groundwater, as demanded by the Directive, will require integrated considerations of water quantity, water quality and ecology. The Water Framework Directive will influence future environmental standards and our management of water resources. This strategy embodies the broad principles and environmental expectations behind the Directive. We believe that the integrated framework of planning we are developing through LEAPs, CAMS, this water resources strategy and water companies' water resource plans will provide a sound basis for development in meeting the requirements of the Directive.

4.3 Societal change

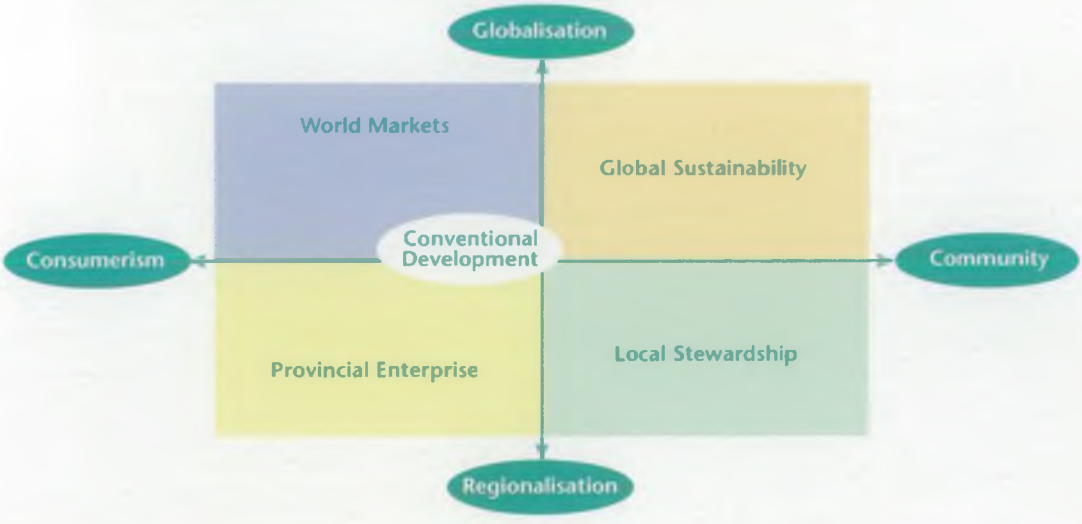
To take account of the uncertainties that surround the ways in which society may evolve it is appropriate to examine different scenarios for societal change. To help

Table 4.2 Southern Region – National Environmental Programme (abstraction)

Habitats Directive Sites	Water Company	Investigate (& find solution)	Solve	Date by
• Chichester and Langstone harbours	Portsmouth	✔		March 2004
• River Itchen	Southern, Portsmouth	✔		March 2004
• Pevensey Levels	South East	✔		March 2004
• Sandwich Bay and Hacklinge Marshes	Southern		✔	Eastry licence given up March 2000
• Medway Estuary and Marshes (North Kent springs)	Southern, Mid-Kent	✔		March 2004
• The Swale (North Kent springs)	Southern, Mid-Kent	✔		March 2004
Sites of Special Scientific Interest				
• Arundel Park (Swanbourne Lake)	Southern		✔	Madehurst licence reduction, March 2003
• The Moors, Bishops Waltham	Portsmouth		✔	Closure of Hoe pumping station, March 2003
Alleviate Low Flow Sites				
• River Meon	Portsmouth		✔	Cap Soberton licence March 2003
• River Hamble	Portsmouth		✔	Closure of Hoe pumping station, March 2003
• Wallop Brook	Southern		✔	Closure of Broughton source, March 2003
• River Dour	Folkstone and Dover	✔		March 2005,subject to DETR confirmation
• Little Stour	Southern, Mid-Kent, Folkestone and Dover	✔		March 2005
• Darent Phase II	Thames (*1), South East (*2)	✔ (*2)	✔ (*1)	March 2005, subject to DETR confirmation

us in formulating a robust set of scenarios for water use and resource management we have been guided by the Foresight "Environmental Futures" scenarios (figure 4.11) (DTI, 1999). These were developed for the government's Department of Trade and Industry. These scenarios are intended to inform and stimulate debate among businesses, regulators, and government departments about the environment and encourage them to develop strategies and policies, which will prove robust to a range of "possible environmental futures". They look at the future by considering two aspects of development: social values and systems of governance. The result is a set of four scenarios, each of which characterises one way in which the country may develop over the next 25 to 50 years. They can be summarised as follows:

Figure 4.11 Foresight scenarios



© 'Environmental Futures' published by Foresight, Office of Science and Technology, March 1999

Table 4.3 **Foresight "environmental futures"**

The Foresight programme, sponsored by the Department of Trade and Industry (DTI), sets out to identify innovative market opportunities and new technologies which will enhance the competitive advantage of businesses in the UK. In 1999, the Energy and National Environment Panel published a set of scenarios focussed on the environment. These scenarios are intended to inform and stimulate debate among businesses, regulators, and Government departments about the environment and encourage them to develop strategies and policies that will prove robust to a range of 'possible environmental futures'.

The scenarios are devised using two core dimensions of social change: social values and systems of governance. These dimensions are used as axes, which define four scenarios describing the UK during the period 2010-2040.

Social values are reflected in policy-making priorities, political preferences, and patterns of economic development. At one end of the spectrum social values are dominated by consumerist attitudes, which emphasise individualism, materialism, and private consumption. Concern for the environment focuses on specific problems which impact on the individual or their immediate local area. In contrast, community orientated values are concerned with securing long-term social goals, such as equality and sustainable economic development. There is a strong emphasis on the enhancement of collective goods and services, reflected in the high priority placed on resource and environment problems.

The second axis relates to the system of governance and represents the structure of political authority and decision making. Globalisation is characterised by the redistribution of political power and influence away from the nation state towards Pan European and global institutions such as the United Nations (UN) and World Trade Organisation (WTO). Economic activity is locked into international trading systems, dominated by transnational corporations. This is distinct from regionalisation where national sovereignty is strengthened and there is a movement towards regional devolution and local government.

Using the pressure-state-response model of environmental change, a story line is developed of the key drivers of social, economic and technological change under each scenario. At a broad scale, this involves assessment of the level of economic growth and structure of the economy. The degree to which environmental issues are prioritised by policy makers, businesses and individuals is considered, along with a review of the state of the environment. In some case indicators are included to illustrate the direction and rate of change.

- **Provincial Enterprise Scenario:** a future in which the nation state disengages from international political and economic systems of governance. This is a low-growth, low-wage, and low-investment scenario with little concern for social equity. The environment is perceived as a low-priority issue, despite the increased pressures placed on natural resources.
- **World Markets Scenario:** a future in which a highly developed and integrated world trading system generates high levels of economic growth. Although average personal affluence rises, there is little concern for social equity. Awareness and concern for the environment is low, particularly among the less well-off.
- **Global Sustainability Scenario:** a future where global institutions play a central role resolving social and environmental problems. High levels of investment in research and development result in the development of innovative clean technologies, which benefit the environment.
- **Local Stewardship Scenario:** a future dominated by regional and local systems of government. Working at the local level, environmental problems are resolved through collective action.

All are possible pictures of the future. They are intended to define a broad contextual framework of social, economic, political and technological change. All of the scenarios considered represent a gradual change from our present conditions. By 2025, there are quite large differences between them but by 2010 the impacts are relatively small.

In the case of water resources, the Foresight programme provides a high-level, qualitative assessment of the implications for water under each scenario, characterised simply in terms of water demand increasing, stabilising or decreasing.

The water demand scenarios that result from this work are discussed in Appendix 2. It is important to note that these scenarios are the Agency's interpretation of the impact of the Environmental Futures framework on the demand for water; while they are derived from Foresight, they are not part of the Foresight programme itself. For this reason, we have named our scenarios Alpha, Beta, Gamma and Delta as follows:

- Provincial Enterprise – Scenario Alpha
- World Markets – Scenario Beta
- Global Sustainability – Scenario Gamma
- Local Stewardship – Scenario Delta

4.4

Using scenarios

The water demand scenarios should be used appropriately. The Agency's use of the Foresight framework is formulated so that the resulting water demand scenarios cover the most likely pattern of water use. When adopting this approach there are several features which must be recognised:

- Some of the scenarios lead to patterns of future behaviour that are not congruent with the current values of the Agency and other organisations. For example, there may be fewer commercial opportunities in one scenario, while in another environmental protection would be given a lower priority than it is today.
- All scenarios should be considered even though some outcomes may be uncomfortable. The challenge is to identify mechanisms and management measures for achieving society's present aims within the constraints that the scenarios present.
- A strategy should not be based on the scenario that the Agency or others consider most acceptable. This would leave the strategy vulnerable to other changes and influences.
- Each scenario should be given equal weight.
- The Agency cannot offer a different strategy for each scenario but should provide a single framework to deal with a range of outcomes that may occur.
- The framework development should be flexible and monitored in order to know when it should be changed.

One of the main objectives of this regional strategy is to illustrate choices and options and their implications so that the actions that the Agency and others need to take to reduce uncertainty in water resources management over the next 25 years, can be identified.

The possibilities associated with each scenario have been investigated. The Agency has taken an approach that involves building a set of solutions and testing their effectiveness under the different scenarios. In doing this, three basic principles are followed:

- There must be plans in place that deal with all reasonable futures;
- These plans should be centred around solutions that are reliable through all scenarios;
- Finalise decisions about actions at the right time, making decisions too soon could result in unnecessary or inadequate solutions.

Taking this framework as our starting point, we have considered the variable impact that changes in regulation, policy and social values will have on society's use of water.

4.5

Global warming and climate change

There is mounting evidence that our climate is changing as a result of man-made atmospheric emissions. The DETR's UK Climate Impacts Programme has reported that UK temperatures have increased by about 0.7°C over the last 300 years, with about 0.5°C of warming during the twentieth century. This is part of a world picture of warming. Globally, 1998 was the hottest year since records began in the middle of the nineteenth century. It is thought that the 1990s may have been the warmest decade of the last millennium.

There is more confidence in some aspects of climate change than others. For example, there is some confidence in the sea level rise and global temperature increase induced by a given change in carbon dioxide concentrations. However, predicting the impact of these changes on climate is more difficult. Climate change could affect both demand for water and its availability, as well as having an impact on water-dependent ecology. Our understanding of the relationship between weather and water use is not perfect, so it is not possible to be certain about how climate change will affect demand. Household water use is likely to be increased by hotter summers. Given the diverse range of industrial uses of water, it is not possible to generalise about their vulnerability to climate change. Climate change will certainly have an effect on agriculture. It will affect not only planting and harvesting dates, but also the varieties of crop that are grown and their distribution across England and Wales. Higher temperatures will also affect livestock production systems. We have outlined how we have estimated the effect of climate change on household demand in chapter 5.

Changes in climate will also change groundwater and river regimes and therefore the availability of water for abstraction. Current estimates of climate change suggest that by the 2020s throughout southern and midland England there will be on average more winter rainfall and less summer rainfall. Northern England would receive more winter rainfall and about the same volume in summer. Higher temperatures mean that potential evaporation rates will probably increase.

There is also evidence that climate change will increase the year-to-year variability of rainfall. Effectively, this means that the climate will be less predictable, with both more dry years and wet years. This in turn means that low flows will probably occur more often. Evidence about the possibility of longer droughts is unclear; the best available view appears to be that increased variability makes droughts that last over several years slightly less likely. However, it is important to note that the understanding of changes in extreme events is more limited than that of changes in average climate.

Nationally we have assumed, based on the results from Arnell (Arnell,1999), that over the next 25 years most public water supply systems will retain their existing yields. This is a reasonably conservative assumption for systems with storage of winter water in either aquifers or reservoirs. Little analysis exists, but where modelling has been carried out it suggests that most reservoir systems and aquifers will actually gain a little yield because of the wetter winters. Direct abstractions will become less reliable in summer, which means that farmers and industries that rely on these will have to consider adapting in some way if they wish to maintain current levels of reliability.

In Southern Region there are a few public water supply abstractions taken from 'run-of-river', without reservoir support. One or two are from rivers with little flow support from groundwater. Some down-rating of the yields of these sources has been applied in water company WRPs and we believe these allowances, proposed supply enhancements and the overall margins considered in this strategy should cover the additional risks of these sources.

Coastal groundwater and surface water abstractions may also be vulnerable to sea level rise and increased occurrence or risk of saline intrusion. This is another particular problem in Southern Region. Folkestone and Dover Water's sources in the Denge peninsular could be particularly vulnerable.

Changes in river flows and wetland levels as a result of climate change may have an impact on the plants and animals that rely on the water environment. Some species will be better suited to the new conditions, while others may find it harder to thrive. For this strategy, we will assume that we can protect the future environment by maintaining current levels of protection through the maintenance of existing controls on abstraction, except where we know that these are in need of improvement for other reasons. The environment that we protect will be dynamic, with species changing over time with climate change.

Appendix 1 contains a summary of ongoing work on climate change and sets out in more detail how this may affect water resources.

4.6

Population and household size

Over the last three years, there has been debate around Government-projected increases of up to 4.4 million households in England and Wales between 1996 and 2016. Total population is predicted to increase by up to 2.8 million over the same period. Housing growth is also influenced by the trend towards smaller household size and single occupancy.

The proposed increases for Southern Region's counties were covered by SERPLAN (the London and South East regional planning conference), who consulted on a Sustainable Development Strategy for the South East in December 1998. In May 2000, following the public examination of the strategy and the subsequent Inspectors' report, the Government Offices of the South East, East Region and London published draft Regional Planning Guidance (RPG9). The draft RPG9 expects councils in the South East to provide 43,000 homes each year for the next five years and possibly to 2016. If this rate applies to 2016, around 380,000 new houses will be built within Southern Region. A further consultation was published in December 2000 by the same Offices, suggesting 39,000 new homes each year until a review in 2006. The county by county breakdown amounts to an increase of 1300 homes each year for Southern Region, beyond the May 2000 figures.

SEERA (the South East England Regional Assembly) will become responsible for preparing, monitoring and reviewing the RPG from April 2001 and it will then cover East and West Sussex, Kent, Hants., the Isle of Wight, Surrey, Bucks., Berks., and Oxon. only.

The Southern Region water companies allowed for approximately 295,000 new households to 2016 within their 1999 WRPs: this is around 85,000 lower than that projected using the May 2000 government figures, as shown in Table 4.4. This difference could amount to an increase in regional water demand of around 30-50 Ml/d above that forecast by water companies in their 1999 WRPs, equivalent to the water demand of an urban area one to two times the size of Brighton and Hove. There will be more household consumption and more 'non-household' consumption through the development of schools, shops, other commercial premises, industry and possibly agriculture.

New housing development could lead to water demands greater than forecast by water companies in 1999

There is a suggestion that the majority of new housing may be filled from within the existing forecast Southern Region population. Trends toward increased single occupancy are used as justification and there are expectations that single occupancy may account for up to 75 % of new housing. We have assumed: half of these single people originate within the region, the remaining 25% of new houses are filled by families of 2.4 people from outside the region and that single occupants might use 20 litres a day more than average pcc. These are not necessarily Agency beliefs, but provide a basis for an estimate for consideration in this strategy. (The non-household demand growth estimates in Table 4.4 are comparable to growth in our Foresight water demand scenarios (chapter 5) at regional level).

SEEDA's regeneration priorities in the Southern Region include Thanet, Hastings, Brighton & Hove, and Portsmouth & Southampton, but it also wishes to maintain a healthy economy in the region as a whole. Thames Gateway in north Kent, included in SEEDA priorities, is a priority for regeneration and growth in its own right.

It is difficult to justify a case against specific development purely on water resources grounds. Developments can be supplied with water brought in from some distance away if local sources cannot be developed, although the costs of such provision may be high even if the environmental impacts are judged to be acceptable and sustainable. But there are locations in Southern Region where it may be inadvisable to develop too quickly or too extensively until water resource and environmental impacts are understood and water supply provision is properly planned. The locations with the most immediate water supply difficulties have been summarised in section 4.1.

The uncertainty over future housing development levels is a key issue for water resource planning across our region and we will try to work closely with planners and water companies to ensure that future demands can be met whilst protecting our environment. Planners and developers have a significant role in water demand management.

Water demand is considered further in chapters 5 and 6. In developing water demand scenarios for this strategy, the Agency has used a nationally-consistent population and household data set obtained from CACI Limited for each water company resource zone for the period from 1997 to 2019, extrapolated to 2025. This data was based on the 1996 population projections (building on the 1991 census information), and adjusted to incorporate 1997 mid-year estimates.

4.7 Land use

The way in which we use land has a significant impact on the water in our environment. Urbanisation, land drainage, agriculture, de-forestation or afforestation and mining of minerals all alter the run-off and groundwater recharge characteristics of an area. Urban drainage, as well as drainage of agricultural and other waste into surface waters can lead to water quality problems. The Agency has co-operated with other bodies in investigating more sustainable approaches; this has

Table 4.4 Household growth projections and estimated water demand

County	Water Company Household projections (1997/98-2016)	Household projections (1996-2016), based on May 2000 draft RPG	Estimated Additional Household Demand (Ml/d)	Estimated Additional Non-Household Demand (Ml/d)
East Sussex	47,300	48,400	0.5	0.5
Hampshire	112,700	143,850	4.5	8
Kent	85,600	128,750	9	14
West Sussex	48,850	58,650	1	2.5
Total	294,450	379,650	15	25

resulted in two publications: "A guide to sustainable urban drainage" (Environment Agency,1997) and "Sustainable urban drainage" (Environment Agency,1999c). Sustainable Urban Drainage Systems (SUDS) aim to reduce the run-off problems in the urban environment by increasing the presence of permeable surfaces, filter strips, swales and ponds.

In Southern Region, the impact of land use change on water quality is an important issue and pollution of groundwater or surface water poses serious risks for public water supplies and the environment. Groundwater pollution is a particular issue for the region, given the dependence on groundwater for supplies and contributions to river flows.

4.7.1 Groundwater protection zones

Over recent years, the Agency has used groundwater flow models to help refine source protection zones around potable sources in support of our "Policy and Practice for Protection of Groundwater". New groundwater protection zone definitions have been completed for all the main aquifers across the region and source protection maps are now being distributed through the Agency's National Groundwater and Contaminated Land Centre.

We have not taken account of land use change in this strategy but it is clear that a fuller understanding is needed of this cross-sectoral issue. Overall, land use and its impact on water resources is a complex issue and many parties share the responsibility for ensuring that it is considered in the context of sustainable development. The Agency will work to ensure that impacts on water resources are considered.

5 Quantifying the pressures on water resources

In the preceding chapters we have set out the framework in which water resources are managed and set out the principles which underpin this strategy. We have summarised the current state of water resources and the pressures, which we expect in the future. We need to quantify these pressures so that we can define appropriate options.

5.1 Incremental demand

The Agency has developed four water demand scenarios incorporating the social and governance evolution reflected in the Foresight "Environmental Futures" scenarios. Our approach is to look at incremental demand for each of these scenarios at 2010 and 2025. Incremental demand is defined simply as the extra water needed compared to that which is used now. We consider the additional demand under the following headings:

- Households demands;
- Leakage;
- Industry and commerce;
- Spray Irrigation.

The flexibility of this approach allows the consideration of additional demands as further elements become important. By using the concept of incremental demands, we can compare future conditions with those of today. This also means that we can consider loss of resource as an element of demand. In this way, we do not need to estimate the current available resource. This task is particularly difficult, because it depends on value judgements about different uses and users of water. Put simply, if the need is judged to be great enough, water can be made available, either by costly technological solutions or at the expense of existing water uses.

5.2 Developing scenarios

We have considered in detail the drivers of water demand and how these vary for each scenario. Table 5.1 summarises the relative changes to each driver of water demand which in turn affects how each component of demand may change over time. Importantly it shows that components change independently of each other, which emphasises the need to assess future water use at a component level.

5.2.1 Household demand

For household demand, we broke down household consumption into its micro-components (such as toilet flushing, washing machine use), and forecast changes under each scenario for that component, based on assumptions about future levels of ownership, frequency of use and volume of use. We have generated unmeasured per capita consumption for each resource zone on this basis.

Metering, and its likely extent and impact was also considered for each scenario. Using the results of the National Metering Trials to guide our assumptions, metering of households provided reductions in consumption ranging from 3% to 21% (National Metering Trials Working Group, 1993). The proportion of metering also varies across the scenarios.

5.2.2 Leakage

For leakage, the scenarios reflect different approaches to prioritisation and target setting. This in turn affects water companies' leakage control philosophy and

Table 5.1 The key drivers of component demand by scenario

Component	Driver of Demand	Influence by scenario			
		Alpha	Beta	Gamma	Delta
All components	Cost of water	Very high	High	Medium	Medium
Household demand	Changes to personal washing use	Large increase	Large increase	Small decline	Small decline
	Garden watering	Increases	Increases	Slow decline	Moderate decline
	Miscellaneous	Moderate decline	High growth	High growth	Moderate decline
	Efficient technology (white goods)	Small decrease	Moderate increase	Increase	Increase
	Regulations particularly effects on WC cistern volumes, power showers and garden watering	Slow decline	Decline	Rapid decline to low volume flush WC	Slow decline to low volume flush WC
	Metering	Very variable locally	Moderate	High	Moderate
Leakage	Regulatory framework	Weak	Light	Strong orientated	Conservation
	Resource situation	Not considered	Secondary consideration	Important	Important
Non-household demand & direct abstraction primary industry	Economic growth (GDP)	1.5%	3%	2%	1%
	Output of manufacturing industries	Increase	Decline	Decline	Decline
	Employment in business services	Decline	Increase	Increase	Increase
	Water minimisation activity	Low	Mixed	High	High
	Greening of business initiatives	Low	Low	High	High
Spray irrigation	Reform of national and international agricultural policies (CAP & WTO)	Increase UK Government support	Removal	Full reform	Increase national & regional support
	Role of supermarkets & food processing firms	Continued role	Expansion	Realign position	Marginal role
	Crop quality premia (potatoes)	High	Very high	Medium	Low
	Drought tolerant crop varieties	Low uptake	Low uptake	Very high uptake	High uptake
	Organic production	Low	Low	High	Very high
	Irrigation efficiency	Medium	High	Very high	High

subsequent find-and-fix activity, pressure management levels, and service and mains replacement rates.

5.2.3 Industry and commerce

For industry and commerce, we identified 19 different sectors to allow application of sector-specific assumptions. By differentiating between large companies and small and medium-sized enterprises (SMEs) the forecasts reflect the variability in the level of uptake of water use minimisation options.

5.2.4 Spray irrigation

Agriculture is subject to a wide range of social, economic and political drivers of change which directly and indirectly affect the use and management of spray irrigation. Our new forecasts have developed the concept of economic demand, reflecting the costs and benefits of irrigating different crops. We recognise that in practice some of this irrigation water demand may be as trickle irrigation.

We have provided more detail concerning the make up of our scenarios in Appendix 2.

5.3

Scenarios of water demand in 2010 and 2025

We can only provide a regional level summary of water demand scenarios. Public water supply scenarios were calculated at water resource zone level, but it was not possible to calculate agricultural and industrial direct abstraction scenarios at the same scale. Also, our public water supply scenarios represent annual average demand: we rely on water company forecasts for the peak demand situation. Within our scenarios, at resource zone level, the distribution of relative public water supply surplus or deficit is similar to those shown in Chapter 4, although the degree of surplus or deficit varies across the scenarios.

5.3.1 Differences in Demand

The Southern Region Foresight scenario outcomes for 2010 and 2025 are presented in figures 5.1 and 5.2 as growth or decline in demand from the present day. (Note, the vertical scales of figures 5.1 and 5.2 are

Figure 5.1 Environment Agency, water demand scenarios. Incremental demand including climate change, 2010

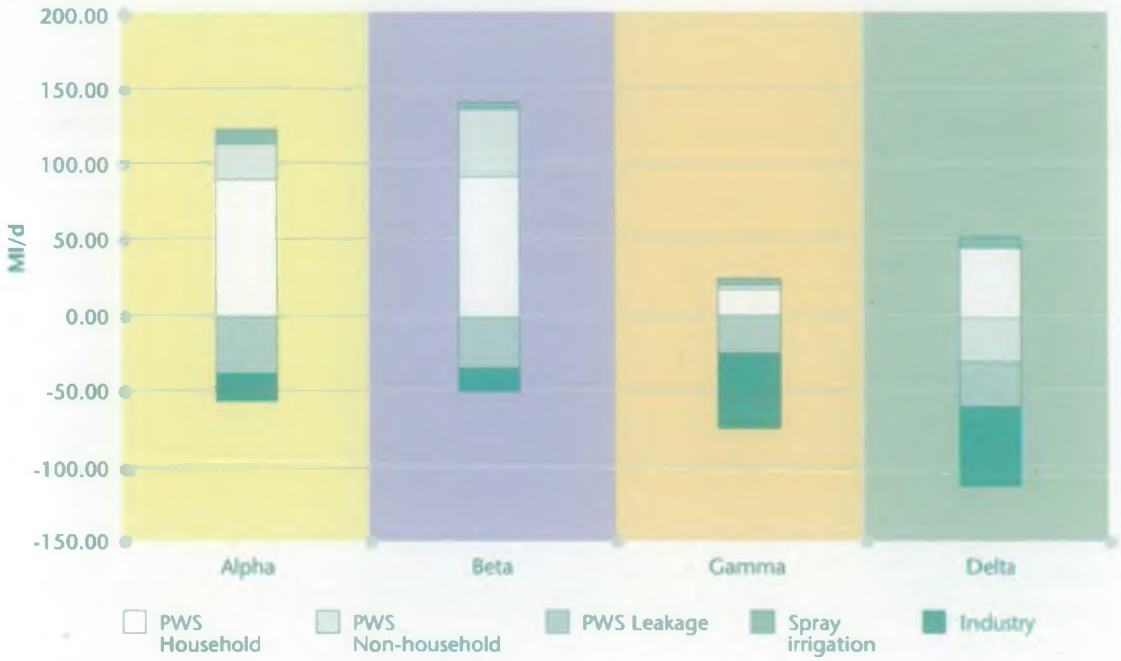


Figure 5.2 Environment Agency, water demand scenarios. Incremental demand including climate change, 2025

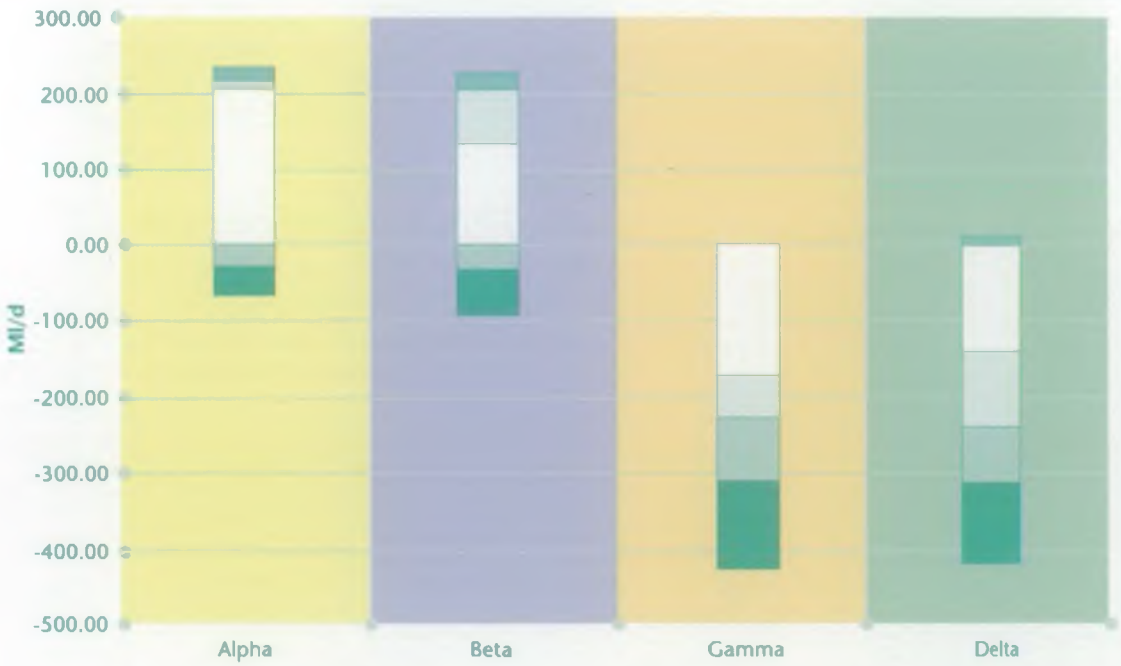


Table 5.2 **Leakage assumptions for each scenario**

	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Alpha	Ofwat 2000/01 target level	Ofwat 2000/01 target level	Passive leakage control policy		
Beta		Ofwat 2000/01 target level			
Gamma		Apply leakage targets that would be achievable with the application of today's best practice and most advanced technology			
Delta		Ofwat 2000/01 target level	Reduce total leakage by 1% per annum until 10% reached. Then hold at 10%		

Table 5.3 **Metering assumptions for each scenario**

	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Alpha	Likely water company rates following Ofwat final price determination	Continue with rate of metering allowed by Ofwat in 2005 for those companies in the south and east, elsewhere no additional metering			
Beta		Water company rates	Metering to a maximum of 95% of all properties		
Gamma		Water company rates	Metering to a maximum of 95% of all properties		
Delta		Water company rates			

different). In the Delta and Gamma scenarios, overall water demands fall by about the same amount by 2025, while those of the Alpha and Beta scenarios rise by about the same amount, although the underlying assumptions are different across all four scenarios. However, we have shown a reduced form of the 2025 Alpha scenario outcome. The full scenario assumes that leakage levels could rise back to some 50% of water put into distribution systems: a 2025 growth 792 Ml/d higher than that shown in figure 5.2. The Southern Region environment could not tolerate the additional abstraction necessary to support such wastage and the Environment Agency would not license such abstraction, so we have excluded the leakage growth from further consideration. It is essential that leakage levels do not rise above current levels. Table 5.2 summarises the leakage regimes of the scenarios.

In the Agency's water demand scenarios for Southern Region, the main component trends in each water demand sector are:

Household use increases in the Alpha and Beta scenarios primarily due to high rate power shower use, external use and miscellaneous use. In the Gamma and Delta scenarios, standard showers replace power showers. Each scenario assumes a scenario-appropriate rate of installation of low flush toilets. Society is generally disposed to water conservation in the Delta scenario. Table 5.3 summarises the influential assumptions about metering regimes across the scenarios;

Non-Household use increases most in the Beta scenario, but also in the Alpha scenario. Significant decline is assumed in the other two scenarios.

Industrial direct abstraction use falls in all four scenarios, although most in the Gamma scenario and least in the Alpha scenario. A 50 to 75 % decline in paper industry abstraction dominates all four scenarios, while chemicals sector and food and drinks sector abstractions rise in the Alpha and Beta scenarios. Construction sector abstraction rises to some degree in all four scenarios, its small rise being the only component increase in the otherwise declining Delta scenario. These PWS and direct abstracting non-household trends result from the combined influences of general economic growth, manufacturing industry output, water waste minimisation activities, greening of business initiatives and the cost of water.

Direct abstraction for **spray irrigation** rises by nearly 50% in the Beta scenario and by nearly 80 % in the Alpha scenario, but it is fairly steady in the Delta scenario and declines by nearly 20 % in the Gamma scenario. Abstraction for vegetable growing increases to some degree in all four scenarios, while main crop

potatoes, small fruit and, to a lesser extent, orchard fruit and early potatoes also contribute to the abstraction growth in the Alpha and Beta scenarios. Small fruit growing abstraction activity also increases in the Delta scenario. These differences in component trends across the scenarios result from scenario by scenario assumptions about national and international agricultural policies and subsidies, while supermarket and food processing requirements for high quality produce lie behind the larger rises in abstraction in the Alpha and Beta scenarios. The greater introduction of drought tolerant plants influences the declining abstraction of the Gamma scenario, while increased organic crop growing, with its associated increase in crop areas, influences the Delta scenario abstraction growth.

The overall outcome is two scenarios with growing demand and two scenarios with demand falling, but each scenario should be treated as equally possible. The scenarios with falling demand will result in reduced abstraction of water and easier restoration of sustainable water resources regimes across the region. However a strategy based on such a benign forecast of water consumption would be unwise. Nevertheless these scenarios do illustrate that there is real potential for further water use efficiencies and our strategy should not be drawn only to the demand growth scenarios. The necessary investment in resource development and the impacts that would result could prove unnecessary.

We use all four water demand scenarios to ensure that our water resource strategy is sufficiently flexible to cope with future political, social and environmental outcomes for the UK.

5.3.2 Climate change

Household water use is likely to increase given more frequent, hotter summers. We have calculated a likely increase in household demand caused by climate change, on the basis of scenario Beta, a high-growth scenario. The effects have been attributed to an increase in demand from garden watering, which has been added to the incremental demands for each scenario. The total effect on public water supply demand is an increase of about 16 Ml/d by 2025. The potential impacts on public supply systems at times of peak demand could be more worrying if demands and resources are not managed carefully.

Climate change will certainly have an affect on agriculture. It is likely to affect planting and harvesting dates, but also crop varieties grown and their distribution across England and Wales. We commissioned Cranfield University at Silsoe to develop and apply a new methodology to assess the impact of climate change on current optimum irrigation needs. The analysis indicates that for the eight crops studied, optimum irrigation need would increase at the six study sites considered. Over the next 25 years, climate change will be one of many challenges facing agriculture. Given that our results are preliminary we have not included climate change in the assessment of incremental demand. We will revise our forecasts in light of the results of the DETR climate change and demand study.

5.4 Environmental need

We have said that a number of sites or catchments are being harmed as a result of current levels of (licensed) abstraction, or may be if abstraction ever increases to currently licensed limits. A strategy aimed at sustainable water resource management would not be complete if it left such a situation untouched.

We have therefore estimated, on the basis of a mixture of knowledge and judgement, the extent of abstraction licence curtailment that will be needed. Our strategy assumes that this level of curtailment will be necessary in the period of the strategy – although we will need to demonstrate the justification for doing so. This need represents a further 'demand' to be set against available resources.

We believe that licensed but unused abstraction - 'paper' licensing - needs to be recovered across much of the Region to prevent more unsustainable abstraction developing, while actual abstraction must be reduced to meet environmental needs at key sites and achieve sustainable water resources management.

We have a number of reasons and opportunities to address this issue over the next few years. For example:

- The NEP programme of investigations
- The Habitats Directive Review
- Preparation of CAMS
- Time limited licensing (implementing the ALR)

We expect the investigations and analyses involved in these reviews will lead to some recovery of both 'paper' licensing and actual abstraction volumes. A significant portion of any actual abstraction recovery is likely to be from current public water supply abstractions.

Table 5.4 shows our lower and upper bound estimates for the potential recovery of licensed volumes and annual average abstraction quantities that may be

Table 5.4 Potential licensing 'recovery' scenarios by Agency Area

Area	Scenarios for recovery of Total Licensed Volume & Actual Abstraction (Ml/d)			
	Lower Bound		Upper Bound	
	Licensed Volume	Actual Abstraction	Licensed Volume	Actual Abstraction
Kent	225	45	350	75
Sussex	25	5	50	15
Hampshire	50	30	100	90
Isle of Wight	0	0	limited	limited
Region	300	80	500	180

needed in each Agency Southern Region Area. Our strategy provides the framework for achieving these over the next 25 years.

We believe we can recover 'paper' licensing without curtailing historical abstraction and in most cases we will be able to leave a reasonable margin above recorded actual abstraction. 'Paper' recovery of public water supply licences should be possible without curtailing drought-reliable source outputs and, where necessary, we should be able to allow a reasonable margin above this. The paper licensing recovery figures are based on a review of our records of licensed totals and recent actual abstraction, together with reflection on our review of resources. We do not aim to recover the maximum difference between licensed 'paper' volume and actual abstraction totals as in some cases licence conditions already protect the environment. We hope to recover much of this 'paper' volume voluntarily from the licence holders over the next 25 years, but the sooner the better. We expect the CAMS/ALR processes to provide another mechanism for achieving them.

The recovery of actual abstraction is a different matter, possibly affecting the supply-demand balance across all sectors of abstraction, including public water supply. The potential actual abstraction recovery figures result from considering:

- The NEP programme of investigations
- Habitats Directive implications
- Other environmental aspirations to restore sustainable abstraction
- The implications of our review of resources

The practical achievement and implications of this range of recovery of actual abstraction is clearly more challenging than the 'paper' recovery. Implementation will require scientific proof of impacts and cost-benefit appraisal of solutions.

Recovery of actual abstraction volumes will normally involve finding a replacement resource or achieving demand savings to reduce the need for abstraction, particularly for public water supply abstractions. The River Darent in Kent and Swanbourne Lake in Sussex are examples where alternative approaches to maintaining public water supplies are being implemented to reduce the impact of abstraction on the environment.

Our strategy anticipates implementing the majority of public water supply abstraction recovery through future Periodic Reviews of water company business by Ofwat. However, we expect the CAMS/ALR processes to help resolve the actual abstraction recovery that is necessary and contribute to the overall mechanism for achieving it.

5.5 Determining incremental demand

In this chapter we have indicated how a set of scenario-based incremental demands has been assembled. These have been compared with currently available spare resources to identify a range of net incremental demands, for 2010 and 2025. We have assumed that existing demands for water are met through existing resources unless there are identified environmental needs (section 5.4) or in the case of public water supply a deficit has been identified in a water company's water resources plan.

Existing resources have been compiled from water companies' calculation of yield, and the current licensed abstractions for industry and agriculture. The latter may not be reliably available during severe droughts, but are appropriate for comparison with existing demands.

5.5.1 Summary of scenario water demands

Table 5.5 summarises the growth or decline in water demand within the main categories of consumption across the Agency's water demand scenarios and water

Table 5.5 Summary of water demand scenarios

Forecast growth in Water Demand (Mld)	To 2010					To 2025				
	Alpha	Beta	Gamma	Delta	1999 WRP's	Alpha	Beta	Gamma	Delta	1999 WRP's
1. Public Water Supply										
Household	90	89	21	44	50	210	144	-167	-136	135
Non-household	20	39	2	-29	-28	13	76	-61	-101	-26
Target headroom	-	-	-	-	13	-	-	-	-	26
Total	**110**	**128**	**23**	**15**	**35**	**223**	**220**	**-228**	**-237**	**135**
2. Direct abstractors										
Industrial	-24	-16	-44	-47	-	-42	-61	-117	-104	-
Agricultural	9	8	5	9	-	16	13	0	8	-
3. RPG 9 - housing and economic growth beyond 1999 WRPs?	assume included	assume included	-	-	20-40	assume included	assume included	-	-	30-60
4. Environmental need	20-50	20-50	20-50	20-50	20-50	80-180	80-180	80-180	80-180	80-180

company 1999 WRP demand forecasts. To the water company forecasts, we add our own estimate of the extra water demand that might result from the additional housing and economic growth, which may be included in Regional Planning Guidance. This addition makes the water company forecasts more comparable with our high growth Alpha and Beta scenarios. We do not add any allowance for additional housing or economic growth to any of our water demand scenarios. We believe the Alpha and Beta scenarios already include equivalent demand growth, while it would not occur in the Gamma and Delta scenarios where water demand generally declines.

The potential recovery of existing abstraction which may be necessary to restore sustainable abstraction is shown as "environmental need". This is common to all scenarios although, if the Gamma and Delta scenarios occur, restoration of sustainable water resources regimes will be easier as a result of reduced requirements for abstraction.

In the next two chapters we will look at the methods used to consider options and recommend solutions to redress the deficits identified.

6 Options and options appraisal

In this chapter we describe how we have identified solutions to meet the incremental demand described in Chapter 5. The process has been iterative considering a full range of possible resource development and demand management options. We have used a series of tools to help us to consider – for any set of options – costs, benefits, risks, uncertainties and contribution to sustainable development.

6.1 Identification of options

The resource development and other supply-side options we have considered for this strategy are largely taken from the options selected or discussed in water company WRPs. (summarised in chapter 4). The leakage control and demand management options are the Agency view of options and go beyond those offered by water companies. The options are summarised in Table 6.1. Each option is given a reference number and in chapter 7 we note those selected as recommendations.

The progression and promotion of options is the responsibility of those who will own and benefit from them. For any resource scheme, principal or other, there are many stages that must be completed before implementation. Stages could include feasibility studies, design, promotion, environmental impact assessment and planning permission. Obtaining Agency authorisations will be part of the process, including abstraction or impoundment licences and discharge consents. We shall expect alternative options to be adequately explored before choosing the proposed development.

6.2 Tools for considering options and strategies

Where there is a range of feasible water resources management options, each has strengths and weaknesses, and costs and benefits. To explore these we have used three approaches:

- A risk and uncertainty framework, looking at the risks, uncertainties and opportunities of options and strategies;
- A sustainability appraisal, looking at sustainability in its widest sense, including social progress that recognises the needs of everyone, the contribution to the effective protection of the environment, prudent use of natural resources and maintenance of high and stable levels of economic growth and employment;
- A costing exercise, looking at the broad financial costs of each option;

Each of these tools can be used either for individual options or for groups of options. We have applied them to both, to help us to think about the components that should make up the strategy, and then to consider the strengths and weaknesses of the strategy as a whole. Together, they help us to meet two of the Agency's duties: to have regard for costs and benefits, and to contribute to sustainable development.

For demand management options and resource development options there are uncertainties about future costs and effectiveness. In estimating what will be possible we have been cautious, basing our figures largely on existing or established technology.

We have not considered in detail options such as icebergs or the transfer of water from overseas. The NRA's 1994 strategy found these to be unfeasible, and we have no reason to change this view (NRA, 1994).

The Agency is a competent authority under the Habitats Directive. We have considered the requirements of the

Table 6.1 **Water resource strategy – options, uncertainty, opportunity and constraints**

Option						Uncertainties					Opportunities					Constraints			
Scheme ref.		Resource Value [Ml/d]	Time to implement [yr]	Cost band	Renewal period [yr]	Technology and investigation	Promotion time	Construction/implementation time	Resource value	Cost	Flexibility in implementation	Environmental enhancements	Resilience to climate change	Meeting other needs	Amenity and recreation	Policy & legislation	Public & stakeholders	Environment	Energy Use
SR1	HARDHAM artificial recharge and recovery	25	5+	M	15-30	●	○	○	●	◐	●	○	●	○	○	◐	○	◐	◐
SR2	ITCHEN uprating (Gaters Mill)	25	5-10	H	50	○	◐	○	●	○	◐	○	◐	○	○	●	◐	●	●
SR3	SWANSCOMBE QUARRY	20	3-5	H	25	◐	○	○	◐	●	●	●	●	●	○	●	○	○	●
SR4	BEWL-DARWELL TRANSFER	15	3	H	50+	○	○	○	○	○	○	○	◐	○	○	○	○	●	◐
SR5	RESERVOIR RAISING (Darwell Assumed)	15	7	H	100	○	●	○	◐	◐	○	◐	●	○	○	○	◐	●	○
SR6	RESERVOIR RAISING (Bewl Assumed)	15	15	M	100	○	●	○	◐	◐	○	◐	●	○	○	○	◐	●	○
	RESERVOIRS																		
SR7	Lower Ouse: BEVERN Stm	11	20	H	100	◐	◐	○	◐	◐	○	◐	●	○	◐	○	●	●	◐
SR8	Lower Ouse: CLAYHILL Stm	9	15	H	100	◐	◐	○	◐	○	○	◐	●	○	◐	○	●	◐	◐
SR9	HAVANT THICKET	25	15	H	100	○	◐	○	○	○	◐	●	●	◐	●	○	◐	◐	◐
SR10	BROAD OAK	40	15	H	100	○	◐	○	◐	◐	◐	●	●	◐	●	○	●	●	◐
	BULK SUPPLIES																		
SR11	SWS - FDW	4	1	H	25	○	○	○	○	○	○	○	○			○	○	○	○
SR12	MKW - FDW	2	<1	H	25	○	○	○	○	○	○	○	○			○	○	○	○
SR13	MKW - SEW	3	2	M	50	○	○	○	◐	◐	○	○	◐			○	○	○	◐
SR14	SWS (COAST) - SEW	3	1	H	25	○	○	○	◐	◐	○	○	◐			○	○	○	◐
SR15	PORTSMOUTH WATER - SWS	15	1	H	50	○	◐	○	◐	○	○	○	◐	○	○	○	○	○	●
SR16	HAMPSHIRE TO SUSSEX TRANSFER (within SWS)	15	5	H	50+	○	●	○	●	◐	○	○	○	○	○	●	●	●	●
SR17	EASTERGATE GROUP LICENCE VARIATION	15 pk	2	L	25	○	◐	○	○	○	○	○	◐	●	○	○	◐	○	○
	EFFLUENT REUSE																		
SR18	Ford-Hardham (Western Rother)	20	5+5?	H	20	◐	●	○	●	◐	◐	◐	●	○	○	○	●	●	●
SR19	Lewes/Newhaven/Seaford to River Ouse	15	10	H	50	◐	●	○	●	◐	◐	◐	●	○	○	○	●	◐	●
SR20	Newhaven/Seaford to Cuckmere	10	10	H	50	◐	●	○	●	◐	◐	◐	●	○	○	○	●	◐	●
SR21	Eastbourne to Wallers Haven	10	10	H	50	◐	●	○	●	◐	◐	●	●	○	○	○	●	●	●
SR22	Kent effluent reuse	40	15	H	50	◐	●	○	●	◐	●	●	●	◐	○	○	●	●	●
SR23	Budds Farm to?	20	15	H	50	◐	●	○	●	●	●	●	●	◐	○	○	●	●	●
SR24	Various "Connectivity" proposals in Hants	5	2	M	50	○	○	○	○	○	◐	◐	◐	○	○	○	○	◐	◐
SR25	Testwood Extensions	30	10	L-M	50	○	○	○	●	○	●	○	◐	○	○	●	◐	●	◐
SR26	Weir Wood output enhancements "Conjuctive use"	10	5	M	50	○	○	○	○	○	◐	●	●	○	○	○	◐	◐	◐
SR27	Wey & Arun canal (for transfer, Thames to Southern)	-	20	H	100	●	●	◐	●	●	◐	●	◐	◐	◐	○	●	●	○
	SEW Surrey to SEW Sussex transfer pipeline	-	10	H	50														
SR28	Route A					○	◐	◐	○	◐	◐	○	◐	○	○	○	◐	◐	●
SR29	Route B	-	10	H	50	○	◐	◐	○	◐	◐	○	◐	○	○	○	◐	◐	◐
SR30	Ouse Licence Re-negotiation	2	1	L	10?	○	○	○	◐	○	◐	◐	○	○	○	○	◐	○	○
	WTW improvements in Kent (within existing licences)																		
SR31	- Folkestone	4	1	H	50	○	○	○	○	○	○	○	○	○	○	○	○	○	○
SR32	- MEW	2	1	M	50	○	○	○	◐	○	○	○	○	○	○	○	○	◐	○
SR33	- SWS	2	1	M	50	○	◐	○	◐	○	○	○	○	○	○	○	○	◐	○
SR34	Conjuctive use inSussex (SEW)	0-10	10	H	50	◐	○	○	●	◐	●	◐	●	○	○	○	○	○	◐
SR35	Conjuctive use in Kent (SWS and/or MKW)	0-10	10	M	50	◐	○	○	●	◐	●	◐	●	○	○	○	○	○	◐
	Local GW enhancments in Kent (within existing licences)																		
SR36	- MKW	7	1	M	50	○	○	○	◐	○	○	○	○	○	○	○	○	◐	○
SR37	- SEW	2	1	H	50	○	○	○	○	○	○	○	○	○	○	○	○	○	○
SR38	DESALINATION - F&DW	2-10	10	H	50	◐	◐	○	○	◐	●	○	●	○	○	○	◐	○	●

● High ◐ Medium ○ Low

Table 6.1 **Uncertainty, opportunity and constraints framework for national (generic) options** *continued*

Option				Uncertainties					Constraints				Opportunities				
Type		Time to implement [yr]	Renewal period [yr]	Technology and investigation	Promotion time	Construction/implementation time	Resource value	Cost	Policy & legislation	Public & stakeholders	Environment	Energy Use	Flexibility in implementation	Environmental enhancements	Resilience to climate change	Meeting other needs	Amenity and recreation
Resource Development	New reservoir	15-20	100	◐	○	○	◐	◐	◐	●	●	●[1]	○	◐	●	●	●
	Reservoir raising	5-10	100	○	○	○	◐	◐	◐	◐	◐	●[1]	○	◐	●	●	◐
	Winter storage reservoirs (single farm)	1-2	15-30	○	○	○	○	○	○	○	○	○	○	○	●	○	○
	Winter storage reservoirs (farm consortium: 10-15)	3-5	15-30	○	◐	○	○	◐	○	○	○	◐	○	◐	●	○	◐
	Surface water abstraction (unsupported for pws)	1-3	30	○	○	○	◐	○	○	○	◐	◐	◐	○	○	○	○
	Groundwater abstraction or enhancement	1-3	30	○	○	○	◐	◐	○	◐	◐	◐	●	○	◐	○	○
	Desalination	2-5	-	○	◐	○	○	○	◐	◐	●	●	◐	○	●	◐	○
	Wastewater re-use (direct pws)	3-5	30	●	●	○	○	●	●	●	○	◐	●	○	●	○	○
	Wastewater re-use (direct non-pws)	3-5	30	○	○	○	○	○	○	○	○	◐[2]	●	○	●	○	○
	Wastewater re-use (indirect pws)	3-5	30	◐[2]	◐	○	◐	◐	◐	◐	◐	◐[2]	●	◐	◐	◐	○
	Wastewater re-use (indirect non-pws)	3-5	30	○	○	○	○	○	◐	◐	◐	◐[2]	●	◐	◐	◐	○
	Aquifer artificial recharge and recovery	5-10	15-30	●	◐	◐	◐	◐	◐	◐	◐	●	●	○	●	◐	○
	Canal transfer	3-5	30	○	○	○	◐	◐	○	○	◐	◐	◐	○	○	◐	◐
	River transfer	3-5	30	◐	◐	○	◐	○	○	●	●	◐	◐	◐	○	◐	◐
	Pipeline transfer	6-10	30	●	◐	◐	○	◐	◐	●	●	●	○	○	◐	◐	○
	Operational improvements	1-3	30	○	○	○	○	○	○	◐	○	◐	○	○	●	○	○
Demand Management	Improved leakage control	1-5	-	○	○	○	◐	◐	○	○	○	○	●	○	●	○	○
	Rainwater use (new development, non-potable)	1-3	15	◐	◐	○	◐	○	◐	●	○	○	○	○	○	○	◐
	Greywater use (new development, non-potable)	1-3	15	●	●	○	○	○	●	●	○	○	○	○	●	○	○
	Waste minimisation of industrial/commercial	1	-	○	○	○	◐	○	○	◐	○	○	●	○	●	○	○
	White goods subsidies	1-3	10	○	●	○	●	○	◐	◐	○	○	●	○	●	○	○
	Retrofit of toilets to dual flush/ interruptible flush	-	15	◐	◐	○	◐	○	◐	●	◐	○	●	○	●	○	○
	Metering (domestic)	10	10	◐	●	○	●	○	●	●	○	○	●	○	●	○	○
	Tariffs for measured charges	10+	-	●	●	○	●	○	●	●	○	○	●	○	●	○	○

[1] Pumped storage = high, gravity = low [2] Low to Medium ● High ◐ Medium ○ Low

Habitats Directive in our risk, uncertainty and sustainability appraisal. We will also ensure that individual actions are subject to appropriate assessment under the Habitats Directive.

6.3

Risk and uncertainty framework

Different options have different risks, uncertainties, opportunities and constraints. It is important to consider these when choosing the options that will contribute to the strategy. A balanced strategy will consist of a series of options that together produce an overall level of risk and uncertainty that is acceptable. Within this, there may be some individual options that are high-risk but may produce highly beneficial results. There is no simple way of calculating risks and uncertainties in the context of this strategy. To help us to think about the different characteristics of different options, we developed a tabular approach that provides a framework for the inevitably subjective analysis of this area. The approach considers:

- Uncertainty in the technology, investigation, time, cost and resource value of an option;
- Opportunities to meet wider objectives, including the ability to be flexible in implementation, opportunities for environmental enhancement, resilience to climate change, and to provide amenity and recreational benefits;
- Constraints that may limit the success of the option, including attitudes and aspirations and legal or institutional barriers.

Table 6.1 applies this framework generically to different resource management options. We used this framework in conjunction with sustainability appraisal to help us to understand the different characteristics of different options.

6.4

Sustainability appraisal

Our approach to sustainability appraisal draws on the DETR's "Proposals for a good practice guide on sustainability appraisal of regional planning guidance" (DETR 1999b), and the Agency's internal guidance documents. The appraisal was applied at each stage of the strategy formulation process, including the strategy objectives, strategic options and policies. These were appraised against the four themes of sustainability:

- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources;
- Maintenance of high and stable levels of economic growth and employment.

In the assessment of strategic options, each of the sustainability themes was sub-divided into criteria against which each option was assessed. These are outlined in table 6.2. The appraisal was carried out by an independent assessor.

Given that the climate is changing, all sectors of society and the economy will have to respond to new climate conditions. Adaptation strategies will be driven by changes both to long-term climate and to extreme events. However, as indicated in section 4.5, the exact nature of climate change is uncertain. Assuming the worst can be very expensive, especially where decisions have to be taken many years in advance. One of the keys to a successful adaptation strategy is to ensure that it is sufficiently flexible to deal not only with current scenarios but at least to some extent with events that are less likely. In the context of the water resources strategy, this means that schemes that improve the management of water use or developments that can be phased will be more appropriate than schemes that are inflexible.

6.5

Costs

For this strategy, we have used the best available financial cost information to compare different options. We have drawn this from a variety of sources and commissioned a study to evaluate and place it on a reasonably consistent basis. However, the wide variety of types of option, and differing levels of detail available mean that precise cost comparisons could be misleading. In addition some financial information has been provided in confidence. We have therefore classified the costs on a three-point scale of low, medium and high. In the longer term, we will seek to ensure that more cost information is placed in the public domain.

The resource development option costs that we have considered have largely come from water company water resources plans. A preliminary environmental cost appraisal was included in the WRP process, but we have not tried to pursue environmental economics for our

Table 6.2 **Sustainability criteria applied in the water resources strategy**

A Effective protection of the environment	
Air/soil/noise pollution	The changes in emissions of pollutants to air or land or in noise generation
Waste generation	The amount of waste generated and the amount of waste disposed of in landfills
Biodiversity	The effects of the option on biodiversity
Water quality/pollution	The effects on water quality or the changes in diffuse pollution of surface and ground waters and discharge of pollutants to surface waters.
Cultural and amenity value	The effects on urban and industrial heritage, sites of historic, cultural value and amenity value
Landscape & tree cover	The effects on natural and environmental assets, landscape and tree cover
B Prudent use of natural resources	
Energy consumption	The level of energy consumption, especially from non-renewable sources
Water resources	The effects on water resources/water table
Fisheries/fish stock	The effect on the quality of fisheries and on fish stock
Aggregates & minerals	The level of use of aggregates and minerals especially from primary sources The level and use of any other resources/materials, such as water treatment chemicals
Infrastructure use	How the option maximises the infrastructure use
Greenfield/brownfield site	The effects on the development of brownfield sites/greenfield sites and open spaces in urban areas
C Social progress which recognises the needs of everyone	
Good quality and affordable water & treatment	Any changes in the affordability of good quality water, waste water collection and treatment (will tend to favour lower cost options)
Availability, protection & quality of amenity value	The changes in the availability (access) of leisure facilities, recreation areas, parks, fisheries and other (diverse) uses
	The changes in the quality (range) of leisure facilities, recreation areas, parks, fisheries and other (diverse) uses
Human health and safety	The effects on human health, including perceptions of possible health impacts
	The effects on safety, including perceptions of possible safety issues for households and operational safety issues
Equal opportunities available to individuals	Opportunities available for education about water management (to learn, understand and gain knowledge about water management)
Public perception of quality of life	Opportunities for community involvement and sharing responsibility for water management
	Possible effects on lifestyle, through technological change, impacts on socio-economic status and disruption
D Maintenance of high and stable levels of economic growth and employment	
Construction costs	Impacts on investment (capital) costs
Operation costs	Impacts on operation costs
Income, employment and attractiveness of area	The direct economic benefits (maintenance or net creation of jobs, income generation), indirect economic benefits (wider effects on economy, for example the effect of environmental quality on investment in the area) and infrastructure improvements which attract investors to the area (transport communications, energy supply and environmental infrastructure)
Agency and public sector	Additional costs to the Agency or public sector.

Source - adapted from *Integrated Appraisal of Environment Agency Policies: Version 1.0* Environment Agency, National Centre for Risk Analysis and Options Appraisal.

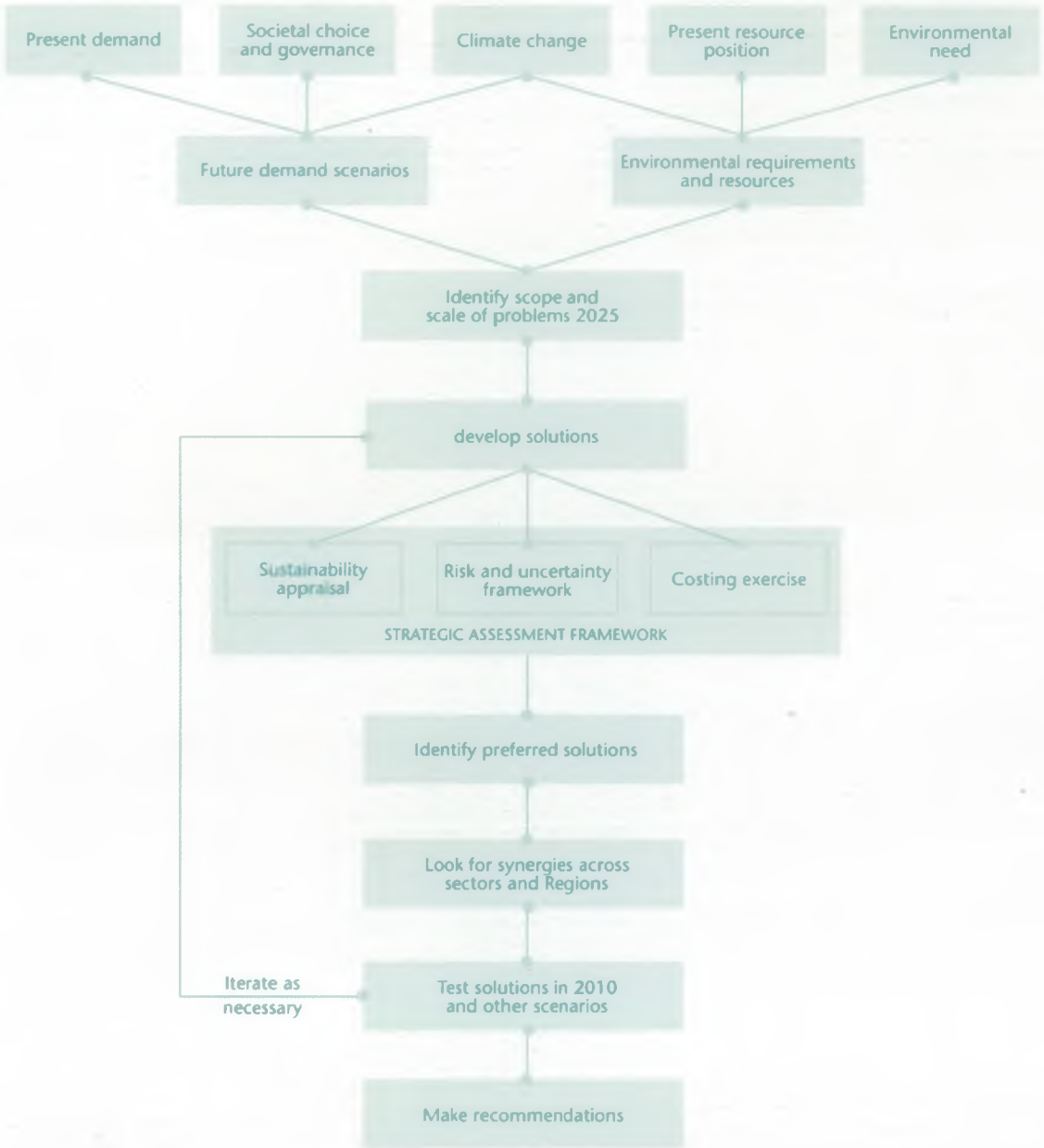
strategy. We have considered this to be inappropriate at this stage, although it would be an essential part in the development of schemes to implement our recommendations. Sustainability appraisal considers the environment alongside other issues in a way that is appropriate at this stage.

6.6

Peak demands

In Southern Region, peak demands can have an important influence on the need for, and timing of, new water resource developments, especially in areas heavily dependent on groundwater. Peak demand-driven abstractions can place increased stress on the water environment as they typically occur in the summer

Figure 6.1 The strategy development process



when groundwater levels and river flows are receding. We must consider each option's ability to help reduce peak demand-driven supply-demand and environmental problems.

6.7

Building a strategy

The process we have followed to combine these approaches recognises the significance of costs but also takes account of the other elements in a logical and consistent manner. It is an iterative approach involving the following steps:

- Identify the options available for meeting any gap between supply and demand. These include both demand management and resource development;
- For 25 years ahead, consider the biggest incremental demand;
- Identify solutions (made up of a set of options) for this incremental demand;
- Look at the strengths and weaknesses of solutions; as indicated by the sustainability appraisal and application of risks and uncertainties framework, which included robustness to climate change: how does the set of options perform?
- Consider the weaknesses and constraints of the individual options identified; could other options

improve the contribution to sustainable development, increase resilience to climate change or reduce uncertainties?

- Look at the effectiveness of this solution 10 years ahead;
- Consider the effectiveness and appropriateness of this solution in the other three scenarios;
- Refine and review the set of options; identifying a robust solution and the necessary timing of actions.

We recognise that costs will influence the delivery of any strategy and we have taken likely costs into account in considering different strategy options. But we have not calculated in detail the financial cost of this strategy. It will be for the organisations who promote schemes in line with this strategy to assess their costs and value for money, and to justify them on that basis. Where the Agency itself needs to take action to help realise the strategy it is, of course, duty bound to consider the costs and the benefits of what it proposes to do.

6.8

Discussion of options

6.8.1 Resource development and other supply-side options

Enhancements/improvements within existing licences.

The removal of engineering constraints such as pumping, pipeline and treatment capacities can lead to increased source outputs within existing licences. A number of individual schemes have been identified in WRPs, the majority relating to groundwater sources.

Water companies favour these schemes because they are generally low cost, capitalising on existing infrastructure, land access and licences. There may also be other reasons for such improvements: to satisfy statutory drinking water standards, for example.

Our review of these options finds them to be fairly low risk, with few constraints, but also offering little opportunity of wider benefits. Sustainability will be our main concern. Water companies will be aware of the environmental issues local to the specific proposals, whilst this document highlights concerns for the overall water balance, including environmental needs.

Sustainability appraisal supports the above summary and also notes that such improvements can provide more benefits in enhancing opportunities for conjunctive use.

Conjunctive use

Some WRPs include one or two schemes which are expected to provide small resource yield benefits through the improved conjunctive use of combinations of sources, but the Agency believes there is further scope: for example, for South East Water in Kent and East Sussex.

Many of the uncertainties, opportunities and constraints applicable to surface water and groundwater abstractions also apply to conjunctive use. We acknowledge the uncertainty surrounding conjunctive-use yield benefits, but are enthusiastic about the possible flexibility of options. The aim of enhancing the overall sum of the use of individual sources makes investigation and implementation of conjunctive-use a valuable contribution to sustainable development.

Distribution and sharing of resources

The region's resources are not evenly distributed geographically or matched with the demands for water. The mismatch influences the 'resource zone' surpluses and deficits portrayed on figures 4.2 to 4.8.

Figure 3.1 shows the existing strategic water supply connections across the region. There is further scope for water supply system integration to link areas of surplus to areas of deficit, both within and between water companies across the region.

Proposals to move water across catchments raise many issues, for example:

- Effluent discharges are unlikely to find their way back to support the donating catchment.
- Changes to the natural flora and fauna due to changes in flows and water quality
- Transfer of treated water by pipeline can minimise concerns about the transfer of foreign flora and fauna, while transfer of raw water using rivers, streams or canals as the conduit may reduce costs and provide useful augmentation of natural flows.

The principle of sharing water resources from areas of surplus to areas of deficit has been central to the regional water resources strategy since 1994. This had a significant influence on the Water Resources in the South East Group's proposals which include six new bulk supply transfers between water companies (Figure 3.1). These are all treated water transfers by pipeline.

Portsmouth Water consider the proposed supply to Southern Water to be dependent on a successful licence variation to increase permitted peak period abstraction from their Eastergate Group groundwater source.

Southern Water's ability to supply South East Water from Darwell reservoir is viewed to be dependent on enhancing the transfer capacity between Bewl and Darwell reservoirs and, in future, possibly enlarging one of the reservoirs. The other proposed bulk supplies have no directly related resource development impacts.

Our review of the proposed system integration, resource sharing and transfer schemes finds uncertainties and risks to be low, while such schemes can also contribute flexibility and robustness. More integrated water supply infrastructure can itself provide supply benefits by: maximising conjunctive-use potential, reducing the need to allow for temporary source losses (outage), enhancing flexibility to satisfy peak demands and improving resilience to climate change. However, abstraction impacts should not be overlooked, and pumping and treatment costs should be fully taken into account against alternatives, though such schemes can represent prudent use of existing resources, avoiding new resource development.

Competition may make companies more wary of integrating systems to share resources and take bulk supplies, but we believe these options remain a sensible way forward.

For Strategic transfers from *outside* the region, the most likely strategic resource will be from Environment Agency Thames Region. The most likely route into Southern Region is by South East Water's abstraction at Bray in Surrey and a pipeline to East Sussex, but we have also considered the Wey and Arun canal, while a route from south-east Greater London to, say Sevenoaks, would be geographically shortest. There are several sources which could provide the necessary support for such transfer in future, including a strategic regulating reservoir in Thames Region, leakage savings by Thames Water or perhaps use of rising groundwater in London to free-up other resources. Beyond the current uncertainties of these sources and their costs, there would be significant engineering and costs involved to deploy the benefits of such transfers across Southern Region. Existing resources might also need to be re-deployed. We have regarded overall costs as probably excessive, but we will investigate options over the next few years and compare them to options within the region.

Reservoirs

Water company WRPs discuss future options to enlarge existing impounding reservoirs. Enlargement of Bewl and/or Darwell reservoirs are considered key strategic options, currently under investigation to establish potential volumes and timing of promotion. The Agency agrees in principle that some future enhancement of storage of the Bewl-Darwell system is sensible.

Enlargement of existing reservoirs at Ardingly and Arlington is discussed, but not preferred in South East Water's WRP. However, a new reservoir in the Lower Ouse catchment in East Sussex is included in proposals, needed in 2020 according to South East Water forecasts. We also note Southern Water has recently carried out a preliminary review of reservoir site options in north West Sussex. For the longer term, other options for review include the Broadoak site in Kent and Portsmouth Water's potential reservoir site at Havant Thicket in East Hampshire.

Reservoir options are viewed positively in respect to recreation, amenity and bio-diversity (reservoir margins), although they clearly have a major local impact. Loss of land, visual impact and construction disruption are less favourable aspects, but peak demand management, construction employment and potential for power generation are other benefits. The resilience to climate change that additional reservoir storage will offer is also a strong point in a region with only 10% of public water supply derived from surface water storage. Reservoirs store winter water for summer use, which suits the region's resource availability.

Winter storage

Our review of resource availability (section 3.5) has highlighted why we do not envisage further consumptive summer surface water abstraction to be sustainable. However, in most of the region winter abstraction is possible. Abstraction and storage in winter for use in the summer months is encouraged for agricultural purposes. Sustainability appraisal comments, and uncertainty and risks considerations, have found winter storage schemes to be mostly beneficial. Individual or joint schemes can help farming communities be self-sufficient and provide security against climate change.

Innovative solutions

Artificial aquifer recharge options are discussed in WRPs and one or two specific sites are either being investigated or are due to be investigated; overall potential is not likely to be great due to the nature of the region's aquifers.

Rainwater collection and *domestic grey water recycling* could be used for non-potable use in the home. Rainwater collection is possible now, but the grey-water option is not likely to be practical until post 2010 when we assume public health aspects will be resolved. The main non-potable use in the home is toilet flushing and

these options offer significant potential savings even if a low flush toilet has already been adopted. But both options are viewed as costly, with some uncertainty over public perception and the promotion time necessary to implement them at any significant level. Grey water re-use is also surrounded by legislative and policy constraints, although it may produce knock-on benefits to sewage treatment, would be resilient to climate change and robust against peak demands.

Desalination options are discussed in some water company WRPs. If implemented, desalination would help to conserve conventional water resource. It is also a fairly flexible option, resilient to climate change. Concerns surround energy consumption, costs, public perception and palatability of supplied water. These concerns probably outweigh the benefits, so desalination is only likely to be promoted where other options are limited.

Effluent re-use

Effluent re-use options are discussed in WRPs, suggesting sewage effluent, appropriately treated, should be considered as a valuable resource, not a nuisance.

Coastal effluent discharges constitute 52% of sewage treatment works effluent discharges within Southern Region. These discharges comprise water abstracted from streams, rivers and groundwater up-catchment, supplied to coastal towns, discharged out to sea and so effectively lost. Another 14% is discharged to estuaries (figure 6.2).

The latest water quality standards have led to investment in the secondary treatment of coastal discharges. With further improvements in treatment, effluents could be of a very high quality, suitable for re-use. In Southern Region the return of suitable coastal discharges inland could, at a cost, retrieve and provide a very significant resource to support abstractions and riverflow.

The Agency does not advocate direct re-use to public water supply, but indirect re-use could be acceptable, using rivers or reservoirs as mixing mediums before re-abstraction. This is not a new concept. Inland sewage effluent discharges already make up a significant proportion of baseflow in many rivers.

Effluent re-use resource should be resilient to climate change and offers flexibility in implementation and operation, including peak demand balancing, but there are public relations concerns, and treatment and energy costs may be high. The latter may be reduced if schemes are operated only infrequently to cover peak demand periods or only during particularly dry periods, though this concept means that satisfactory discharge to sea would remain the primary mode of operation, incurring day to day costs and impacts.

The impact on the water quality and ecology of receiving waters remains a concern, despite arguments that conventional treatment technology can provide adequate safeguards. Technological refinements and further research into impacts may make options easier to promote in five to ten years.

6.8.2 Leakage control

Whilst substantial progress has been made by the water companies in reducing leakage from the supply network we believe there is still scope for further savings. We have considered two future scenarios for leakage in Southern Region:

(i) Leakage could be reduced to current mandatory targets and held at that level until 2025 (essentially what is proposed in water company WRPs);

(ii) Progressively lower levels will be achieved in the future.

Figure 6.2 Inland, estuarine and coastal effluent discharge proportions

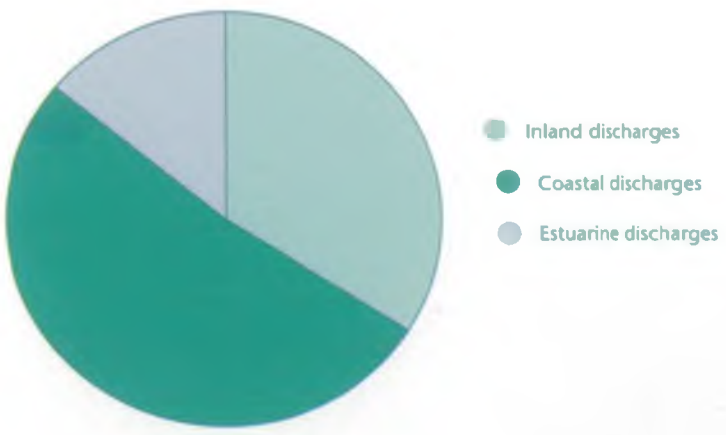


Table 6.3 Leakage levels, targets and Agency 'Gamma' scenario (in Ml/d)

Company	Reported	1999 WRP forecasts			Ofwat target
	1992/93	2001	2010	2025	2001/02
Folkestone & Dover Water	17.9	8.4	8.0	8.0	8.2
Mid Kent Water	41.1	28.6	26.3	26.3	28.8
Portsmouth Water	26.8	30.3	30.3	30.3	30.0
South East Water	37.7	30.7	28.0	28.1	75.1**
Southern Water	156.4	92.0	86.2	85.4	92.0
Regional Total	279.8	190.0	178.8	178.0	190.2
Agency 'Gamma' Scenario	**1992/93**	**2001**	**2010**	**2025**	**2001/02**
Folkestone & Dover Water	n/a	8.4	5.91	4.76	n/a
Mid Kent Water	n/a	28.61	23.05	16.62	n/a
Portsmouth Water	n/a	30.0	37.8	24.5	n/a
South East Water	n/a	31.4	22.5	16.8	n/a
Southern Water	n/a	92.0	98.4	70.7	n/a
Regional Total	n/a	190.4	187.7	133.4	n/a

** 75.1 Ml/d is the OFWAT target for South East Water encompassing it's 'Hants. & Surrey' and 'Kent & Sussex' sub-divisions. The latter is the division falling within the Southern Region. An 'indicative' figure for' Kent & Sussex' is approx. 31.2 Ml/d.

Within our Gamma water demand scenario we have modelled the level of leakage that may be technically achievable within the 25 year planning horizon. Wherever possible our modelling used water companies' current leakage management information as base data, though it also assumes that future technological innovation will be effective and will influence leakage target setting. We have forecasted savings by applying conventional active leakage control, but with the latest technology, assumed to be the Permalog system being employed by Severn Trent Water and South East Water with very positive results. Our modelling suggests further savings of up 50 Ml/d beyond current mandatory targets could be achieved across Southern Region. Table 6.3 compares current leakage levels, mandatory targets and our Gamma scenario forecasts.

Future leakage control costs are uncertain both in absolute terms and in terms of what may be acceptable. Furthermore, leakage control costs will vary from low to high relative to other options, depending on the starting leakage position and the other options available. However, we believe our Gamma scenario leakage levels will be technically feasible by 2025 at reasonable cost.

In Southern Region, the Gamma scenario leakage control option makes a predominantly positive contribution to sustainable development on economic, social, environmental and water supply grounds. The potential for leakage repair work to cause disruption is the only detrimental factor.

6.8.3 Demand management options

In Southern Region, water companies have been reasonably proactive in providing leafleted advice on water efficiency opportunities and some companies offer audit services to schools and offices. Most companies have also made toilet cistern devices available to customers. However, companies generally remain sceptical or cautious about the long-term impact of

Dishwashers have been regarded as a luxury by many, but will they become the 'norm' in future? Greater affluence has been linked to greater consumption of water in the home

water efficiency measures. Little saving has been projected in the current demand forecasts prepared by most companies.

Figure 6.3 shows the typical components of household water consumption as a percentage of total consumption. The demand management and water efficiency measures which can be targeted at these water use activities, include:

For the home, workplace and public facilities

- low flush or dual flush toilets
- toilet flush volume reduction devices
- waterless urinals (workplace and public)
- water efficient taps
- lower power (flow rate) showers
- water efficient white goods
- proactive maintenance of plumbing

For the garden and parks

- drought resistant plants
- water butts
- alternatives to sprinklers
- recycling opportunities
- irrigation equipment maintenance
- optimum water application

Attention to toilet flushing is an important area because it accounts for such a high proportion of overall use. Studies have shown that cistern volume reduction devices such as "Hippo" or "Save-a-Flush" bags can save at least 1 litre per flush. This could reduce the average pcc by 6-8 litres a day. Progression to lower flush or dual flush toilets will have a bigger impact.

Toilet flushing accounts for 25% of water used in the home

Garden sprinklers have been targeted successfully by water companies to reduce peak consumption

Changing from a 9 to 6 litre flush could save 15 to 30 litres a head each day.

Water efficient taps, including spray taps, push taps, electronic taps and flow restraint taps, can save water in public facilities such as offices and schools. Manufacturers claim that spray taps can reduce water use by 60-70 % compared to normal flow taps. Flow restraint taps, push taps and electronic taps can save 50%.

Garden water efficiency is an important component of any demand management strategy. Sprinklers can use as much water in one hour as a family of four uses in one day!

For our strategy we have considered 'common' demand management options, to include:

- integrated domestic water use audit
- toilet cistern conversion to dual flush
- water efficient washing machines

The latter two options are only assumed to produce savings if they are applied to accelerate the natural change-over to such devices over the next twenty-five years. We have considered the integrated domestic water audit option to be a catch-all term for various mixes of water efficiency promotion and implementation that could be packaged together.

Demand management measures are flexible to implement, resilient to climate change and reduce peak demands as well as average demands. However there is uncertainty around the savings that will be achieved. Imperfect knowledge of the public's acceptance of such

measures, lack of experience of the degree of promotion necessary to establish long-term savings and lack of transparency of costs contribute to this. Sustainability appraisal finds demand management to be a prudent use of water resources, helping to protect the environment and offering a positive contribution to social progress by giving a strong message of the value of water. Cost savings to consumers are another benefit, particularly when they are charged by volume used. Implementation costs will vary depending on the package of measures applied.

Water (Supply and Fittings) Regulations

The Water (Supply and Fittings) Regulations provide one means of influencing water conservation. They stipulate the quality and standards that water fittings and installations must satisfy and the circumstances suitable for their use. They apply to any water fitting installed or used, or to be installed or used, in premises supplied with water by a 'water undertaker' (water company). Importantly, for water conservation, the Regulations:

- state that no water fitting shall be installed, connected, arranged or used to cause, or be likely to cause, waste, misuse, undue consumption or contamination of water supplied by a water company, nor erroneous measurement of water supplied;
- require the water supplier to be notified if high use facilities such as those listed in the Water Industry Act are to be installed (see section 6.8.4 below);
- the single flush toilet cistern capacity to be 6 litres for all new installations from 2001 and allow dual flush cisterns in new installations from that time.

Washing machines should be sold with clear water use labelling to encourage efficient machines to be chosen

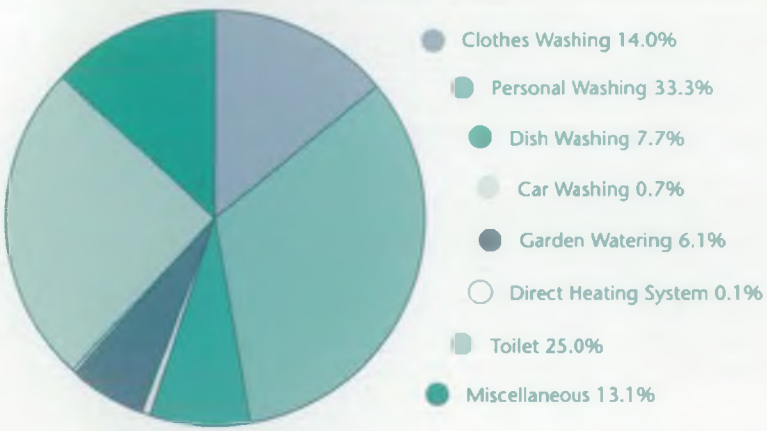
Using a handheld hose allows the gardener to direct the application of water. But garden watering has a large influence on peak demands for water

6.8.4 Metering

The Agency believes that by paying for the volume of water used, consumers are more likely to use water efficiently and repair plumbing and supply pipe leaks. Household metering with an appropriate tariff can reduce consumption.

The number of metered households has more than doubled overall since 1992/93. This increase has mainly been through voluntary take-up, installations in new homes and metering of sprinkler or swimming pool users. Folkestone and Dover Water have run more

Figure 6.3 Micro-components of household demand 1997/98



proactive installation campaigns. Water companies predict that over 20% of all households and 90% of commercial and industrial premises will be metered within the region by 2001.

In November 1998 the Government published the findings of its consultation on water charging. As a result, under the new Water Industry Act 1999, a meter will now be supplied and installed by water companies free of charge to households opting for one.

Over the last three years, the Agency has received three sets of water demand forecasts from water companies, each set involving different considerations of future metering in relation to Government and Ofwat guidance:

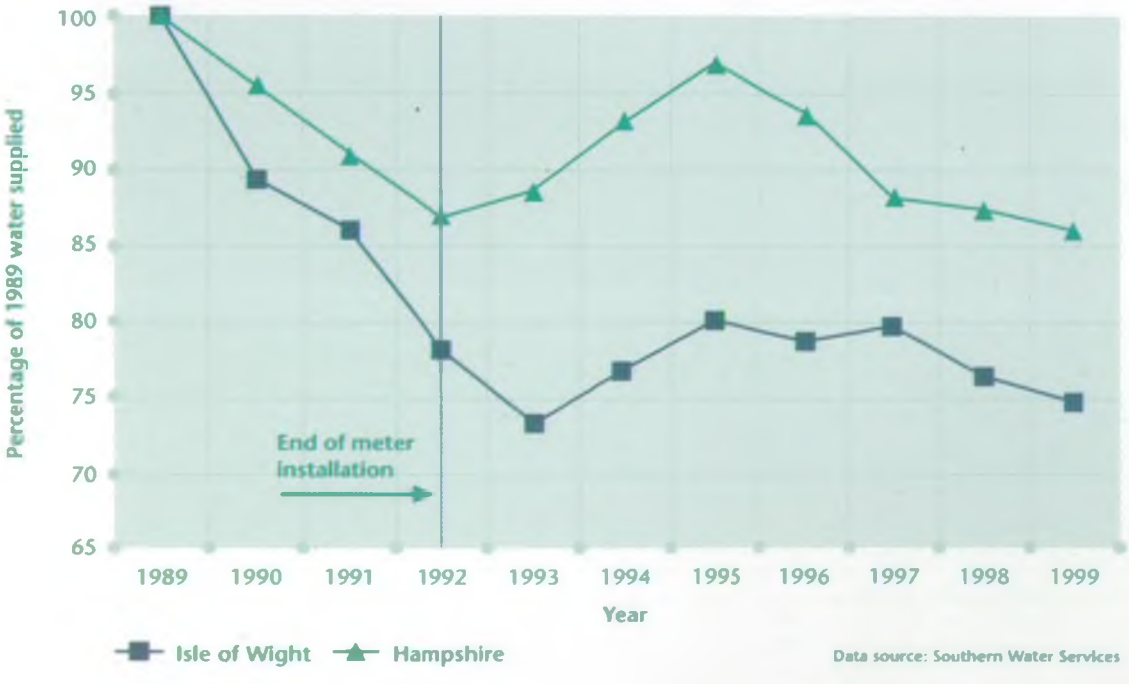
- In draft WRPs received in 1998, company forecasts could include the compulsory metering of particular groups of customers or whole areas;
- In the 1999 WRPs, companies had to adopt the restrictions on compulsory metering announced by

Table 6.4 **Summary of household metering forecasts (% of households)**

Company	ACTUAL	DRAFT WRP			1999 WRP			OCT 2000 REVIEW		
	1992/93	2001	2010	2025	2001	2010	2025	2001	2010	2025
Folkestone & Dover Water	2.7	36.5	69.3	96.3	31.7	56.0	65.3	30	46	57
Mid Kent Water	2.6	20.3	54.7	72.8	20.3	54.7	70.8			
Portsmouth Water	0.1	0.8	2.0	3.9	5.0	31.4	48.5			
South East Water	3.3	29.8	57.1	76.8	29.8	55.7	84.0	30	60	88
Southern Water	9.6	26.9	47.3	51.9	24.0	39.3	44.7	21	36	48
Region*	6.0	22.8	43.5	52.7	21.8	43.1	55.3			
Agency scenarios										
Alpha					15.1	27.8	50.2			
Beta					15.1	27.8	95.0			
Gamma					15.1	27.8	95.0			
Delta					15.1	27.8	50.2			

*Regional figures based on company weighting according to number of households (1999 figures) - except 1992/93, which is actual

Table 6.4 **Effect of compulsory metering**



Data source: Southern Water Services

the government and forecast the optional take-up of free meters;

- In October 2000, companies submitted their first annual review of WRPs. Some companies amended forecast free meter take-up in line with their interpretation of the allowances within customer price limits set by Ofwat for the period 2000-2005.

The Agency's four water demand scenarios each assume a progressive implementation of metered charging of domestic households. Table 6.4 summaries the Agency forecasts and the sequence of water company forecasts. All forecasts assume increases in household metering over the next twenty-five years. There is less consensus over the water savings that result from metering.

Savings assumptions are influenced by whether metering is compulsory or voluntary, with the likelihood that voluntary metering is less effective at saving water. During the Third Periodic Review, Ofwat advised water companies to assume no more than 5% saving against those opting for a meter.

Selective metering by Folkestone and Dover Water has helped to reduce the company's water into supply figures: demands in 1998 were actually lower than 1985. Similarly, Southern Water compulsory metered 90% of their customers on the Isle of Wight between 1989 and 1992. Figure 6.4 taken from Southern Water's 1997 Isle of Wight Report, shows the water use reductions achieved in comparison to the Hampshire area where compulsory metering was not introduced. Compulsory metering is likely to be most effective at securing water savings.

Water companies' opportunities to meter compulsorily are set out in the Water Industry Act 1999.

Water Industry Act 1999

This Act introduced a new structure for setting charges to customers by water companies. A primary concern of the Act is that no one should be deprived of water for essential purposes. Companies cannot disconnect households for non-payment and the Secretary of State can prescribe regulations to protect vulnerable customers.

Under the Act, companies are required to have a charging scheme for household dwellings approved by Ofwat. This must include an obligation to install meters free of charge for customers requesting to pay a metered charge and allow customers to revert to an unmeasured charge within the first year of the installation.

Water companies can no longer compulsorily meter households, except customers with high water using facilities such as swimming pools greater than 10,000 litres capacity, baths greater than 230 litre capacity, high flow rate showers and non-hand held garden watering apparatus. Companies should install meters to new properties and can install meters on change of occupancy at existing properties.

However, water companies may apply for areas to be determined "water scarce" by the Secretary of State. In such areas, the company would be able to compulsorily meter any or all customers. Three criteria will be considered by the Secretary of State in determining water scarce status:

- the likely demand for water in that area over the next ten years
- the water resources which are, or could be made, available for meeting that demand
- the measures that the company could take for meeting or managing that demand

Metering of the majority of household customers should be possible over the next 25 years if water companies install meters for everyone asking for one, as well as high users, new properties and occupancy changes. Greater metering levels may depend on establishing 'water scarce' status.

There is, of course, a cost associated with metering household water customers. This includes the cost of the meter itself, the work required to adapt the existing pipework to allow the meter to be installed, and an ongoing revenue cost in collecting meter readings and producing bills. This must be set against the tangible and intangible benefits of a well-organised and understood system of water resource management. The introduction of metering and imaginative tariffs should also provide benefits to consumers, while protecting vulnerable consumers.

Metering is a flexible measure to implement and it offers resilience to climate change through demand management. However there is uncertainty around public acceptance, which could be a constraint.

6.8.5 Industrial water audits

Non-household (industrial and commercial) use of public water supplies and direct abstractions by industry have been thoroughly considered within our water demand scenarios. We have considered water consumption by sector: 19 sectors within public water supply and 11 sectors for direct abstraction. We have also distinguished between small and medium sized enterprises (SMEs) and large companies to reflect

variability in the level of uptake of water waste minimisation options. Drawing on information from the Environmental Technology Best Practice Programme (ETBPP) and published sources, we devised sector-specific water savings which reflect differences in cost and pay back periods. Five water efficiency measures have been considered for production manufacturing industries and three for the business and service sectors:

Production - manufacturing

- good housekeeping
- management
- reuse
- recycle
- redesign

Business and service

- good housekeeping
- management
- water saving technology

6.8.6 Agricultural water use efficiency

Our agricultural water demand assumptions are based on concepts of economic demand, reflecting the costs and benefits of irrigating different crops. The methodology draws on the optimum irrigation water requirements developed under the Agency's "Optimum Use of Water" R&D project. Irrigation forecasts for lower value crops such as sugar beet, cereals or grass, are significantly reduced compared to theoretical estimates from conventional crop water requirement approaches. For high value crops such as potatoes, vegetables and fruits, theoretical and economic demands for water are more closely matched.

We will increasingly expect agricultural water use to be efficient. Irrigation should be carried out efficiently by suitable apparatus, scheduling, controls and monitoring within overall best practice. Future crop selections should also consider climate changes, while we hope consumers and supermarkets will not encourage excessive irrigation and washing of produce. Also, use of lower quality waters, public health permitting, might relieve environmental stress in some locations.

6.8.7 Managing peak supply-demand problems

The management of peak demands needs particular consideration in Southern Region to ensure sustainable use of water resources, protecting the environment. Opportunities include:

Supply-side options

- strategic links
- additional raw water storage
- infrastructure enhancements
- conjunctive-use
- effluent reuse
- aquifer storage and recovery

Demand-side options

- pressure management
- customer awareness
- education campaigns
- water conservation measures
- metered charging with tariffs
- rainwater collection
- grey-water recycling
- garden design and optimum watering.

7 Conclusions and proposals

In preceding chapters, we have looked at the state of water resources, the present and future pressures, and how we can use a scenario approach to develop a strategy. We have also outlined our approach to identifying and selecting options. In this chapter we describe the resulting strategy for managing water resources for the next 25 years.

7.1

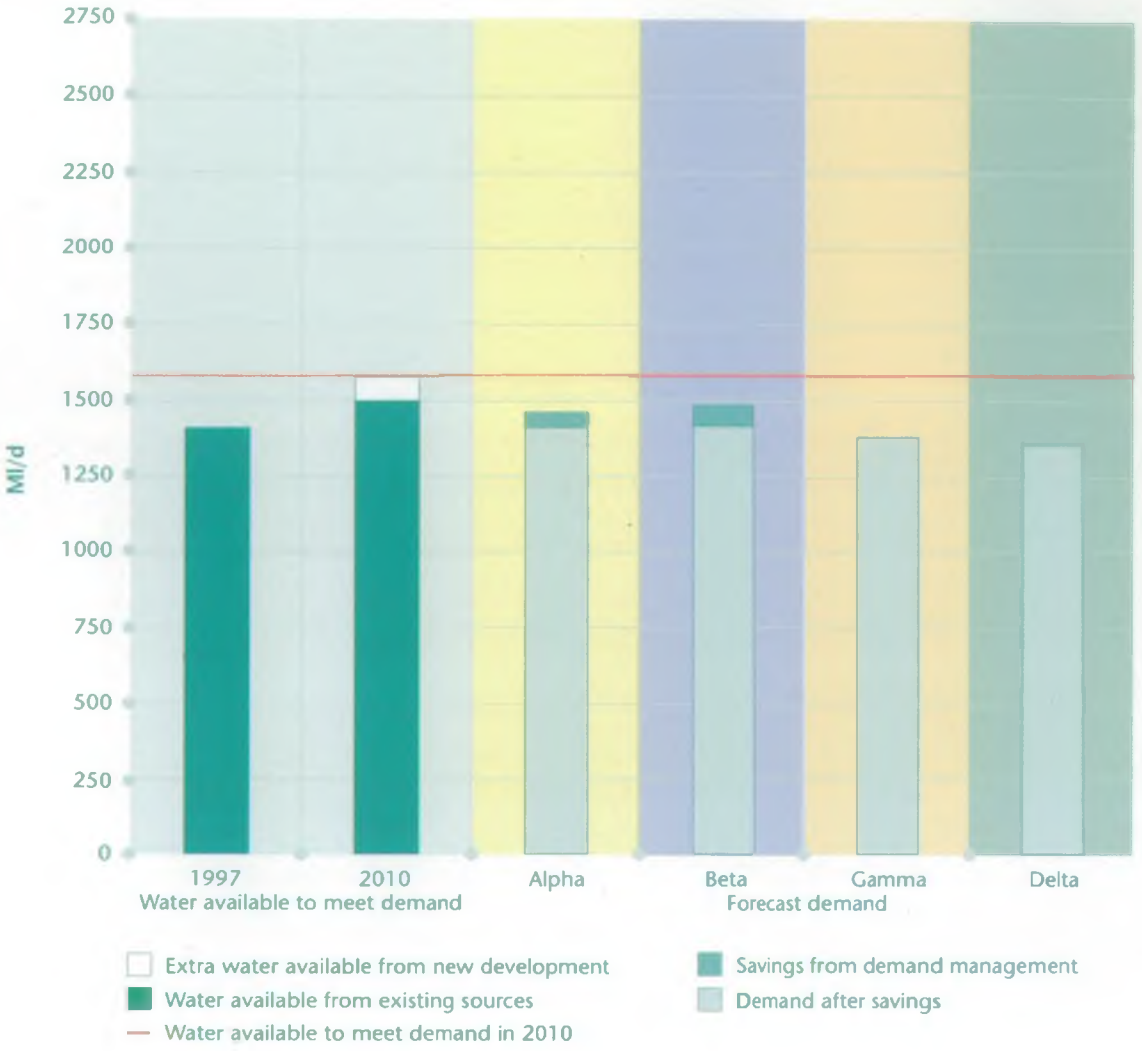
Water resources strategy for Southern Region

Key principles underlying the regional strategy include:

- the Agency taking steps to secure the proper management of water resources, including:
- requiring water companies to explore the economic and environmental benefits of leakage control, metering and water efficiency measures, with all licence applications
- refusing new abstraction or impoundment licences to companies with poor leakage or water efficiency statistics and activity
- promoting efficient water use by industry, commerce, agriculture and in the home
- making best use of available water resources before developing new schemes
- favouring schemes which meet the widest interests and improve the environment
- taking account of the potential impact of climate change
- likelihood that any future strategic resource developments should be shared developments benefiting more than one water company; and contributing to environmental improvement, possibly by helping water companies relinquish existing abstraction that is proven to be damaging
- the Agency supporting, in principle, the core proposals of the "Water Resources in the South East" plan (section 3.2.3), although specific aspects and implementation are still subject to further work and the licensing process, where this is involved
- having reviewed and considered the water company 1999 WRPs, belief there is further scope for bulk supply transfers and sharing of resources between areas of surplus and deficit. We encourage this, subject to there being no adverse effects
- the Agency continuing policies of:
- 'presumption against' further consumptive abstraction from (unconfined) chalk and other main aquifers
- 'presumption against' consumptive abstraction of summer surface water
- encouraging 'winter storage'
- recognising the control of abstraction to be increasingly important and increasingly complex. Existing licence conditions must be reviewed during CAMS studies. We envisage flow and water level conditions being extended, in terms of their geographic coverage, the proportion of licences controlled by them and the degree of control they place on abstraction. Seasonal or even monthly conditions are likely to become more commonplace. The distribution of control points may also need to increase.

Our recommendations for Southern Region are a combination of resource developments and demand management. Our approach is firmly 'twin track' water resource management: expecting continued progress in using water efficiently, while encouraging timely promotions of new resource developments. Southern Region recommendations are summarised in Table 7.1.

Figure 7.1 Impact of recommendations across Agency water demand scenarios – 2010



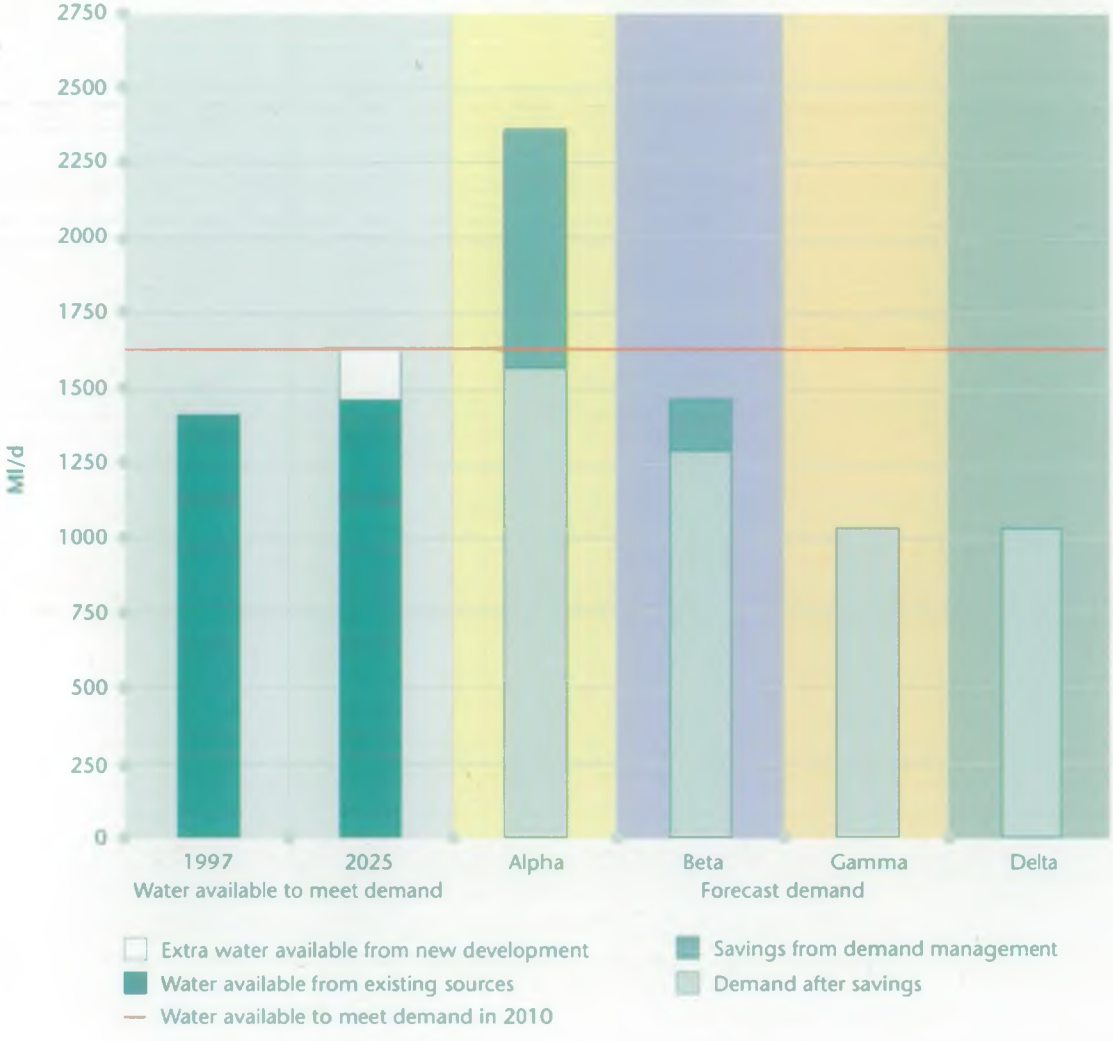
We have also identified some alternative options that could be considered if our preferred options prove inappropriate or inadequate in some way.

Figures 7.1 and 7.2 demonstrate the impact of our recommendations across the four Agency scenarios at a regional level. In these figures we show first the water taken for public water supply, industry (excluding power generation) and spray irrigation in 1997/98. The second column shows the same information either for 2010 or 2025, with the top section of the column representing the resource development or enhancement that we are proposing. The next four columns show the demands for the four different scenarios for the same year. The top section of the bars for scenarios Alpha and Beta represents the saving that we expect from demand management. These are the same demand management measures, but they deliver different savings in different scenarios.

We are proposing a single set of actions that is robust enough to manage water resources through all of the scenarios that we have considered. It can be seen that our proposed strategy ensures that supply meets demand through all four scenarios for both 2010 and 2025. The strategy provides additional water to deal with the possible impact of climate change on domestic demand, and to restore sustainable abstraction regimes in those areas currently considered to be adversely affected.

At regional level, our proposed strategy gives a surplus of supply over demand across all scenarios (figures 7.1 and 7.2). But in Southern Region, the regional summary of the supply-demand balance can be misleading, because it hides the distribution of resources and demands that exist across the region. We described the pressures on public water supply and environmental stress across the region in chapter 4. These are unevenly distributed and it may not always be possible to use existing or forecast surplus resource to solve resource deficits elsewhere. Our strategy promotes further integration of the public water supply systems of the region, but we recognise that complete integration might require cross-catchment transfer on a scale that could be either environmentally unacceptable or

Figure 7.2 Impact of recommendations across Agency water demand scenarios – 2025



unsustainable relative to other options. The transfers, resource enhancements and developments we recommend are targeted at the areas where deficits would otherwise be anticipated. Demand management and leakage control are also key objectives. A regional surplus results, but within it, many water resource zones may only just be in balance. Also, figures 7.1 and 7.2 represent the annual average situation. But, the equivalent peak demand situation would appear tighter, although at a regional level a surplus could still result from the recommendations in this strategy.

Figures 7.1 and 7.2 show the result of implementing the lower boundary of our suggested range of abstraction licensing recovery. However the outstanding surplus shows that the higher environmental requirement could also be met by the strategy if it is proven to be necessary.

The regional surplus is larger in the Gamma and Delta scenarios. In these scenarios, society would use less water, partly by individual choice but also because of changes in the economy and regulation. Our strategy does not propose that we must achieve these levels of reduction in demand. Such savings could not be realised on the basis of today's values and regulations. They would be a response to major shifts in societal attitudes to water use and the environment, which would be the result of many factors beyond the control of those who manage water resources. It would be unwise to base a water resources strategy on the hope that such changes would occur. However, these scenarios do illustrate that there is real potential for further efficiencies in water.

In the light of such uncertainties, we have proposed a strategy that is flexible and phased. The final decisions on many of the later actions need to be made some way into the future, when there is more certainty about the result of earlier actions. This means that the monitoring of progress is essential.

In the following sections we consider in more detail our recommendations by sector, in terms of recommended options and alternatives.

Table 7.1 Summary of Southern Region recommendatons

For public water supply, by 2010

We expect to see water savings of up to 75 Ml/d and have allowed for resource developments of up to 115 Ml/d.

- Demand management options[1] including metering and water efficiency measures.
- Progressive metering toward 2025 expectations.
- Progressive leakage control toward 2025 expectations.
- Enhancement of some local source outputs (50 Ml/d).
- Further integration of existing water supply systems (25 Ml/d).
- Bulk supplies and other resource sharing, including potential enhancement of storage by enlarging either Bewl or Darwell reservoirs (40 Ml/d).
- Determine the best use of Swanscombe quarry as an additional or alternative resource.

For public water supply, by 2025

We expect to see water savings[1] of up to 125 Ml/d and have allowed for further resource developments of up to 50 Ml/d.

- Demand management options including metering and water efficiency measures for savings of at least 75 Ml/d.
- Increased household metering.
- Higher levels of metering in some areas where water is particularly scarce.
- Further leakage control, for savings of up to 45 Ml/d more than 1999 WRP forecasts.
- Further water company system integration, optimisation and resource sharing.

[1]excludes water savings through maintaining current active leakage control targets.

For agriculture, by 2025

- Individual and consortium winter storage reservoirs totalling 15 Ml/d.

For industry and commerce, by 2025

- Water use minimisation will be promoted, for savings of up to 30 Ml/d.

For the environment, by 2025

- Abstraction recovery of 80 Ml/d to 180 Ml/d across the region, where abstraction is damaging the environment.
- Recovery of up to 500 Ml/d of licensed but unused abstraction ('paper' licensing), as necessary.

Other options under consideration

- Re-use of effluent currently discharged to coastal waters.
- Potential resource developments of new reservoirs including Havent Thicket (Hampshire) and Broadoak (Kent).
- Strategic transfer into the region from the Thames Region.
- Desalination.

Other significant uncertainties

- There is uncertainty regarding the outcome of investigations on existing concerns about over-abstraction and the means to redress any abstraction that is proved to be damaging.
- Housing numbers and economic development proposals for the region.
- Climate change.

7.2 Public water supply

7.2.1 Enhancing resources

We consider that water companies need to develop resources over the period of this strategy. Many of our resource-side recommendations involve making the most of existing schemes. These include further integration of supply systems; works, infrastructure or process improvements to reduce the risk and impact of temporary interruptions to supply (outage); and bulk transfers of water between water companies.

We recommend that where new or existing developments are not fully utilised water companies should consider sharing this water with others (Action A1).

Between 2000 and 2010

Preparation of this strategy has involved further review of the resource developments and other supply-side measures proposed by water companies in WRPs. The schemes intended by 2010 remain sensible and in most cases should make a useful contribution to sustainable resources management, although details are subject to further review and the licensing process where relevant. Our strategy anticipates the following supply-side enhancements:

- enhancement of some local source outputs (50 Ml/d), including:
  - River Ouse licence re-negotiation
  - water treatment works improvements
  - conjunctive-use development
  - groundwater source enhancements

See Table 6.1, schemes SR30, 31, 32, 33, 34, 36, and SR37 for main examples.

- further integration of PWS systems (25 Ml/d), including:
  - various 'connectivity' proposals to reduce outage risks
  - Weir Wood reservoir output enhancement and conjunctive -use with Hardham output

See Table 6.1, schemes SR24, and SR26

- multi-company resource sharing(40Ml/d), including:
  - bulk supplies, see section 3.2.3
  - Eastergate Group (north of Bognor Regis) licence variation
  - increased transfer from Bewl to Darwell reservoir
  - the enlargement of either Bewl or Darwell reservoir

See Table 6.1, schemes SR4, 5, 11, 12, 13, 14, 15 and SR17

The Agency considers that the development of the Bewl - Darwell system should form a component of the region's water resources and water supply infrastructure. This option is likely to remain preferable to other alternatives and would contribute to water supplies in Kent and Sussex. As water company proposals stand at present, Darwell reservoir is to be enlarged in preference to Bewl. We do not think this will be necessary until after 2010, although it is likely to be necessary before 2015. Before either reservoir is enlarged, Southern Water plan phased enhancements of the transfer capacity from Bewl to Darwell.

The Bewl-Darwell reservoir system is a key component of the region's water resources. The investigation of its development potential is essential and must remain a priority activity until more detailed conclusions are agreed.

We believe further investigation of groundwater resources around Swanscombe Quarry, near Northfleet in Kent is also important. The quarry needs to be de-watered and groundwater abstraction to help achieve this could be used for supplies, quality permitting. This potential is well-placed in relation to the tight supply-demand balance and difficult resource availability in Kent and north East Sussex. The Agency will need to decide how this resource could be used best.

Desalination should be kept under review by Folkestone and Dover Water and perhaps by South East Water in East Sussex. Similarly, we encourage Southern Water to investigate the several options from which they might select further solutions for north West Sussex, another location where difficulties could prevail if high demand growth occurs. Other north West Sussex options include the re-use of coastal effluent and artificial recharge at Hardham. We encourage further work to establish the preferred option for north West Sussex, although alternative investigations should be progressed in view of the uncertainties of any individual option.

The Agency intends to investigate and substantiate the potential for the re-use of effluent currently discharged to coastal waters, preferably working with water companies. We believe the redirection of coastal effluent discharges inland should be fully considered as an important resource in Southern Region. We propose to review current and planned Southern Region arrangements, effluent standards and re-use options. This should be completed before 2004 and an informed debate should follow.

We will also explore how the benefits of strategic resource development options might be deployed across the region. For example, the Havant Thicket reservoir or Broadoak reservoir options in Hampshire and Kent, respectively, are quite strategically placed, but are unlikely to be developed for a sole local purpose. Similarly, deployment of possible strategic transfer of resource into the region will be explored.

There are some other areas where the Agency expects water companies to carry out further work and in some cases progress may be needed before new licences would be granted. Areas for further work include:

- improvement of source performance information
- full exploration of conjunctive-use potential between existing sources

- further verification of pcc figures and monitoring of water efficiency campaigns
- improvement to source outage records and justification of outage allowances

Southern Region companies should also explore and implement all economic opportunities to minimise the influence of peak demands on the supply-demand balance and the environment.

Between 2010 and 2025

Our longer-term strategy holds an expectation of further environmentally acceptable PWS system integration, optimisation and resource sharing to use forecast surpluses to satisfy deficits.

We anticipate the Bewl-Darwell reservoir system being the principal option for creating new public water supply resource. Enlargement of one of the reservoirs is likely to be needed by 2015, while enlargement of the other reservoir may also be proposed before 2025.

Between now and 2010 we will monitor and review the needs beyond 2010. If high demand growth scenarios materialise or the environment's needs are at or above the highest requirements anticipated, some of the alternative options mentioned above may be required by 2025 in addition to the recommended options. These alternative options must be explored by 2010, and by 2005 where possible, so that the region is in a position to choose between effluent re-use, new reservoirs and strategic transfer into the region, if extra resource proves necessary.

The region's water companies must manage customer demand and leakage now and in the future, but they must also bring forward proposals for resource development where this is appropriate. We expect metering, water efficiency and leakage control to progress over the 25 year strategy period, from the start. But we also encourage early investigation of all options that may be needed in the longer term.

7.2.2 Water efficiency, metering and water-use minimisation

We believe that water efficiency and water-use minimisation should make a significant contribution to effective water resources management over the next 25 years. In this strategy we make a number of general recommendations relating to the efficient use of water in households, industry and commerce.

We believe that there is considerable scope for additional household water efficiency over the next 25 years. Opportunities include:

- per capita toilet use can be reduced by almost 10 l/h/d by introduction of dual-flush or low-flush systems;
- average washing machine volumes can be reduced to 50 litres per cycle;
- average dishwasher volumes can be reduced to 20 litres per cycle;
- use of efficient shower heads/ flow constrictors as part of water audit would limit the impact of the growth of power showers/high-volume showers.

Everyone needs to appreciate the benefits of saving water. Influencing behaviour takes time and effort, and we believe that energetic facilitation is essential. Water companies have a duty to take an active role in this, and the draft Water Bill asks companies to consider water conservation in their own operations (DETR 2000e).

Water Fittings Regulations will continue to be important, as they provide a legal limit on the water consumption of devices and appliances. These are set by government but enforced by water companies. While they have to be set within the context of the European single market, it is important that **Government should keep the Water Regulations under active review to ensure that they make the best possible contribution to efficient use of water and that water companies enforce them actively (Action A2).**

In Southern Region, the Agency will seek out further opportunities to promote sustainable water consumption. We intend establishing a stronger portfolio of independent and collaborative Southern Region projects by early of 2002 and report on their progress and results near the end of 2003. We will look for all ways to influence the implementation of optimum and efficient use of water.

We value the promotion and implementation of water conservation and efficient use that happens in many local authorities. They can continue to play two prime roles:

- We hope they will guide all new developments to be implemented to the highest specification of water conservation and efficient use
- We will invite local authority offices, schools and hospitals to report water savings to the Agency so that their valuable efforts can be used to spur on others. This will also enhance understanding of the further potential. Those not undertaking measures so far should do so.

Similarly we hope regional industry will co-operate to allow the Agency to collate water waste minimisation achievements. The Agency and water companies should ensure that industries that have not carried out water waste minimisation reviews do so.

Metering

We believe that metering can make a significant contribution to the effective management of water resources. Most non-household customers of water companies are already metered and charged for water by the volume that they use. The Agency advocates more use of household metering within a regulatory framework that has regard to the Government's broader social and environmental policies including the protection of vulnerable households.

Metering of households encourages people to consider their use of water, partly by allowing them to understand how much they are using. It raises awareness directly, when the bill arrives. Provided that appropriate tariffs are charged, metering of households encourages high users of water to reduce their water use. In the longer term, it should lead to changes in attitude, so that, for example, when new appliances or bathrooms are needed, people will choose devices that are water-efficient.

There is, of course, a cost associated with the introduction of meters to household water customers. Metering may also enable household customers to benefit more readily from any increase in competition in the provision of household supplies. Charging for metered supplies by tariffs that give incentives to the efficient use of water will also benefit customers who are in a position to save on their water bills by sensible discretionary uses of water. Such tariffs can be designed to aid environmental protection and will also help to manage water resources in the face of climate change. The Agency believes that householders should understand all of the potential benefits in metering for themselves, society and the environment. **The Agency will work with Ofwat, government and the water industry in the provision of accessible information to householders about metering and in the development of tariffs that encourage water efficiency while having regard to the government's broader social and environmental policies (Action A11).**

Existing legislation means that the extension of household metering will occur gradually. One of the significant barriers to the growth of metering was removed when the Water Industry Act 1999 introduced the right to free meter installation for households. Almost all new homes are fitted with meters, because for these homes it is not possible to charge for water on the basis of rateable value. All further new homes should have meters.

We believe metering should reach between half and three-quarters of households across Southern Region by 2025. By making it normal for water use to be measured, a culture of awareness will be developed. This will place the region in a strong position to face the challenges of the future, including societal and climate change and it can contribute to, or be driven by, competition in the water industry. **Water companies should take a positive attitude towards targeted household water metering where this is appropriate and where opportunities arise (Action A12).** These opportunities include new homes, changes of occupancy, unattended sprinkler users and targeted metering of potentially large water users.

In certain locations where water is particularly scarce we advocate higher levels of metering. The water companies involved would need to seek the formal designation of supply zones as water scarce areas. Folkestone and Dover Water may need to consider this approach. Other parts of Kent, East Sussex and perhaps West Sussex might also take this course in the medium term if, or in case, other options prove unsatisfactory.

With the limited water resources availability in Southern Region, efficient water use is essential if supply-demand balances are to be maintained, the environment is to be protected and water resources management is to contribute to sustainable development. Metering can be argued to produce water savings in its own right, so can other water efficiency measures. However, our strategy does not rely on the summation of the potential savings from metering and those from water efficiency promotion. Rather our strategy anticipates overall savings from these measures of up to 75 Ml/d by 2025, distributed across the region, but with the greater portions in areas with tighter supply-demand situations or environmental concerns.

Industry

In England and Wales, about a third of the water supplied by water companies goes to commerce, industry and agriculture. Almost all of this use is metered, but many independent studies have shown that there is considerable scope for reducing water use. Many industrial and commercial users could make changes to their use of water that would reduce their consumption and effluent discharges, and therefore their water bills. We propose simple water efficiency measures that generally would pay for themselves in less than one year. However, the uptake of schemes for

water conservation has been slow. We have calculated that water conservation in commerce and industry using public water supply can save up to 15 Ml/d over the next 25 years in Southern Region. It is essential that this saving is delivered and maintained to protect the environment and to secure appropriate water use for everyone. We recommend the further implementation of water conservation schemes across industry and commerce as a low-cost and effective contribution to managing water resources over the next 25 years. **Water companies should actively promote this among their industrial and commercial customers in compliance with their statutory duty to promote efficient use of water (Action A3).**

Water efficiency is important in all sectors that use public water supply. To deliver the savings that we propose in this strategy will require widespread adoption of water saving techniques. This can be achieved by building on water companies' water efficiency plans, and publicity campaigns such as DETR's "Are you doing your bit?". **Ofwat, Government, water companies, trade associations and the Agency should vigorously promote water efficiency. They should also monitor the results of this work. (Action A4).**

The Agency's National Water Demand Management Centre will continue to support and encourage water efficiency initiatives. **The Agency will work with water users and water companies to ensure that water efficiency is delivered. (Action A5).**

Both increased competition in the water industry and future restructuring of water companies could play a part in determining how the efficient use of water develops. We consider it essential **that the Government should ensure that any steps towards competition and restructuring maintain and encourage the efficient use of water resources (Action A6).**

7.2.3 Leakage

Over the last five years, progress in leakage control has been rapid, with all water companies committed to maintaining or reducing current levels. Much of the reduction in leakage has been as a result of Government initiatives and the establishment by Ofwat of mandatory leakage targets.

The calculation of appropriate leakage targets is complicated, because it depends on an understanding of the cost of leakage control effort as well as the cost of alternative options. Water companies' performance on leakage control is a matter of public interest, but some of the relevant information is not in the public domain. **The Agency will seek better access to information on leakage and leakage-control (Action A7).** Government, Ofwat and the Agency are working together on a tripartite project to examine ways of progressing with leakage management. Such co-operative action should be instrumental in further enhancing opportunities for leakage control.

In compiling this strategy, we have had to take an informed view on how leakage can be managed over the next 25 years. We believe that further progress on leakage control is appropriate across Southern Region. This will provide environmental protection by preventing the waste of valuable water resources and reducing the need for new resource development. For planning purposes, we have identified a level of leakage that would be achievable with the application of today's best practice and most advanced technology (Appendix 4). While it would be expensive to achieve widespread Gamma scenario leakage savings immediately, we have assumed that this represents a reasonable goal for leakage in 25 years time. Achieving progress towards this level will require concerted effort by the water industry, Ofwat, the Agency and Government. Our strategy assumes 75% of the total regional Gamma scenario savings will be achieved, acknowledging some uncertainty in achieving the full scenario. If this progress is not achieved further demand management or resource development will be necessary. If the full scenario can be achieved other investment and abstraction impacts can be saved.

Leakage control can contribute significantly to balancing supply with properly managed demand. It is effective across the range of societal and climate scenarios. It lies firmly within the control of the water industry and its regulators. **To deliver the leakage savings proposed in the strategies, the water industry should continue to develop and implement new and better methods of leakage control (Action A8).**

In one of our scenarios, we see increasing leakage. This is a warning that effort in leakage management must be maintained; without measurement, control and targeted activity, leakage could start to rise. We consider that the present process of setting leakage targets has been both necessary and successful. In Southern Region any rise in leakage is environmentally unacceptable. **The system for setting annual leakage targets should be maintained and developed (Action A9).** The draft Water Bill proposes that the Secretary of State or the National Assembly for Wales should be able to set

standards of performance that could apply, for example, to setting leakage targets. **The Agency will continue to explore with Government, Ofwat and others how the current regulatory framework and the new legislation proposed in the draft Water Bill can assist in achieving good leakage control (Action A10).**

There are a few parts of England and Wales where leakage reduction beyond present targets is unlikely to be essential. We propose that water companies in these areas must not let leakage rise and so will need to maintain leakage control, taking advantage of any new technical developments which may present opportunities for further reductions.

7.2.4 Conclusion

Our strategy for public water supply is based on the best information available to us about different options. As more details emerge, other options may appear to be favourable. Water companies will need to make their own commercial decisions about how they will manage their water supplies. This will involve detailed studies of timing of need, feasibility, cost and environmental impact.

7.3 Agriculture

We indicated in chapters 3 and 5 some of the broad uncertainties facing farming over the next 25 years. In particular changing economic frameworks and global warming may make for substantial change. Agricultural demand for irrigation is likely to increase.

Cost of irrigation will be critical. Large joint schemes requiring substantial pipework and pumping are unlikely to be economic; therefore agricultural demand for water will remain essentially a matter needing local solution. Our resource availability review has highlighted the difficult situation across much of Southern Region, but does not rule out small scale licensing opportunities at a local level, although further licensing must be efficient. Existing abstractions will also be reviewed in this context.

The Agency will encourage farmers to adopt good practice in water use around the farm (Action A14). We will work in partnership with NFU, central Government and the National Assembly of Wales. This needs to allow for radical changes as well as adjustments between traditional food crops. **The Agency will continue to work with agriculture to develop indicators of good practice in water use (Action A15).**

The Government has said that it considers that the Agency should use its own existing powers to apply abstraction licence conditions in order to deal with profligate water use. The Agency will develop licence conditions accordingly; one possibility may be a condition requiring abstractors to seek regular certification that their processes have undergone a water waste minimisation audit. Conditions could be included in new licences; we will want to see existing licence-holders co-operating voluntarily with similar good practices.

However our conclusion more generally is that the farming industry must review its own resources. Water needs to be recognised in many farming areas as a scarce, maybe limiting resource. The Agency's recent R&D project entitled "Optimum use of water in industry and agriculture dependent on direct abstraction" (Agency 1998a) should assist farmers. **We consider that farmers should actively seek ways of minimising their water use (Action A16).** To help with this, farmers could consider the installation of meters to help them to understand better their use of water around the farm.

Traditional methods, in particular individual or joint development of winter storage can provide reliable supplies in some places. This is particularly relevant across Southern Region. Many farms already have winter storage reservoirs that allow water to be stored in times of surplus and used for irrigation during the summer. These provide more security of supply than direct surface water abstractions, but are relatively expensive. **Farmers should consider working together to develop schemes that can be shared by several farms (Action A17).** In some parts of the country, grants may be available from MAFF under the Rural Enterprise Scheme for the construction of water storage facilities and the provision of associated equipment.

The trading of abstraction licences can be of particular benefit to agriculture. Farmers may be able to acquire access to additional water without affecting the natural environment. An individual farmer holding an abstraction licence may find that a neighbour values use of some of his licensed abstraction more highly than he himself; in such a circumstance, a trade would make sense to both. **The Agency will assist trading of abstraction licences between abstractors, provided the trade is not doing any harm to the environment (Action A18).** We believe that this means trades that are for essentially the same body of water. **We recommend that farmers should consider the possibility of trading of abstraction licences to meet their needs (Action A19).** Trading can take place now,

but provisions in the draft Water Bill would facilitate it. The Government proposed other facilitation measures in its April 2000 consultation paper on economic instruments in relation to water abstraction and its decisions on those are expected early in 2001.

7.4

Industry and commerce - direct abstraction

Some industrial and commercial users of water have already reaped reward from minimising water waste. Many others can still save water and money. This applies to both industrial and commercial public water supply and direct abstraction. We anticipate a fuller uptake of water waste minimisation by industry and commerce. We have assumed direct abstractors can save 15 Ml/d by 2010 and a further 15 Ml/d by 2025.

As for agricultural abstractors, the Agency will develop licence conditions to deal with profligate water use and hopes that existing licence-holders will co-operate voluntarily with similar good practices.

7.5

Environment

A fundamental aim of our strategy is to redress any abstraction that is proven to be damaging although, if in doubt, we will apply the precautionary principle. To help secure protection of the water environment, we also aim to recover any unused licences or portions of licences to correct past over-licensing. This will also simplify the resources balance and clarify the potential for new licensing across all sectors of abstraction.

The Agency will be pro-active to reduce licensed abstractions which are:

- under-utilised
- causing environmental problems
- in excess of the available resource
- threatening to cause environmental problems if fully utilised.

The Agency recognises the need to improve knowledge of resource availability and particularly the proportion of the total resource that is needed to sustain the environment. This will be a high priority for the Agency but will require several more years of study and monitoring before conclusions can be drawn. We believe that the development of CAMS will help us identify available resources, vulnerable resources and

Swanbourne Lake: changes to abstraction licences will protect this popular location

any unsustainable abstraction. Proposals to reduce or revoke existing abstractions or licences will have to consider any knock-on consequences for other catchments if replacement abstraction is sought.

We have outlined our perception of need and means of addressing them in section 5.4

The Agency will work to clarify environmental needs, paying particular attention to those areas identified as in need of remediation or investigation in chapter 4. **We will seek the co-operation of others, including environmental organisations and abstractors, in identifying the actions that are needed to improve the water-related environment in these areas (Action A22).** We will expect co-operation from relevant abstractors in implementing appropriate solutions.

The Agency will promote greater understanding of the value of the water environment, by providing clear information to the public on how water use affects the natural environment (Action A23).

7.6

Navigation

Ensuring that water levels are maintained for navigation requires sufficient water. In some catchments this is a significant demand. **Navigation authorities should consider whether boating demand will increase their need for reliable water resources. If it will they should prepare to identify and justify schemes to provide more water within the expected new legislative framework (Action A24).**

7.7 Transfers

Cross-catchment transfer of water features in our strategy and we see scope for further proposals, particularly as bulk supplies of treated water. **We will encourage the development of more local transfers of raw or treated water to meet particular circumstances, provided that they take account of the needs of the environment and other users (Action A25).** However, a transfer of any type may be limited by its effect on the receiving water, both in terms of its flow regime and quality.

The compatibility of chemistry of donating and receiving waters is important, even in considering piped treated water transfers. If transferring raw water, compatible ecology must be a consideration where the natural environment is used in transfer. There can be merit in flow augmentation, but water quality and ecology must be safeguarded. There are particular concerns over the movement of alien species and of plant, animal and fish diseases between different river habitats. Energy costs and other operational aspects also need to be part of overall appraisal. Overall costs and impacts must also be considered in comparison to other options.

Further review of longer-term strategic resource development options is needed and in Southern Region, the Agency should particularly explore deployment of their benefits across the region. This applies to the deployment of potential new reservoirs and strategic transfers into the region.

7.8 Overarching issues

In this section, we consider some options generically, ensuring that cross-boundary or cross-sectoral possibilities are explored.

The Agency believes that the legal, institutional and financial framework for water resources management should support sustainable development and the sustainable use of water. The present system contributes to this aim, its inevitable tensions creating an effective check on tendencies to move towards extremes. First in "Taking Water Responsibly" (DETR and Welsh Office, 1999) and more recently in the draft Water Bill (DETR, 2000e), the government has set out its intentions in various ways to improve water abstraction licensing and related issues.

However, there are several issues that require further attention.

7.8.1 Access to information

Access to information is essential to ensure that best practice can be shared, and the open exchange of views promotes confidence that the management of resources is being carried out to best effect. While some progress has been made on information exchange, much water company information is not in the public arena and some is not available to the Agency. In particular, there is a need for clear information on leakage control methods and their costs, and the effectiveness of water efficiency measures. Measures proposed in the draft Water Bill promise to improve this situation.

7.8.2 Further integration of the water resources planning system

The Agency will work with Ofwat towards further rationalisation of the ways that we each seek water resources information from water companies (Action A26). Links beyond those directly associated with water management are also important. Local planning can significantly impact on water resources. New developments need water; as the Government's recently revised PPG11 and PPG12 (DETR, 2000f and DETR, 1999d) make clear, their timing in relation to water supply developments should be a consideration in the planning system. In Southern Region we think it particularly important to include water demand, water supply, water resources, and related environmental issues within the planning processes. We hope to facilitate a more advanced and open state of knowledge and debate about water resources options.

In Southern Region it is essential new developments are as water efficient as possible. There are often opportunities for water efficiency measures to be incorporated at low-cost at the design and planning phase. **The Agency will work with planners to identify opportunities for water efficiency in new developments (Action A27).** We can ensure that new homes are water-efficient by making this a condition of planning consents; installing water-efficient devices and appliances in new buildings will further water conservation with no disruption to lifestyles or commerce.

7.8.3 Time taken for the development of major new schemes

Experience in recent decades indicates that 15 to 20 years might elapse from the initiation of a large water

resources scheme (such as a surface reservoir) to its readiness for use, of which only some five years would be construction time. Any significant scheme deserves major public scrutiny, but it would reduce uncertainty if some way of accelerating the process could be found. **The Agency will work with Government to identify opportunities for streamlining the process of approval for essential water resources development while maintaining full public accountability (Action A28).**

7.8.4 Water efficiency body

We need people to understand the importance of saving water in their homes and in their businesses. Saving water needs real encouragement, especially in industry and commerce, but also in farming and in the home. We think that the best way to achieve this is through an independent organisation specifically funded for this purpose. This could involve either the development of a new body or an extended role for an existing organisation. The organisation would undertake promotional work and the active identification and implementation of water efficiency measures. It would need a secure funding base: possibilities for exploration, depending partly on its ultimate remit, might include the water sector; or a small levy on all abstractors through the abstraction charging scheme. **The Agency will seek views from Ofwat and Government departments, the water industry, farming and industrial organisations, and environmental and consumer groups. If we find support for this idea, we will encourage its further development (Action A29).**

7.8.5 Further research and development

The thinking that has gone into developing our strategies has inevitably thrown up a range of issues where we do not currently have enough information or understanding.

Issues include:

- Environmental requirements of plant and animal species – there is scope for further work on the requirements of different species and species assemblages.
- Implementation of recent work on reconciling surface and groundwater resource yields – this would improve future plans.
- Impact of land use changes, including forestry, on water availability and on atmospheric flows.
- The use and economics of introducing drought-tolerant varieties and cropping systems into agriculture.
- Cultivation and land-management techniques that improve the retention of water in soil, modifying catchment response to floods and droughts.
- Impacts of climate change on demand for water – the DETR study (Climate Change and Demand for Water) will develop new methods of assessment, but these will need to be applied across England and Wales.
- Impact of climate change on water availability – improved climate change scenarios and related information should enable more detailed assessments at regional and local level.
- The impact of extreme events on resource availability – further work is essential to consider the security of supply systems.
- The acceptability and effectiveness of customer restrictions – more understanding of the effect of, for example, hosepipe bans on demand is necessary.
- Components of per capita consumption – more work is necessary to understand the drivers of individual components of water use.
- Garden watering – to help predict how and when gardeners will use water.
- Population projections – a source of uncertainty, with different organisations working with different information; a working group on population projections would help the water resources planning process.
- Impact of price and tariffs on domestic and industrial demand – more development work would help our understanding.
- The evaluation of costs and water savings of demand management options.

The Agency will work with others to prioritise and take forward appropriate research and development (Action A30).

7.9 Conclusion (sustainability appraisal)

There are many benefits associated with this strategy. It provides a robust series of actions that help to ensure that adequate supplies of water are available across all sectors. Many of the actions that we recommend produce useful benefits in almost any circumstances.

Our strategy also shows that we can manage water resources over the next 25 years or so in a way that will allow an improvement to present levels of environmental protection.

Development options and demand management options all require actions if they are to deliver the full benefit of the scheme. Some actions need to be started considerably in advance. For resource schemes, there are many stages that must be completed before construction begins, and these must be planned in good time. Demand management savings may also take some years to achieve. Business plans for water companies, commerce and industry and agriculture should all take account of these time constraints.

For each option, we have considered environmental implications. But any additional abstraction of water from the environment has the potential to pose a threat to habitats and therefore to plant and animal species. All schemes need further investigation, and alternative schemes should be evaluated using similar criteria.

We recognise that costs will influence the delivery of any strategy and we have taken likely costs into account in considering different strategy options. However we have not calculated in detail the financial cost of this strategy. It will be for the organisations who promote schemes in line with this strategy to assess their costs and value for money, and to justify them on that basis. Where the Agency itself needs to take action to help realise the strategy, it is of course duty bound to consider the costs and the benefits of its proposals.

Our strategy provides significant environmental benefits in those areas indicated as potentially over-licensed or over-abstracted in Sections 3.5 and 4.1 We have used sustainability appraisal through the development of this strategy to help to ensure that it contributes to the four aspects of sustainable development. The appraisal has been carried out by the independent consultants ERM, employed by the Agency for this purpose. ERM found that the contribution to sustainable development is generally positive:

Prudent use of resources is clearly promoted by strong emphasis on:

- demand management measures, waste minimisation and leakage savings;
- improving infrastructure to link surplus and deficit resource zones within the region;
- increasing supplies from existing local water sources within their existing licence conditions;

Table 7.2 **Sustainability appraisal of Southern Region recommendations**

Sustainability Themes								
Southern Region recommendations	Effective Protection of the Environment		Prudent Use of Natural Resources		Social Progress which recognises the needs of everyone		Maintenance of high and stable levels of economic growth and employment	
	Positive impact	Negative impact	Positive impact	Negative impact	Positive impact	Negative impact	Positive impact	Negative impact
A. Enhancement of local sources	+	(-)	+	0	0	0	+	0
B. Further integration of PWS systems	+	(-)	++	0	(+)	0	+	(-)
C. Multi-company sharing - includes the Bognor Regis to Hardman transfer	+	-	+	-	+	(-)	+	-
D. Enlargement of Bewl or Darwell reservoir	+	-	+	0	0	(-)	+	
Household water use savings	+	0	+	0	+	(-)	+	-
Gamma leakage savings +	(-)	++	0	+	0	+	(-)	
60% voluntary	+	0	+	0	+	(-)	+	-
95% compulsory	++	0	++	0	+	- -	++	-
Industrial water use minimisation	+	0	++	0	0	0	+	0
Winter storage for agriculture	(+)	0	++	0	+	0	+	0

Key:

++ = very positive impact
+ = positive impact
(+) = slight or indirect positive impact
0 = the option is neutral
-- = very negative impact
- = negative impact
(-) = slight or indirect negative impact

- plans to reduce abstraction and recover abstraction licences.

These actions will also provide clear benefits in terms of environmental protection.

There are potential environmental impacts associated with the improvement of pipework infrastructure and development of the Bewl and Darwell reservoir system. However, it may be possible to mitigate these impacts through effective design and the implementation of controls.

The strategy also contributes to both social progress and maintenance of economic growth. There may be some short term costs and social impacts associated with leakage savings and compulsory metering (though some people will receive benefits from metering), but these impacts may be offset by the prudent resource use and environmental protection benefits of these measures.

8 Actions and the way forward

In this strategy we have described the framework for the management of water resources, the pressures that we expect, and the conclusions that we have drawn. Here we summarise our recommendations and look at the way forward.

8.1 Overview

This strategy is designed to offer a framework for decisions and actions that are needed to manage water resources over the next 25 years or so. The strategy sets out our expectations of others, and should guide all stakeholders as to what they can expect from the Agency. In the strategy, we have considered the sometimes conflicting elements of sustainable development and the substantial uncertainties about the future. We have allowed for uncertainty by using a scenario approach. As our understanding of climate change and societal trends develops we will be able to refine our conclusions. However, until significant change from our assumptions or analysis is apparent, we believe that this strategy provides a sound basis for water management in Southern Region.

The conclusions we drew in chapter 7 will require action and commitment from various parties if the vision we have set down is to be achieved. Inaction would increase risks unacceptably; and action that conflicts with our strategies would need particularly good justification to convince the Agency and, we believe, others. In particular, we will not expect to grant new abstraction licences unless they accord with the strategy or show convincing arguments why they do not.

In this chapter, we set out our recommended national actions. Some of the outcomes will not be achieved easily; they will require energy and commitment from various players. In the area of water use minimisation, we consider that some institutional facilitation may be required to deliver the undoubted benefits. Enactment of legislation proposed in the draft Water Bill will also help materially.

Working together will be the key to delivering the sustainable development of water resources. We will work to ensure that institutional structures and legislation assist effective water management. Chapter 7 indicated a number opportunities for research and investigation to contribute to better informed decisions during the life of this strategy.

In Table 8.1 we summarise our recommended national actions and the groups that need to be involved. Implementing the regional strategy will make a strong contribution to the national strategy and will involve participation in many of the national actions.

8.2 Future of this strategy

This strategy is the Agency's present considered view of the actions that are required over the next 25 years to ensure the sustainable development of water resources. Some areas need monitoring and further evaluation. We will keep social and climate change scenarios under review, taking into account new information and ideas as they become available.

We will publish an annual bulletin reporting on progress against this strategy. We plan to review the strategy completely in a few years.

8.2.1 Working together

We believe that this water resources strategy provides the required framework for meeting the many challenges that lie ahead in Southern Region. We now look forward to working closely with water companies, local authorities, planning bodies, and environmental organisations to secure sustainable water supplies for both society and the environment.

Table 8.1 **Actions**

Action Ref	Action	Agency	Water companies	Agriculture	Industry	UK Government and NAW	Ofwat	Planning bodies	NGOs and others
A1	Where new or existing developments are not fully utilised water companies should consider sharing this water with others.		✓						
A2	Government should keep the Water Supply (Water Fittings) Regulations under active review to ensure that they make the best possible contribution to efficient use of water and that water companies enforce them actively.		✓			✓			
A3	Water companies should actively promote waste minimisation schemes among their industrial and commercial customers in compliance with their statutory duty to promote the efficient use of water.		✓		✓				
A4	Ofwat, Government, water companies, trade associations and the Agency should vigorously promote water efficiency to all sectors and monitor the results of this work.	✓	✓			✓	✓		✓
A5	The Agency will work nationally and locally with water users and water companies to ensure that water efficiency is delivered.	✓							
A6	Government should ensure that any steps towards competition and restructuring maintain and encourage the efficient use of water resources.					✓			
A7	The Agency will seek better access to information on leakage and leakage-control.	✓							
A8	The water industry should continue to develop and implement new and better methods of leakage control.		✓						
A9	The system for setting annual leakage targets should be maintained and developed.	✓				✓	✓		
A10	The Agency will explore with Government, Ofwat and others how the current regulatory framework and the new legislation proposed in the draft Water Bill can assist in achieving good leakage control.	✓				✓	✓		
A11	The Agency will work with Ofwat, Government and the water industry in the provision of accessible information to householders about metering and in the development of tariffs that encourage water efficiency while having regard to the Government's broader social and environmental policies.	✓	✓			✓	✓		
A12	Water companies should take a positive attitude towards targeted household water metering where this is appropriate and where opportunities arise.		✓						
A13	The Agency will seek to identify opportunities to make water available for agricultural purposes from existing and new developments.	✓		✓					
A14	The Agency will encourage farmers to adopt good practice in water use around the farm.	✓		✓					
A15	The Agency will work with agriculture to continue to develop indicators of good practice in water use.	✓		✓					
A16	Farmers should actively seek ways of minimising their water use.			✓					
A17	Farmers should consider working together to develop schemes that can be shared by several farms.			✓					
A18	The Agency will assist trading of abstraction licences between abstractors, provided the trade is not doing any harm to the environment.	✓							
A19	Farmers should consider the possibility of trading abstraction licences to meet their needs.			✓					
A20	The Agency will seek dialogue with supermarkets and food processors to encourage greater understanding and consideration of the impact of their crop requirements on farmers' use and management of water and of the consequences for the water environment.	✓							✓

Table 8.1 **Actions** *continued*

Action Ref	Action	Agency	Water companies	Agriculture	Industry	UK Government and NAW	Ofwat	Planning bodies	NGOs and others
A21	The Agency will approach proposals for hydropower schemes positively and work constructively with the developers to achieve viable schemes.	✓							
A22	The Agency will seek the co-operation of others, including environmental organisations and abstractors, in identifying the actions that are needed to improve the water-related environment in relevant areas.	✓	✓	✓	✓		✓		✓
A23	The Agency will promote greater understanding of the value of the water environment, by providing clear information to the public on how water use affects the natural environment.	✓							
A24	Navigation authorities should consider whether boating demand will increase their need for reliable water resources. If it will they should prepare to identify and justify schemes to provide more water within the expected new legislative framework.								✓
A25	The Agency will encourage the development of more local transfers of raw or treated water to meet particular circumstances, provided that they take account of the needs of the environment and other users.	✓							
A26	The Agency will work with Ofwat towards further rationalisation of the ways that we each seek water resources information from water companies.	✓					✓		
A27	The Agency will work with planners to identify opportunities for water efficiency in new developments.	✓						✓	
A28	The Agency will work with Government to identify opportunities for streamlining the process of approval for essential water resources development while maintaining full public accountability.	✓				✓			
A29	The Agency will explore with others the idea of an independent water efficiency body; if we find support, we will encourage its further development.	✓							
A30	The Agency will work with others to prioritise and take forward appropriate research and development.	✓							

Appendix 1
Climate change

A1.1

Overview

There is mounting evidence that our climate is changing as a result of man-made atmospheric emissions. The DETR's UK Climate Impacts Programme (UKCIP) has reported that UK temperatures have increased by about 0.7°C over the last 300 years, with about 0.5°C of warming during the twentieth century. This is part of a world picture of warming. Globally, 1998 was the hottest year since records began in the middle of the 19th century. It is thought that the 1990s may have been the warmest decade of the last millennium.

There is evidence that at least some of this change is the result of human action. Since the industrial revolution, the concentration of greenhouse gases in the atmosphere has increased, and by changing the atmosphere, we have changed the climate. Experts predict that the changes in climate will continue through this century. There is more confidence in some aspects of climate change than others. For example, the effect of a given change in carbon dioxide concentrations on sea level rise and global temperature increase is reasonably well understood.

This appendix looks in detail at the possible effects of climate change on water resources, and considers the role of adaptation in the planning of water resources.

A1.2

Climate change predictions

Predicting future climate change is difficult. In 1998, UKCIP published four scenarios for climate change. These are based on modelling carried out at the Meteorological Office's Hadley Centre and the Climate Change Unit at the University of East Anglia (Hulme and Jenkins 1998), and make different assumptions about the proportions and effects of different greenhouse gases. The scenario approach was taken in recognition of the uncertainties associated with climate change prediction. In summary, all of these scenarios suggest that by the 2020s throughout southern and midland England and all of Wales, there will be more winter rainfall and less summer rainfall. The decrease in summer rainfall is more marked in the south and east of the country. Under all of the scenarios, northern England would receive more rain in winter and about the same volume in summer.

The interpretation of such results is difficult. The climate is naturally variable; water availability in the 2020s may differ from the present situation simply because of climatic variability. Climate change is superimposed on this natural variability. The result may either magnify or reduce the effect of climate change. Work carried out for the Agency by Arnell (1999) shows that changes due to climate change are systematic, with greater effects in the south than in the north. There is also evidence that climate change may increase the year to year variability of rainfall. Effectively this means that the climate will be less predictable, with both more dry years and wet years. This in turn means that low flows could occur more often. However, it is unlikely that summers will be any drier than the extremes observed in previous decades. Evidence about the possibility of longer droughts is unclear; the best available view appears to be that the increased variability makes droughts that last over several years slightly less likely. While climate change prediction is inevitably uncertain, our understanding of changes in extreme events is even more limited than that of changes in average climate.

Over the next few years, we expect that the understanding of climate change will improve. It is most likely that this will involve refining existing results, adding detail and reducing uncertainty in the present scenarios. However, it is quite possible that new predictions could be quite different from those that we have now. It must also be acknowledged that we do not understand fully all of the possible effects of global warming. For example, it has been suggested that there could be a change in the behaviour of the Gulf Stream, resulting in the cooling of north-western Europe. While the best available information suggests that this is not likely, we must be aware that present assessments may change. We cannot rely on their accuracy, which means that we need ways to deal with climate change that are flexible. However, we must balance our concern about the possible effects of climate change against other

potential changes, and produce a measured response that allows society to adapt to accommodate the new climate as it evolves.

A1.3

The impact of climate change on water resources

Climate change has an effect on three elements of water resources planning:

- Demand for water;
- Availability of water;
- Impact on the natural environment.

Demand for water

Climate change will affect the demand for water in many different ways. Our understanding of the relationship between weather and water use is not perfect, so it is not possible to be absolutely certain about how climate change will affect demand. DETR has commissioned a study from the Environmental Change Institute at the University of Oxford to investigate the impact of climate change on domestic, industrial and agricultural water use. This will report in 2002. For this strategy, we have used the best information available at present.

Household water use is likely to be increased by hotter summers. This water will be used for increased garden watering and additional personal washing. The definitive study looking at this was carried out by Herrington (1996). This additional water use is predominantly driven by temperature. While Herrington's work did not use the UKCIP climate change scenarios, it provides a reasonable first estimate of the effect on domestic demand. We have applied the appropriate factors to household consumption for the Beta scenario to calculate an incremental demand as a result of climate change. Our calculation is based on the probable increase in garden watering, as this scenario already includes increased personal washing. Of course, under different Foresight scenarios society would respond to climate change in different ways. It would be possible to make an assessment of the different impact on garden watering in different scenarios. However, the quality of the data on changes in water use is poor, and does not warrant such sophistication. We have applied the value calculated for the World Markets scenario to the other scenarios as well. This is a precautionary assumption, as this scenario represents a worst case and it is anticipated that outdoor water use under the other scenarios would be lower. We have added this climate change demand to the incremental demands for each scenario. The total effect on public water supply demand nationally is about 180 Ml/d for 2025. This impact is distributed so that it is greater in the south and east than in the north. In the Southern Region, this has a total effect on public water supply demand of 16 Ml/d by 2025.

The impact of climate change on industrial water use is more problematical. Given the diverse range of industrial uses of water, vulnerability to climate change is likely to vary considerably between sectors. We can identify two possible areas where climate change may have an effect: in the demand for specific products and in the efficiency of some industrial processes. Consumer demand for some products is sensitive to temperature fluctuations; this has a particular impact on the food and drink industry. Some industrial processes such as cooling may become less efficient with higher temperatures, leading to a greater demand for water. The precise nature of these changes is unclear. For the purpose of this strategy, we have assumed that our forecasts of industrial demand do not need to be modified to allow for climate change over the next 25 years. We will review this when the results of the DETR study are available.

Climate change will certainly have an effect on agriculture. It will affect not only planting and harvesting dates, but also the varieties of crop that are grown and their distribution across England and Wales. Climate change may allow an extension of the area given to crops that are presently marginal, such as lupins, sunflowers and navy beans. In combination, these changes will influence crop water requirements and irrigation need.

Livestock production systems will also be affected by higher temperatures, with increases in animal drinking and water wallowing sites for outdoor pigs. For indoor livestock units there may be a requirement for cooling, adding an additional demand for water.

To provide indicative estimates of the potential impact of climate change on current optimum irrigation needs, we commissioned Cranfield University at Silsoe to develop and apply a new methodology. This builds on the concept of agroclimatic zones, defined as areas with common climatic conditions that will lead to similar crop growth patterns. The analysis indicates that for the eight crops studied, optimum irrigation need would increase at the six study sites considered. The magnitude of the increase varies quite markedly in relation to the climate change scenario. For example,

for main crop potatoes in Norfolk, the increase above current optimal levels is between 5 and 14 per cent. The DETR study on the demand for water will build further on our preliminary results.

Over the next 25 years, climate change will be one of many challenges facing agriculture. Other factors could include reform of the Common Agricultural Policy (CAP) and increased globalisation of the market for agricultural produce, as well as changes in consumer preferences. It is within this context that the impact of climate change on spray irrigation demand should be assessed.

Other factors that influence demand may be affected by climate change. For example, higher winter temperatures may mean less frost-heave and therefore lower winter mains burst rates. However, the impact of such effects is probably small and at present almost impossible to quantify. Ignoring such secondary factors is reasonable in the context of this strategy.

Availability of water

Changes in climate will change flow regimes and therefore the availability of water for abstraction. All of the current UKCIP scenarios suggest on average more annual rainfall throughout England and Wales, with less summer rainfall in the south. Higher temperatures mean that potential evaporation rates will probably increase.

Work carried out by Arnell (1999) has looked at the effect of the four UKCIP climate change scenarios on river flows. The impact varies according to location and the underlying rock type. For rivers dominated by groundwater, average flows decrease in late summer and increase through the rest of the year. The decrease in late summer flows is greatest in the south and east. Average recharge to aquifers is expected to increase in all scenarios for all aquifer types.

Rivers not dominated by groundwater show a similar pattern, with lower flows in July, August and September throughout England and Wales. However, the decreases are small in the north. Flows increase in the rest of the year in all scenarios, with the increases being lowest in the south.

The implication of this for water users is mixed. As recharge increases everywhere in all scenarios, groundwater abstractions should be at least as reliable as they are now. Abstractions that need summer water will become less reliable through much of England and Wales, as licence conditions that protect low flows become effective more often. This will be a particular problem in the south, and will apply also to rivers dominated by groundwater in this area. However, higher winter flows mean that other abstractions should continue at current levels of reliability. The storage of winter water should be more reliable, with more potential for reservoir filling later into the spring.

The above refers to the average effect of climate change. It implies that climate change can be considered against the long-term average climatic conditions. However, we know that the climate varies naturally from year to year and that the long-term average changes over time. It is also possible that the frequency of extreme events will change: the present UKCIP scenarios suggest more dry summers by 2025 but about the same frequency of dry periods that last more than one year.

This discussion is deliberately very general. Individual catchments respond to rainfall and evaporation in different ways; understanding of the effect of a particular change in climate in a specific location requires detailed catchment modelling.

Different water supply systems will respond in different ways, according both to their physical characteristics and the way in which they are operated. The yield and reliability of public water supply systems depends on the magnitude and duration of dry periods, as well as the frequency of occurrence of such events. The increased variability associated with present scenarios suggests that long dry events will be no more frequent than at present, which implies no change from present yields for large reservoirs and groundwater-fed systems. However, this result is by no means certain.

In this strategy, we have assumed, based on the results from Arnell (1999), that over the next 25 years most public water supply systems will retain their existing yields. This is a reasonably conservative assumption, as most systems depend to a great extent on the storage of winter water either in aquifers or reservoirs. Little analysis exists, but where modelling has been carried out it suggests that most reservoir systems will actually gain a little yield because of the wetter winters. However, some systems do appear to suffer from a reduced yield, emphasising the need to carry out careful investigations of individual systems.

Direct abstractions will become less reliable in summer, which means that farmers and industries that rely on these will have to consider adapting in some way if they wish to maintain current levels of reliability.

The impact on the natural environment

Species and habitat dynamics in the face of climate change is an area that is poorly understood. Wildlife and habitats (including pests and diseases) are expected

to move north and to higher altitudes as mean temperatures rise. One study for the DETR suggests that 10% of the UK's internationally designated areas could be at risk of permanent inundation or gradual loss of conservation value as a result of sea level rise, temperature rise and changes in water availability; water quality changes might exacerbate the situation. We expect that further information and strategies to enable the protection of sensitive species will be developed in the coming years.

Changes in river flows and wetland levels as a result of climate change will have an impact on the plants and animals that rely on the water environment. Some species will be better suited to the new conditions, while others may find it harder to thrive. The water requirements of different species are hard to establish, partly because factors other than water availability determine current species distribution. Many species can tolerate a certain level of stress due to occasional drought.

For this strategy, we will assume that we can protect the future environment by maintaining current levels of protection through the maintenance of existing controls on abstraction, except where we know that these are in need of improvement for other reasons. The environment that we protect will be dynamic, with species changing over time with climate change. This is an area in need of further research and public debate.

A1.4

Adaptation strategies

Given that the climate is changing, all sectors of society and the economy will have to respond to new climatic conditions. Adaptation strategies will be driven both by changes to long term climate and by changes in extreme events. However, the exact nature of climate change is uncertain. This makes it difficult to plan, especially where decisions have to be taken many years in advance. Some decisions may involve significant investment; it is hard to justify expenditure that may turn out to be unnecessary. One of the keys to a successful adaptation strategy is to ensure that it is sufficiently flexible to deal not only with current predictions but at least to some extent with events that are less likely or not foreseen. In the context of water resources strategies, this means that schemes that improve the management of water use or developments that can be phased will be more appropriate than schemes that are inflexible.

The Agency has a significant role in helping to mitigate climate change by regulating major industries that emit greenhouse gases. While water resources has little impact on this, it is important to take into account the energy use of different schemes. Pumping large volumes of water around uses significant amounts of energy, and therefore contributes to total emissions. For this reason, our risk and uncertainty framework and sustainability appraisal both consider energy use.

Climate change is an important element of uncertainty in water resources planning. Over the next 25 years or so, it is not, however, the greatest source of uncertainty in aspects such as water use. Societal values and economic growth will also play an important role. Given the increase in average annual rainfall predicted by the current climate change scenarios, it would be difficult to justify new water resources development solely because of climate change. However, it is important to ensure that any water resources management initiatives consider climate change and the way that they may be affected by different weather conditions. Vulnerability to extreme events is especially important, given that the scenarios include predictions of more droughts with a duration of one year or less. Different sectors of water use are affected by extreme events in different ways. For example, arable agriculture is affected badly by severe summer droughts, but many water supply systems can cope with short periods of very dry weather but are vulnerable to long dry periods.

While all sectors suffer from dry weather, the impact on the availability of public water supply is especially important. Experience during the 1995 drought shows that failures in public water supply would be unacceptable, and that it is essential that we plan to maintain basic supplies through all types of drought. As a result, all water companies have developed drought plans, setting down the steps they will take to maintain supplies as a drought progresses. We reported to government on these in June 2000. In this strategy we prefer options that provide maximum security of supply during different types of drought. Different water company systems have different characteristics, depending for example on the proportion of water stored in reservoirs or taken from groundwater.

A1.5

Climate change in context

Climate change must be considered carefully in water resources planning. However, many other factors affect our use of water and the natural environment. Demand for water may change according to different social and economic factors. The range of possible demands is

much greater than the effect of climate change on water availability. Of course, it is quite possible that the greatest demand could be combined with the worst climate change scenario, and our planning must take this into account. As long-term average water availability appears to change little over even the next 80 years, we must pay special attention to the vulnerability of water resource systems and the environment to more frequent drought events. Unfortunately, information about these is sparse and we must at present plan for these by enhancing flexibility where this is possible and practical.

There is a substantial UK programme to develop further the understanding of climate change. This is being developed through initiatives such as UKCIP and the new Tyndall Centre in Norwich, as well as many individual projects, including some carried out by the Agency. Future work includes assigning probabilities of occurrence to different climate change scenarios, and developing better information on the frequency and magnitude of extreme events such as droughts. DETR is presently running a project to look at the impact of climate change on all types of demand for water, as well as considering strategies for nature conservation in the face of climate change. Other studies focus on reducing the uncertainty in climate change models and developing climate scenarios with higher spatial and temporal resolution for western Europe. The Agency will keep these under review and examine their impact on strategies as appropriate.

Appendix 2

A scenario approach to water demand

A2.1

Overview

This appendix describes how we have used scenarios to consider a range of factors that could affect society's demand for water over the next 25 years. Drawing widely on expertise from within and outside the Agency, including our own National Water Demand Management Centre, we have developed a set of consistent water demand scenarios for the components of public water supply and direct abstraction. This builds on the Foresight "Environmental Futures" framework.

A2.2

The Foresight "Environmental Futures" scenarios and water demand

The Foresight scenarios are intended to define a broad contextual framework of social, economic, political and technological change. Assessment of the impact of these processes on specific sectors of the economy, or particular aspects of the environment, is deliberately general with the intention that experts will add to the framework to develop coherent, sector-specific scenarios. In the case of water resources, Foresight provides a high level, qualitative assessment of the implications for water under each scenario, characterised simply in terms of water demand increasing, stabilising or decreasing (see Table 5.1 in the main report).

Taking this framework as our starting point, we have considered the variable impact that changes in regulation, policy and social values will have on society's use of water. It is conceivable that within the same scenario some components of demand will increase while others decrease. To track such changes and fully illustrate their impact, we have built on latest information and methodologies to develop forecasts of water demand for the following components:

- Household;
- Leakage;
- Industry and commerce;
- Agriculture.

The UKWIR/NRA demand forecasting methodology and subsequent best practice manual identified the key drivers of household, leakage and non-household or industrial water demand. The drivers of spray irrigation demand have been assessed in the Agency's "Optimum use of water" R&D project.

In developing our forecasts, we have assumed that the key drivers of demand will remain consistent in identity

across all scenarios. This means that we can use a single forecasting model for each component of demand, making different assumptions about rates of change for each scenario.

Within each scenario, the assumptions regarding social, economic, technological and political change across the different components are consistent with the Foresight framework. For example, under Scenario Alpha (Provincial Enterprise) disengagement from international economic trading systems will affect both agricultural and industrial demand for water, by increasing the level of production of certain goods within the UK. The timing of application of such assumptions has been carefully assessed to ensure that each water demand scenario is internally consistent and robust.

The drivers of demand are detailed in Table 5.1 in the main report. They have been broken down by component to reflect the Agency's assessment of how each will vary under the four scenarios. The starting point for each scenario is the same, and the assumptions that have been applied reflect a conservative assessment of likely changes at the micro-component level. The technologies and policies included within the four scenarios are all available within the UK or overseas today. Hence the assumptions are within present bounds of possibility and represent a realistic assessment of likely change.

The methodologies and information sources informing this process are outlined in the rest of this appendix. Each section includes an indication of the scenario outcomes for each component at the national level.

We have adopted a micro-component approach in our household demand scenarios, breaking down consumption into fourteen discrete micro-components (Table A2.1) falling under the eight broad categories identified in Figure A2.1. Such a disaggregated approach enables us to link the scenarios to the key drivers of demand to consider how behavioural factors will influence future water use.

The household demand methodology

To establish base year values for Ownership, Frequency and Volume (OFV) for the relevant micro-components we drew on information supplied by eight of the water companies in their water resource plan submissions. The data supplied by these companies was reclassified into our fourteen micro-component categories. Where OFV data was not available, we developed an analysis based on a socio-economic profile of each water company resource zone.

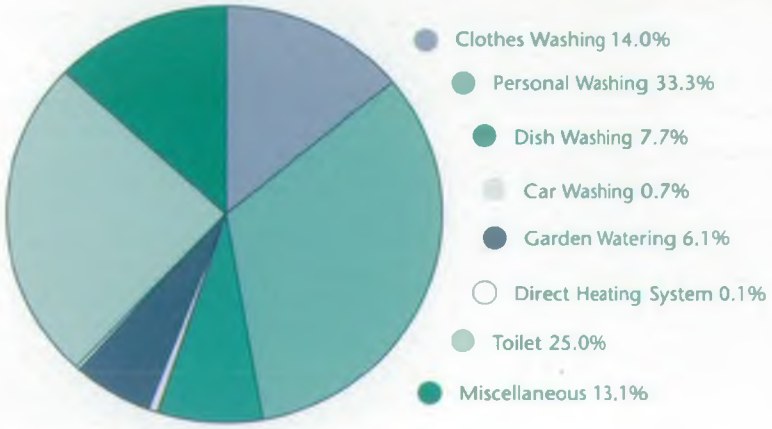
Projections of future changes in OFV values have been informed by a number of sources of information. The OFV values reported in Herrington (1996) have been updated for example in light of changes introduced in the Water Supply (Water Fittings) Regulations 1999. Technological innovation in the volume of water used by white goods and other appliances was assessed by reviewing manufacturers' information, while changes in the rate of uptake of sanitary ware were discussed with representatives from the British Bathroom Council.

Information on garden watering is sparse and often inconsistent. We developed a nationally consistent set of assumptions drawing on information from a number of

Table A2.1 **Household forecast micro-components**

Component	Micro-component
Toilet use	Toilet use
Personal washing	Bath
	Standard shower
	Power shower
	Hand basin
Clothes washing	Clothes washing by machine
	Clothes washing by hand
Dish washing	Dish washing by machine
	Dish washing by hand
Car washing	Car washing
Garden use	Sprinkler use
	Other garden use
Direct heating system	Combination boilers
Miscellaneous	Miscellaneous

Figure A2.1 Micro-components of household demand 1997/98



organisations and equipment manufacturers.

Drawing on all of this information, scenario specific assumptions have been developed for each of the fourteen micro-components to generate an unmeasured per capita consumption for each resource zone.

Metering scenario assumptions

Metering gives customers the opportunity to pay for the volume of water used, offering an element of choice to the consumer and also providing an incentive to manage demand. It is likely that different tariff structures would be developed under different scenarios; we have not considered these in detail because our general assumptions about water use within each scenario have a similar effect. Generalised savings based upon the results of the National Metering Trials have been used to guide our assumptions. The greatest reduction in demand is delivered in Scenario Gamma (Global Sustainability). The proportion of metering also varies across the scenarios to reflect differences in the degree of social acceptability and regulatory influence. This differentiated approach is presented in Table A2.2.

It is essential to note that this table reflects the changes that would happen under certain social and governmental scenarios. For example, the compulsory metering in some scenarios would require a change in the law. The Agency is not seeking or endorsing such a change, but merely illustrating what might develop in some future scenarios.

To complete the forecasts, a nationally consistent population and household data set was obtained from CACI for each water company resource zone for the period from 1997 to 2019, extrapolated to 2025. This data was based on the 1996 population projections (building on the 1991 census information), adjusted to incorporate 1997 mid-year estimates.

Household Demand: Scenario Outcomes:

Scenario Alpha (Provincial Enterprise): Growth in personal affluence is stifled, with the result that availability and take up of more efficient technologies is limited. Replacement of white goods and investment in new water using devices declines, with households preferring to repair existing appliances as necessary. Existing sanitary ware is retained.

Scenario Beta (World Markets): With high economic growth technological innovation leads to improvements in the water efficiency of white goods, average washing machine use reduces to 50 litres by 2025. Discretionary uses of water increase with more power jetters, power showers and swimming pools.

Figure A2.2 Metering assumptions for each scenario

	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Alpha	Likely water company rates following Ofwat final price determination	Continue with rate of metering allowed by Ofwat in 2005 for those companies in the south and east, elsewhere no additional metering			
Beta		Water company rates	Metering to a maximum of 95% of all properties		
Gamma		Water company rates	Metering to a maximum of 95% of all properties		
Delta		Water company rates			

Scenario Gamma (Global Sustainability): By 2010 measures to manage demand within existing regulation are fully implemented. From 2010 revisions to flow and volume limits in regulations provide stricter controls, particularly associated with power showers. New high water efficiency technology is promoted leading to a 15 litre reduction in the volume of water used by washing machines. Given the relatively high rate of growth and affluence, the rate at which consumers replace appliances does not decline markedly. Purchases reflect their positive attitude to the environment with the uptake of more water efficient appliances.

Scenario Delta (Local Stewardship): Consumer attitudes shift markedly with a major impact on water using behaviour. Overall, there is a decline in the use of water for discretionary purposes such as garden watering which declines from 9 l/h/d to less than 3 l/h/d by 2025. There is widespread uptake of demand management measures, and a shift to low water using appliances. Community initiatives become more widespread. Rain water collection for garden watering is the norm where some form of watering is required.

A2.3

Leakage

For our strategy, the formulation of the four leakage scenarios has focussed in particular on the political and regulatory framework likely to influence the setting of leakage targets, and the consequent impacts for total leakage at water company level (Table 5.1 in the main report). High level changes in political and social attitudes will affect the priority given to leakage by government, and therefore will influence the formulation of targets. This in turn will affect water companies' leakage control philosophy and subsequent find and fix activity, pressure management levels, and service and mains replacement rates.

The leakage scenario approach

Our four leakage scenarios reflect differential approaches to setting leakage targets. Three scenarios reflect recent UK and overseas experiences, and draw on information from the recent past to inform the development of company leakage targets. Only one scenario has necessitated detailed modelling, to reflect the impact of new technologies.

The calculation methods and associated timings for each scenario are detailed in Table A2.3.

Scenario Alpha (Provincial Enterprise) leakage assumptions

Given the lack of investment and short-termism that characterises this scenario, leakage levels are forecast to increase in line with the Natural Rate of Rise (NRR). The Natural Rate of Rise relates to the average rate at which leakage rises when a water company practices passive leakage control, when the only bursts that are repaired are the ones reported by members of the public. Lambert et al (1998) recognise that the average rate of rise can vary widely from zero to over 20 litres/property/hr each year.

It is important to note that this leakage scenario would result from a completely different set of values to those that there are held at present. We are not suggesting that present water companies would allow leakage to rise in this way, but that there is a real possibility that this could result from a relaxation of the rules governing leakage in a less regulated scenario. The rate of rise may look extreme. It is possible to postulate a mechanism of relaxed control that allows leakage to rise more slowly but has the same result by 2025, the time horizon of this strategy.

Figure A2.3 Leakage assumptions by scenario

	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Alpha	Ofwat 2000/01 target level	Ofwat 2000/01 target level	Passive leakage control policy		
Beta		Ofwat 2000/01 target level			
Gamma		Apply leakage targets that would be achievable with the application of today's best practice and most advanced technology			
Delta		Ofwat 2000/01 target level	Reduce total leakage by 1% per annum until 10% reached. Then hold at 10%		

Scenario Gamma (Global Sustainability) leakage assumptions

The implementation of improved leakage-control methods forms the cornerstone of leakage targets in this scenario, based on the assumption that techniques currently available are developed slightly. We have identified a level of leakage that would be achievable with the application of today's best practice and the most advanced technology. This is described in detail in Appendix 3.

Leakage: Scenario outcomes

The national leakage scenario outcomes are shown in figure A2.4 and described below.

Scenario Alpha (Provincial Enterprise): This is a low growth, low investment scenario in which short termism predominates. government regulation of the water industry is very weak, with no political commitment to sustainable development. Investment in leakage control is curtailed.

Scenario Beta (World Markets): The water industry is subject to light levels of regulation. Given the primacy of market forces, leakage targets are not considered necessary, as the need to be competitive is assumed to promote sufficient incentive. Leakage control is not perceived as a critical issue in maintaining public water supplies. Although there is a slight deterioration in system leakage this is balanced by improvements in supply pipe leakage achieved through universal metering.

Scenario Gamma (Global Sustainability): Sustainable development is accorded high political priority, with the water industry subject to strong regulation to protect and enhance the environment. There is rapid technological innovation, with government placing a high priority on research and development. The leakage target setting process reflects innovative technical solutions.

Scenario Delta (Local Stewardship): Leakage control is given high priority, although this is inhibited by the decentralised system of regulation. Capital constraints curtail investment in R&D slowing development of innovative leakage control technologies. Leakage targets are based on a political judgement that 10% of water put into supply is an appropriate level.

A2.4

Non-household and Primary Industry demand

Each of the drivers of non-household demand identified in Table 5.1 (in the main report) play a critical role in shaping the use and management of water within industry.

To address these issues and avoid applying blanket assumptions, two key distinctions are drawn in our forecast model. Firstly, to allow application of sector specific assumptions, the forecast has broken down water consumption by industrial sector. Linked to the Standard Industrial Classification, we have broken down public water supply non-household demand into 19 sectors, while direct abstraction includes 11 sectors. Second, we have drawn a distinction between Small and Medium sized Enterprises (SMEs) and large companies to reflect variability in the level of uptake of water use minimisation options.

Forecast methodology

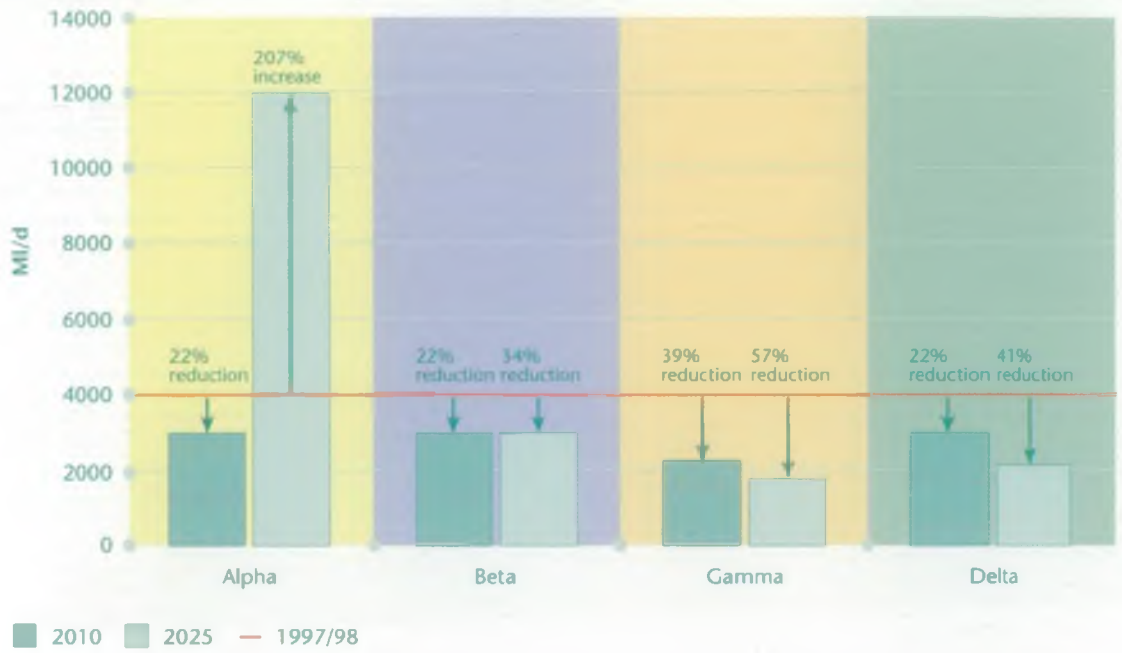
Availability of base-year water consumption data, disaggregated by industrial sector, played an important role in determining our forecast methodology. Due to the paucity of non-household water use data, we identified weighted output growth as the most appropriate forecast method for both PWS non-household and direct abstraction primary-industry demand. This method allows us sufficient flexibility to apply a range of assumptions at the industrial sector level regarding economic growth, employment and output, as well as the direct application of water efficiency assumptions.

Drawing on information from the Environmental Technology Best Practice Programme (ETBPP) (now Envirowise) and other published sources, we have devised sector specific water savings that reflect differences in cost and pay back period. Hence for production and manufacturing industries five water efficiency measures have been defined:

- Good housekeeping;
- Management;
- Reuse;
- Recycle;
- Redesign.

Good housekeeping represents the cheapest options with immediate pay-back, while plant redesign or refurbishment requires significant capital investment and incurs pay-back periods of three years or more.

Figure A2.4 National leakage by scenario in 2010 and 2025



Reflecting the different nature of water use, we defined three separate categories for the business and service sectors and education and health once again ranging from the cheapest to the most expensive options. These are:

- Good housekeeping;
- Management;
- Water saving technology.

The water efficiency reductions employed in this analysis are all technically feasible today, and these values have been held constant across all four scenarios. Variability between scenarios is introduced through the level of uptake by businesses of relevant water efficiency measures.

Industrial Demand: Scenario outcomes

Scenario Alpha (Provincial Enterprise): The political climate results in a decline in both the levels of imports and exports. Sectors such as chemicals, business services, and electronics face slower rates of growth from 2005, reflecting the reorientation of production to meet domestic demand. This is counter-balanced by growth in primary industry and manufacturing industries, such as metals, textiles and engineering, where long term changes to the structure of the economy are reversed. There are very low levels of water use minimisation activity, compounded by the lack of investment in manufacturing infrastructure.

Scenario Beta (World Markets): The removal of all international trade barriers results in a reduction in the level of gross output and employment within UK based primary manufacturing industries such as textiles, machinery and metals. This decline is balanced by an increase in the level of output and employment within business services, chemicals and biotechnology. Given the drive towards technological innovation we assume that by 2025, 20% of firms across all sectors will implement low-cost water efficiency measures such as good housekeeping, management and reuse options. This only partially suppresses the demand generated by high levels of growth within the business sectors.

Scenario Gamma (Global Sustainability): Resource intensive systems of production such as paper, minerals, rubber, textiles, metals and fuels are subject to stricter environmental regulations from 2010. These emphasise water efficiency and 90% of businesses within these sectors are affected. Other industrial and business sectors adopt voluntary measures to minimise their impact on the environment, with 50% of businesses within retail, business services and construction implementing water efficiency measures by 2025.

Scenario Delta (Local Stewardship): From 2009/10 retail and business services and leisure industry decline reflecting the shift in consumer attitude. Industries such as chemicals, a high water using sector, also decline, in part reflecting the shift towards organic systems of agricultural production. The environment is placed at the centre of industry and business decision making, with eco-efficiency driving the decline in raw material use. By 2025 65% of firms across all sectors have implemented low cost water efficiency measures, but

more expensive measures such as plant redesign are inhibited by the lack of available capital for investment.

A2.5

Spray irrigation demand

Agriculture is subject to a wide range of social, economic and political drivers of change, which directly or indirectly affect the use and management of spray irrigation.

The key drivers of irrigation demand, affect the following forecast micro-components:

- Total crop area;
- Irrigated area;
- Crop yield;
- Crop prices and quality premiums;
- Irrigation practice;
- Irrigation need or depth of water applied;
- Cost of irrigation;
- Irrigation efficiency.

Drawing on information within the MAFF (1995) irrigation survey, the forecast is built up from total crop and irrigated crop area. Eight crop categories are defined:

- Potatoes;
- Sugar beet;
- Vegetables for human consumption;
- Grass;
- Cereals;
- Soft fruit;
- Orchard fruit;
- Other.

For each crop category, information related to the eight micro-components feeds into the base year data, to which scenario specific assumptions are applied. Assumptions have been based on many sources of data, including MAFF, British Potato Council, National Institution of Agricultural Botany, Soil Association, NFU, and CLA. Two core assumptions underpin the development of scenario specific assumptions at the crop level:

- Increases in supply of a crop, through high yields, will affect the price that it realises when sold. Thus, if high yields result in over supply of the market, there is likely to be a reduction in the prices paid.
- There are natural limits on the availability of land and its suitability to certain types of production due to soil type and agro-climatic conditions; in addition rotational restrictions prevent crops being grown on the same piece of land continuously.

We note that under some Foresight scenarios, there is a prospect of a significant switch from agriculture to forestry, or specific planting for bio-energy through coppicing. The expectations are that this would occur not on class 1 land where irrigation demand will be most pressing, but that it will be concentrated mainly in the west side of England and Wales, on poorer quality land where the natural rainfall will provide the support. This switch is therefore not treated as a driver of future irrigation demand.

Forecast methodology

Previous forecasts of spray irrigation demand have been based on the concept of theoretical crop water requirements to maximise crop yield and quality. Such approaches fail to take into account the costs and benefits of irrigation, which play a critical role in determining the actual level of irrigation. For example, in some situations the benefits of irrigating a crop, although positive, may not be sufficient to justify the investment and risk. In other cases, decreasing returns to irrigation may only justify investment in a lower level of irrigation capacity.

The new Environment Agency forecasts, undertaken by Cranfield University at Silsoe, have developed the concept of economic demand, reflecting the costs and benefits of irrigating different crops. The methodology draws on the optimum irrigation water requirements developed under the Agency's " The optimum use of water for industry and agriculture dependent on direct abstraction" R&D project. The forecasts estimate the ratio between the economic demand and the optimum demand for selected crops, under different economic and water resource constraints. This approach assumes that water resource constraints or low economic returns will limit on-farm investment in irrigation capacity (total licensed quantity or reservoir capacity) and in peak application rates (pump and pipeline capacities, number of hosereels etc.). These constraints then limit irrigation depending on each year's weather pattern, with greatest effect occurring in years with highest demand.

This approach marks an important development. Comparison with "baseline" crop irrigation forecasts based on theoretical and economic demand highlights

a number of important issues. The methodology confirms that for high value crops, such as potatoes, vegetable and fruit crops, economic and theoretical demand are closely matched. However, the economic benefit of irrigating lower value crops, such as sugar beet, cereals or grass, is not sufficient to justify applying the full theoretical crop water requirement. Irrigation forecasts for these crops, based on the economic optimum, are significantly reduced.

Spray irrigation demand: Scenario outcomes

Scenario Alpha (Provincial Enterprise): There is strong emphasis on home produce and self-sufficiency, with a reduction in the level of food imports. This serves to increase the total area of crops such as potatoes, sugar beet, field-scale vegetables and horticulture although as yields gradually increase the total area under production declines slightly by 2025. Supermarkets and food processing firms continue to focus on produce quality with high price premiums. The price premiums encourage greater efficiency in the use of irrigation, although there is limited technological innovation in irrigation equipment and scheduling systems.

Scenario Beta (World Markets): Agriculture is subject to strong international competition with the level of food imports increasing. This impacts in particular on potato, sugar beet and orchard fruit crops, where total area declines. Despite this, the emphasis on produce quality, and the associated high price premiums, favours increased irrigation of high value potato and horticultural crops.

Scenario Gamma (Global Sustainability): The level of imports increases, with a consequent reduction in the total areas of potatoes, sugar beet and orchard fruit. Supermarkets realign their approach to agriculture, using their influence to promote and support environmentally sensitive systems of production. Price premiums for irrigated produce fall, with less emphasis placed by consumers on the appearance of produce. This, combined with the widespread adoption of drought tolerant varieties encourages farmers to reduce the volume of water applied. Irrigation efficiencies increase rapidly reflecting national investment in irrigation technology development.

Scenario Delta (Local Stewardship): Significant emphasis is placed on food self sufficiency, with a movement away from reliance on supermarkets to local shops and farmers' markets. Less emphasis is placed on appearance reducing the incentive to irrigate. The area under organic or low external-input systems increases, with a consequent increase in total crop areas. Average yields reduce, average farm commodity prices rise and input costs fall. Water is used wisely because of its associated public good, rather than its commercial value, leading to high irrigation efficiencies.

Appendix 3

Calculating possible leakage levels in 2025

Our strategy recommends that further leakage reductions should play a part in managing public water supply over the next 25 years. To identify the contribution that this could make we have calculated possible future leakage levels. This appendix provides details of the approach.

General approach

Our approach makes an estimate of the progress that can be made in leakage control over the next 25 years. We take into account the application of existing technology and methods, as well as changes that are already widely anticipated in the water industry. We have assumed that methods that some companies find cost-effective today will probably be cost-effective for all water companies in the future. We have not tried to calculate economic levels of leakage over the 25-year period, principally because these require comparison of the cost of leakage control against the cost of other options. Instead, we have looked at the way that leakage control methods can be applied and calculated the resulting level of leakage for each water supply zone.

Method

We have considered three components of leakage:

- Reported bursts: leaks that are noticed and reported by the public
- Unreported bursts: leaks that are not noticed by the public, but are found by a water company's active leakage control work.
- Background leakage: the sum of small leaks from joints, fittings and small holes that cannot at present be found by active leakage control methods.

The duration of a burst depends on:

- Awareness time: how long it takes before a company is aware that there is a burst;
- Location time: how long it takes to find the burst's location;
- Repair time: how long it takes to repair the burst.

By definition, active leakage control cannot find bursts that are presently undetectable. This does not mean that background levels of leakage will never change: it is to be expected that advances in leakage technology will improve the sensitivity of leakage detection. Additionally, background leakage depends on the pressure in the system and it is also reduced as pipes are refurbished or replaced.

To calculate the effect of leakage practice for a given water company requires information about:

- Number of properties or connections;
- Length of mains;
- Average zone night pressure;
- Annual burst rate.

We have obtained this information from companies' reports to Ofwat and information provided to the Agency. We have used industry standard data on average flow rate from bursts, the number of service pipe bursts, the ratio of reported to unreported bursts, background levels of leakage, and the relationship between pressure and leakage.

Assumptions

To calculate the leakage control that could be achieved over the next 25 years, we have made the following assumptions:

Find and fix activities

"Find and fix" is the general term for the activities involved in locating and repairing leaks. Some companies have introduced permanent acoustic loggers that sit in the leakage network listening for leaks. They emit signals to a receiver that is mounted in a van that is driven round the network. Over the next decade it should be possible to combine the technologies of

acoustic loggers and mobile leak noise correlators that will locate the leak and report it to a control room by telemetry. This could reduce the time taken to find and locate leaks to as little as half a day compared to the present average of around 11 days. As the technology is proven and acoustic loggers are already in place in some companies, it is reasonable to assume that these methods could be widespread over the next 25 years. We have not made any assumptions about increased sensitivity of leakage detection or faster repair methods, although it is likely that these will both improve over time.

Pressure management

Pressure reduction reduces the rate of leakage. Where pressures are higher than necessary, reducing them is known to be cost-effective. Pressures can be lower in areas that have low relief or where there are few very tall buildings. We have assumed that over time companies can reduce pressures so that their average zone night pressures approach an optimum based on the topography of the company's area. This means, for example, that companies in the north or the west would be expected to have higher pressures than companies in East Anglia. We have assumed that the following average zone night pressures could be achieved by 2025:

- Areas of low relief – 30 m
- Areas of mixed relief – 37.5 m
- Areas of high relief – 45 m.

Reducing pressure is also thought to reduce burst frequency, but there is too little information to predict this effect with any certainty.

Service pipe and mains replacement

We have assumed that replacing pipes and mains reduces background levels of leakage to values that are currently achieved in areas of low leakage. We have assumed that water companies can achieve a rate of replacement of between one and three per cent in a year. The maximum rate that we have assumed for each company depends on its existing resource position. The present average replacement rate is 1.5% each year.

Our calculated possible leakage rate for each public water supply resource zone is based on modelling the effects of these three changes on present leakage rates. For this we have used the computer model BABE (Bursts And Background Estimation). We have modelled the present leakage rate of each resource zone using current data and then used our three new assumptions to identify the potential reduction in leakage over the next 25 years.

Conclusions

This appendix describes how we have calculated a possible leakage level for each water company and resource zone. By assuming a modest extension of existing good practice, we may assume that achieving this calculated level should not be excessively expensive. Whether this level of leakage activity is necessary depends on the relative merits of other options. The area of leakage control attracts much attention and it is to be expected that our results will be refined as the result of further studies over the next few years. The current tripartite leakage study being carried out by Ofwat, DETR and the Agency will help to clarify the potential for progress.

Appendix 4

R & D proposals

The thinking that has gone into developing our strategies has inevitably thrown up a range of issues where we do not currently have enough information or understanding.

Issues include:

- Environmental requirements of plant and animal species – there is scope for further work on the requirements of different species and species assemblages.
- Impacts of climate change on demand for water – the DETR study (Climate Change and Demand for Water DETR, 2000) will develop new methods of assessment, but these will need to be applied across England and Wales.
- Impact of climate change on water availability – improved climate change scenarios and related information should enable more detailed assessments at regional and local level..
- The impact of extreme events on resource availability – further work is essential to consider the security of supply systems.
- The acceptability and effectiveness of customer restrictions – more understanding of the effect of, for example, hosepipe bans on demand is necessary.
- Components of per capita consumption – more work is necessary to understand the drivers of individual components of water use.
- Garden watering – more work is needed to understand how and why gardeners choose to water.
- Population projections – a source of uncertainty, with different organisations working with different information. A working group on population projections would help the water resources planning process.
- Impact of price and tariffs on domestic and industrial demand – more development work would help our understanding.
- Implementation of recent work on reconciling surface and groundwater resource yields – this would improve future plans.
- Impact of land use changes, including forestry, on water availability.
- The evaluation of costs and water savings of demand management options.

The Agency will work with others to prioritise and take forward an appropriate programme of Research and Development.

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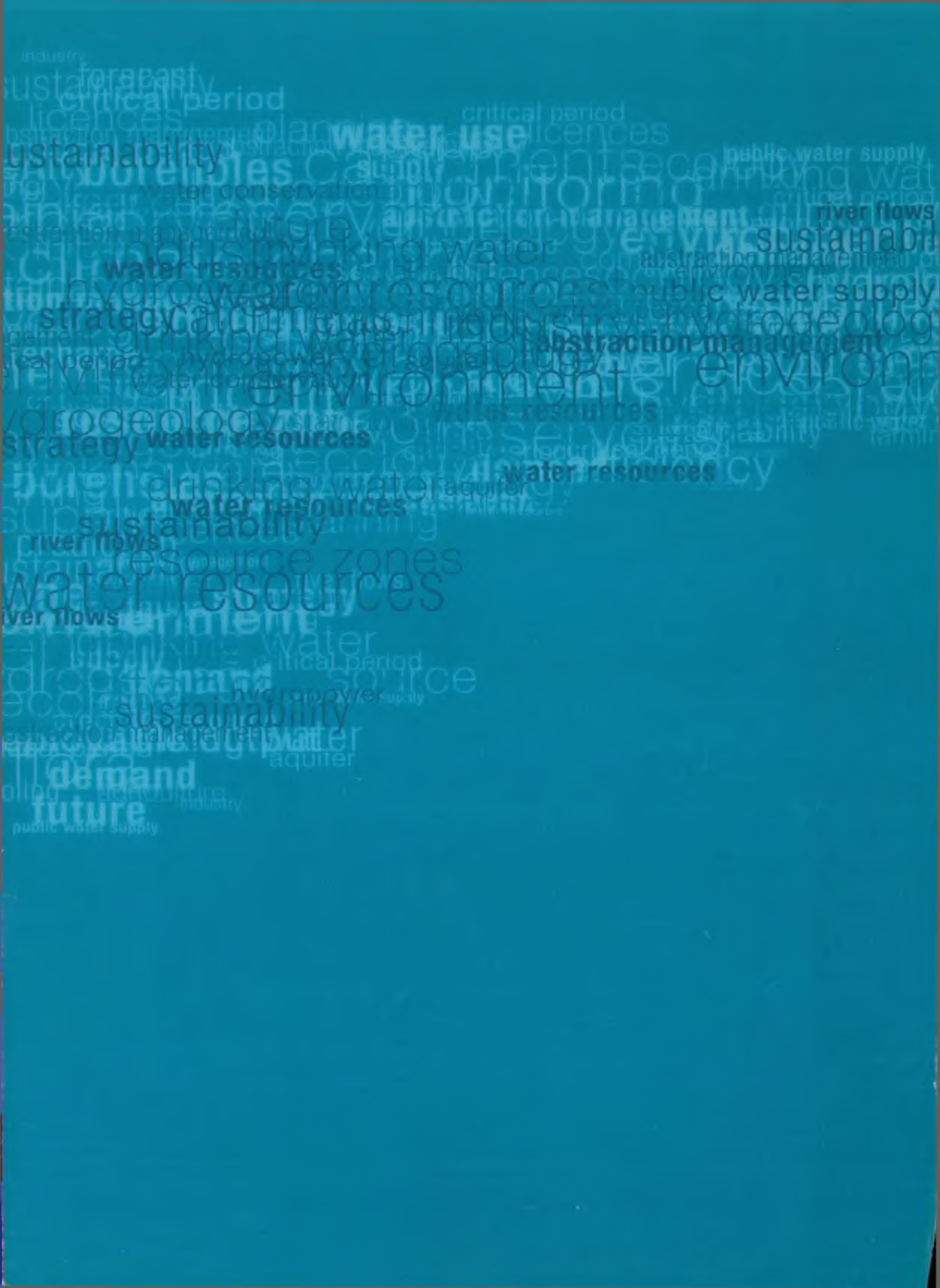
Glossary of terms

Term	Definition
Abstraction	The removal of water from any source, either permanently or temporarily.
Abstraction charges	The charges payable to the Environment Agency under the terms of an abstraction licence.
Abstraction licence	The authorisation granted by the Environment Agency to allow the removal of water from a source.
Active leakage control	Water company operating practices of detecting leakage from knowledge of night flows, pressure etc.
AISC	Average incremental social cost.
Aquifer	A geological formation, group of formations or part of a formation that can store and transmit water in significant quantities. An aquifer is *unconfined* where the water table is not covered by a confining layer.
AARR	Aquifer artificial recharge and recovery.
Borehole	Well sunk into a water-bearing rock from which water will be pumped.
Catchment	The area from which precipitation and groundwater will collect and contribute to the flow of a specific river.
CAMS	Catchment Abstraction Management Strategies.
CAP	Common Agricultural Policy.
Conjunctive use	Combined use of different sources of water.
Consumption	Water delivered billed less underground supply pipe losses. Consumption can be split into customer use plus total plumbing losses.
Consumptive use	Use of water where a significant proportion of the water is not returned either directly or indirectly to the source of supply after use.
Demand management	The implementation of policies or measures that serve to control or influence the consumption or waste of water. (This definition can be applied at any point along the chain of supply.)
Deployable output	The output of a commissioned source or group of sources or of bulk supply as constrained by: – environment – licence, if applicable – pumping plant and/or well/aquifer properties – raw water mains and/or aqueducts – transfer and/or output main – treatment – water quality for specified conditions and demands.

DETR	Department of the Environment, Transport and the Regions.
Drought order	A means whereby water companies and/or the Environment Agency can apply to the Secretary of State for the imposition of restrictions in the uses of water and/or which allows for the abstraction of water outside of existing licence conditions.
Effluent	Liquid waste from industrial, agricultural or sewage plants.
EIA	Environmental impact assessment.
Flow regime	The pattern of a river's varying (daily) flow rates.
GATT	General agreement on tariffs and trade.
GDP	Gross domestic product.
Groundwater	Water within the saturated zone of an aquifer.
Habitat	The customary and characteristic dwelling place of a species or community.
Households	Properties (normally occupied) receiving water for domestic purposes which are not factories, offices or commercial premises.
Hydrogeology	The study of the quality, quantity, storage and movement of water in rock and the interaction with geology.
Hydrology	The study of water on and below the Earth's surface.
l/h/d	Litres per head per day.
l/prop/hr/year	Litres per property per hour per year (change in the rate of use).
LEAF	Linking Environment And Farming.
Leakage	The sum of distribution losses and underground supply pipe losses.
LRMC	Long run marginal cost.
MAFF	Ministry of Agriculture, Fisheries and Food.
Main river	The watercourse shown on the statutory "main river maps" held by the Agency and MAFF. The Agency has permissive powers to carry out works of maintenance and improvements on these rivers.
Ml/d	Megalitres per day (one megalitre is equal to one million litres).
NAW	National Assembly for Wales.
NEP	National Environment Programme.
NFU	National Farmers Union.
Non-consumptive use	Use of water where a significant proportion of the water is returned directly and immediately to the source of supply.
NRR	Natural rate of rise.
OFV	Ownership, Frequency and Volume.
Ofwat	Office of Water Services.
PCC	Per capita consumption (consumption per head of population).
Potable water	Water of a suitable quality for drinking.

Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Pumped storage reservoir	Surface water storage area where the natural inflow is supplemented by water pumped from a separate source, typically a nearby river.
PWS	Public water supply. Term used to describe the supply of water provided by a water undertaker.
Recharge	Water that percolates downward from the surface into groundwater.
Regulated river	A river where the flow is augmented through the addition of water from another source.
Resource zone	The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers experience the same risk of supply failure from a resource shortfall.
RSAP	Restoration of Sustainable Abstraction Programme.
SAC	A Special Area of Conservation is one classified under the EC Habitats Directive and agreed with the EC to contribute to biodiversity by maintaining and restoring habitats and species.
SME	Small and medium-sized enterprises.
Source	A named input to a resource zone. A multiple well/spring source is a named place where water is abstracted from more than one operational well/spring.
SPA	A Special Protection Area is one classified under the EC Wild Birds Directive and agreed with the EC to contribute to biodiversity by maintaining and restoring habitats and species.
SSSI	Site of Special Scientific Interest.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
UKCIP	UK Climate Impacts Programme.
UKWIR	UK Water Industry Research Limited.
Waste minimisation	The reduction of waste by the adoption of more efficient and cleaner technologies.
Water available for use	The value in Ml/d calculated by the deduction from deployable output of allowable outages in a resource zone.
Winter storage reservoir	Reservoirs to store water during the winter months when it is plentiful for re-use during the summer.
WRSE Group	Water Resources in the South East Group. (Group chaired by Environment Agency Southern Region, comprising Ofwat, Southern Water, Mid-Kent Water, Folkstone and Dover Water, Portsmouth Water, South East Water and Thames Water).
Yield	The reliable rate at which water can be drawn from a water resource.


industry
critical period
water use
sustainability
public water supply
river flows
water resources
strategy
environment
abstraction management
hydrogeology
drinking water aquifer
resource zones
demand
future