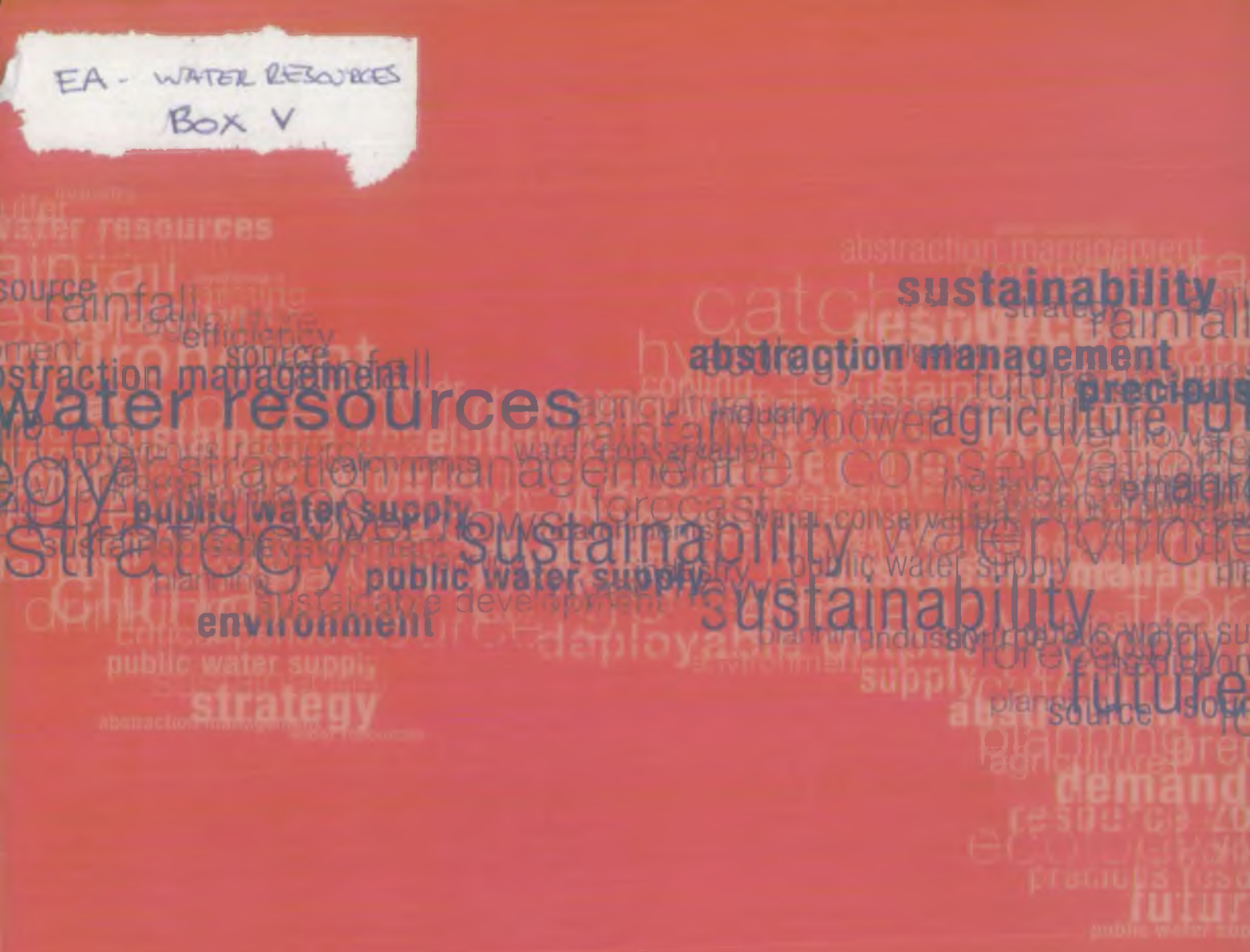

Water resources for the future

A STRATEGY FOR NORTH EAST REGION

March 2001

ENVIRONMENT AGENCY

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Environment Agency
Rivers House
21 Park Square South
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Fax: 0113 246 1889

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Foreword

Water plays a significant part in defining the essential character of the landscape and countryside in the North East of England, and shapes a rich diversity of aquatic habitats. Whilst we often regard the Region as well provided with rainfall, much of this resource must remain in the environment to protect and enhance these valuable habitats.

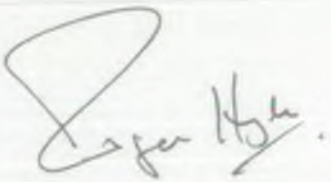
Society justifiably relies on water for a multitude of uses from domestic consumption through to agricultural and industrial processes. In addition, the water environment attracts recreational activity and quiet relaxation, adding value to the quality of life in urban and rural areas. Yet when water becomes scarce, as experienced during the droughts of the 1990s, we realise its importance and the demands placed on it.

The water environment adds value to the quality of life: fishing is enjoyed by many in the North East

The Environment Agency's vision in the North East Region is for our rivers and wetlands to support a healthy and diverse wildlife that everyone can enjoy, while at the same time providing reliable water supplies for use in our homes, industry and agriculture. This strategy sets out how we believe these aims can be achieved. We advocate a dual approach, within which managing our use of water plays an essential role alongside the future development of some resources.

We recognise the magnitude of the challenge facing us. Continued economic growth, new housing developments and the likely increase in irrigated crops will impact directly on the natural environment. In addition, climate change will make future demands for water more uncertain and direct river abstractions, that are unsupported by either storage or interconnected supply systems, potentially less reliable.

This strategy sets out a framework, which requires action by many different organisations and individuals. Local authorities, water companies, industrialists, farmers, environmental organisations and many others have a role to play. The publication of this strategy is an important step in a continual process. We look forward to working with others in delivering the actions required to make our vision a reality.



Roger Hyde
Regional Director for the North East Region

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Summary

Introduction

Water is essential for life. Society relies on water for a multitude of uses from domestic consumption through to agricultural and industrial processes. 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.

Generally the overall water resources position in the North East is healthy: High Force in Teesdale

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 North East Region. The Region covers the area east of the Cheviot Hills and Pennines from the Scottish Border south to the Peak District, and includes the major cities of Newcastle upon Tyne, Leeds, Kingston upon Hull and Sheffield. This strategy forms part of a suite of eight strategies that are consolidated in the Agency's national strategy for England and Wales. This regional strategy looks some 25 years ahead. It considers the needs for water both of the environment and of society, and examines the uncertainties about future demand and 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. The Agency will continue to be active in encouraging initiatives that contribute to sustainable development.

Our strategy concludes that:

- Generally the overall water resource position in the North East is healthy. Whilst the Region may be regarded as well provided with rainfall, much of this water must remain in the environment to protect and enhance the valuable aquatic habitats. In particular, some modest re-balancing of over-allocated resources may be required in the Sherwood Sandstone aquifer that extends from Selby to Nottingham.

- The Region's water resources offer a good level of support to new investment and economic growth reliant on water. This investment should be located appropriately.

- Continued availability of reliable public water supply is essential. We recommend the enhancement of public water supply by the improvement of existing systems and the development of some resources in the south of the Region. Although built prematurely, Kielder Water provides considerable potential for future security of supply to the whole of the North East Region.

- The efficient use of water is 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, in the context of the Governments' broader social and environmental policies including the protection of vulnerable households.

- Further attention to leakage control will also be necessary.

- Agriculture must continue to use available water to best effect. In most agricultural areas, the reliability of any new run of river abstractions, with little or no backup storage, is not assured. Farmers should consider crop suitability and the possibility of increased winter storage.

- 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 the North East Region, the picture shows that generally the overall water resource position is healthy, particularly when compared to other parts of the country. However, a notable exception is the Sherwood Sandstone aquifer that extends from Selby to Nottingham, where historically resources have been over-allocated.

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 the next century. The latest climate change scenarios suggest that temperatures will rise across England and Wales. Climate change may increase overall water resources availability in the Region, specifically in the winter months. However, direct river abstractions in the Region that are unsupported by either storage or interconnected supply systems may become less reliable and sustainable in the future.

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 the enhancement of public water supply by the improvement of existing systems and the development of some resources in the south of the Region. These improvements include enhancing groundwater storage through aquifer artificial recharge and recovery. This process involves pumping treated water into an aquifer during wet periods, for use in times of need. Furthermore, the continual improvements in water quality of South and West Yorkshire rivers, together with the development of storage close to river, should provide potential potable water supplies. Such schemes will need further work to demonstrate that 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.

The Agency will complete the review of consents required under the Habitats Directive for 40 sites in the Region and ensure that actions are taken to modify or revoke abstraction licences, where necessary. Water companies should complete the investigations and actions required of them under the National Environment Programme. The Agency will continue to work with English Nature and others on the investigations and actions summarised in our recent joint review of water abstraction and Sites of Special Scientific Interest in England. We will prioritise and monitor progress on other abstraction-related concerns through our Restoring Sustainable Abstraction Programme within the context of our future Catchment Abstraction Management Strategies process.

Continued attention to leakage control will be essential in public water supply. We believe that 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 of domestic customers can contribute greatly to sustainable water resources management. 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. It is essential that further metering is accompanied by the development of 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. We will continue to work with partners, seeking benefits of water efficiency and integrated water-use minimisation for all sectors. We will strive to

set best practice standards in our own offices and facilities. We will also work with planners, developers and the water companies to ensure that the large amount of new housing development predicted in the Region makes efficient use of resources.

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 adoption of these approaches.

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 and procedures may be increasing water use.

We have identified a number of areas in need of further research. The Agency will work with others to define the problem and subsequently 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.

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

Actions

Our recommended 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 of the actions for the North East Region can be found in Chapter 7 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

1.1

Need for a strategy

Water is essential for life. Society relies on water for a multitude of uses from domestic consumption through to agricultural and industrial processes. Water also shapes a rich diversity of habitat for plants and animals and plays a great part in defining the essential character of the landscape and countryside of the North East of England.

The North East Region of the Environment Agency comprises all catchments draining eastwards from the Cheviot Hills and the Pennines extending from the Scottish Border south to the Peak District. Major catchments include the rivers Coquet, Tyne, Wear, Tees, Ouse (Yorkshire), Wharfe, Derwent (Yorkshire), Aire, Calder, Don and Hull. The landscape ranges from the uplands of the Cheviot Hills, the North York Moors and the Pennines through to the lowlands of the Vale of York. Figure 1.1 highlights the geographical boundaries of the respective Government Offices and the water companies' supply areas in the Agency's North East Region. The total land area of the North East Region is 22,774 km^2.

While the North East Region may be regarded as well provided with rainfall, much of this water must remain in the environment to protect and enhance the valuable aquatic habitats. This, coupled with a relatively high water demand for public water supply, and from industry and agriculture, means that careful management of water resources is essential.

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

This is the first regional water resources strategy to be developed by the Agency since its inception. It looks 25 years ahead and:

Figure 1.1 Boundaries in the North East Region

- considers water resources needs for the next generation;
- builds on a long tradition of water resources planning;
- adopts a flexible approach which reflects the many uncertainties that face water resources;
- provides a secure way forward that protects the water environment and contributes to sustainable development;
- provides a broad framework for the management of water resources;
- provides a backdrop for other strategies and plans which follow, from 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* (Environment Agency, 2000d).

This strategy forms part of a suite of documents 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 and the Wales water resources strategies. This water resources strategy for the North East applies these approaches to focus on the current state of water resources locally and explores options for their long-term sustainable development. Together, these documents form part of a nationally co-ordinated and consistent process of strategic water resources planning.

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 illustrate the impact of different social and economic choices on future water use;
- to manage water resources in a way that causes no long-term degradation of the environment;
- to improve the state of existing degraded catchments;
- to ensure that water is available to those who need it, and that it is used wisely by all;
- to indicate the present state of water resources;
- to cater robustly for risks and uncertainties;
- to promote the value of water to society and the environment;
- to review feasible water management options including innovative solutions where appropriate;
- to provide a framework for logical decisions to be taken at the right time;
- to 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;
- an 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, showing how the thematic approach to improving our environment translates into tangible actions affecting a specific sector. In water resources, actions in one place have implications elsewhere, making the direct consideration of links especially appropriate.

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. We believe that our strategy will be more successful if it meets the needs and concerns of others who are involved in the process. For this reason, in October 1999 we published a national consultation document seeking the views of groups and individuals on a variety of issues (Environment Agency, 1999a).

A national consultation response document was produced in September 2000, summarising the replies received (Environment Agency, 2000c). Of the 270 responses, 31 were from the North East, and we have taken these views into account in the preparation of this strategy. We had a good spread of responses across the main sectors with interests in water in the North East.

Responses from consultees broadly reflected many of the national trends, but also highlighted some strong

The Agency is keen to work with all our stakeholders in the North East: shipping at Middlehaven, Middlesbrough

local concerns amongst stakeholders. These included that water is undervalued and that many water users are unaware of the impact they have on the water environment. This is further exacerbated as water is often consumed far from where it is collected.

Turning to the opportunities for solutions, there were some areas of broad consensus amongst stakeholders, but other aspects where views differed. Key areas of agreement were:

- the concept of sustainable development, including the consideration of the protection, improvement and reversal of previous environmental damage to the water and water-related environment, for example moorland gripping in Yorkshire;
- there appears to be an increase in the frequency of extreme events, and in particular the need to collect baseline hydrometric and biological data against which future trends may be compared;
- the importance of water efficiency and demand management across all sectors to make best use of our existing resources, despite less incentives in those areas of the North East Region where long-term supplies are available;
- an expectation that demand management alone will not be sufficient to manage all future needs and support for some form of "twin-track" approach to demand management and resource development, including water quality improvements of potential sources, for example the river Aire;
- additional winter storage, especially for agriculture, is seen as a sensible response to the predicted impacts of climate change. Concerns were, however, expressed about costs, the need to consider environmental impacts and local authority planning considerations.

Divergent views were particularly evident on:

- the feasibility of a more integrated water supply system. Despite such a system having the potential to increase flexibility of supply, concerns were expressed regarding the benefits of mixing differing supplies;
- the role of market forces in determining access to water resources. However, respondents recognised that safeguarding adequate water supplies to consumers is vital;
- whether the economic level of leakage calculations represent an acceptable inclusion of the economic and environmental implications of leakage.

We have tried to take these views and many other details into account as we have formulated this strategy. The issues on which we consulted are fundamental ones, where differing views are not unexpected. It is inevitable that some people will be disappointed. There are also areas of genuine uncertainty that have to be resolved with the opportunity for further input. However, we are keen to build on the areas of consensus, and to continue to work with all our stakeholders in the North East to look for ways of reconciling the differences to achieve mutual gain.

Consultation does not end with the publication of our strategies. The published documents are part of an ongoing process. 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 North East Regional Office, or e-mail: northeast.water.resources@environment-agency.gov.uk

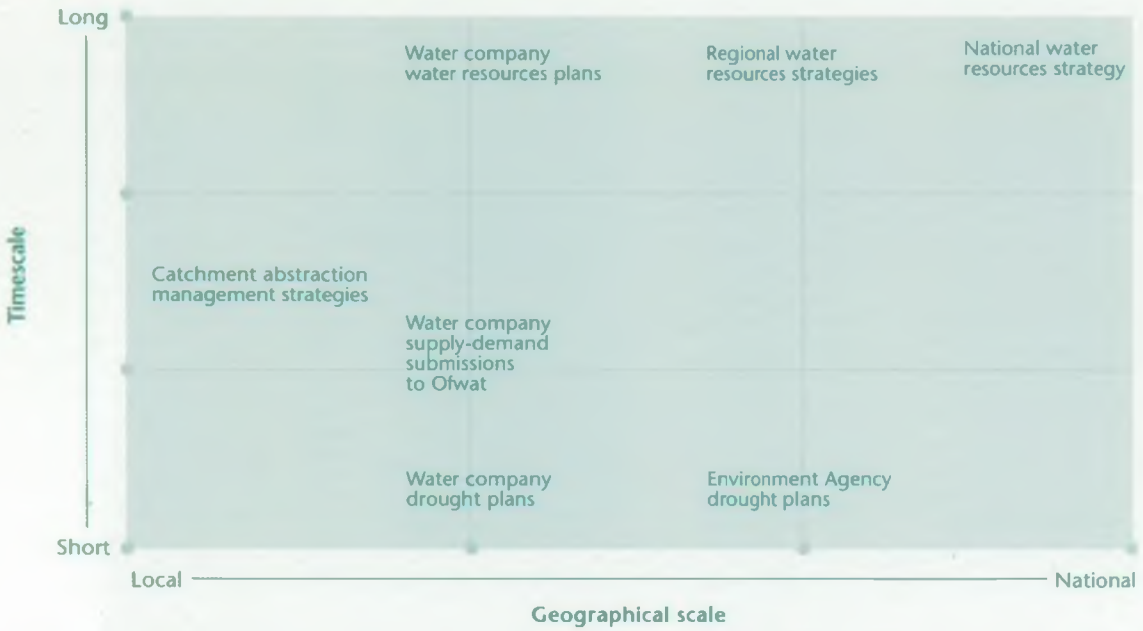
1.4

Links with other water resource 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. Figure 1.2 depicts the different timescales and geographical extent of these activities.

This strategy looks 10 to 25 years ahead, and covers the whole of the North East of England. It covers all aspects of water resources management, including public water supply. This is always prominent in 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

Figure 1.2 Scales of water resources planning activities



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.

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 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 the minimisation of the waste of water);
- fisheries;
- navigation on some rivers.

The management of abstraction to fulfil our duties is achieved through the abstraction 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 Head of Water Resources at our Bristol address.

The Environment Agency is responsible for:

- 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;
- Local Environment Agency Plans (LEAPs) which set out an integrated framework for sustainable management of the environment at a catchment level;

- Drought Plans, setting out the Agency's role in managing droughts;
- regular review of water companies' Water Resources Plans and Drought Plans;
- this water resources strategy, setting out the Agency's vision for the long-term management of water resources in the North East;
- a national water resources strategy, setting out the Agency's vision for the long-term management of water resources throughout England and Wales.

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 sources, as demanded by the Directive, will require integrated considerations of water quantity, water quality and ecology. The Water Framework Directive may 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 Resources Plans will provide a sound basis for development in meeting the requirements of the Directive.

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. The Minister for the Environment is responsible for water regulations to control the waste of water.

The management of water resources is carried out by several institutions: the Agency has entered into a formal agreement with Northumbrian Water on the operation of Kielder Water

2.1.3 Water companies

Private water companies provide public water supply in England and Wales. The Environment Agency regulates their water abstractions and effluent discharges. 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 water supply in its area, and the Agency's duties in respect of water resources management do not relieve the companies of that obligation. The five companies operating within the North East Region are Northumbrian Water, Hartlepool Water, Yorkshire Water, which acquired York Water Works in 1999, North West Water and Severn Trent Water.

Water companies are responsible for:

- providing a clean and reliable supply of water;
- 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;
- 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 Drinking Water Inspectorate regulates the quality of the water delivered by water companies to their customers.

2.1.6 Planning and local authorities

The growing importance of regional government has meant that the Agency's North East Region has major links with the Government Office for the North East and the Government Office for Yorkshire and the Humber. These Offices are co-ordinating the forthcoming sustainability frameworks. In addition, the two Regional Development Agencies covering the Environment Agency's North East Region, One NorthEast and Yorkshire Forward, have developed regional economic strategies. These frameworks and strategies will have a bearing on the demand for water.

Strategic and local planning 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 (RPG) for the North East and for Yorkshire and the Humber.

Many planning authorities are proposing to review their Development Plans to reflect the guidance of the RPGs. 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. 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 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 sections 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 social values, systems of governance and climate change. We explain in Chapter 5 how we have allowed for these.

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 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.

The North East boasts a wealth of internationally and nationally important wildlife habitats supporting a wide variety of plants and animals. Many of these sites require water of suitable quality and quantity for their survival and, amongst others, include:

- the inter-tidal mudflats, salt marshes and rocky shore of the Lindisfarne coastal area;
- the pristine river environment of the SSSI designated river Coquet;
- the North Pennine Moors and the Upper Wharfedale;
- the complex of important riverine sites of the Lower Derwent Valley in Yorkshire;
- the raised bog habitats of the Thorne and Hatfield Moors;
- the reed-beds, salt marshes and mudflats of the Humber Estuary.

Figure 3.1 Topography of the North East Region

Figure 3.2 Geology of the North East Region

Figure 3.3 Designated areas of the North East Region

Figure 3.4 Rainfall distribution of the North East Region

Figures 3.1, 3.2 and 3.3 show the topography, geology and designated areas of the North East Region respectively.

3.1

The water resource

Rainfall, and its movement over and through the ground, shapes the water resources in the Region. The diversity of geography and topography in the region influences the spatial distribution of rainfall. The Cheviot Hills and the Pennines, combined with the prevailing westerly winds, produce an average annual rainfall in excess of 1400 mm in this vicinity, as illustrated in Figure 3.4. In contrast, the flatter, low-lying areas in the south east of the Region, receive an annual rainfall closer to 700 mm. Within the North East Region, Northumbria receives 855 mm of rainfall in a typical year and Yorkshire and Humberside receives around 820 mm. Table 3.1 compares the average and summer rainfall figures for the respective Environment Agency Regions.

Not all of this rainfall finds its way into rivers, reservoirs or aquifers. Significant rainfall evaporates either directly or through the surrounding vegetation. The remaining rainfall, often referred to as "effective", supports the riverine and other environmental needs as well as those of water users. The average annual effective rainfall for Northumbria is around 350 mm, or about 41% of total rainfall, and for Yorkshire and Humberside around 300 mm, or nearly 37% of total rainfall. Figure 3.5 shows typical monthly proportions of total and effective rainfall for the North East Region.

Rivers, groundwater and wetlands

The diverse physical characteristics of the North East Region have resulted in wide-ranging flow regimes. In general, the impermeable soils of the upland catchments mean that they have little ability to retain water. This, together with the characteristic steep-sided channels, results in some rivers responding rapidly to rainfall events; for instance the river South Tyne. In contrast, the lowland rivers in the south east of the Region, such as the river Hull, derive significant proportions of their summer flow from groundwater. This is released at a relatively steady rate throughout the year and results in less extreme flow characteristics than the upland catchments.

The North East Region embraces a wide variety of geological formations some of which date back 400 million years. Many of these formations yield significant

Table 3.1 Average and summer rainfall

Region	Annual average rainfall (1961-90) (mm)	Average summer rainfall (1961-90) (mm) (April to September)	1976 summer rainfall (mm)	1995 summer rainfall (mm)
Anglian	604	304	212	204
Midlands	814	385	310	241
North East	825	401	333	265
North West	1208	538	415	312
Southern	738	335	233	232
South West	1019	421	303	281
Thames	690	329	222	218
Environment Agency Wales	1312	533	427	344
England & Wales	897	405	308	262

quantities of good-quality water, and are referred to as aquifers. The main aquifers within the region include:

- the Fell Sandstone between Berwick and Wooler;
- the Sherwood Sandstone extending from Doncaster to Teesside;
- the Magnesian Limestone from Doncaster to between Darlington and Sunderland;
- the Corallian Limestone north of the Vale of Pickering;
- the Cretaceous Chalk in the Yorkshire Wolds.

Some areas in the North East Region are exempt from the full abstraction licensing legislation. Abstractions from surface waters in the catchment of the river Tweed in England, which includes the whole of the river Till, are exempt from licensing. The Northumbrian Water Order 1984 applies to the area of the former Northumbian Water Authority and exempts abstractions from springs and groundwater of up to 227,000 litres per day with a maximum annual abstraction of up to 4500 cubic metres. The issue of exemption orders is being reviewed as part of the Government's Abstraction Licensing Review.

Drought

Droughts are a natural phenomenon caused by long periods of low rainfall. During such periods the effective rainfall in a year may be halved due to lack of rainfall and higher plant use and evaporation. Dry periods may continue over several years, creating a cumulative deficit in water resources, particularly in groundwater. In the past, the North East Region has experienced dry, hot summers and winters with little rainfall, notably 1976 and 1995/96. These extended dry periods affect the aquatic environment; in particular reservoirs and river flows may drop to well below normal levels and groundwater supplies may not be replenished sufficiently.

The Agency plays a significant role in managing droughts. The Agency has developed regional drought plans, which detail the measures that will be taken through more serious droughts to ensure that water is used in the best way possible. Drought management measures to restrict the use of water, for instance through hosepipe bans, or to increase the security of supply, for instance by reducing compensation water flows from reservoirs, provide an important tool for managing water resources limited by exceptional rainfall shortages.

3.2 Distributing water

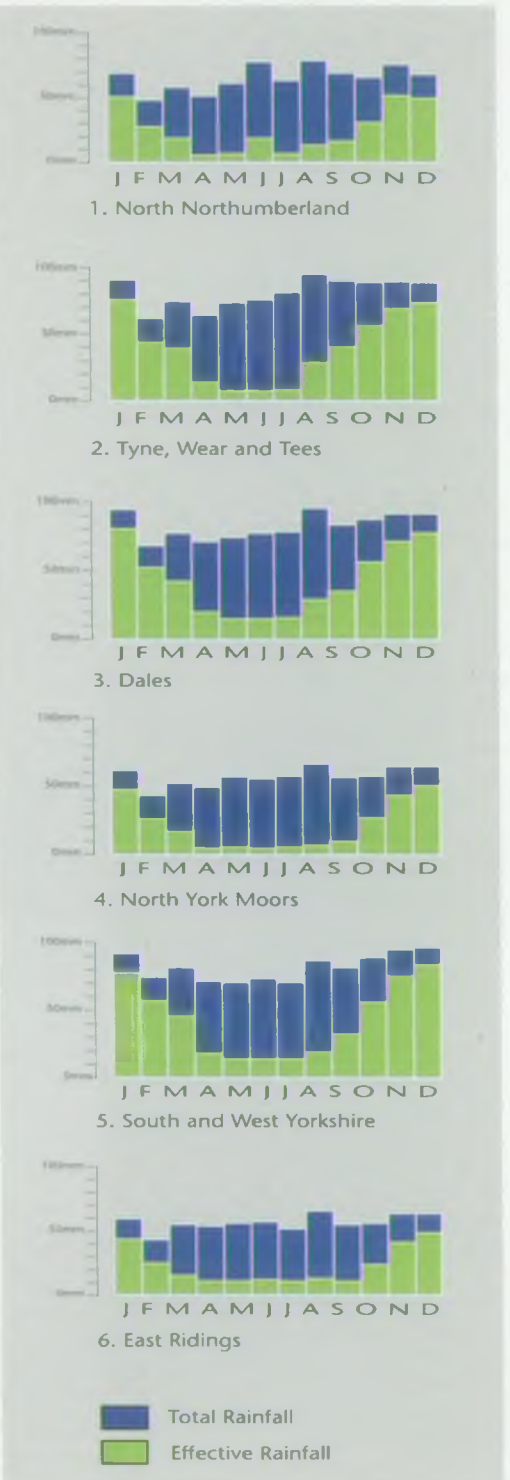
3.2.1 Abstractions

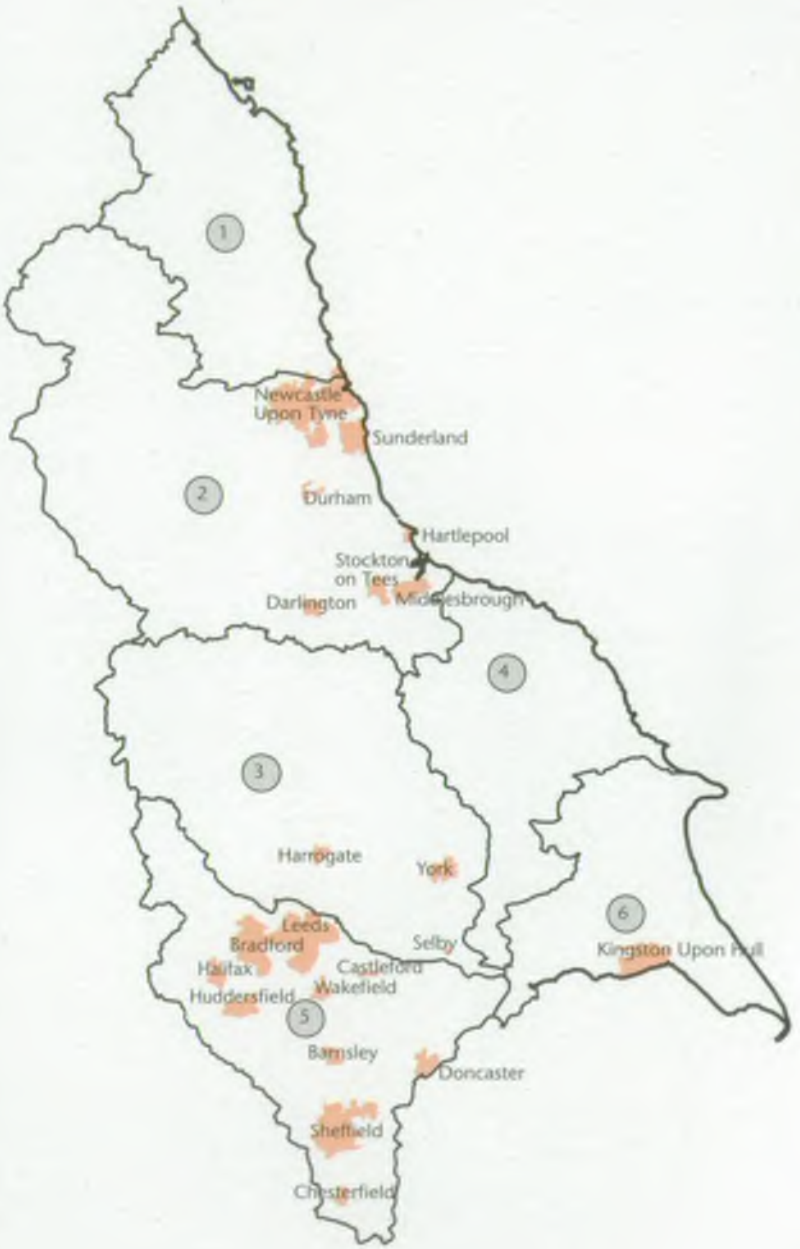
In order to ensure that sufficient water is available for us to use, we need to ensure that water is available at the right place at the right time, while minimising the impact on the water environment.

Water is abstracted from surface and groundwater sources either for use directly by the end user, or for treatment and distribution by water companies. In some parts of the North East local sources are insufficient, or provide inadequate security of supply during dry spells. This has led to the development of a wide variety of public water supply systems. Most are based on conjunctive use of abstractions from different types of resources. Water from reservoirs and direct abstractions from rivers and groundwater can be used at different times to give greater reliability. Larger systems involve transferring water by rivers, pipelines and aqueducts.

The nature of the supply systems of each of the Region's water companies can be summarised as follows:

Figure 3.5 Total and effective rainfall in the North East Region





- Northumbrian Water has a flexible distribution system, with Kielder Water supporting abstractions from the rivers Tyne, Wear and Tees when necessary. This flexibility allows greater use of local resources before relying on Kielder Water, and affords appropriate levels of environmental protection. The considerable spare capacity within this system guarantees that no new major resources will be required in Northumbria in the foreseeable future. The Agency has entered into a formal agreement with the company on the operation of Kielder Water and Cow Green Reservoir. This agreement ensures appropriate releases from the reservoirs downstream to the rivers Tyne and Tees respectively;
- Hartlepool Water's supply system comprises an integrated network of groundwater resources, with the company enjoying adequate water supplies;
- Yorkshire Water benefits from a highly developed distribution system, with links extending throughout

Yorkshire. Since the 1995/96 drought, Yorkshire Water has invested heavily in their distribution system to improve flexibility and reduce leakage. However, as a result of a legacy of many relatively small reservoir developments in the south of the Region, combined with a large population, this supply system is more susceptible to droughts than that in the north of the Region;

- although North West Water's supply area extends into the North East Region, the Agency's North West Region covers proposals affecting this supply area in the North West Regional Water Resources Strategy;
- again, the Agency's Midlands Region deals with the proposals affecting Severn Trent Water's supply area in the Midlands Regional Water Resources Strategy.

3.2.2 Leakage

A significant proportion of water abstracted for public water supply is lost through leakage from the distribution and mains systems, and supply pipes on customers' premises. Losses vary across the Region. This variation is the result of a number of factors, including the surrounding topography and associated pressure on the distribution network. Less obvious factors, such as shrinkage of clay soils in summer and ground movement due to winter frosts, result in mains and pipe bursts that further increase leakage levels.

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,

Table 3.2 **Water company leakage**

	Total leakage (Ml/d)			Leakage targets
	1992-93	1995-96	1998-99	1999-00
Anglian	212.0	236.0	201.0	195.0
Essex & Suffolk	95.9	90.3	76.4	74.3
Cambridge	16.1	16.0	13.1	14.4
Tendring Hundred	5.6	6.4	5.5	5.4
Severn Trent	570.0	632.0	344.0	342.0
South Staffs	83.1	92.9	77.1	76.1
Northumbrian	180.0	190.0	171.0	168.0
Hartlepool	5.0	6.1	4.7	4.7
Yorkshire	494.0	485.0	333.0	329.0
York	11.1	9.9	9.0	9.1
North West	945.0	789.0	510.0	489.0
Folkestone & Dover	14.3	12.7	8.7	8.6
Mid Kent	39.5	39.7	30.1	29.2
Portsmouth	33.4	30.3	30.5	30.3
South East	89.7	94.2	98.9[1]	79.1
Southern	161.0	120.0	95.0	93.0
South West	158.0	142.0	92.0	84.0
Wessex	137.0	133.0	100.0	89.0
Bristol	63.9	65.5	56.4	54.8
Bournemouth & W Hants	27.3	27.5	25.7	23.6
Thames	803.0	1109.0	770.0	665.0
Three Valleys	175.3	168.1	135.0	122.7
North Surrey	29.7	31.4	22.3	22.8
Sutton & East Surrey	34.7	26.1	24.9	24.5
Dŵr Cymru (Welsh Water)	383.0	413.0	306.0	292.0
Dee Valley	13.9	14.6	11.9	11.8
Industry total	4782.0	4981.0	3552.0	3337.4

[1] 1996/1997 figure
As Cholderton & District is a very small company, not all of the information is readily available or appropriate.

Source: Ofwat 1998-1999 Report on Leakage and Water Efficiency

mandatory leakage control targets were introduced and this has resulted in a marked reduction in total levels of leakage. Table 3.2 records total leakage from the respective water companies' supply systems over the last decade. 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 possible future approaches to leakage target setting.

In 1997/98, leakage accounted for just under 25% of the total water put into supply in the North East.

3.2.3 Transfers

A transfer of water from one place to another requires:

- a reliable source of water;
- a means for the transfer (pipeline, river, or canal);
- a demand for the water in another location.

Transferring water from one place to another is relatively expensive. Water is heavy and bulky, which means that its movement can consume much energy, although many of the existing transfers make use of gravity.

Figure 3.6 Strategic water resources infrastructure in the North East Region

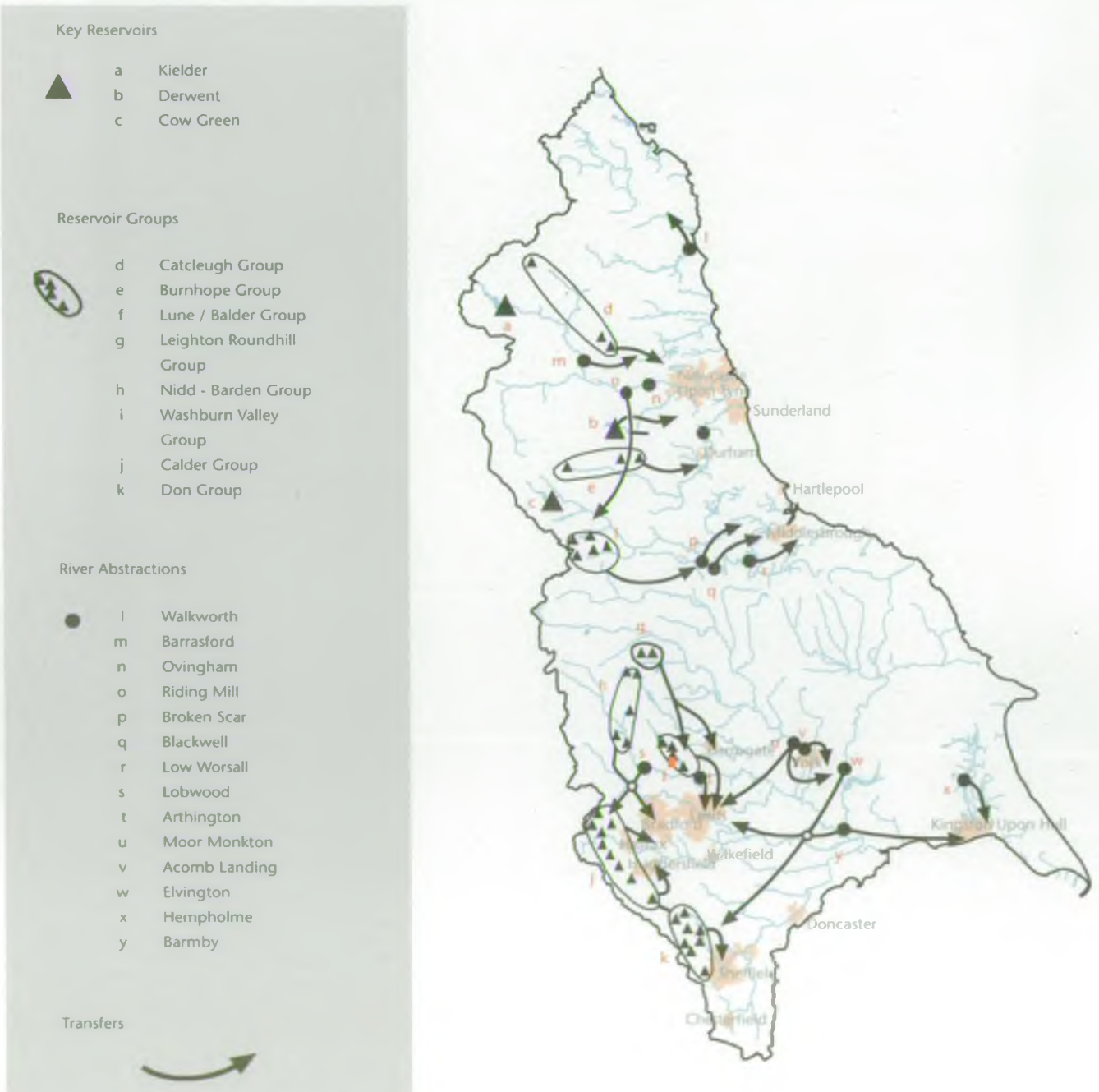


Table 3.3 **Major water transfers in the North East Region**

Transfer source	Type	Destination	Licensed quantity (Ml/d)
River Tyne at Riding Mill (Transfer supported by releases from Kielder Reservoir)	River regulation/pipeline	Weardale & Teeside	Licensed quantity 909 Ml/d Operationally restricted to 540 Ml/d
Catcleugh	Pipeline	Redesdale	60
Upper Nidd	Pipeline	Bradford	109
River Ouse at Moor Monkton	Pipeline	Leeds/Sheffield	68
River Wharfe at Lobwood (Transfer supported by Grimwith Reservoir)	Pipeline	Bradford	93
River Wharfe at Arthington (Transfer supported by Grimwith Reservoir)	Pipeline	Leeds	134
River Derwent at Elvington	Pipeline	Leeds/Sheffield	205
River Derwent at Loftsome	Pipeline	Hull	100
Ladybower Reservoir (Midlands Region)	Pipeline	Sheffield	40

Figure 3.6 illustrates the present strategic water supply infrastructure in the North East. This figure illustrates the considerable extent to which water is transferred about the Region to meet public water supply needs. Table 3.3 lists the more significant transfers occurring within the North East.

3.3 Uses of abstracted water

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

Figure 3.7 breaks down actual abstraction from non-tidal sources into its constituent uses. Public water supply represents the largest use of water that does not involve immediate direct return to the environment.

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. Table 3.4 summaries the non-tidal water used by these sectors in the North East Region.

Figure 3.7 **Non-tidal abstractions in the North East Region in 1997/98**

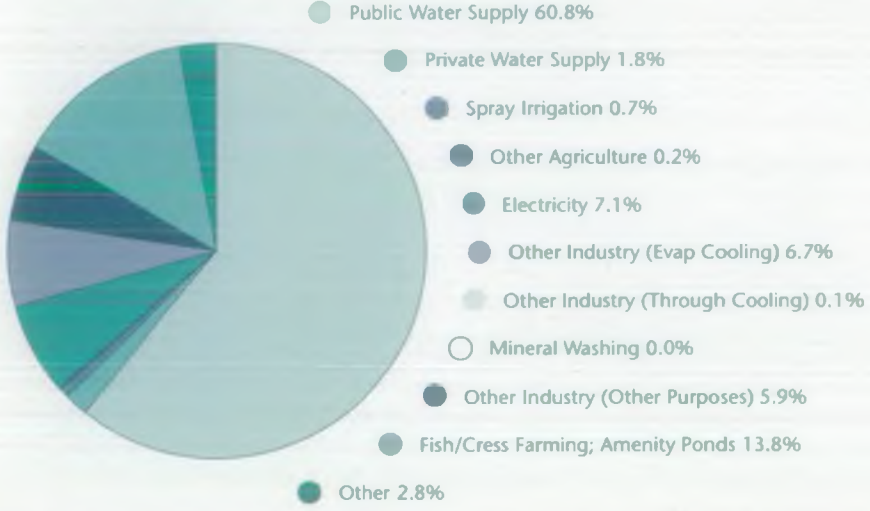


Table 3.4 **Components of demand in the North East Region 1997/98 (in Ml/d)**

Component	Average Demand (Ml/d)		
Direct abstraction primary industry	540		
Spray irrigation	20		
Power generation	260		
Public water supply	**Hartlepool Water**	**Northumbrian Water**	**Yorkshire Water**
Household	14	360	600
Non-household	16	240	330
Leakage	5	190	340
Total public water supply	35	790	1270
Total	2910		

3.3.1 Household water use

The behaviour of individuals drives household water demand. Present average household water consumption across the North East Region varies between 136 and 160 litres/head/day. Figure 3.8 illustrates the range in average household consumption across the Region. In addition, household water consumption differs between measured and unmeasured household customers. Currently, water companies' water-metering penetration levels in the Region range from 1% to 12% of their respective total household customers.

Most water used in households is returned to rivers or the sea through the sewerage network. However, its return may be some way from the original point of abstraction, or even in another catchment; for example water taken from the Kielder system may be discharged over 80 miles away in the Tees catchment.

A small percentage of the population rely on their own water supply, with such supplies accounting for nearly 2% of the total non-tidal water abstracted in the North East. In some rural areas, particularly in North Northumbria and North Yorkshire, private domestic supplies constitute the only viable source of water. Most of the water is returned close to the point of abstraction after use.

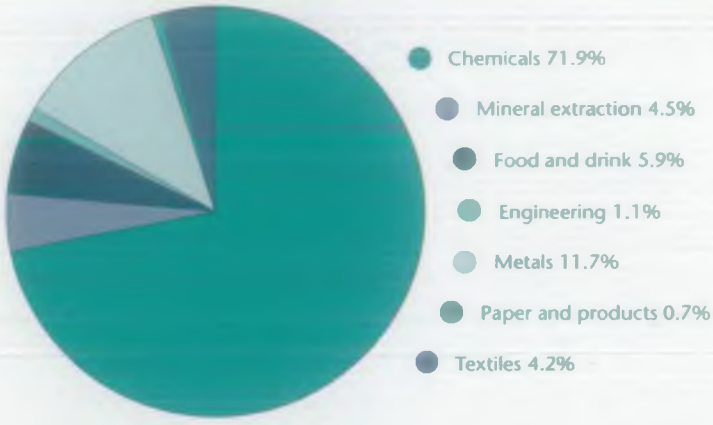
Figure 3.8 **Average per capita consumption of water in the North East Region in 1997/98**

3.3.2 Industry

Industrial demand is very closely linked to the economic trends in the region, and reflects the main economic sectors and their state of buoyancy. Heavy industry is concentrated to the north and south of the Region on Teesside, Tyneside, West and South Yorkshire and Humberside. The major water-reliant industries within the Region include the production of chemicals, steel and other metals, and food and drink, as well as the removal of minerals from the ground. Figure 3.9 classifies the proportion of direct abstraction by primary industry in the North East Region.

The demand for direct abstraction water use and mains supplies varies quite considerably across industrial sectors. Direct abstraction industrial water demand in the Region has risen moderately over the last five years, in contrast to non-household public water supply. Currently, this sector uses on average 540 Ml/day. Non-evaporative cooling accounts for over 40% of this

Figure 3.9 Direct abstraction by primary industry in the North East Region in 1997/98



demand, with the majority returning directly to watercourses below the point of abstraction.

Treated mains water supplies offer a more costly though reliable source of high-quality water. Currently, water companies in the North East Region provide, on average, 590 Ml/day for non-household water consumption.

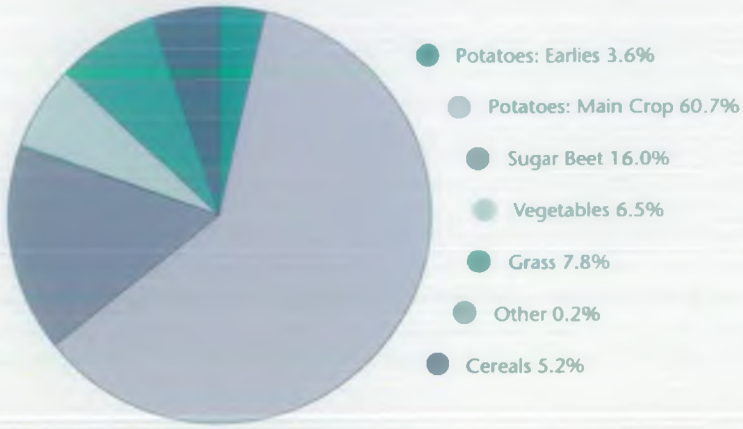
Over the last five years, information on water use and waste minimisation in industry has become widely available. Among others, the Environmental Technology Best Practice Programme (now Envirowise) and the Agency's *The optimum use of water for industry and agriculture dependent on direct abstraction best practice manual* (Environment Agency, 1998) project have both demonstrated clearly that there is significant scope for reducing water consumption in industry and business, with considerable cost savings.

3.3.3 Agriculture

The most significant 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. As spray irrigation is concentrated in summer months, the demand for irrigation can have a particular impact at a time of the year when river flows are at their lowest. Over the last 10 years, the number of winter abstraction licences has increased, with many farmers investing in reservoir storage.

During the summer spray irrigation in the North East Region can consume as much as 170 Ml on a particular day, with the majority centred in the Vale of York and East Ridings. The principal irrigated crops in the North East Region are potatoes and sugar beet. Figure 3.10 shows the proportion of crop irrigated areas. These are the crops where there are significant yield and crop quality benefits from irrigation. Irrigation is a vital element of total crop management, ensuring that farmers meet the crop quality criteria set down by their supermarket and food processing customers. Unreliability of abstraction supply can have a significant impact on the quality and yield of the crop, with farmers potentially incurring a significant reduction in crop value. Although this has a direct effect on the economic viability of the individual farm, the implications are more far-reaching, with indirect impacts on rural employment and the national balance of trade.

Figure 3.10 Proportion of irrigated area in the North East Region in 1997/98



Over the last 5 to 10 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 have limited flexibility to incorporate water efficiency measures into their farm management practices. Only when these specifications change will it prove economically viable for farmers to implement medium-term water efficiency measures.

Apart from spray irrigation, a number of fish farms exist across the Region. Although fish farming returns the majority of water abstracted back to the respective watercourse, the immediate downstream environment may experience reduced flows where historically a considerable proportion of summer river flows are diverted for fish farm intakes.

3.3.4 Power Generation

Power generation is a significant use of water in the North East, with the water primarily used for cooling. Tidal fresh water provides nearly 95% of this demand within the Region. New power stations generally use less water, with some being air-cooled.

As part of its response to climate change, the Government has made a commitment to reduce the UK emissions of greenhouse gases. This includes a requirement that, by 2010, 10% of UK electricity will be produced from renewable sources. The specific implications for water resource management relate to the development of hydropower and new crops for bio-fuel. Currently, hydropower is concentrated in Wales and the South West and North of England.

Hydropower is a clean source of energy. However, care is needed to ensure that its impact on the local river environment is acceptable. The most important issue is the volume of water abstracted and the effect of that loss on the deprived reach. With sensitive design and operation, the local environmental impact can often be minimised.

3.4 Recreational and other uses of water

3.4.1 Navigation

The rivers and canals in the North East have a long history of navigation. Use is now mainly recreational, but many people value the opportunity to travel on the waterways. Navigation is an important use of water. While it is non-consumptive, navigational needs affect water resources in various ways; for instance a secondary role of Barmby Barrage on the river Derwent is to maintain sufficient river levels for boating. Canals often take water from one catchment and transfer it to another, through the use of locks. If canal traffic rises, more water may be needed. The Government has signalled in the draft Water Bill (DETR, 2000e) its intention to bring abstractions to canals into the abstraction licensing system. The exact duties of the Agency and navigation authorities such as British Waterways will need clarification. This points to the need in the future for good forecasts of canal traffic.

The restoration of disused canals or the creation of new navigations can present a significant challenge for the provision of water. The Agency has a Navigation Restoration Policy and works with those considering such restorations.

3.4.2 Angling

Healthy and thriving fish populations require waters with suitable quality, quantity and physical habitat. Rivers throughout the North East support important stocks of migratory, non-migratory and coarse fisheries. For example, the river Tyne is a continually improving salmonid fishery and achieved the highest catch of rod caught salmon in England and Wales during 1999. Nearly 3,570 km of river in the North East is designated as salmonid fishery and 940 km as coarse fishery.

Fish rely on an adequate supply of water throughout their life cycle. Of particular importance is the effect of water flow on the migrations of salmon and sea trout, both downstream as smolts and upstream as returning adults from the sea. Generally, increases in river flow known as spates stimulate these movements and are important in enabling adult fish to negotiate obstructions. The Agency can in some places manage abstractions and control structures to provide artificial spates at times when river flows are low.

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 with a significant economic value to many urban and rural areas.

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

Between 10% and 20% of our native species are considered to be threatened: the native White Clawed Crayfish

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). 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 (Natural Habitats etc.) 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.

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 and consultation with relevant parties.

3.5 Water resources and the environment

The present environment of the North East 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 understand the present status of water resources, we need to identify how much water is needed to protect these environmental assets. To summarise the current position we have produced two maps. They cover summer surface water availability and groundwater availability. All catchments in the North East Region have some winter surface water 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.

Each map shows three categories. These are:

- unsustainable or unacceptable abstraction: current actual abstraction is causing definite or probable environmental problems, or problems are anticipated if abstraction reaches full licensed 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.

These maps represent the strategic position across the North East, based on our established licensing practices, and an understanding of the local hydrology and hydrogeology. They are not intended to prejudge licensing decisions; for any proposed abstraction, further analysis would be needed, including an appropriate evaluation of the environmental impacts of the proposal. Within each mapped area there will be local variations, so the map cannot be used to reach a conclusion for a specific site. The maps are based on the average conditions across large areas. Individual locations may have further environmental needs for water.

Catchment Abstraction Management Strategies (CAMS) will make detailed assessments for each catchment in a six-year programme starting later in 2001. Earlier this year we published the results of our consultation on the CAMS process and in the next few months we will present our proposed process.

Summer surface water

The summer surface water availability map, Figure 3.11, illustrates a number of key points:

- surface water resources are generally healthy within the North East Region. However, there is no strategic summer water available for licensing in the rivers Coquet, Wharfe, Derwent and Hull;
- present spare resources in Kielder Water, of which the rivers Tyne, Wear and Tees are potential recipients, currently guarantee future abstractions from these rivers at any time of the year;
- Kielder Water, although clearly not being used for its original design purpose of meeting industrial demand in the North East, nevertheless now provides considerable security of supply for future water needs and new investment in the North East Region;
- continuing water quality improvements in South and West Yorkshire rivers should provide local potable supplies;
- reliability of any new run of river abstractions, with little or no backup storage or conjunctive use, is not assured.

Winter surface water

All catchments within the North East Region have some winter surface water available for further abstraction. However, abstractions from the river Hull are almost at their winter threshold.

Groundwater

The groundwater availability map, Figure 3.12, illustrates that in the major aquifers there are generally spare groundwater resources available. However, the section of the Sherwood Sandstone aquifer that extends from Selby to Nottingham, is over-allocated and may be over-abstracted. Furthermore, parts of the Corallian Limestone and Chalk aquifers in the south east of the Region are fully committed.

As Figures 3.11 and 3.12 largely indicate that some additional water may be available across the Region, we have felt it necessary to provide further clarity on summer surface water availability and groundwater availability. Details are described in Appendix 1.

Figure 3.11 **Current indicative availability: summer surface water in the North East Region**

Figure 3.12 **Current indicative availability: groundwater in the North East Region**

4 Pressures on water resources

Whilst we know most of the current pressures on water resources and the environment, there are many aspects of the future that are uncertain. These include, for example, the effects of climate change and societal change. How society values the environment and chooses to use water in future will determine the type and size of demands placed on water resources. Population pressures and land use change will also have an effect on the way that water is used.

4.1 Environmental needs

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).

Section 3.5 identified strategic areas where we consider that current licensed abstraction is causing environmental problems, or that it would do so if actual abstraction reached full licensed volumes. Of particular concern is the section of the Sherwood Sandstone aquifer that extends from Selby to Nottingham. In addition, some abstractions may be causing environmental problems because of their location near to a site that is especially vulnerable. In these cases, the total amount of water abstracted from the catchment is often acceptable, but the location of the take or the abstraction regime may need modification. Other catchments are approaching the total limit of abstraction, so that more use of water would lead to general environmental degradation.

Our strategy allows for the resolution of established problems. 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). These sites include the Lower Derwent Valley and Hatfield and Thorne Moors. We have also implemented the Restoring Sustainable Abstraction Programme (RSAP). This programme catalogued all river and wetland sites that potentially suffer from related abstractions, and established a future strategy to investigate these implications.

Figure 4.1 identifies the 51 RSAP sites in the North East, which include 40 Habitats Directive sites and seven Sites of Special Scientific Interest. Completion of these studies depends on Regional prioritisation, existing action plans in place for the sites and funding commitments. However, the deadline for assessing urgent sites is 31 March 2003. The programme is ongoing and will enable the inclusion of new sites in the future. In addition, the programme ensures a consistent approach, providing effective management and allocation of future resources.

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 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 us in formulating a robust set of scenarios for water use and resource management we have been guided by the Foresight "Environmental Futures" scenarios (DTI, 1999). These were developed for the Government's Department of Trade and Industry (DTI). These scenarios are intended to inform and stimulate debate

Figure 4.1 **Restoring sustainable abstraction sites in the North East Region**

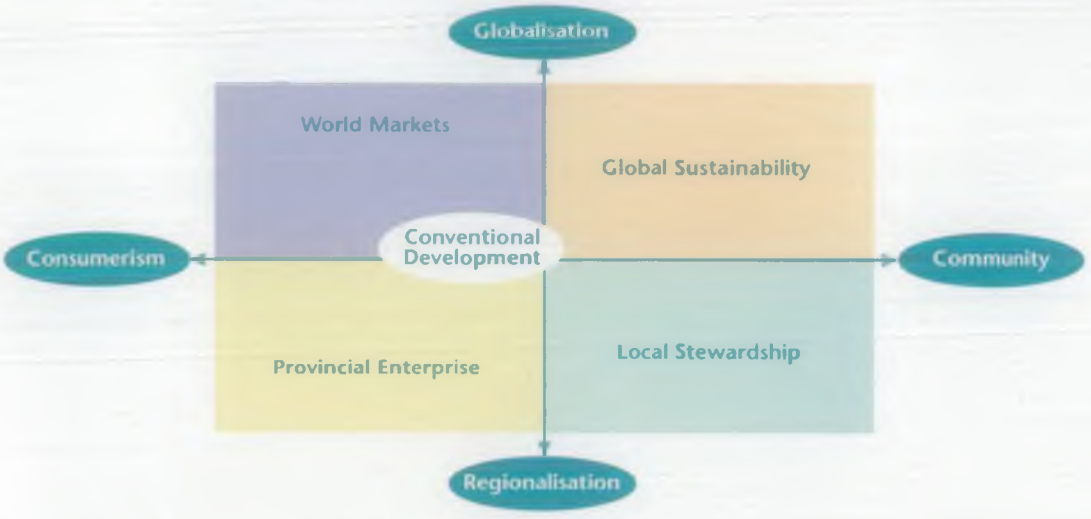
1 Lower Derwent
2 Hatfield & Thorne Moors
3 Ford Moss
4 Holburn Lake & Moss
5 Roman Wall Loughs
6 Border Mires, Kielder to Butterburn
7 Flamborough Head & Bempton Cliffs
8 Humber Flats, Marshes and Coast
9 Teesmouth & Cleveland Coast
10 Till Riverbanks
11 Beast Cliff
12 Berwickshire & North Northumberland Coast
13 Bollihope, Pikestone
14 Castle Eden Dean
15 Coquet Island
16 Craven Limestone Complex
17 Denby Grange Colliery Ponds
18 Durham Coast
19 East Arncliffe
20 Ellerswood & Sand Dale
21 Farne Islands
22 Hornsea Mere
23 Ingleborough Complex
24 Kirk Deighton
25 Lindisfarne
26 Moor House / Upper Teesdale
27 Newham Fen
28 North Northumberland Dunes
29 North Pennine Dales Meadows
30 North Pennine Moors
31 Northumbria Coast
32 North York Moors
33 Ox Close
34 Skipwith Common
35 South Pennine Moors
36 Strensall Common
37 Thrislington
38 Tweed Estuary
39 Tyne & Allen River Gravels
40 Tyne & Nent
41 West Beck / River Hull
42 Newbald Becksies
43 Mickletown Ings
44 Hell Kettles
45 Low Gill Moor Wetlands
46 Pocklington Canal
47 Hulam Fen
48 River Ouse
49 River Wharfe
50 River Ure
51 Upper Wharfedale

among businesses, regulators, and Government departments about the environment and to 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. Figure 4.2 portrays this principle. The result is a set of four scenarios, each of which characterises one way in which England and Wales may develop over the next 25 to 50 years.

They can be summarised as follows:

- **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.

Figure 4.2 Foresight scenarios



- **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. Table 4.1 describes these characteristics.

The water resources demand scenarios that result from this work are discussed in Appendix 3. 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

Table 4.1 Foresight Scenario characteristics

	World Markets	Global Sustainability	Provincial Enterprise	Local Stewardship
Values	Consumerist	Conservationist	Individualist	Conservationist
Governance	Globalised	Globalised	National	Regional/National
UK GDP (pa)	3%	2%	1.5%	1%
Equity	Declines	Improves	Declines	Improves
Fast growing sectors	Health care, leisure, financial services	Business services, IT, household services	Private health care and education, maintenance services	Small-scale intensive manufacturing, locally based financial and other services, small-scale agriculture
Declining sectors	Manufacturing, agriculture	Resource intensive agriculture and manufacturing	High-tech specialised services, financial services	Retailing, leisure and tourism
Water demand	Increases	Declines	Stable	Declines
Environmental issues and priorities	Environmental improvement not a priority. Emphasis on issues which impact on the individual or local area	Sustainable development accorded high political priority. Resource use efficiency drives policy	Low priority placed on the environment. Low levels of investment create significant environmental problems	Sustainable development closely integrated into all areas of decision making. Effective community action resolves local environmental problems

Source: DTI, (March 1999) Environmental Futures, Office of Science and Technology, London.

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

4.3

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 compatible 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 involve unnecessary or inadequate solutions.

4.4

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 flow 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 will 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 more 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.

In this strategy, we will assume, 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 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.

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

4.5

Population and household size

The latest Government projections show an increase of 3.3 million households in England and Wales between 1996 and 2016. This is largely due to the trend towards smaller household size. Total population is also predicted to increase by 2.8 million over the same period.

In developing the strategies, 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. These show that between 1997 and 2025 the North East Region may expect a household growth of 300,000 with the population increasing by 100,000.

4.6

Land use

Land use is highly variable across the Region. The major conurbations of Tyneside, Teesside, West Yorkshire and South Yorkshire are associated with coal mining and heavy industry, which developed during Victorian times. Arable farming dominates the Vale of York, Yorkshire Wolds, the Vale of Pickering and other valley and coastal areas. The Holderness region of East Yorkshire has the highest concentration of piggeries in the UK, whereas in the Pennines and other upland areas sheep farming predominates.

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, and as such has highlighted potential impacts relevant to the North East.

Impacts through physical changes

Farmers have previously received subsidies to drain upland areas by means of artificial drainage channels, known as moorland grips. Initial studies indicate that the immediate downstream watercourses may experience increased flows; however, this effect diminishes further downstream. The Upper Wharfedale "Best Practice" project is assessing the effects of blocking these grips.

The development of reservoirs in the Region's upland catchments has impacted on downstream watercourses. For instance, following the construction of Kielder Water, the river North Tyne is now a highly regulated river. In addition to safeguarding public water supplies, some individual or groups of reservoirs make releases to augment downstream flows. These flows prove an important and sometimes vital component in sustaining

aquatic communities, particularly over the summer months.

Past engineering works have altered river channels. Such activities have affected river flow regimes in different ways, for instance the straightening of river channels accelerates the movement of water. In certain cases, these practices have been reversed, for instance the river Skerne restoration project.

Urban areas have a high proportion of impermeable surfaces, which impede the movement of water into soils and rocks. This impacts on local groundwater levels, as drainage systems remove excess water quickly to nearby watercourses. Furthermore, the installation of drains in riparian fields speeds up the movement of rainfall into streams and rivers. The Agency has co-operated with other bodies in investigating alternative approaches to urban drainage; this has resulted in the 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.

Impacts of land use on water quality

It is imperative that water resources are not lost through long-term pollution. Past mining activities still affect water resources. Deep mining has left a legacy of poor groundwater quality in parts of the Coal Measures. As dewatering from deep mines ceases and subsequently flood, poor-quality water is likely to find its way towards the surface. Unless appropriate measures are taken, this may cause contamination of surface waters or nearby aquifers.

Changes in farming practices and the leaching of agricultural fertilisers have resulted in rising nitrate levels. Specific areas where the reduction of nitrate levels was feasible through fertiliser controls were designated Nitrate Sensitive Areas. These included Kilham, Newbald and Springwell on the Chalk aquifer and Hatfield, Pollington and Carlton on the Sherwood Sandstone aquifer. Farmers in these areas were encouraged to join a voluntary MAFF scheme designed to change farming practice and limit the amount of nitrate leached. This scheme has now ceased.

The Agency has also identified Nitrate Vulnerable Zones. These zones cover the Nitrate Sensitive Areas as well as additional sources. As of December 1998, farmers in these areas must comply with a Statutory code of practice on fertiliser usage. The Agency enforces this practice. Continuation of the current increase in nitrate levels in the Chalk and Sherwood Sandstone aquifers will cause significant water quality problems for groundwater abstractions and river sources dependant on groundwater from these aquifers.

Overgrazing, specifically in upland catchments, exacerbates soil erosion. The resulting sediment is often deposited in river channels, which affects width, depth and ultimately the river levels. In addition, sedimentation will alter the water quality and may cover river gravels, which would otherwise be valuable spawning grounds for certain fish species.

It is imperative that water resources are not lost through long term pollution: the impact of old mine workings is clear on Howley Beck

5 Quantifying the pressures on water resources

In preceding chapters we have set out the framework in which water resources are managed and set out the principles that underpin this strategy. We have summarised the current state of water resources and the pressures that 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 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 as the extra water needed compared to that which is used now. We consider the additional demand under the following headings:

- household demand;
- 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 demand 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 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 the scenarios

We have considered in detail the drivers of water demand and how these vary for each scenario. Table 5.1 summarises the influence of the 4 scenarios on each driver of water demand. 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 and 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 have been considered for each scenario. Using the results of the National Metering Trials to guide our assumptions, metering of households provides reductions in consumption ranging from 3% to 21% (National Metering Trials Working Group). The proportion of metering varies across the scenarios.

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)	Increased 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

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 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 have 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 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.

5.3

Scenario demand in 2010 and 2025

5.3.1 Differences in demand

Figure 5.1 shows the regional results of this forecasting work in 2010 and 2025. It can be seen that, by 2010, the differences between scenarios are small, reflecting the slow rate of divergence from today's values. By 2025, demands vary significantly, with increases in total demand for water under two of the scenarios, but decreases in the other two. Within this, the different components behave in different ways.

Household demand

The scenarios show a wide divergence in potential regional household demands by 2025, with most of the changes developing after 2010. Household water use is set to rise most under Scenario Alpha, with an increase of 34% between 1997 and 2025. Reductions in water use under Scenarios Gamma and Delta illustrate the range of potential savings that can be achieved.

Leakage

The large leakage rise after 2010 under Scenario Alpha illustrates the possible outcome of a passive approach taken in controlling leakage. Clearly such a practice would threaten the security of water supplies. The projections under Scenarios Gamma and Delta indicate further leakage savings that can be achieved beyond current targets.

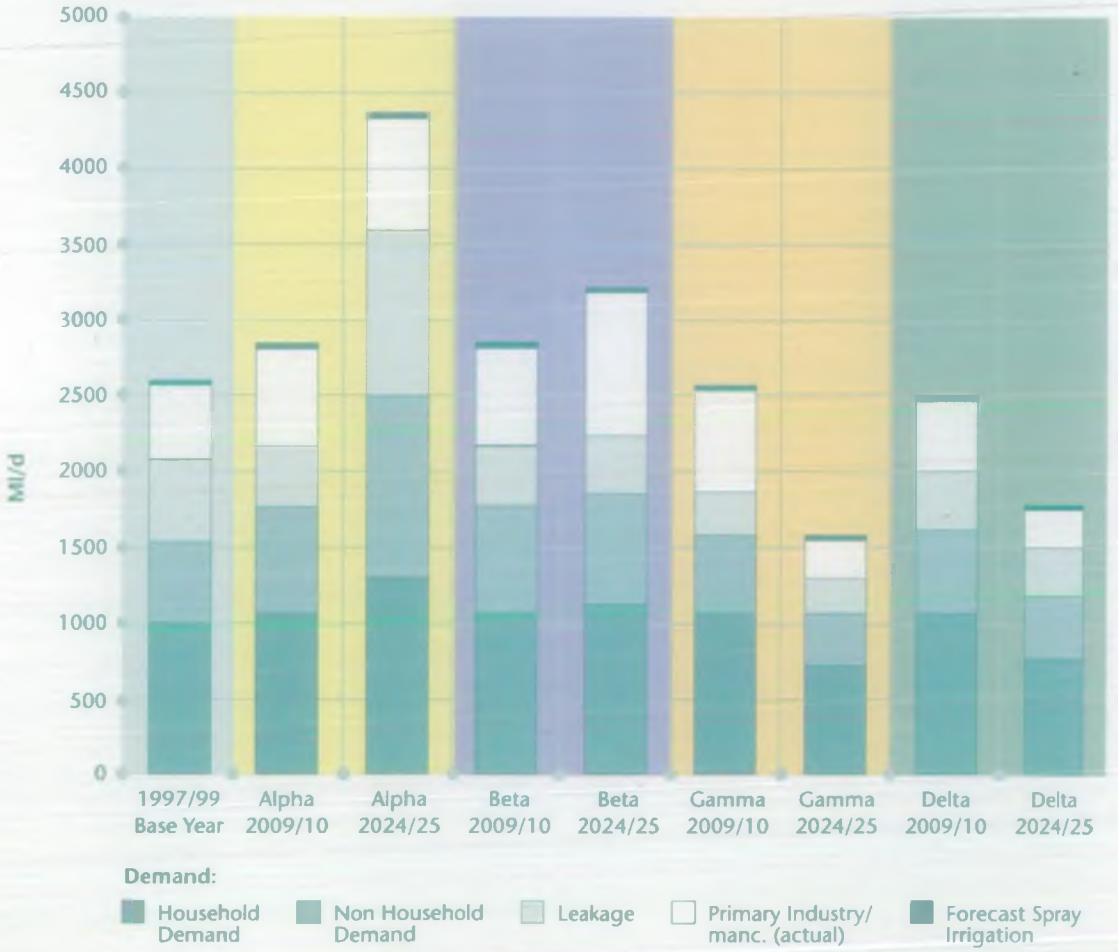
Industry and commerce

The growth in demand for this sector is most noticeable in Scenario Beta, with non-household public water supplies increasing by 36% and direct abstraction industrial demands rising by 39% by 2025. Both Scenarios Gamma and Delta show a potential decrease in water demand for this sector.

Spray irrigation

The demand for spray irrigation in the North East is expected to rise over the next 10 years for all four scenarios. This trend is set to continue for Scenarios Alpha and Beta between 2010 and 2025, with the

Figure 5.1 Demand by scenario in 2010 and 2025 for the North East Region



growth of 58% and 38% by 2025 respectively. Under Scenarios Gamma and Delta this initial growth will taper off by 2025.

5.3.2 Climate change

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 effect on public water supply demand regionally is an increase of about 17 Ml/d by 2025.

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 for spray irrigation. We will revise our forecasts in light of the results of the DETR Climate change and demand study.

Summary

This scenario approach illustrates the realistic range of possible future demands for water that may arise in the North East. Despite the continued underlying economic growth pressures, the projections for the respective sectors show that future demands for water may rise or decline over the next 25 years, depending on the outcomes of choices made by society.

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. A strategy aimed at sustainable use of water would not be complete if it left such a situation untouched.

We have therefore estimated, based on knowledge and judgement, the extent of licence curtailment that will be necessary in the North East Region. We estimate that a reduction in licensed quantities of up to 25 Ml/d

The scenario approach illustrates the realistic range of possible future demands for water: recreation alongside industry in Blyth Harbour, Northumberland

may be required to achieve a sustainable resource allocation across the whole region. In practice, the impact of these changes on individual abstractors may be offset by more innovative ways of taking water from the respective environment.

Our strategy assumes that this reduction of existing abstractions will be necessary in the period of the strategy. We will work to demonstrate the justification for doing so. This need represents a further demand to be set against available resources.

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.

In the next chapter we look at the methods used to identify options and recommend solutions.

6 Options and option 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

We have considered a wide range of potential strategic options for managing water resources. These include both options that increase supplies and options that reduce demand. The types of option considered are listed in Table 6.1. These options build on previous strategies and the water companies' Water Resources Plans, where appropriate.

Potential resource development options include:

- enhancing groundwater storage, for example through aquifer artificial recharge and recovery, whereby treated water is pumped into an aquifer during wet periods and is then available during times of need;

The twin track approach takes a balanced view, seeking the efficient use of water, while bringing forward timely resource development proposals in the North East

- increasing surface water storage capacity in the south of the Region, for example bankside storage on the river Ouse;
- new surface water abstractions with backup storage, for example a river Aire abstraction with bankside storage;
- transferring water both within the region, for example from the river Tees to Yorkshire, and from outside the region, for example from the river Trent to South Yorkshire.

All of the resource options considered would need specific investigation if they were to be progressed further.

Demand management options cover a range of generic measures, from improving leakage control through to water use minimisation schemes. Clearly, 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.

6.2 Tools for considering options and strategies

In most cases there is a range of feasible water resources management options, each with 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;

Table 6.1 Options considered in the North East Region

Type	
Resource Development	**Regional Options**
New reservoir	Bankside storage on River Ouse
Surface water abstraction	Abstraction from River Aire near Keighley
	Abstraction from River Aire upstream of Knostrop supported by bankside storage
	Abstraction from River Trent at Newark
Aquifer artificial recharge and recovery (AARR)	AARR in the Sherwood Sandstone
River transfer	Transfer from River Tees to River Wiske
Pipeline transfer	Transfer from River Tees to Yorkshire Water's distribution system
Demand Management	
Leakage reduction	
Rainwater use (non-potable)	
Greywater use (non-potable)	
Water use minimisation for industry and commerce	
White goods subsidies	
Retrofit of toilets to dual flush/interruptible flush	
Increased household metering	
Tariffs for measured charges	

- 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.

The Agency is a competent authority under the Habitats Directive. We have considered the requirements of the 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 6.2 applies this framework to the different resource management and generic demand 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:

Table 6.2 **Uncertainty, constraints and opportunities framework for the North East Region**

Option			Resource Value [Ml/d]	Time to implement [yr]	Estimated Cost	Renewal period [yr]	Uncertainties					Opportunities					Constraints			
Type							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
Resource Development	Reservoir	Bankside storage on River Ouse	120	15-20	◐	100	◐	●	○	○	◐	●	◐	●	●	●	◐	◐	◐	◐
	Surface Abstraction	Abstraction from Aire near Keighley	20	10	●	-	○	○	○	○	○	◐	○	○	○	○	○	○	◐	●
		Abstraction from Aire upstream of Knostrop supported by bankside storage	60	>15	○	-	◐	◐	○	◐	◐	◐	◐	●	○	●	○	◐	○	◐
		Abstraction from River Trent at Newark	35	10-15	●	-	●	●	◐	●	●	○	◐	○	○	○	○	◐	○	●
	Groundwater	Aquifer artificial recharge and recovery in the Sherwood Sandstone	30	5	○	40	◐	○	○	◐	○	◐	○	●	○	○	◐	○	○	◐
	Transfers	Transfer from River Tees to River Wiske	35	5	○	50	●	●	○	○	◐	◐	○	●	◐	○	◐	●	●	◐
		Transfer from River Tees to Yorkshire Water's distribution system	150	5-10	○	50	●	◐	◐	○	●	●	○	●	○	○	◐	◐	◐	●
	Demand Management	Improved leakage control	up to 150	1-5	(1)	-	○	○	○	◐	◐	●	○	●	○	○	○	○	○	○
		Rainwater use (non-potable)	1-5	1-3	●	15	◐	◐	○	◐	○	○	○	○	○	◐	◐	●	○	○
		Greywater use (non-potable)	1-5	1-3	●	15	●	●	○	○	○	○	○	●	○	○	●	●	○	○
		Water use minimisation for industry and commerce	55	1	(2)	-	○	○	○	◐	○	●	○	●	○	○	○	◐	○	○
		White goods subsidies	30	1-3	●	10	○	●	○	●	○	●	○	●	○	○	◐	◐	○	○
		Retrofit of toilets to dual flush/interruptible flush	15-20	-	◐	15	◐	◐	○	◐	○	●	○	●	○	○	◐	●	◐	○
		Increased household metering	up to 50	10	●	10	◐	●	○	●	○	●	○	●	○	○	●	●	○	○
		Tariffs for measured charges	5	10+	●	-	●	●	○	●	○	●	○	●	○	○	●	●	○	○

Note (1) Leakage reduction costs range from low to high, depending on the level of activity required
Note (2) Water use minimisation costs range from low to high depending on the level of activity required

● High ◐ Medium ○ Low

- 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 6.3. An independent assessor carried out the appraisal. Table 6.4 reports their appraisal of the regional options.

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 above, the exact nature of climate change is uncertain. Assuming the worst can be

Table 6.3 **Sustainability criteria applied in the water resource industry**

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.

Table 6.4 Sustainability appraisal for the proposed options for the North East Region

Proposed options		Sustainability Themes							
		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	
	Resource value Ml/d	Positive impact	Negative impact	Positive impact	Negative impact	Positive impact	Negative impact	Positive impact	Negative impact
Abstraction from River Aire upstream of Knostrup supported by bankside storage	60	(+)	-	+	(-)	+	0	+	-
Water use minimisation	55	+	0	++	0	0	0	+	0
Increased household metering	30	+	0	+	0	+	(-)	+	-
Aquifer artificial recharge and recovery in the Sherwood Sandstone	30	+	(-)	+	0	0	0	+	0
Combination of household water efficiency measures and leakage savings (incl. Toilet retrofits and white goods)	29	+	0	++	0	+	0	+	-

++ = 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

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 this financial information and place it on a reasonably consistent basis. It is particularly important to be careful with comparisons between demand management and resource development options. 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. Table 6.2 highlights the appropriate costs. In the longer term, we will seek to ensure that more cost information is placed in the public domain.

We have not tried to pursue a detailed application of environmental economics. We have considered this detailed investigation to be inappropriate at this stage of strategy development, although it would be an essential part in the development of schemes to implement our recommendations. Sustainability appraisal considers the components of environmental cost alongside other aspects in a way that is appropriate at this stage.

6.6

Building a strategy

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

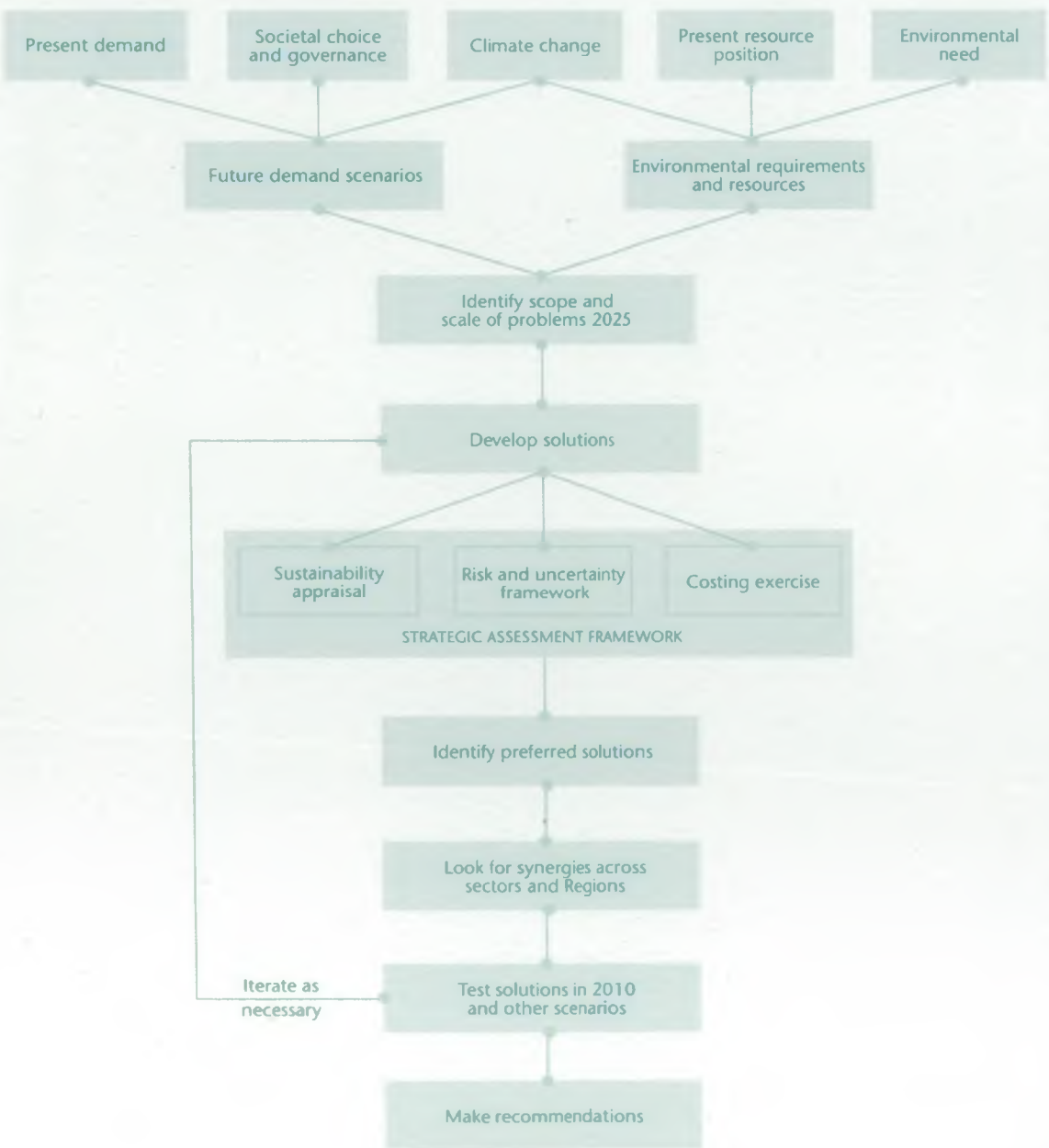
- identify the options available for meeting any gap between supply and demand. These include both demand management and resource development;
- for 25 years ahead, consider the biggest incremental demand;
- identify a first solution (made up of a set of options) for this incremental demand;
- look at the strengths and weaknesses of this solution; as indicated by the sustainability appraisal, application of risks and uncertainties framework and 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.

The strategy development process is illustrated in Figure 6.1.

Our strategy is based on the objectives and values set out in Chapters 1 and 2. It involves value judgements with which others may not agree. We recognise that costs will influence the delivery of any strategy and we have taken likely costs into account in considering different strategy options. 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 proposed actions.

Figure 6.1 The strategy development process



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

National and Regional water resources strategies

This strategy has been developed as part of a suite of strategies for England and Wales. The process identifies and considers any inter-Regional transfer opportunities or other scope for co-operation.

For the North East Region, our recommendations consist of a combination of resource developments and demand management. Table 7.1 lists these recommendations, together with some alternative actions should our preferred options prove inappropriate in some way.

Although we have considered transferring water south into Yorkshire Water's supply system, supported by Kielder Water, the environmental impacts and costs of such a scheme make local options more attractive. Providing that our water resources are managed carefully, we believe that a Kielder supported transfer southwards will not be necessary over the next 25 years.

We propose:

- minor resource development, most notably enhancing groundwater storage through aquifer artificial recharge and recovery of the Sherwood Sandstone and a river Aire abstraction supported by bankside storage. This would give an approximate yield of 90 Ml/day;
- water use minimisation and demand management options for domestic, industrial and agricultural water users. It is estimated that this would deliver water savings of up to 85 Ml/day.

Figures 7.1 and 7.2 show our proposed solutions for the North East in 2010 and 2025, respectively. 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 for either 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 in the North East for both 2010 and 2025. This does not mean that water can be made available for all uses at all times of year; for example, in some areas, the provision of water for spray irrigation is becoming increasingly problematical. The strategy also 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. This combination of prudent demand management and development of additional resources is a twin-track approach.

In some scenarios, our proposed strategy gives a significant surplus of supply over demand. 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

Table 7.1 **Strategy for the North East Region**

For public water supply, by 2010

We expect to see water savings of up to 39 Ml/d and have allowed for resource developments of up to 30 Ml/d.

- Demand management options including metering and water efficiency measures.
- Groundwater resource developments through aquifer artificial recharge and recovery in the Sherwood Sandstone.

For public water supply, by 2025

We expect to see water savings[1] of up to 85 Ml/d and have allowed for resource developments of up to 90 Ml/d.

- Demand management options including increased household metering and water efficiency measures.
- Surface water resource developments through a take on the River Aire upstream of Knostrop supported by bankside storage.

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

For agriculture, by 2025

- Optimise use of existing licensed allocations through improved water efficiency.
- Local groundwater development, where available.
- Development of local winter storage reservoirs.

For industry and commerce, by 2025

- Optimise use of existing licensed allocations through water use minimisation initiatives.
- Local groundwater resource developments, where available.
- Utilise existing surface water resource developments, for instance Kielder Water.

For the environment

- Reduction of 25 Ml/d in authorised quantities to move towards sustainable levels of abstraction.

Other options under consideration

- A Kielder-supported transfer south into the Yorkshire Water supply system.

Other significant uncertainties

- On-going and further investigations to confirm the environmental needs.

Figure 7.1 **Proposed solutions for 2010 for the North East Region**

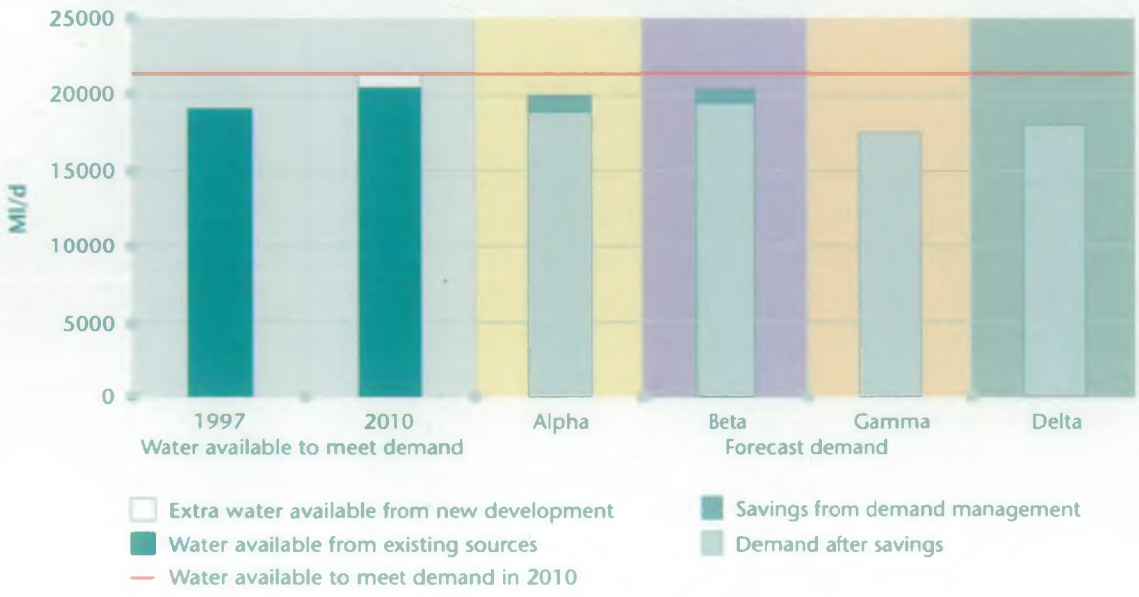


Figure 7.2 **Proposed solutions for 2025 for the North East Region**

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 possibility of such changes. However, these scenarios do illustrate that there is real potential for further efficiencies in water use.

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.

7.2 Public water supply

7.2.1 Enhancing resources

The vulnerability of public water supply to dry periods and potential growth in demands means that over the period of this strategy some resource development should be required, particularly in the south of the Region. It is essential that such schemes offer flexibility in safeguarding against the various pressures facing public water supply. We recommend that **where new or existing developments are not fully utilised, water companies should consider sharing this water with others (Action A1).**

Our resource-side recommendations involve making the most of existing resources, for example maximising the conjunctive use of the supply systems. In the first instance, we support the concept of aquifer artificial recharge and recovery, whereby treated water is pumped into an aquifer during wet periods. This process stores water, which is then available during times of need. Yorkshire Water is currently undertaking trials in the Sherwood Sandstone aquifer near Loftsome bridge. While initial results prove positive, there is still some uncertainty regarding the further development of such schemes, and both Yorkshire Water and the Agency will need to undertake further work.

Furthermore, the continual improvements in water quality of South and West Yorkshire rivers could provide future potential potable water supplies. In particular, the river Aire together with the development of storage close to the river makes an attractive supply option for local water demands.

Local development options and wastewater re-use schemes provide valuable local water supplies. The Agency considers properly and appropriately treated wastewater to be an important and sometimes undervalued element of our water resource. It can support a healthy river environment and provide an

associated amenity, but also can provide for a range of re-uses to support our quality of life and sustainable economic activity.

7.2.2 Water efficiency 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:

- toilet use can be reduced by almost 10 l/h/d by the 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.

Currently in the North East, individuals use around 142 litres of water each day, which is slightly below the average for England and Wales. An increase of water use minimisation in the home along with a general improvement in awareness of the value of water will reduce household water demand. The techniques and equipment, such as low-use showerheads, water-efficient washing machines and drought-tolerant gardens, are all well established. Increased metering of houses will also provide an incentive to householders to value water and therefore use less.

People need to appreciate the benefits of saving water. Influencing people's behaviour takes time and effort, and we believe that that energetic facilitation is essential. Water companies have a duty to take an active role in promoting water efficiency, and the draft Water Bill asks companies to consider water conservation in their own operations.

We have calculated that household water use minimisation in the North East could save in excess of 30 Ml/day over the next 25 years under Scenario Alpha. It is essential that this saving is delivered and maintained to protect the security of public water supplies.

The Water Supply (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 the Regulations have to be set within the context of the European single market, it is important that **Government should keep the 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 (Action A2).**

In the North East, nearly 40% 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 in excess of 50 Ml/day over the next 25 years in Scenario Alpha. 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 way of managing water 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 the 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 by commerce (including amenity, sport and leisure uses), industry and agriculture. 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 and monitor the results of this work. (Action A4).**

The Agency will continue to support and encourage water efficiency initiatives. **The Agency will work nationally and locally 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 **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. In much of the North East we believe that in the longer term further progress on leakage control will be appropriate. 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, detailed in Appendix 4. 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. If this progress is not achieved, further demand management or resource development will be necessary.

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. **The system for setting annual leakage targets should be maintained and developed (Action A9).** The draft Water Bill proposes that the Secretary of State should be able to set standards of performance that could apply, for example, to setting leakage targets (DETR, 2000e). **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 the North East 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 that may present opportunities for further reductions.

7.2.4 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. 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. 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. 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. This means, for example, that the 300,000 new homes that are envisaged regionally between 1997 and 2025 will all have meters.

We believe that, in most of the North East, metering should reach between half and three-quarters of households by 2025. By making it normal for water use to be measured, a culture of awareness will be developed. This will place the North East 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, unattended sprinkler users and targeted metering of potentially large water users when properties change hands.

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.

7.2.5 Summary

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.

The 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. Unfortunately, much of the current and future demand for irrigation water is in the south east of the Region, where local resources are approaching their summer licensed threshold.

A potential option is for agriculture, commerce and industry to benefit from schemes that are developed principally for public water supply. Given appropriate agreements, it may be possible for agriculture to benefit in the short term from public water supply schemes before they are fully utilised. Where possible, **the Agency will seek to identify opportunities to make water available for agricultural use from existing and new developments (Action A13).**

The Agency will encourage farmers to adopt good practice in water use around the farm (Action A14). We will work in partnership with the National Farmers Union and central Government. This work needs to allow for radical changes in cropping patterns as well as for adjustments between traditional food crops. **The Agency will work with agriculture to continue 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

Agricultural demand for water is likely to increase in the North East

certification that their processes have undergone a water use 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 *The optimum use of water in industry and agriculture dependent on direct abstraction: best practice manual* (Environment 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. 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 (DETR, 2000e) would facilitate it. The Government proposed other facilitation measures in its April 2000 consultation paper on economic instruments (DETR, 2000c) in relation to water abstraction and its decisions on those are expected early in 2001.

The Agency also recognises that the big retail chains and food processors are making product quality demands on farmers that involve more irrigation. **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 (Action A20).**

7.4 Industry and commerce

7.4.1 Direct abstraction

Increases in industrial demand are hard to identify long in advance, and by and large will be local in nature. We do not predict significant independent development of new sources by the industrial or commercial sectors. As new demands do arise, options will include supply from water company resources, direct abstraction if available, or opportunistic use of spare water from a nearby declining demand through trading.

Where abstraction comes directly from rivers or groundwater we make the same recommendation as in section 7.2.2 above: **water efficiency should be positively encouraged (Action A4).**

For direct abstractors, the economics of this are less obvious. The abstractors face only abstraction charges rather than the full cost of public water supply, although they too face effluent treatment charges. The monetary savings will depend partly on the degree to which the water has to be treated. However, studies have shown that most commerce and industry can make savings that still pay for themselves within the year even when the abstraction is directly from the environment. Saving water in this way can have the added benefit of reducing other raw material costs, as well as the volume of water that has to be discharged.

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.

7.4.2 Hydropower

In recent years, interest in the development of hydropower schemes has increased. For hydropower schemes, as with all other abstraction proposals, we will endeavour to work closely with planning authorities and conservation organisations in order to try to prevent conflicts or duplication between regulators. Hydropower developers need to consider carefully the design of their schemes and the possible environmental impacts. **The Agency will approach proposals for hydropower schemes positively and work constructively with the developers to achieve viable schemes (Action A21).**

7.5 Environment

In Chapters 3 and 4 we showed the importance of water for the environment, fisheries, navigation and recreation.

The Agency will work to clarify environmental needs, paying particular attention to those areas identified as in need of remediation 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).

The Agency will promote greater understanding of the value of water environment: canoeing is a popular pastime in the North East

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

One important question concerns the need for the large-scale transfer of water around the North East. Transfers of water already feature in parts of our strategy. There may be further proposals for new transfers; we will consider these where they can make a positive contribution to prudent water resources management. In particular we will consider carefully any specific proposals that British Waterways puts forward. **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 watercourse, in terms of both its flow regime and quality. There are particular concerns associated with transferring water of different qualities, and with the movement of alien species and of plant, animal and fish diseases between different river habitats.

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. 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 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

Saving water needs real encouragement. 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 of an existing organisation. The organisation would undertake promotional work and the active identification and implementation of water efficiency measures. **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 identified areas where further research is required. A full list of research topic areas can be found in Appendix 5.

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

7.9 Conclusion

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 carefully. Any additional abstraction of water from the environment has the potential to pose a

threat to habitats and therefore to plant and animal species. We have considered only those schemes where the effects are likely to be acceptable or, in the minority of cases where their effects can be mitigated successfully. All these schemes would need further investigation, and any alternative schemes should be evaluated using similar criteria.

Our strategy provides significant environmental benefits in those areas identified as over-abstracted in section 3.5. 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. Independent consultants, employed by the Agency, have carried out the appraisal. Their unedited summary of the options for the North East Region is shown in Table 7.2. It shows that the contribution to sustainable development is generally positive, but that the strategy is weak in its contribution to social equity. As a result, we have addressed this aspect in some of our supporting recommendations.

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.

Table 7.2 **Summary of sustainability appraisal for the North East Region**

The proposed strategy for the North East generally measures up well in terms of sustainable development. The emphasis on demand management options and higher water efficiency levels will make a significant contribution to the prudent use of natural resources. A positive contribution is also expected from all options in terms of environmental protection.
Some potential negative impacts are associated with the option of abstraction from the River Aire (and the related bankside storage scheme), mainly during the construction phase and through reduced levels of dilution downstream of the abstraction point. These potential impacts are balanced out by environmental benefits relating to the River Aire abstraction such as additional storage capacity which will help ensure efficient use of available water resources and the creation of water habitat through the use of a disused opencast mine on a brownfield site.
All options make positive contributions to economic growth and employment; although there are also clearly financial costs associated with construction, operation and maintenance, for example, pumping and treatment costs of the River Aire options. Financial investment will also be required in relation to household metering and efficiency measures. Three of the five options also generate positive impacts in terms of social progress; for example, the creation of a reservoir in the disused open cast mine linked to the River Aire option could provide recreational opportunities.

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 the North East 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. 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 summarise our recommendations. 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 (DETR, 2000e).

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 of opportunities for research and investigation to contribute to better informed decisions during the life of this strategy.

In Table 8.1 we summarise our recommendations and the groups that are involved in their implementation.

This strategy is the Agency's present considered view of the actions that are required to ensure the sustainable development of water resources: River Derwent near Elvington

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.	✓							

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. However, we believe that this strategy provides an appropriate framework for long-term water resources planning in the North East.

Appendix 1

Water resources availability

Section 3.5 illustrated strategic summer surface water availability and groundwater availability maps. These maps largely indicate that some additional water may be available across the Region. As such, we have felt it necessary to provide greater clarity on summer surface water availability and groundwater availability. For this purpose, we have split the Region into 6 strategic resource divisions:

- North Northumberland;
- Tyne, Wear and Tees;
- Dales;
- North York Moors;
- South and West York. ire;
- East Ridings.

Summer surface water

We have looked at how susceptible summer surface water resources will be to cessation clauses placed upon relevant abstraction licences, in order to protect the environment at times of reduced flow. We have considered four categories of likely restrictions for each of the 6 resource divisions:

- supplies reliable most of the year without restrictions;
- supplies typically restricted for up to 1½ months in a year;
- supplies typically restricted for up to 4 months in a year;
- supplies only reliable in winter months when river flows are high.

Figure A1.1 shows the summer surface water availability map together with likely restrictions. In particular:

- the North Northumberland and Tyne, Wear and Tees resource divisions highlight that some surface water supplies are available most of the year without restrictions. This is mainly due to spare resources in Kielder Water;
- limited surface water availability in Dales and North York Moors resource divisions mean that new supplies could be restricted typically between 1½ and 4 months in a year;
- the continuing water quality improvements in South and West Yorkshire rivers should provide potable local supplies that may typically be restricted for up to 1½ months in a year;
- surface water abstractions in East Ridings are almost at their winter threshold.

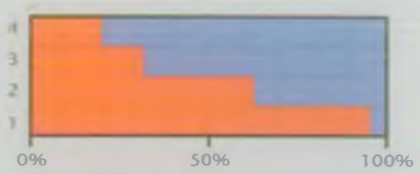
Groundwater

We have considered the proportion of the groundwater resources currently allocated in the major aquifers and provided an early indication of potential future availability. Figure A.1.2 illustrates the groundwater availability together with the proportion of resource allocated. In particular, there are generally spare groundwater resources available of varying magnitude across the Region. However, the section of the Sherwood Sandstone aquifer that extends from Selby to Nottingham, is over-allocated. Parts of the Corallian Limestone and Chalk aquifers in the south east of the Region are fully committed.

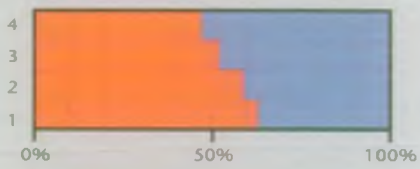
Summary

These maps are not intended to prejudge licensing decisions; for any proposed abstraction, further analysis would be needed, including an appropriate evaluation of the environmental impacts of the proposal. Catchment Abstraction Management Strategies (CAMS) will make more detailed assessments for each catchment in a six-year programme starting later in 2001.

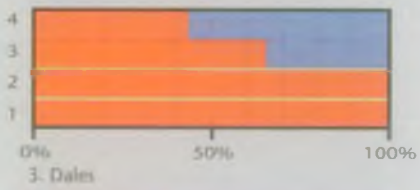
Figure A1.1 Current indicative ability: summer surface water in the North East Region



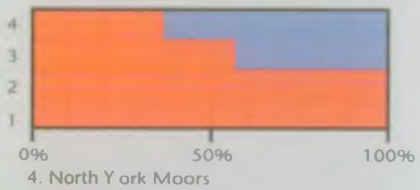
1. North Northumberland



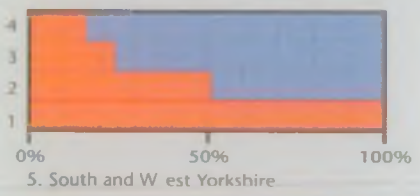
2. Tyne, Wear and Tees



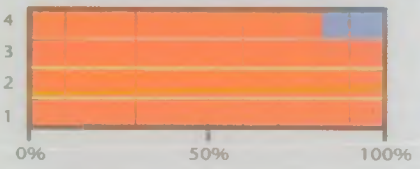
3. Dales



4. North York Moors



5. South and West Yorkshire



6. East Ridings

Surface water resources allocated.

Surface water resources available.

1 -- Supplies reliable most of year without restrictions.

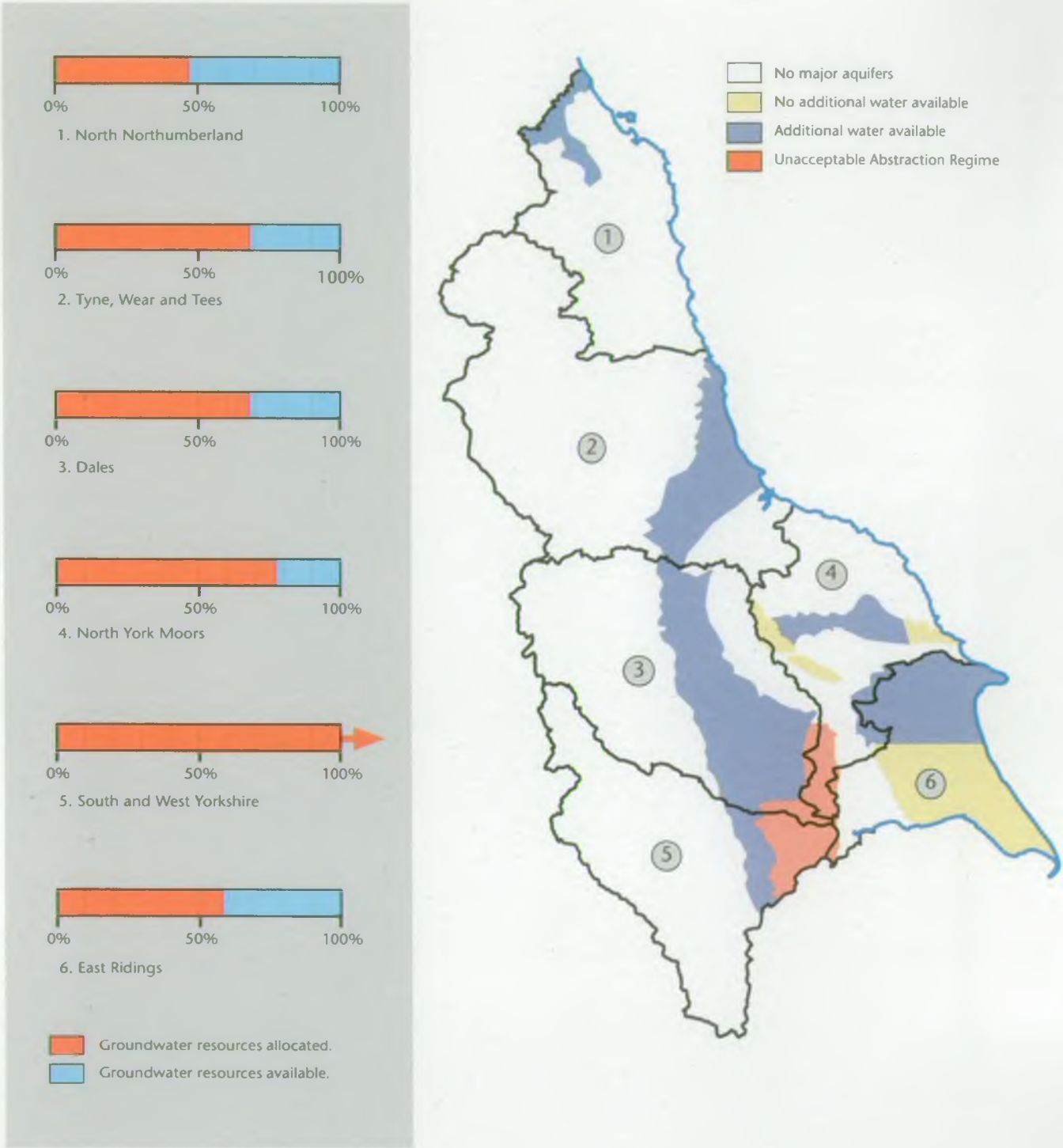
2 -- Supplies typically restricted for up to 1½ months in a year

3 -- Supplies typically restricted for up to 4 months in a year

4 -- Supplies only reliable in winter months when flows are high.

Note:-
Availability calculated at resource division level and does not reflect local issues.

Figure A1.2 **Current indicative ability: groundwater in the North East Region**



Appendix 2
Climate change

A2.1

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 nineteenth 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.

A2.2

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 more wet years. This in turn means that low flows will 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.

A2.3

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.

A2.3.1 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 Scenario Beta 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 Scenario Beta 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 regionally is about 17 Ml/d for 2025. This impact is distributed so that it is greater in the south and east than in the north of the Region.

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 agro-climatic 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 the Vale of York, the increase above current optimal levels is between 10% and 19%.

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.

A2.3.2 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.

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 to the way in which they are operated. The yield and reliability of public water supply systems depend 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 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 in either 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.

A2.3.3 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 (DETR, 2000d). 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.

A2.4

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 (Environment Agency, 2000b). 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. Table A2.1 indicates the vulnerability of water companies to extreme events.

A2.5

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

Table A2.1 Vulnerability of water companies to extreme events

Water Company	Vulnerability to:				
	One dry summer	One wet summer	One dry winter	One wet winter	Additional vulnerability to two year plus drought
Anglian	○	○	○	○	◐
Essex & Suffolk	○	○	○	○	◕
Cambridge	○	○	◐	○	●
Tendring Hundred	○	○	◐	○	◕
Severn Trent	◐	○	◕	○	●
South Staffs	◐	○	◕	○	●
Northumbrian	○	○	○	○	○
Hartlepool	○	○	○	○	○
Yorkshire *(incl. York)	○	○	◐	○	●
North West	○	○	○	○	◐
Folkestone & Dover	◐	○	◐	○	●
Mid Kent	◐	○	◐	○	◕
Portsmouth	◐	○	◐	○	◐
South East	◐	○	◐	○	◐
Southern	◐	○	◐	○	◕
South West	○	○	◐	◐	◐
Wessex	○	○	◐	○	◐
Bristol	○	○	○	◐	◐
Bournemouth & W Hants	○	○	◐	◐	◐
Cholderton & District	○	○	◐	○	◐
Thames	○	○	◐	○	●
Three Valleys	○	○	◐	○	●
North Surrey	○	○	○	○	◐
Sutton & East Surrey	○	○	◐	○	●
South East Water	○	○	◐	○	◕
Dŵr Cymru (Welsh Water)	◐	○	◐	○	●
Dee Valley	◐	○	◐	○	●

Key ○ Low ◐ Medium ◕ Medium/High ● High

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 practicable.

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 3

A scenario approach to water demand

A3.1

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 (DTI, 1999).

A3.2

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 4.1 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;
- non-household
- primary industry and manufacturing;
- spray irrigation.

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 (UKWIR and Environment Agency, 1997). The drivers of spray irrigation demand have been assessed in the Agency's *The optimum use of water for industry and agriculture dependent on direct abstraction best practice manual* R&D project (Environment Agency, 1998a).

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.

Table A3.1 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

Each section includes an indication of the scenario outcomes for each component at the national level.

A3.3

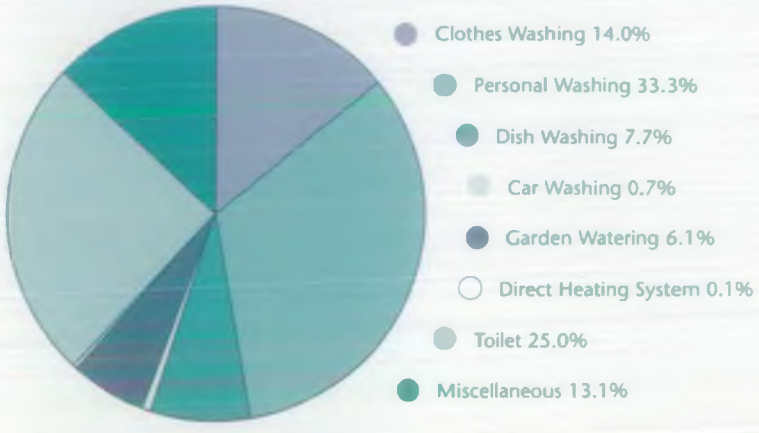
Household demand

We have adopted a micro-component approach in our household demand scenarios, breaking down consumption into 14 discrete micro-components, as identified in Table A3.1, falling under the eight broad categories identified in Figure A3.1. 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.

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 14 micro-component categories. Where OFV data were 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.

Figure A3.1 Micro-components of household demand in 1997/98



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

Drawing on all of this information, scenario-specific assumptions have been developed for each of the 14 micro-components to generate an unmeasured per capita consumption for each resource zone.

A3.3.1 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 (National Metering Trials Working Group, 1993). 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 A3.2.

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. These data were based on the 1996 population projections (building on the 1991 census information), adjusted to incorporate 1997 mid-year estimates.

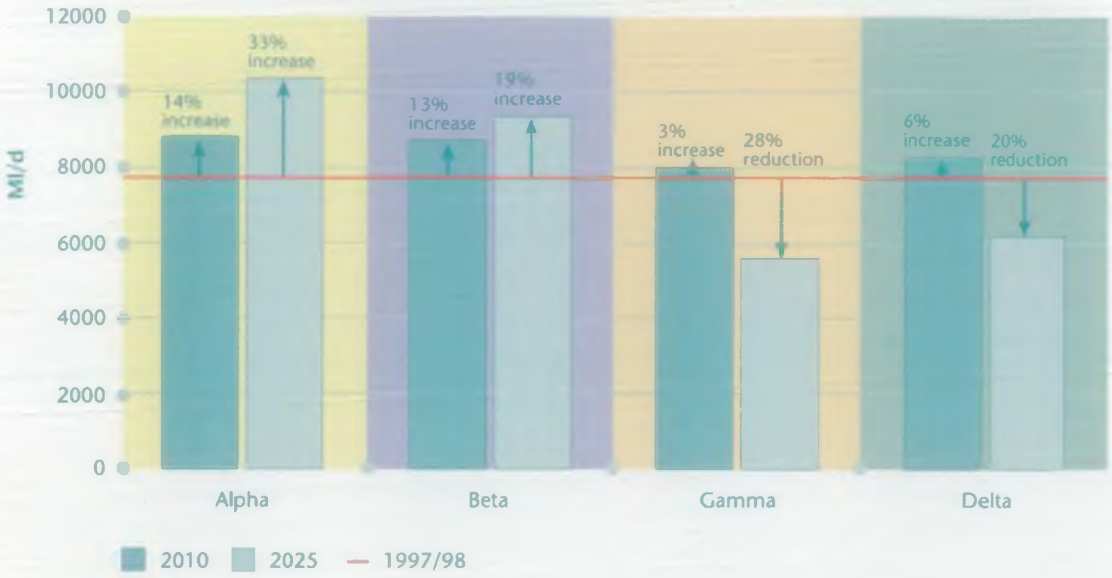
A3.3.2 Household demand: scenario outcomes:

- **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 and average washing machine use reduces to 50 litres by 2025. Discretionary uses of water increase with more power jetters, power showers and swimming pools.
- **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

Table A3.2 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			

Figure A3.2 Public water supply household demand by scenario in 2010 and 2025



become more widespread. Rain water collection for garden watering is the norm where some form of watering is required.

Figure A3.2 illustrates public water supply household demand by scenario for 2010 and 2025.

A3.4

Leakage demand

For our strategy, the formulation of the four leakage scenarios has focused 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 (see Table 3.3 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.

A3.4.1 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 A3.3.

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 practises passive leakage control, when the only bursts that are repaired are the ones reported by members of the public.

Table A3.3 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%		

Lambert *et al* (1998) recognise that the average rate of rise can vary widely from 0 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 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.

Scenario Gamma (Global Sustainability) leakage assumptions

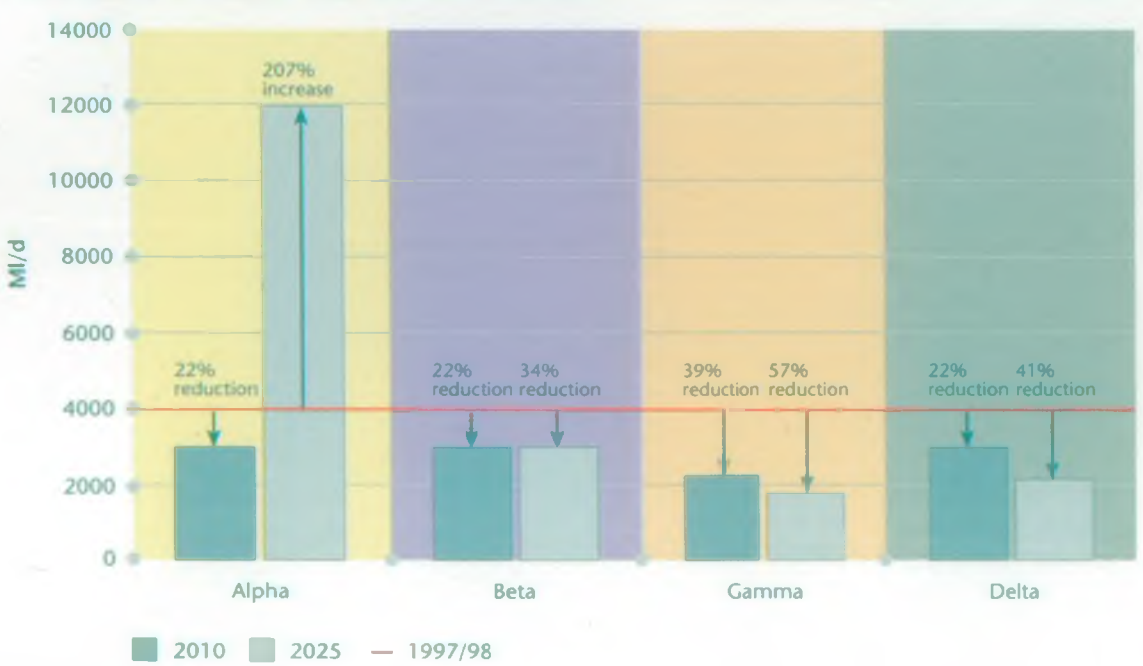
The implementation of improved leakage control methods forms the cornerstone of leakage targets in this scenario, based on the assumption that techniques currently available are developed slightly. We have identified a level of leakage that would be achievable with the application of today's best practice and the most advanced technology. This is described in detail in Appendix 4.

A3.4.2 Leakage demand: scenario outcomes

- **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 research and development, 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.

Figure A3.3 illustrates leakage by scenario for 2010 and 2025.

Figure A3.3 **Leakage by scenario in 2010 and 2025**



A3.5

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 (SIC, 1992). Secondly, 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.

A3.5.1 Forecast methodology

Availability of base year water consumption data, disaggregated by industrial sector, played an important role in determining our forecast methodology. Owing to the paucity of non-household water use data, we identified weighted output growth as the most appropriate forecast method for both public water supply 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;
- re-use;
- 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.

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.

A3.5.2 Industrial demand: scenario outcomes

- **Scenario Alpha (Provincial Enterprise):** The political climate results in a decline in the levels of both 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 re-use 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 2010 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.

Figures A3.4 and A3.5 illustrate non-household demand and direct abstraction demand by scenario for 2010 and 2025 respectively.

Figure A3.4 Public water supply non-household demand by scenario in 2010 and 2025

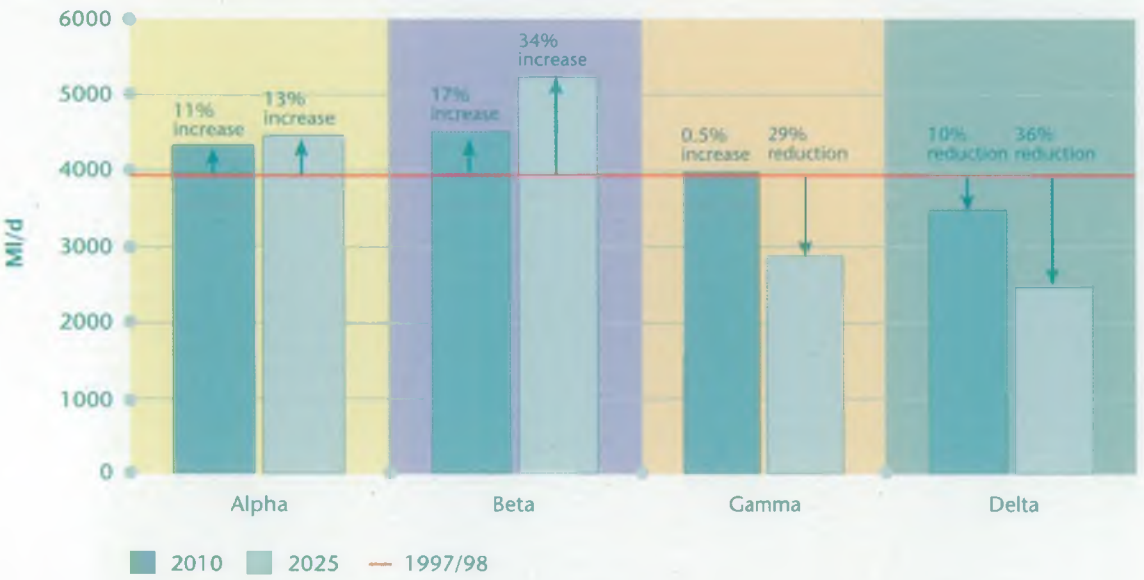
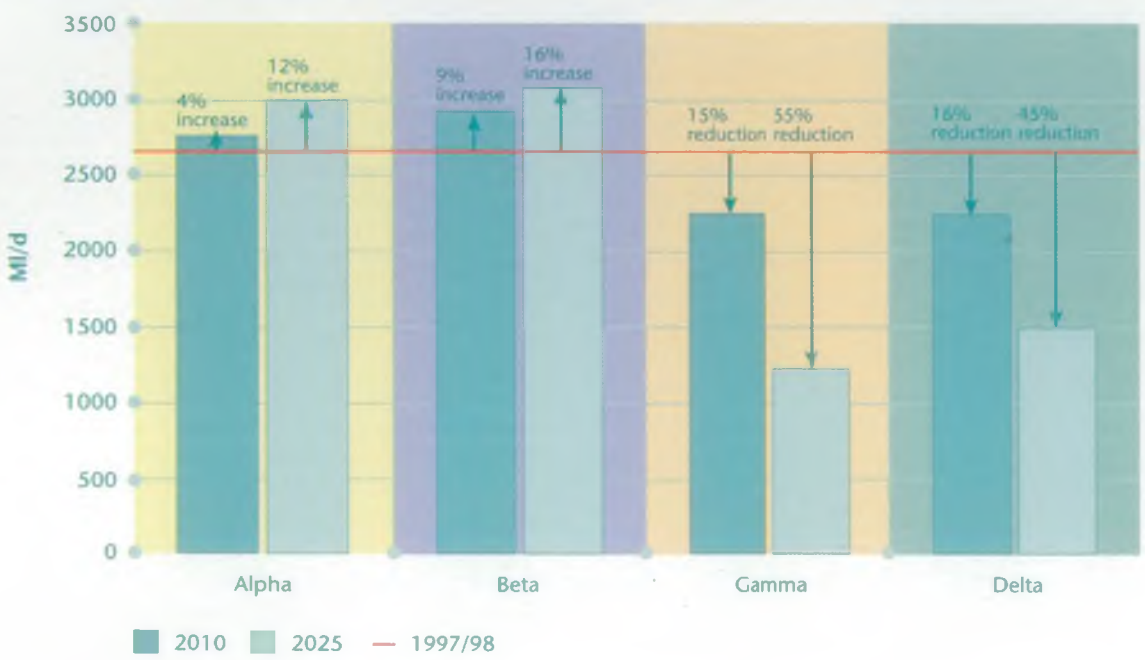


Figure A3.5 National direct abstraction demand by scenario in 2010 and 2025



A3.6

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 irrigation survey (MAFF, 1995), 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 and National Farmers Union. 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 one 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.

A3.6.1 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 best practice manual* R&D project (Environment Agency, 1998a). 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 the 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

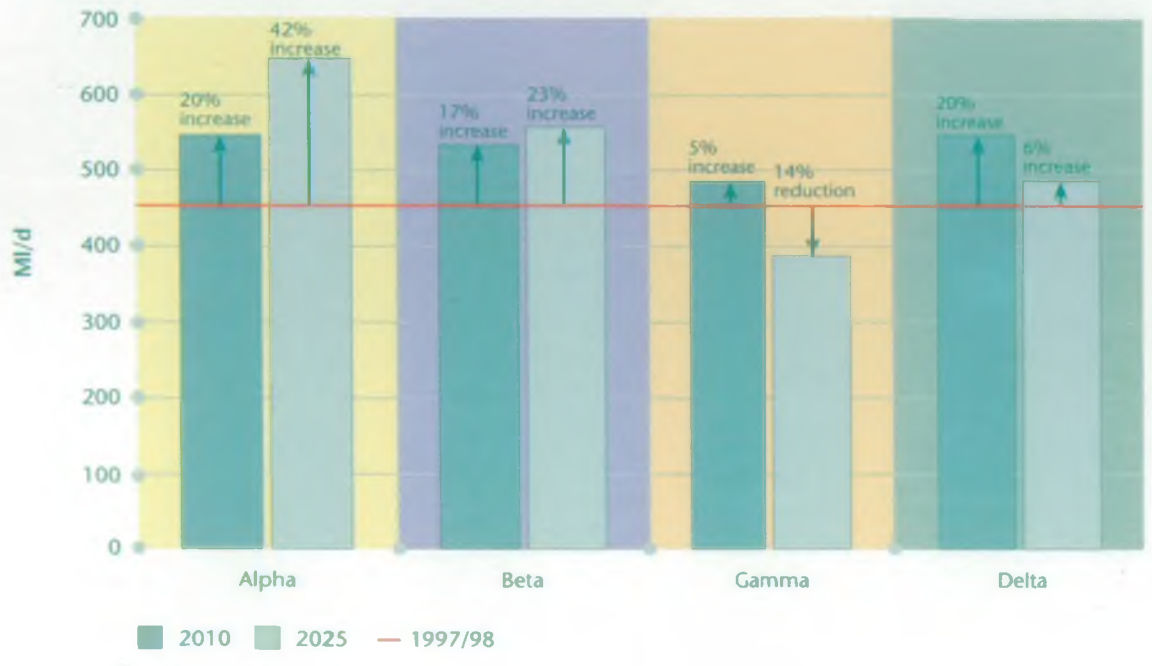
a number of important issues. The methodology confirms that for high-value crops, such as potatoes, vegetable and fruit crops, economic and theoretical demand are closely matched. However, the economic benefit of irrigating lower-value crops, such as sugar beet, cereals or grass, is not sufficient to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

A3.6.2 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.

Figure A3.6 illustrates spray irrigation demand by scenario for 2010 and 2025.

Figure A3.6 **Spray irrigation by scenario in 2010 and 2025**



Appendix 4

Calculating possible leakage levels in 2025

A4.1

Introduction

Our strategy recommends that further leakage reductions should play a part in managing public water supply over the next 25 years. We have drawn attention in the main body of the report to the tripartite leakage study being sponsored by Ofwat, DETR and the Agency. This will help to clarify the potential for progress. In the meantime we have developed our own approach, to calculate possible future leakage levels. The assumptions should be useful material for the tripartite study; this appendix provides details of the approach.

A4.2

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.

A4.3

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.

A4.4

Assumptions

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

A4.4.1 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.

A4.4.2 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.

A4.4.3 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 1% and 3% 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.

A4.5 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 5

Research and development 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 the 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 – 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 and on local climate;
- 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.

Bibliography

Arnell, N. (1999) *Effects of Global Warming on Water Resources: Implications of Multi-decadal Variability and Changes in Year-to-year Variability – Report to the Environment Agency.* Department of Geography, University of Southampton: Southampton.

DETR (1999a) *A Better Quality of Life: A Strategy for Sustainable Development for the United Kingdom.* Department of the Environment, Transport and the Regions: London.

DETR (1999b) *Proposals for a Good Practice Guide on Sustainability Appraisal of Regional Planning Guidance.* Department of the Environment, Transport and the Regions: London.

DETR (1999c) *Quality of Life Counts – Indicators for a Strategy for Sustainable Development for the United Kingdom: A Baseline Assessment.* Department of the Environment, Transport and the Regions: London.

DETR (1999d) *Planning Policy Guidance Note 12: Development Plans.* Department of the Environment, Transport and the Regions: London.

DETR (2000a) *Climate Change – Draft UK Programme.* Department of the Environment, Transport and the Regions: London.

DETR (2000b) *Competition in the Water Industry in England and Wales – Consultation Paper.* Department of the Environment, Transport and the Regions: London.

DETR (2000c) *Economic Instruments in Relation to Water Abstraction – A Consultation Paper.* Department of the Environment, Transport and the Regions: London.

DETR (2000d) *Potential UK Adaptation Strategies for Climate Change.* Department of the Environment, Transport and the Regions: London.

DETR (2000e) *Water Bill – Consultation on Draft Legislation.* Department of the Environment, Transport and the Regions: London.

DETR (2000f) *Planning Policy Guidance Note 11: Regional Planning.* Department of the Environment, Transport and the Regions: London.

DETR and Welsh Office (1999) *Taking Water Responsibly – Government Decisions Following Consultation on Changes to the Water Abstraction Licensing System in England and Wales.* Department of the Environment, Transport and the Regions: London and Welsh Office: Cardiff.

DTI (1999) *Environmental Futures.* Foresight, Office of Science and Technology: London.

Environment Agency (1997) *A Guide to Sustainable Urban Drainage.* Environment Agency.

Environment Agency (1998a) *The Optimum Use of Water for Industry and Agriculture Dependent on Direct Abstraction.* Best Practice Manual. Environment Agency.

Environment Agency (1998b) *A Price Worth Paying The Environment Agency's Proposals for the National Environment Programme for Water Companies 2000 – 2005, A Submission to Government.* Environment Agency: Bristol.

Environment Agency (1998c) *Water Resources Planning Guideline.* Environment Agency: Bristol.

Environment Agency (1999a) *Sustainable Water Resources for the Future: Values and Challenges.* Environment Agency: Bristol.

Environment Agency (1999b) *Planning Public Water Supplies: The Environment Agency's Report on Water Company Water Resources Plans to the Secretary of State for the Environment, Transport and the Regions and the Secretary of State for Wales.* Environment Agency: Bristol.

Environment Agency (1999c) *Sustainable Urban Drainage.* Environment Agency.

Environment Agency (2000a) *Managing Water Abstraction: Towards a Shared Strategy – A Consultation for Catchment Abstraction Management Strategies.* Environment Agency: Bristol.

Environment Agency (2000b) *The Environment Agency's Review of Water Company Drought Plans.* Environment Agency: Bristol.

Environment Agency (2000c) *Water Resources Strategies Consultation Response.* Environment Agency: Bristol.

Environment Agency (2000d) *An Environmental Vision: The Environment Agency's Contribution to Sustainable Development.* Environment Agency: Bristol.

Environment Agency National Centre for Risk Analysis and Options Appraisal (undated) *Integrated Appraisal of Environment Agency Policies: Version 1.0.* Environment Agency: London.

Herrington, P. (1996) *Climate Change and the Demand for Water.* HMSO: London.

Hulme, M and Jenkins, G. (1998) *Climate Change Scenarios for the United Kingdom: Scientific Report, UKCIP Technical Report No. 1.* Climate Research Unit: Norwich.

Lambert, A., Myers, S., Trow, S. (1998) *Managing Water Leakage: Economic and Technical Issues.* Financial Times Energy: London.

MAFF (1995) *Survey of Irrigation of Outdoor Crops in 1995, England and Wales.* Ministry of Agriculture, Fisheries and Food: York.

MAFF (1996) *Irrigation Demand and On-Farm Water Conservation in England and Wales.* Ministry of Agriculture, Fisheries and Food: London.

MAFF and National Assembly for Wales (2000) *Salmon and Freshwater Fisheries Review.* Ministry of Agriculture, Fisheries and Food: London and National Assembly for Wales: Cardiff.

National Metering Trials Working Group (1993) *National Water Metering Trials Final Summary Report.* Department of Environment: London.

NRA (1994) *Water – Nature's Precious Resource.* HMSO: London.

NRA and UKWIR (1995) *UKWIR/NRA Demand Forecasting Methodology.* NRA: Bristol and UKWIR: London.

Ofwat (1999a) *Final Determinations: Future Water and Sewerage Charges 2000-05.* The Office of Water Services: Birmingham.

Ofwat (1999b) *1998-1999 Report on Leakage and Water Efficiency.* The Office of Water Services: Birmingham. December.

Ofwat (2000) *Leakage and Efficient Use of Water: 1999-2000 Report.* The Office of Water Services: Birmingham. September.

SIC (1992) *Standard Industrial Classification.* The Stationery Office: London.

UK Government (1994) *Biodiversity: The UK Action Plan, CM 2428.* HMSO: London.

UKWIR and Environment Agency (1997) *Forecasting Water Demand Components: Best Practice Manual.* UKWIR: London.

World Resources Institute (1998-99) *Data table of Freshwater Resources and Withdrawals 1970-98.*

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 or the NAW 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 and planning allowances 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.
Yield	The reliable rate at which water can be drawn from a water resource.

NORTH EAST REGION ADDRESSES

REGIONAL OFFICE
Environment Agency
Rivers House
21 Park Square South
Leeds LS1 2QG
Tel: 0113 244 0191
Fax: 0113 246 1889

NORTHUMBRIA AREA OFFICE
Environment Agency
Tyneside House
Skinnerburn Road
Newcastle Business Park
Newcastle-upon-Tyne
NE4 7AR
Tel: 0191 203 4000
Fax: 0191 203 4004

DALES AREA OFFICE
Environment Agency
Coverdale House
Amy Johnson Way
Clifton Moor
York YO30 4GZ
Tel: 01904 692 296
Fax: 01904 693 748

RIDINGS AREA OFFICE
Environment Agency
Phoenix House
Global Avenue
Leeds LS11 8PG
Tel: 0113 213 4600
Fax: 0113 213 4609

www.environment-agency.gov.uk

ENVIRONMENT AGENCY
GENERAL ENQUIRY LINE
0845 933 3111

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