NRA WATER RESOURCES 31

SAVING WATER

THE NRA'S APPROACH TO WATER CONSERVATION & DEMAND MANAGEMENT

SEPTEMBER 1995

NRA
National Rivers Authority

A CONSULTATION REPORT BY THE NATIONAL RIVERS AUTHORITY

"The NRA strongly encourages water companies and other major abstractors to adopt policies and procedures that result in the efficient use of water in their operations and by the public, through a balanced approach combining water conservation and demand management with phased traditional source development where appropriate. Balanced policies will have regard to both cost to customers and environmental impact."

THE NRA AND THE ENVIRONMENT AGENCY

The National Rivers Authority will form the major part of a new organisation which will have responsibilities for the environmental protection of water, land and air. The new Environment Agency starts its work of managing the environment in England and Wales on 1 April 1996.

PREFACE

BACKGROUND

The Environment Agency is due to come into being in 1996. As one of the existing bodies that will make up the new Agency the National Rivers Authority's (NRA) policies for sustainable development and water conservation will take on a greater significance. Conservation of water resources involves the co-operation of Government, the regulators, the water industry, agriculture, industry and the general public. The NRA as '*Guardians of the Water Environment*' is intent upon ensuring that water resources are used effectively and efficiently and not wasted.

This consultation report reviews current water conservation and demand management practices both in the UK and overseas, and establishes the potential for saving water in England and Wales. The report then considers elements of a water conservation and demand management strategy, possible responsibilities and how such a strategy might be put into practice.

ENVIRONMENT AGENCY POLICY

This report and the ensuing consultation will enable the Environment Agency to formulate its policy in the area of water conservation and demand management.

SCOPE

The NRA is the environmental regulator for England and Wales and it is for these countries that this report is primarily written. There is some mention of Scotland and Northern Ireland whose own forthcoming environment agencies may find this report useful in determining their own water conservation and demand management policies.

SUBMISSION OF COMMENTS

Comments on the proposals in this report should be sent by 29 December 1995 to:

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Telephone 01903-820692. Fax 01903-821832.

Please indicate whether your comments may be made public or if you would prefer them to be held in confidence.

Executive Summary

Introduction

Water conservation and demand management are topics which have been receiving increasing attention in recent times. There are many opportunities to contribute to using water more carefully and a large number of organisations and customers have a role to play.

The report examines historical and present practice in the UK and also reviews overseas practice. Potential savings and costs of different demand management options have been considered and the report outlines the opportunities which could comprise a demand management strategy together with roles and responsibilities for taking the strategy forward.

This consultation report is being widely circulated and a summary of responses will be available in due course.

UK Review

Water conservation and demand management issues are of relevance to a range of interested parties including water companies, regulators, industry, environmental and customer groups, government departments and bodies representing commercial organisations.

In the 1960s and 70s simple extrapolation techniques were used to predict the demand for water and to justify augmenting supplies. Such methods have been replaced by component based approaches which specifically include demand management components, such as leakage reduction. The droughts of 1984, 1988-92 and 1995 have also been significant in raising awareness of the need to use water sensibly.

The review of current demand management practices in the UK includes opportunities for leakage control, domestic metering, economic instruments, wastewater re-use and recycling, water saving technology, water byelaws, education/awareness, levels of service and industrial and agricultural use options.

Overseas Review

Demand management practices have been examined both in the developing and developed world. The review concludes that although significant initiatives have been applied in other countries they tend to be on a piecemeal rather than on a co-ordinated basis. Only Canada and Israel appear to have a nationally coordinated demand management strategy and even then it is expected that the fragmented nature of the water industry in Canada may mean that it will be difficult to apply in practice.

Demand Management Potential in England and Wales

Water saving potential (in England and Wales) and associated costs of a number of water conservation options reveals that:

- leakage control, WC conversion (to lower flush volumes), more efficient washing machines and fitting flush controllers to urinals can all be cheaper than developing resources for equivalent volumes of water;
- theoretically the amount abstracted for public water supply could be reduced by as much as 42% but this would require full implementation of all the identified demand management options, some of which could not be financially justified; and
- the cost of universal domestic metering is likely to be marginally more expensive than a high cost reservoir development, if environmental costs and benefits are excluded.

A National Demand Management Strategy

A national water conservation and demand management strategy is presented which proposes that:

- water companies consider the full range of demand management options as part of their abstraction licence applications (not limited to leakage control and metering);
- water companies set and achieve leakage targets to be agreed by NRA and OFWAT. (The current OFWAT approach of measuring efficiency by comparing costs of water delivered is not a sufficient stimulus for companies to reduce leakage);
- selective domestic metering is progressed with appropriate safeguards for low income families;
- water conservation is included in building codes and water byelaws;
- relevant organisations instigate education initiatives;
- economic instruments for abstraction charging are developed;
- a low cost water audit service for commercial premises, industry and agriculture is established;
- waste minimisation in business and industrial use of water is promoted;
- a UK water conservation manual to assist practitioners in water conservation planning is prepared.

Roles and Responsibilities

The NRA recognises that such a strategy can only be put into practice with the commitment and co-operation of all the different organisations involved. A National Water Conservation Committee is suggested which would represent the main responsibilities and interests.

The NRA's Role and Programme

The priority areas of work for the NRA which are expected to be carried forward into the new Environment Agency are:

- greater awareness of the results of the National Leakage Initiative and the application of its findings in discussions with water companies;
- regular updating of demand forecasts; taking into account the latest knowledge relating to demand management;
- comparison of actual quantities of water supplied with those forecast;
- national co-ordination on a range of water saving initiatives including waste minimisation projects;
- continued independent and collaborative Research and Development;
- development and implementation of an educational programme directed at a wide spectrum of interests;
- further investigation into the demand effects of domestic metering and support of government and OFWAT policy in appropriate circumstances; and
- continued promotion of water conservation and demand management issues to water users, water supplies, opinion shapers, other regulators through the National Centre for Demand Management and its regular Bulletin.

Comments

Comments on the proposals in this report should be sent by 29 December 1995 to:

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Contents

1. Introduction

1.1 Definition

The NRA's definition of Demand Management is as follows:

> *"The management of the total quantity of water abstracted from a source of supply using measures to control waste and consumption."*

This reflects the NRA's statutory duties under Section 19 of the Water Resources Act 1991 to conserve, redistribute or otherwise augment water resources and secure their proper use. The NRA is also required by Section 16 of the Act to exercise its powers in such a way as to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological or physiological features of special interest.

A narrower definition of demand management, often preferred by economists is the control of consumption of a service by a price mechanism. As only 25% of the public water supply in England and Wales is sold by volume and over 28% is *"unaccounted for"* the NRA's broad definition is more appropriate to the water industry in England and Wales. A USA definition of water conservation measures from the Central Utah Completion Act of 1992 is as follows: *"actions to improve the efficiency of the storage, conveyance, distribution, or use of water, exclusive of dams, reservoirs or wells."*

1.2 Sustainable Development/Sustainability

Demand Management accords with the concept of sustainability which first gained international credence following the publication of the Bruntdland Commission Report '*Our Common Future*' (WCED 1987) and was a cornerstone of many of the principles outlined in the UNCED Earth Summit in Rio in 1992. Sustainability is a concept relating to the relationship between economic development and the environment. Although many definitions of sustainability exist it broadly means keeping the consumption of renewable natural resources within the limits of their replenishment. Principle three of Agenda 21 (The Rio Declaration) states that:

> *"The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."*

With regard to the water environment Agenda 21 also states:

> *"By the year 2000 all states should have national action programmes for water management, based on catchment basins or sub basins, and efficient water use programmes. These could include integration of water and other resource planning with land use planning development and conservation, demand management through pricing, regulation, conservation, re-use and recycling of water."*

In January 1994 the Government published "*Sustainable Development – the UK strategy*" setting out the challenges faced by the UK over the next twenty years to achieve the goal of sustainable development. In Chapter 8, "Freshwater" on the issue of water resources and demand management, the following areas for sustainability are identified:

- to ensure adequate water resources are available to meet consumer's needs
- to manage and meet the demand for water from households, agriculture and industry

On the issue of new reservoirs, groundwater abstractions and inter-regional transfers the report emphasised that such developments can be costly and give rise to environmental problems and that in some cases the costs and benefits of cutting waste or reducing demand are likely to be more attractive.

The chapters conclusion states that "Maintaining and improving the yield of the existing developed resources will require":

- demand management (economic instruments, selective metering, improved abstraction charges)
- day to day management measures (leakage, waste minimisation)
- control of pollution

The reports conclusion states *'The approach should be that new resources should be provided only when the alternatives have been utilised to the extent that it is practicable and economic (with environmental considerations being given proper weight in the decisions)'.*

On 20 April 1995, the Department of the Environment, Ministry of Agriculture, Fisheries and Food and the Welsh Office produced draft guidance to the Environment Agency under the Environment Bill on its objectives, which included the contribution it is to make towards the achievement of Sustainable Development.

> *'To promote sustainable development in relation to water management, in order to protect and enhance the water environment it is essential for the Agency to exercise its various functions in an integrated manner. This integration must cover not only the Agency's activities primarily concerned with water, but also activities that can have a direct or indirect effect on water, such as integrated pollution control, waste regulation and contaminated land regulation.'*

On the specific subject of Water Resource Control the guidance states:

> *'In regulating river flow and access to water resources, the Agency must balance the frequently competing requirements of human beings, enterprises of various kinds, natural habitats,*

fisheries and (in some cases) recreation and navigation. It has a duty to conserve, redistribute or augement water resources. In the longer term pressures on water resources are expected to be a significant issue in sustainable development, particularly in the South and East of England. The Agency's use of its regulatory and other powers (and in the light, in particular, of its regional water resource strategies) will be crucial in securing adequate supplies for domestic, agricultural, commercial and industrial purposes, while maintaining and improving the natural environment where it is dependent on the water flows traditionally experienced. The Government expects the Agency to use its powers and to encourage water conservation in areas of potential shortage where it is economic to do so. Planning Policy Guidance Note No.1 (Development Plans) sets out the Government's view on the relationship between development planning and water resource control. This is amplified in the appropriate Regional Planning Guidance. In addition Ministers expect that the Agency will pursue, and develop, the objectives of the National Water Resources Strategy prepared by the National Rivers Authority in 1994 – Water – Nature's Precious Resource : a strategy for the sustainable development of water resources'.

Clearly demand management is an integral part of the move towards sustainable development. It is generally recognised that, in most cases, a reduction in demand will benefit the water environment. The NRA's main concern is that there should be no long term systematic deterioration in the water environment due to water resource development and water use.

1.3 Is Demand Management required in the UK?

The general view has been that the UK has more than enough water to satisfy current and future needs. In 1986 the World Resources Institute produced a categorisation of water availability based upon the average per person living in the country concerned (Table 1.1)

	m^3/annum per person
Very Low	< 1000
Low	1,000 – 5,000
Medium	5,000 – 10,000
High	> 10,000

Table 1.1 Water Availability

England and Wales with a water availability per person of 1400 m^3/annum fit into the '*Low*' category, the same category as South Africa, Poland and Haiti. The water availability in the USA is 7 times greater than England and Wales, Australia 15 times greater and Norway 70 times greater. Upon consideration of regional variations Anglian, Severn Trent, Southern and Thames NRA regions fall into the '*Very Low*' category with Thames being the lowest at 250m^3/annum. Although domestic water use is only some 50m^3/head/year there is no room for complacency. In the development of the NRA's water resources strategy "*Water – Nature's Precious Resource (1994)*" demand management is recognised as having a key role in national planning. Until the drought of 1976 the only consideration had been to develop new sources to meet the rising demand and even then only limited action was taken to control the demand.

The drought in 1988-92 where parts of eastern and southern England were short of ten months of average rainfall, was significant in raising awareness of the possible scarcity of water resources. Water supplies were maintained throughout that period although some hosepipe bans were necessary.

At that time about forty rivers were identified as suffering from low flow problems due to continued abstraction. This was exacerbated by the drought. As a result wildlife habitats were damaged and pollution problems became more apparent due to the lack of dilution of effluent. The NRA is committed to alleviating the low flow in those rivers. The current status of the low flow rivers are as follows; eight improvement schemes have been fully implemented, eight are underway, ten have solutions identified, investigations have started on a further six and eight schemes have been identified as no longer being an abstraction problem.

As a consequence of the drought two influential documents were published. '*Using Water Wisely*' (Department of the Environment 1992) examined possible options for reducing demand and '*Dealing with Drought*' (Parliamentary Office of Science and Technology 1993) examined the technical and environmental aspects of water shortages. Both have made significant contributions to the demand management debate. The publications are described in greater detail in 3.6.

Demand management forms a central part of the NRA's Water Resources Development Strategy. Even with effective demand management it is expected that local transfer schemes, local source development and possibly inter regional transfers will be required to meet the demands into the next century.

1.4 Demand Management in the NRA

The NRA's policy on demand management has been developed over the period 1991-95, with a number of important statements setting out the role of demand management in attaining sustainable development of water resources and fulfilling the NRA's statutory duty to conserve and secure proper use of water resources. The NRA Board approved the following

statement in June 1992 on "*Managing the Drought and Water Resources*"

> "*Before any new sources are developed, it is essential that water companies make sure they are doing all they can to reduce leakage and to carry out effective demand management. The NRA supports selective domestic metering, with an appropriate tariff, in areas where water resources are stressed. Where it can be shown that proper attention is not being given to the control of leakage, or where appropriate consideration has not been given to the introduction of selective metering, the NRA will not grant licences for new sources.*"

The challenge for the NRA is to manage the water resources to achieve the right balance between the needs of the environment and those of abstractors.

In 1993 the NRA created a National Centre for Demand Management. The Demand Management Centre provides a service to NRA Head Office and Regions by co-ordinating NRA involvement across a wide range of projects and interests, covering:

- demand forecasting
- domestic consumption monitoring studies
- domestic and non domestic metering
- leakage from customer and company pipes
- industrial and agricultural demand
- water use restrictions
- levels of service to water supply customers
- tariffs and economic incentives
- water saving technology
- customer and water company education on efficient water use.

None of these topics is the sole, or main, concern of the NRA, but the NRA seeks to develop its role in these issues in co-operation with the DoE, OFWAT, the Water Companies and other interested bodies as detailed in section 2. This consultation document is intended to further develop the NRA's role by consideration of the possible roles of the main interested parties.

1.5 Document Structure

This document is structured into three clearly defined parts. Part I includes the organisational framework, development of demand management in the U.K. followed by a review of current U.K. practice. Part II seeks to make comparisons reviewing current overseas practice. Logically following on from the reviews, Part III contains an assessment of demand management potential in the U.K. and a proposed Demand Management Strategy.

2. Organisational Framework

Demand management is not the responsibility of any single body. Many different organisations are involved to a greater or lesser degree. For each organisation their roles and responsibilities are defined in addition to their involvement in demand management.

2.1 Department of the Environment (DoE) and Welsh Office

The role of the DoE in relation to water use is legislation and general policy. Under the Water Industry Act 1991 the Secretary of State for the Environment and Secretary of State for Wales have the following main functions:

- to appoint Companies to act as water and sewerage undertakers, the Director General of Water Services and individuals to serve on the National Rivers Authority.
- elaborating and supplementing the regulatory framework by means of subordinate legislation, for example, to establish standards of performance in relation to supply of water and sewerage services, to determine standards of wholesomeness of water, to set out criteria for the classification of river quality and to impose requirements to take precautions against pollution.
- approving various codes of practice including conservation and recreational duties, and the exercise of pipelaying powers.
- enforcing certain statutory obligations imposed on water and sewerage undertakers, for example, by making enforcement orders and initiating the prosecution of any water undertaker which supplies water unfit for human consumption.

In respect of the National Rivers Authority, the Secretary of State's main functions are (Waterfacts 1993):

- paying a grant-in-aid to water quality, fisheries, conservation and recreational functions, settling financial duties and controlling overall staff numbers and conditions of service
- designating water protection zones and making drought orders
- approving charges schemes for water abstraction and discharge consents

all of which have some bearing on the ability of the NRA to carry out effective demand management. In addition, the Secretary of State will adjudicate on appeals against the refusal of abstraction licenses.

The Secretary of State has overall responsibility for building regulations and the water byelaws where the potential exists to ensure that low volume water appliances are used.

The Secretary of State also exercises powers through the Land Use Planning function and the associated influence on local authority development plans. Once new developments have obtained planning permission the Water Companies have a statutory duty to provide water. Planning Policy Guidance Note 12 suggests that the availability of water should be a consideration in local authority development plans.

Finally new reservoir and transfer schemes need planning permission and in most cases involve a public enquiry. New reservoirs would also need abstraction and impoundment licences from the NRA which may also lead to a public inquiry. The Secretary of State can ensure that at such inquiries the potential for demand management (and environmental impact) has been thoroughly investigated.

The DoE came to the forefront of the debate in 1992 with the publication of the consultation document 'Using Water Wisely' (described in section 3.6.1) and the response to the consultation *'Water Conservation – Government Action'* (section 8.1) in 1995.

2.2 Director General of Water Services (OFWAT).

The Director General of Water Services has a primary duty under the Water Act to secure that (*Waterfacts 1993*):

- water and sewerage functions are properly carried out throughout England and Wales.
- undertakers are able (in particular, by securing reasonable returns on their capital) to finance the proper carrying out of these functions.

The Director General is required by Section 2 of the Water Industry Act 1991 to use his powers in a manner which he considers best calculated to promote economy and efficiency on the part of water and sewerage undertakers. The way he may carry out this duty, which has important consequences for demand management, is as follows:

- The Director General carries out a five year review of Water Companies' Asset Management Plans on which the settings of the 'K' factors (the amount over and above inflation the Water Companies are allowed to charge their customers) are based. The Director General will want to be convinced that any proposed source developments are necessary and these will come under heavy scrutiny.

- Distribution Losses are seen as an important factor in measuring efficiencies of Water Companies relative to each other. Distribution Losses form part of the annual '*July Return*' to OFWAT and are published in '*The Cost of Water Delivered and Sewage Collected*'.
- The 1989 Water Industry Act prohibited Water Companies from using pre-1990 rateable values as a basis for water charges after the year 2000. The Director General has taken the lead in the debate over the method of future charging and believes that metering and unit water pricing, which gives customers the opportunity to control their costs, is the preferred option in the long term.

2.3 National Rivers Authority (NRA)

The NRA is an independent statutory body set up under the Water Act 1989. It has a Board of up to 15 members, appointed by Ministers from DoE, MAFF and the Welsh Office. The NRA is financed from a variety of sources; including land drainage precepts, and charges for abstraction. It has powers to recover from dischargers the costs of enforcing water pollution control and it receives grant-in-aid to meet its shortfall. The income from abstraction licences meets the cost of the NRA carrying out its water resources functions.

The NRA is responsible for:

- river quality and the quality of inland and coastal waters
- land drainage and flood control
- management of water resources
- fisheries
- recreation and conservation
- navigation
- licencing the abstraction of water
- independently monitoring river quality and discharges from sewage treatment plants

To assist in fulfilling its duty to conserve, augment and redistribute water resources (ie to safeguard the resources of the catchment), the NRA controls abstractions by issuing the licences which are required for all large scale continuous abstractions regardless of the source of water and its intended use. In addition the NRA issues licences for impoundments (for obstructions to flow) and sets prescribed flows for stretches of river through the minimum acceptable flow regime.

The NRA's role in demand management is as defined in 1.4 and 3.8.

2.4 Environment Agency (EA)

The Environment Agency is due to come into being in 1996 as the amalgamation of the NRA, Her Majesty's Inspectorate of Pollution (HMIP), the waste regulation authorities and some functions of the DoE. The Agency will be a non-departmental public body sponsored by the DoE. It will provide integrated environmental protection, management and enhancement and play a central role in putting the Government's environmental policies into practice. Like its predecessor bodies, the Agency will have major responsibilities for management and regulation of the water environment, and for controlling industrial pollution and wastes. One of the principal reasons for the creation of the Agency is to provide a more coherent and integrated environmental protection enhancement service than is currently provided by the separate predecessor bodies.

The Agency's main responsibilities in relation to water resources are expected to be:

- to take any necessary action to conserve, redistribute, augment and secure proper use of water resources.
- to publish information about the demand for water and available resources.

These responsibilities are very similar to sections 19 and 188 of the Water Resources Act 1991.

2.5 Water Companies

In every area of England and Wales there is a water undertaker appointed under section 6 of the Water Industry Act 1991, with a duty under section 37 of that Act to develop and maintain an efficient and economical system of water supply within its area, to ensure that arrangements have been made for providing supplies of water to premises in that area and for making such supplies available to persons who demand them. There are ten water service companies (the former regional water authorities) who provide water and sewerage services and 21 water supply companies who supply water only.

The primary statutory duty of the water companies relates to the supply of water and in doing so, as private sector companies, they are answerable to their shareholders and the Director General of Water Services. The turnover and profits of the regulated business come from supplying water.

Generally the degree to which water companies have been active in promoting water savings relates to the relationship between demand and surplus resource both now and in the future. For example, Anglian Water, which under a high demand scenario could face

a shortfall of water resources in 2021, have been actively reducing leakage, are carrying out detailed surveys of water use in the home so as to make better demand forecasts and have a programme for company wide domestic metering.

Distribution losses (leakage) are variable across the companies and are dependent upon a number of factors in addition to the investment in monitoring and detection such as age of distribution system, acidity of water (degree of corrosion), pressure of the system and soil type. This means that the water companies will have different levels of leakage and this is one reason why The Director General of Water Services has not set leakage targets. It is possible, however, that some water companies are not operating at their economic levels of leakage.

In drought situations water companies can make appeals for voluntary reductions in water at any time when there is a serious deficiency. They can also apply a hosepipe ban under section 76 of the Water Industry Act 1991. The NRA or water company can apply under Section 74 of the Water Resources Act (1991) to the appropriate Secretary of State for an ordinary drought order (restricting non-essential use) and water companies can also apply for an emergency drought order which allows the imposition of rota cuts, standpipes and water tanks.

As water companies use 51% of all water abstracted (in England and Wales) conservation measures are particularly important in the public water supply sector though the importance of industrial and agricultural abstractions in localised areas should not be under-estimated.

2.6 Water in Scotland

In Scotland, water and sewerage to over two million households are local authority services provided by the nine Regional and three Islands councils established under the Local Government (Scotland) Act 1973. The Government have announced plans for local authorities in Scotland to be replaced with single tier councils from April 1996. As a result three public water authorities will take over the provision of water and sewerage services.

Following publication of the consultation paper, '*Improving Scotland's Environment – The Way Forward*' in 1992, the Government confirmed in February 1993 its plans to establish a Scottish Environment Protection Agency (SEPA), which would bring together HM Industrial Pollution Inspectorate, the River Purification Authorities and the district and islands councils in respect of pollution control and waste regulation activities.

The Secretary of State for Scotland's responsibility for water resources is set out in the Water (Scotland) Act 1980 as follows:

> It shall be the duty of the Secretary of State:
>
> (a) to promote the conservation of the water resources of Scotland and the provision by water authorities and water development boards of adequate water supplies throughout Scotland ; and
>
> *(b) to secure the collection, preparation, publication and dissemination of information and statistics relating to such water resources and water supplies.*

In fulfilling duty (b) The Scottish Office Environment Department has, since 1975, collected information from water authorities and published an annual report on water supplies in Scotland.

In 1992/93 the available yield of public water supply sources was 3560 Ml/day made up of 97% surface water and 3% groundwater. This compares to an average daily demand of 2206 Ml/day giving a demand to yield ratio of 0.62. Due to the fall in non-household demand as a result of the closure of heavy water using industry demand in Scotland has been falling steadily since 1975. Leakage is around 28% of water put into supply (similar to England and Wales). In 1995 the Scottish Office published '*Public Water Supplies in Scotland. An Assessment of Demands and Resources at 1994*'. One important conclusion was that, with commercial and industrial demand predicted to fall and almost offset the expected rise in household demand, there would be sufficient resources to meet average demand up to 2016, the limit of the forecast.

It would appear, against this background of falling demand and surplus resource that water conservation and demand management activity is not likely to be of high priority in the foreseeable future.

There is no licensing of abstraction of water similar to that in England and Wales. For the public water supply a Regional Council or, for hydroelectric power, the power company, acquires water rights by means of a water order made by the Secretary of State for Scotland. For direct abstractions the riparian owner can abstract from his/her land provided the water is returned unpolluted. The National Heritage (Scotland) Act 1991 contains provisions enabling the control of abstraction of water for irrigation for commercial agriculture or horticulture. Under these provisions River Purification Authorities can seek a control order for a specified area from the Secretary of State; where an order is granted abstractions can be controlled through a licencing system. As at March 1994 only one such control order has been granted.

2.7 Water in Northern Ireland

The provision of water and sewerage services in Northern Ireland is a central government function

and is administered by the Water Executive of the Department of the Environment of Northern Ireland in accordance with the Water and Sewerage Services (Northern Ireland) Order 1973. There are four divisions which collectively supply 530,000 households.

Sources in Northern Ireland are made up as follows: 40% upland impoundments, 36% freshwater loughs, 13% river intakes and 11% groundwater and springs. Generally rainfall is high (900-1100 mm per annum) but there is some doubt as to the adequacy of sourceworks for future demands.

Leakage levels of 23 to 40 litres/prop/hr in 1984 have been reduced to 8 to 11 litres/prop/hr following a leakage initiative begun in 1985.

The Water Executive have recently produced a new Water Resource Strategy for the province which includes resource development, major enhancements and further leakage control.

On 15 July 1992 the Secretary of State for Northern Ireland announced that he intended to privatise water and sewerage services in Northern Ireland during 1995/96. However, for technical reasons it has been deemed not possible to do this during the lifetime of the present Parliament. In the interim, the Water Executive will be established as a 'Next Steps Agency' not later than April 1996. This will allow it to operate as a separate unit within the department and to build on work to develop the commercial orientation of the organisation.

2.8 Water Services Association (WSA)

The WSA is an association of the ten English and Welsh water companies (former Regional Water Authorities) that provide both water and sewerage services.

Its principal role is to:

- promote and protect the common interests of the water companies in dealings with the Government, the EC and other regulatory authorities.
- try to influence policy and regulatory initiatives on water issues by governmental and other agencies, nationally and internationally.

2.9 Water Companies Association (WCA)

All the water supply (only) companies, with the exception of Mid-Kent Water and Cholderton and District, belong to the WCA which was formed in 1885 to encourage the companies to exercise their powers effectively and to discharge their responsibilities efficiently.

2.10 Building Services Research and Information Association (BSRIA)

BSRIA is a member based, independent, non-profit distributing organisation that was founded in 1955. They conduct research investigations and test work into different aspects of Building Services. It has 90 staff, 750 member companies and an annual turnover of £3 million. BSRIA's relevance to demand management is that the organisation is in a good position to investigate water efficiency measures in households and commercial buildings.

2.11 Centre for Exploitation of Science and Technology (CEST)

CEST is an independent non-profit organisation funded mainly by industry with additional funding from the UK government. CEST identifies emerging global issues which could give rise to significant commercial and technological opportunities. All CEST projects are participative and designed to help companies identify new opportunities earlier and hence reduce lead-time for them to realise a commercial gain. CEST have been active in the promotion of waste minimisation schemes.

2.12 Water Research Centre (WRc)

WRc are an independent UK research based company with seventy years experience in water supply, pollution prevention and environmental management.

WRc's particular areas of involvement have been:

- National Metering trials (4.4.3). Chair of the Working Group and editor of the Final Report
- National Leakage Control Initiative (4.5.3). Involvement in the project groups and as publisher of the reports
- Leakage control consultancy services to the water industry.

2.13 Ministry of Agriculture, Fisheries and Food (MAFF)

MAFF administers Government policy for agriculture, fisheries and food industries to meet the needs of UK and overseas consumers in an efficient, safe and humane way. The Ministry seeks to achieve a balance between the interests of agriculture, the economic and social interests of rural areas, conservation of the countryside and the promotion of its enjoyment by the public. The Codes of Good Agricultural Practice for the protection of Water, Air and Soil (1991) are evidence of trying to achieve this delicate balance. MAFF's involvement in demand management is principally in advising farmers to construct on-site

storage facilities (so that summer abstraction can be minimised) and on best practice irrigation methods.

2.14 National Farmer's Union (NFU)

The NFU promotes the interests of farmers and sympathetic understanding between everyone involved in farming. In 1993 the NFU published 'Better Use of Water – the NFU's Proposals' which considered the storage of surplus water available in winter, temporary transfer of licences and water efficiency initiatives both in agriculture and other sectors. There is also a second farming organisation; the Farmers Union of Wales.

2.15 Confederation of British Industry (CBI)

The CBI is Britain's business voice. It is an independent, non-party political organisation, funded entirely by its members in industry and commerce. The CBI has an Environmental Affairs Directorate which exists to assist and promote environmental best practice (as a competitive issue) and the Environment Policy Group which is instrumental in monitoring and developing policy and legislation.

2.16 Department of Trade and Industry (DTi)

The DTi has a number of areas of responsibility, its chief role being the promotion of British industry, particularly in export markets. Other areas of responsibility include energy, international trade policy, industrial competitiveness, consumer protection and scientific and technical research. The DTi's principal involvement with demand management has been the promotion of waste minimisation projects and the setting up of the UK Ecolabelling Board.

2.17 Council for the Protection of Rural England (CPRE)

The CPRE is a registered charity funded almost entirely by supporters subscriptions, donations and legacies. It is an independent organisation concerned with the care and improvement of England's countryside and furthers its aims by research, debate and lobbying. In 1988 the CPRE jointly (with the Royal Society for the Protection of Birds with the support of the World Wide Fund for Nature) commissioned a report entitled '*Liquid Assets*' which examined the likely effects of privatisation of the water authorities on wildlife habitats and landscape. In a section on over-abstraction it concluded '*Thus the problem of over-abstraction with resulting environmental damage could worsen under the Bill*'. Through the publication of '*Water on Demand – the case for demand management in water charging policy (1991)*' and '*Water for Life - Strategies for Sustainable Water Resource Management (1993)*' the CPRE has made a valuable contribution to the demand management debate. There is also a Campaign for the Protection of Rural Wales (CPRW).

2.18 Local Planning Authorities

County councils, district councils, unitary authorities and metropolitan boroughs are guided by Policy Planning Guidance Note 12 that suggests that water availability should be a consideration in local authority development plans. As a result some councils have been supportive of demand management measures.

2.19 Country Landowners Association (CLA)

The CLA is an association of owners of agricultural and other rural land. It promotes the interests of the members and works to safeguard and develop the capital invested in the ownership of land and to secure an appropriate return from these assets. These objectives are achieved by political representation, advising members and publicising information of concern. They have been active in promoting the wise use of irrigation water particularly through the use of winter storage.

2.20 Friends of the Earth (FoE)

FoE is an environmental pressure group funded by subscriptions and public donations. FoE believes in informing and empowering the public through its network of over 300 local groups. Campaigning is at local, national and international level on a wide range of environmental issues.

In 1992 FoE provided a very comprehensive response to '*Using Water Wisely*' indicating broad support for demand management as an alternative to expanding supplies. Their response included support for a legal duty to be placed on water companies to promote the efficient use of water. They also supported the proposal that OFWAT set and enforce mandatory leakage targets and OFWAT itself should be required to promote economy and efficiency in the use of water as well as on the part of water companies. Support for domestic metering was limited to locations where it will produce 'tangible' results (i.e. areas where resources are stressed). Other proposals of interest were as follows:

- statutory minimum acceptable flows should be set for all rivers and should be the basis for the NRA's consideration of licence reviews and applications.
- the Government should overhaul the system for granting and revoking abstraction licences, in order to allow the NRA to revoke licences without having to pay compensation to licencees.

- incentive charges for water abstractions and discharges, although worthy of consideration should not operate in the absence of minimum environmental standards.
- the results of abstraction monitoring should be placed on a public register.
- the Government must begin to address the fundamental question of why high water demand crops are being grown in the driest areas of the country.

One of the conclusions of the response was *'water resources cannot be managed in isolation. Policies for planning, pollution control and drainage all have implications for water resources. There is a need to develop integrated policies for the management of the water environment as a whole'.*

2.21 Royal Society for the Protection of Birds (RSPB)

The RSPB is a registered charity. As well as improving land for wildlife by such practices as recreating wetlands and tree planting, the RSPB works with other conservation organisations and campaigners by lobbying Parliament, advising landowners and planners and opposing developments that threaten the environment. The RSPB supported an amendment in the Environment Bill to 'place legal duties on the Environment Agency, OFWAT and the water undertakers to promote the efficient use of water' and 'to introduce an incentive charging scheme for abstraction licences'.

In July 1995 the RSPB published their own proposals for water resources management 'Water Wise'. They concluded that action is needed now in the following areas to manage the demand for water more effectively:

- site protection
- improved regulation
- financial measures
- demand management
- planning guidance.

3. Development of Demand Management in the UK

3.1 Demand Forecasting of the 1960s/70s

In the 1960s and 1970s Water Resource planners used fairly crude extrapolation techniques in their demand forecasts for resource planning. During this time, a period of economic expansion, due to both the increase in population and per capita consumption the growth in domestic demand in particular was high and it was expected that this trend would continue. The demand in 1971 was 35% greater than 1961 and 135% greater than 1940. Little attention was paid to who was using the water, to what uses it was being put and how much was being lost through leakage. In January 1974 the Water Resources Board (WRB) published a national strategy which identified three major reservoir developments which, it stated, were essential to meet projected demands in 1981:

- 3 reservoirs at Brenig in north Wales
- Kielder (Northumberland)
- Carsington (Derbyshire)

Also required were 2 reservoir extensions, major groundwater schemes in the Thames and Anglian regions, and a massive programme for interlinking supplies.

In the strategy the only reference to demand management was as follows:

> *"At some stage the rate of increase will presumably slacken, but we do not think that it is safe to assume that this will occur to any great extent over the next ten years; it may take much longer. There is still a long way to go before all households have modern standards of water sanitation; and these standards are themselves likely to rise. Nor do we think any changes of pricing policy, for example by metering household supplies, will have a marked permanent effect on overall demand. Such a change could be introduced only slowly; and, in any event, the real cost of water is, in our view, not likely for the foreseeable future to be sufficiently high to have a marked impact on household expenditure."*

In the 1970s and early 1980s water economists, such as Rees (1982) and Herrington (1971 & 1981) in the UK, advocated demand management in the water industry as an alternative to supply development. Their argument was from the standpoint of least community cost, rather than specifically environmental considerations.

3.2 The creation of the Water Authorities (1974)

A Local Government and water industry reorganisation in 1974 replaced the 100 water boards, 50 local council undertakings, seven water undertakings, seven water committees, 27 river authorities, 2 river conservancies, 1366 council sewerage undertakings and 7 joint sewerage undertakers with 10 regional water authorities. The 30 water (only) companies were not affected. The new water authorities were based on river catchment areas and they had control over the whole water cycle, including water supply, sewerage, flood prevention, river quality and sludge disposal. One advantage was that the Water Authorities could plan at a more strategic level and better utilise regional water resources. As a result the Water Resources Board was abolished and replaced by the less powerful Central Water Planning Unit (CWPU). The CWPU carried forward the work of the WRB and sought to improve on the extrapolation approach to demand forecasting. In Technical Note no. 19 '*Public Water Supply in 1975 and Trends in Consumption (1977)*' it states:

> "Quite apart from the doubts attached to the identification of a single underlying trend, extrapolation involves the doubtful assumption that past trends will continue into the future."

The CWPU attempted to establish how water is used domestically and to relate trends in consumption to trends in economic and social variables. Further work suggested a component based approach to demand forecasting.

3.3 Public Inquiries

The traditional water resource planning approach of the 1960s/70s is typified by the following statement from an Engineer witness for the promoters of the Empingham reservoir (now Rutland Water) to a Parliamentary select committee in 1969:

> "In an area where reservoir sites are scanty and demand is high and foreseeable future demands are going to grow, one wants to put in a reservoir as large as the country will permit, within reason, and we put the gross capacity of this one at this figure, as we consider that it is as large as the area can accommodate"

In other words, in deciding the size of a reservoir, the demand forecast was not the sole consideration. Listed below are some examples of proposed reservoirs which illustrate either the deficiencies in the forecasting technique and/or the lack of consideration given to demand management.

Kielder

Kielder Reservoir in Northumberland was planned in the 1960s and was believed to be required for industrial and economic expansion of the steel, oil and chemical industries in the North East. At the public inquiry in 1973 despite the fact that the projected growth in demand had been revised downwards and there was the possibility of a recession with oil price rises looming the scheme

was approved. By the time the reservoir was built in 1982, at a cost of £150 million it was clear that it would be largely under utilised unless used for inter regional transfers.

In 1990, in the Northumbrian region of the NRA there was a 94% surplus of resource as percentage of average demand, largely due to Kielder. (The next largest region was Welsh with a 26% surplus).

Broad Oak

In 1976, Southern Water Authority (SWA) and Mid Kent Water Company drew up a scheme to flood 700 acres of farmland at Broad Oak, near Canterbury. The idea was to draw water from the River Stour and supply 94 Ml/day to Canterbury, Thanet and Ashford. At the public inquiry in 1979 SWA and Mid Kent Water Co. claimed that demand would rise by 56% in the next twenty years, based on a crude extrapolation forecast.

The Secretary of State for the Environment did not believe that the promoters (SWA and Mid Kent Water Co.) had struck the right balance between their own interests and the interests of others. In recognising that the promoters would now wish to consider an alternative scheme he stated that he would expect them to have regard to:

1) matching the yield to what is needed for meeting estimated water demands within a reasonable planning horizon of, say, 30 years;
2) revising their estimates of reliable yields of existing sources and forecasts of demands, taking due account of the need to pursue vigorously efforts to reduce wastage and take all practicable measures to conserve supplies;
3) reviewing their method of demand forecasting with particular reference to unmetered demand; and
4) the effect of abstractions on flows and water quality in the River Stour.

This was probably the first case in the UK of a scheme being rejected for reasons other than poor demand forecasting alone; instead the emphasis was on the need to pursue water conservation, particularly the reduction of leakage, and as such represents a turning point in the consideration of the need for new supply schemes.

Ennerdale

In 1980 a public inquiry was held to adjudicate on North West Water's proposals to raise the levels of Ennerdale to provide an additional water resource for Cumbria.

The inquiry inspector's report to the Minister stated:

> " The Secretary of State would need to be satisfied that the size of any scheme was justified by evidence of need in the North West. Water Authority demand forecasts submitted at the inquiry did not reflect the results of pursuing water conservation policies and he would expect the updated forecasts to have due regard to the need to pursue vigorous efforts to reduce wastage in the public supply system and take all practical measures to conserve supplies."

the emphasis in this case being wholly on the need to reduce leakage and implement water conservation policies.

Roadford

In 1976, South West Water Authority (SWWA) decided to carry out a detailed survey of household domestic use to incorporate in demand forecasts that would stand scrutiny at the public inquiry for a new reservoir at Roadford. Between March 1977 and April 1988 1000 households were externally metered.

At the inquiry in 1978 the scheme was approved. However, the inquiry was re-opened in 1982 but only on the basis of the demand forecast. SWWA argued that Roadford would need its full capacity in 2020. At the time Plymouth, which Roadford would serve, had a leakage rate of 35% and SWWA argued that the best that they could hope to achieve was to reduce it to 28% over the next twenty years. Although this was challenged by the CPRE it was dismissed on the grounds that those opposing the scheme were not sufficiently knowledgable about leakage, and the scheme was approved.

3.4 Leakage Control in the 1980s

In 1980 following the publication of Standing Technical Committee Report 26 "Leakage Control Policy and Practice" (1980), the Water Authorities, realising the economic consequences of operating with high leakage levels, formulated leakage control policies based on the guidelines in that report. Some of the Authorities installed continuous monitoring systems (district meters) that, with teams of waste inspectors, were able to respond quickly to increased leakage. Some of the impetus for this initiative was lost in the run up to Privatisation (1989) and beyond.

3.5 The 1988-92 Drought in the UK

Between 1988-92 many parts of the UK experienced their longest drought this century. Many areas were affected but the drought was most severe in eastern and southern England which was short of approximately ten months rainfall. It was not a drought of extremes but the combination of four successive dry winters and intervening hot, dry summers was sufficient to seriously deplete water resources, both underground aquifers and rivers.

In the south and south-east of England, where 60% of the public water supply is drawn from groundwater

sources (compared to 33% throughout England and Wales) the problems were most acute as groundwater levels fell to their lowest for 100 years. Many rivers also fell to very low levels, primarily due to low rainfall and subsequent run-off, but also due to low groundwater levels as groundwater from springs is often an important contributor to river flow.

The water industry's response to the drought was to reduce demand by a combination of appeals for voluntary restraint, hosepipe bans and drought orders. Some capital works which improved flexibility of supply were brought forward.

In 1990/91 some 20 million people were subject to a hosepipe ban and 6 million lived in an area with a drought order.

One of the main effects of the drought was that water resources and possible future shortages, as in 1976, were brought to the media and the public's consciousness. The 'disappearance' of some rivers (due to over abstraction but exacerbated by the drought) was considered by many to be environmentally unacceptable.

3.6 Principal Demand Management Documentation for the UK

Principal Demand Management documentation in the UK, to date, has been:

3.6.1 Using Water Wisely (Department of the Environment 1992)

In 1990 the Government published a white paper "This Common Inheritance" which set out their commitment to wise stewardship of the planet and its natural resources. Following on from this and in response to the 1988-92 drought, Michael Howard, the then Secretary of State for the Environment, launched the DoE's consultation paper 'Using Water Wisely' at a press conference in August 1992. The purpose of the paper was to consider the scope for reducing demand for water as an alternative to major works to increase supply. It described the main ways in which water is used at present, explains how water resources are managed and the options available to augment them. The paper also examined, in considerable detail a range of measures to cut waste and reduce demand, including the use of economic instruments. The Government's purpose was to initiate a wide and constructive debate on the options. Views were sought on a number of possible measures and a final strategy paper 'Water Conservation – Government Action' was published in August 1995.

3.6.2 Dealing With Drought – Environmental and Technical Aspects of Water Shortages (Parliamentary Office of Science and Technology, February 1993)

This was a report intended for Parliamentarians to understand reasons for water shortages, their environmental impacts and the potential of various supply solutions and demand management policies in their resolution. Although the report does consider supply augmentation and inter regional transfers it largely concentrates on demand management as the way forward. The summary concludes with a number of options for demand management which is reproduced below (Table 3.1).

BODY	ACTION
DoE	Introduce replacements for water byelaws
	Tighten byelaw specifications on water using appliances; require spray taps in offices; require new houses to have a shower
	Encourage water audits and disseminate information on the efficient use of water in industrial and commercial sector.
DTI/DoE	Labelling of water consumption for appliances
DoE/Water Companies	Public education campaign on the efficient use of water
DoE/NRA/OFWAT/ Water Co's	Develop methodology to include environmental benefits when assessing the economic case for leakage control and metering
NRA	Monitor leakage control programmes, including customer supply pipe leakage
	Introduce economic incentives for abstraction
OFWAT	Give the DG a duty to promote the efficient use of water
	Give the DG powers to set performance standards for water companies' water efficiency campaigns
	Give the DG powers to set mandatory targets for leakage
	Examine possibilities for co-operation over meter reading with other utility regulators
Water Co's	Give water companies a duty to encourage the efficient use of water
	Give water companies improved powers of entry and easier recovery of costs for repairing supply pipe leakage
	Introduce spot checks on byelaw compliance

Table 3.1 Summary of options for Demand Management (P.O.S.T report)

3.6.3 Water for Life – Strategies for sustainable water resources management (CPRE, 1994)

Professor Judith Rees and Sarah Williams at the University of Hull, on behalf of CPRE, considered the range of demand management options available to Government, water companies, regulators and consumers. Four water management options were identified;

- new resources and supplies
- re-use and lower quality supplies
- demand reduction (leakage, metering, appliances)
- reallocation and relocation of demand.

To achieve the goal of sustainable water resources management four management tools were advanced;

- collective action (planning and design)
- direct regulation (legislation and regulations)
- persuasion (education and publicity)
- economic incentives (tariffs, tradeable permits).

The report was strong on the economic aspects and concluded that economic tools cannot replace direct regulation, but that it was important to see them as complementary tools and a combination is required.

Many of the ideas in the report emanated from an NRA sponsored R&D project 'Economics of Water Resource Management' completed by Rees and Williams in 1993.

The proposed actions from these three documents are listed in Appendix B.

3.7 The Environment Act 1995

On 19 July 1995 The Environment Act was passed and amended section 93 of The Water Industry Act 1991 to impose a duty on water undertakers to promote the efficient use of water by its customers. The section is reproduced in full on the next page:-

3.8 The Role of the NRA

In March 1994, the NRA published the first national water resources strategy since 1973, '*Water – Nature's Precious Resource*', following a two year consultation period. The aim was to develop an environmentally sustainable water resources development strategy for England and Wales. The following concepts were embodied and considered essential to an environmentally sustainable strategy:

- Sustainable development – to try and ensure that there is no long term systematic deterioration in the water environment due to water resource development and water use.
- Precautionary principle – where significant environmental damage may occur, but knowledge on the matter is incomplete, decisions made and measures implemented should err on the side of caution.
- Demand Management – For the first time in a national water resources strategy demand management was recognised as having a significant role to play.

The strategy defined three different demand scenarios, high, medium and low. Each scenario reflected different growth rates and differing levels of demand management. For the low scenario (significant, but achievable demand management) the report concluded that no strategic developments would be required for the next thirty years.

The majority of NRA regions have produced their own regional water resources development strategies and demand management features in all of these. The strategies are listed in Appendix D.

The NRA had already shown its commitment to water conservation and demand management by the creation of its National Demand Management Centre in 1993.

This strategy document, which clearly defines the NRA's role in water conservation and demand management, and suggests how a national strategy might be put into practice, is further evidence of that commitment.

Duty to promote the efficient use of water

93A.

(1) It shall be the duty of every water undertaker to promote the efficient use of water by its customers.

(2) The duty of a water undertaker under this section shall be enforceable under Section 18 above -

a) by the Secretary of State; or

b) with the consent of or in accordance with a general authorisation given by the Secretary of State, by the Director.

(3) Nothing in this Part shall have effect to authorise or require a water undertaker to impose any requirement on any of its customers or potential customers.

Power of Director to impose requirements on water undertakers

93B.

(1) The Director may require a water undertaker, in its performance of its duty under Section 93A above, to –

(a) take any such action; or

(b) achieve any such overall standards of performance, as he may specify in the document imposing the requirement.

(2) Where the Director, in the document imposing a requirement on a water undertaker under subsection (1) above, stipulates that any contravention of the requirement by the undertaken will be a breach of its duty under Section 93A above, any contravention of that requirement by the undertaker shall be a breach of that duty.

(3) Without prejudice to the generality of subsection (1) above, a requirement under that subsection may –

(a) require a water undertaker to make available to its customers or potential customers such facilities as may be specified in the document imposing the requirement;

(b) require a water undertaker to provide or make available to its customers or potential customers such information as may be specified in the document imposing the requirement, and may specify the form in which, the times at which or the frequency with which any such information is to be provided or make available.

(4) In exercising his powers under this section in relation to any water undertaker the Director shall have regard to the extent to which water resources are available to that undertaker.

(5) Before imposing any requirement on a water undertaker under subsection (1) above the Director shall consult that undertaker.

(6) Nothing in this section authorises the Director to impost any requirement on a water undertaker which has or may have the effect of authorising or requiring that undertaker to impost any requirement on any of its customers or potential customers.

Publicity of requirements imposed under section 93B

93C.

(1) Where, under section 93B(1) above, the Director imposes any requirement on a water undertaker, the Director may arrange for that requirement to be publicised in any such manner as he may consider appropriate for the purpose of bringing it to the attention of that undertaker's customers.

(2) Without prejudice to the generality of subsection (1) above, the Director may arrange for such publicising of the requirement as is mentioned in the subsection by –

a) himself publicising the requirement or causing it to be publicised; or

b) directing the undertaker to inform or arrange to inform its customers of the requirement.

Information as to compliance with requirements under section 93B

93D.

(1) Where a water undertaker is subject to any requirement imposed under section 93B(1) above, the Director may arrange for there to be given to the customers of that undertaker at any such times or with such frequency, and in any such manner, as he may consider appropriate, such information about the level of performance achieved by the undertaker in relation to that requirement as appears to the Director to be expedient to be given to those customers.

(2) Without prejudice to the generality of subsection (1) above, the Director may arrange for such giving of information as is mentioned in that sub-section by–

a) himself disseminating the information or causing it to be disseminated; or

b) directing the undertaker to give or arrange to give the information to it customers.

(3) As such times and in such form or manner as the Director may direct, a water undertaker shall provide the Director with such information as may be specified in the direction in connection with the undertaker's performance in relation to any requirement imposed upon the undertaker under section 93B(1) above.

(4) A water undertaker who fails without reasonable excuse to do anything required of him by virtue of subsection (3) above shall be guilty of an offence and liable on summary conviction to a fine not exceeding level 5 on the standard scale.

4. Present UK Practice

4.1 Introduction

This chapter describes the current UK practice for a range of water conservation and demand management options. To understand the potential for the different options it is helpful to appreciate the purposes for which water is abstracted as shown in Figure 4.1 (England and Wales only).

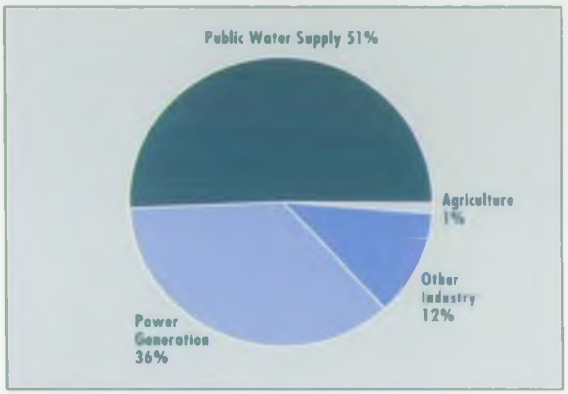


Figure 4.1 Water Abstraction by Purpose (Non Tidal Surface Water and Groundwater only).

4.2 Demand Forecasting

Demand Forecasting is not strictly a demand management technique, in that its application does not directly reduce demand for water. However, a knowledge of the contributing components, especially domestic consumption and leakage is vital to understanding demand management potential. An accurate and realistic forecast, with demand management techniques included in that forecast can show that there is not a requirement to develop new sources in the future. (For example, the NRA's 'low' scenario in "Water – Nature's Precious Resource").

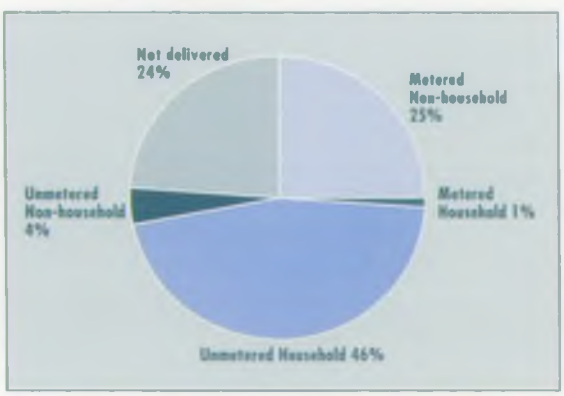


Figure 4.2 Components of the Public Water Supply (by volume).

A current assessment of unmeasured per capita consumption (pcc) is extremely important since an over estimation of pcc will result in an under estimation of leakage, which is a demand that is within the capability of water companies to reduce. Demand forecasting methodology has improved since the extrapolation techniques of the 1960s/70s and during the 1980s most companies have adopted a component based approach to demand forecasting. The components are as shown in Figure 4.2

Unmeasured and Metered Household

The largest component is domestic consumption, which is the product of per capita consumption and population. The population statistics are normally derived from OPCS (Office of Population Census and Surveys) who predict population trends into the future. More difficult to predict is the unmeasured per capita consumption. Most water companies carry out surveys to determine the current level of pcc but a prediction of the growth rate involves an assessment of the rate of increase in ownership of water using appliances (washing machine, dishwasher, sprinklers etc.), their frequency of use and their consumption of water for each use. Although there may be an increase in ownership of such appliances this has to be offset against the fact that such appliances may become more water efficient. Current forecasting techniques now take account of variations in pcc with property type.

The main reason for some of the previous over forecasting of demand was more due to overestimation of the growth of pcc rather than the overestimation of population growth although the latter was the case in the late 1960s.

For metered households it is common to apply a reduction factor based upon the results from the National Metering Trials which demonstrated that metering reduces the average daily demand by about 10%. The results from the National Metering Trials are explained in more detail in Section 4.4.3.

The situation is further complicated by the possibility of climate change which has been assessed as increasing domestic demand by up to 10% in 2031 by Binnie and Herrington (1992) due to increased garden watering and personal showering.

Non Household Consumption

For non household consumption it is necessary to make predictions about the state of the economy and in particular the effect on industries that use significant volumes of water. This is likely to differ regionally as demonstrated by the decline of heavy water using industries in the north of England during the 1980s.

Also there is a need to assess the effect of improved efficiency of new and refurbished plant.

'Losses'

'Losses' are a function of a number of factors including:

- age of the distribution system
- pipe materials
- soil type
- pressure
- water company's commitment to leakage control
- rate of renewal of the distribution system
- availability and cost of water resources

A prediction of future losses is dependent upon the water company policy, in particular the rate of mains renewal, the degree of pressure reduction and the resources allocated to detecting and repairing leakage.

Peak Demands

A considerable area of uncertainty is the magnitude of peak demands. Peak demands affect:

- sizing of basic water resource schemes
- sizing of new trunk mains and distribution network
- need for service reservoirs

Peak demands generally rise with standard of living as they are influenced by non-essential luxury use such as sprinklers and garden watering. Peak demands are particularly important to investment decisions and especially in groundwater areas that do not have the impounding reservoir storage of a surface water area. As will be demonstrated later (4.4.3) domestic metering has a significant effect on peak demands by reducing them by up to 30%. Statistical analysis has been carried out of peaks and generally they are predicted by the application of peaking factors dependent upon economic forecasts. Currently, a typical ratio for average day in a peak week to an average day in an average year is 1.3.

Water Company Strategic Business Plan Forecasts

For the demand forecasts in the water company Strategic Business Plans (SBP's) an outline methodology using standard definitions and components was agreed between OFWAT, NRA and WSA/WCA. This allowed comparison of demand forecasts between water companies and a national forecast to be calculated from the aggregate (Future Levels of Demand and Supply of Water, OFWAT Occasional Paper 1, November 1994) which is below the NRA 'low' forecast as calculated in 'Water – Nature's Precious Resource' due mainly to reduced leakage. (Fig. 4.3).

The individual company forecasts showed variations in the per capita consumption (pcc) from 170 litres/head/day to 127 litres/head/day (in 1993) and widely differing growth rates ranging from 0.4 l/hd/day/annum to 2.0 l/hd/day/annum. There may be valid reasons to account for regional differences.

UKWIR/NRA Initiative

Although for the Strategic Business Plans there was an agreed outline methodology for demand forecasting, this allowed variation in interpretation and one of the reasons for the differences in both current pcc's and growth rates across water companies is the lack of an agreed *definitive* methodology for water demand forecasting. Whilst there is no agreed *definitive* methodology there is an area of uncertainty and potential disagreement between water companies and the regulators.

In order to resolve this deficiency, in September 1994 a joint water companies/NRA project was commissioned. The project was funded by the NRA and UKWIR (United Kingdom Water Industry Research Ltd).

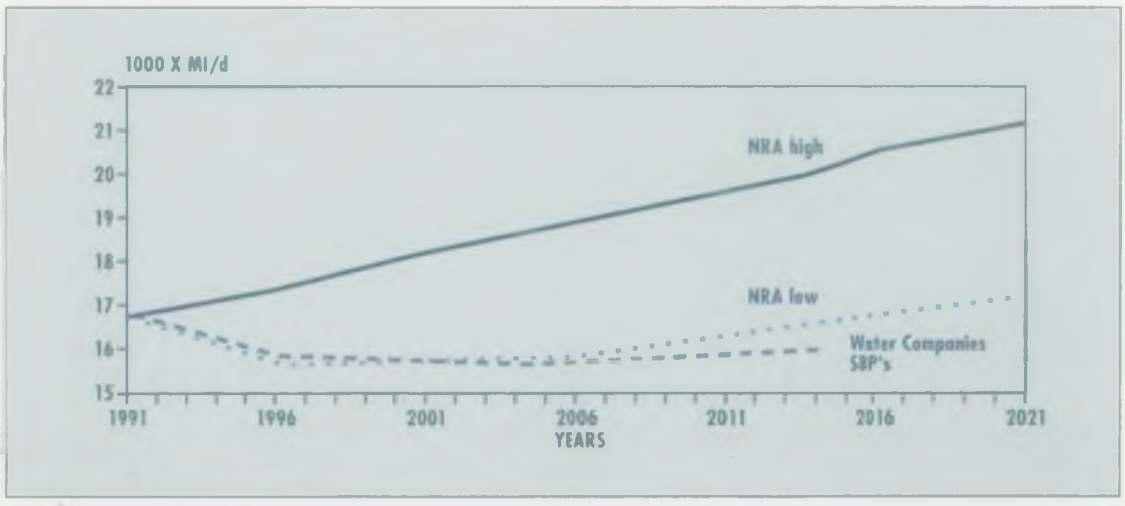
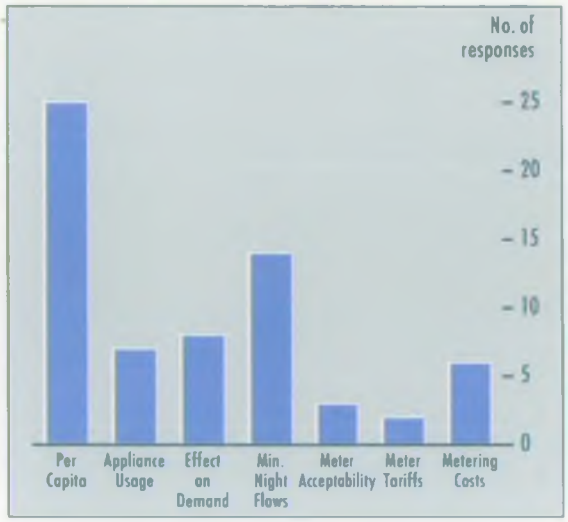


Figure 4.3 Comparison of distribution input between water companies and NRA forecasts.

Figure 4.4 Domestic Consumption Monitoring Studies



The aims of the project were as follows:

- to derive a forecasting methodology for public water supplies acceptable to and applicable by NRA, Water Companies and OFWAT.
- to define the components of demand, both present and future, and recommend methods of determining baseline and projected values.

With the production of a forecasting manual and accompanying spreadsheet package this represents a major step forward in the area of demand forecasting.

4.3 Domestic Consumption Monitoring

A pre-requisite for a professional demand forecast is an accurate estimate of current pcc, an understanding of the trends in ownership of water appliance usage and the frequency of use. Because only 7% of households are currently metered, and many of these are low water users who have opted for a meter to save money and so are not representative, this information is not readily available without conducting specific domestic consumption monitoring experiments.

In 1994 the NRA conducted a survey of all the water companies to establish the scale, design and purpose of any such studies. The majority of water companies were involved in collecting data on household consumption for the reasons as shown in figure 4.4. For example 25 studies are being undertaken to determine local unmeasured per capita consumption, 7 to investigate appliance usage etc.

Studies that warrant a particular mention are:

Thames Water: 700 meters installed externally have been monitoring domestic consumption since 1976. Household surveys are carried out every four years and results related to ACORN group, household size and property type. (ACORN is A Classification of Residential Neighbourhoods.)

South West Water Study: The survey of domestic consumption was set up in 1977, comprising of 900 domestic households throughout Devon and Cornwall and chosen to be representative of the region as a whole. The households have externally located meters and are read every six months. Since 1989, 200 of the survey households have had internal meters which are logged on an hourly basis. Interviews have been held on a regular basis to determine changing appliance ownership and occupancy rate.

Severn Trent Water: 1500 meters, installed internally have been monitoring domestic consumption since 1986. The consumptions are related to appliance usage by recording the number and type of appliances within the property. Diary studies have been carried out to determine appliance usage. The results are related to ACORN groups.

Southern Region Control Areas: A joint study between Southern Region NRA and the water companies that has been running since 1986. There are 67 discrete areas which are logged and the results used to determine the pcc. The results are related to ACORN groups. Valuable time series information has been obtained which shows a peak of pcc in 1988 of 147.3 l/hd/day which has fallen in successive years to 135.9 l/hd/day in 1993. The methodology assumes that the majority of the minimum night flow (a 15 minute minimum) is leakage.

National Metering Trials: In a joint WSA/WCA/OFWAT/DoE/Water Research Centre project the trials lasted from 1989-92 where 60,000 households in the twelve trial areas were charged for their water and sewerage services by meter. The trials were set up to provide general information (installation costs, operating costs, customer acceptability and effect on bills, meter location, effect on demand and meter accuracy) on widespread domestic metering. Information on pcc has been obtained, and of particular interest with regard to demand management is the effect on average and peak demand.

Domestic Water Consumption in Scotland in 1991: This study was carried out by the Foundation for Water Research. The study involved metering on a zonal, rather than an individual household basis throughout eight Regional Councils. Thirty eight zones were selected comprising eight different types of housing with an average zone population of 540. A household survey was carried out and in 20% of households a seven day diary of water use was completed. From the studies the pcc was calculated as 148 litres/hd/day, an increase of 24% over the result from a similar study in Scotland in 1982. The increase in ownership of the washing machine (49% in 1982 to 80% of households in 1992) and the reduction in household size were deemed to be largely responsible for the increase.

Anglian Water – The Survey of Domestic Consumption (SODCON) study: 2000 households have external meters for which pcc's can be calculated. Within that sample 100 households have every separate water using appliance monitored at the point of use. This survey began in April 1992 and will provide valuable time series data on both pcc and appliance use across different household, soil, climatic and socio-economic types.

4.4 Metering

The UK is almost unique in Europe in that households are not generally charged for water by the amount used. Figure 4.5 shows the structure of the domestic water price for the majority of European countries. The working price refers to the quantity of water drawn and is calculated accordingly in terms of cubic metres of water. The basic price is the fixed element charged monthly or yearly and not dependent on the amount of water consumed. In the UK (apart from the 7% of properties now metered) the basic price is 100% of the charge. Of the other countries only the Netherlands and Norway have a basic price greater than 50%. This is a little misleading as the Netherland's figure is based on Amsterdam which is not representative of the country as a whole, where some 80% of properties are metered. The majority of countries have a working price that makes up 75% or more of the total charge. In the UK, in effect, to the majority of householders the marginal cost (the cost of supplying an extra unit) is zero, and as such, there is no incentive to economise on water use.

Figure 4.5 The structure of the domestic water price (Europe).
(Source: 'European Water Charges: A Comparison of 17 Cities, CRI, 1995).

4.4.1 Legislation

Under section 145 of the Water Industry Act 1991 it stated that water companies could no longer use rateable values as a method of charging after 31 March 2000. However, on 4 April 1995, in response to pressure from water companies and the realisation that it would not be possible to meter all properties by that date, the Environment Secretary John Gummer announced:

> *"Companies will however need an alternative to metering as a basis of charging after 31 March 2000. The Secretary of State for Wales and I have therefore decided that the best course would be to allow the use of rateable values after that date. The necessary changes to the legislation will made in due course."*

Although allowing the water companies to continue to use this charging method the Secretary of State is not going to allow the use of council tax banding as a method of charging and he also made it clear that he believed metering to be the most favoured option in the long term.

4.4.2 The Director General of Water Services

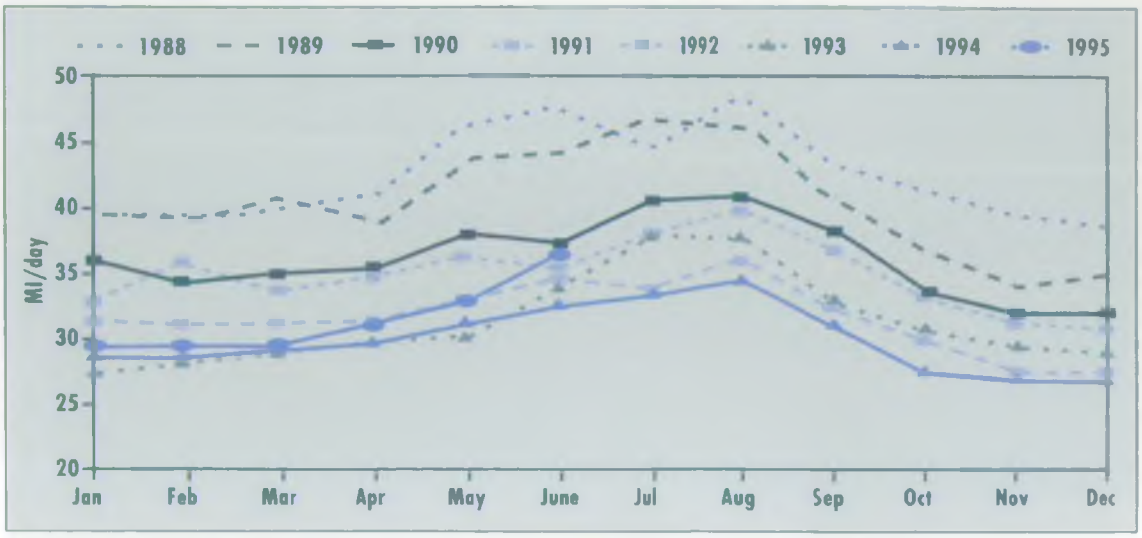
The Director General of Water Services is in favour of domestic metering as he believes it is the fairest method of charging and it allows customers to control their costs but that there is no strong case for a rapid change to universal metering of existing properties. In '*Paying for Water*' (Dec 1991) he states:

> *"There is a good economic case for selective compulsory metering of existing properties in certain places, where there are shortages of supply; where customers, perhaps those in large houses and gardens, have considerable scope to economise in the use of water; and where meter installation is straightforward. For example, if meters are installed when communication pipes are replaced, the savings of resources as a result of metering can be expected to outweigh the costs of installation."*

The Director General believes that charges should reflect the cost of the water and sewerage service and that charging policies need to achieve fairness and equity. He sees household metering as achieving those goals by being targeted and spread progressively. He also believes that there is a good case for spreading the cost of metering across all customers as they all benefit from the reduction in demand.

In '*Paying for Growth*' (Feb 1993), the DG goes on to say *"It is neither economically or environmentally justified to meet all possible demands for water when the customer is not charged for additional use."* and *"Household metering provides a direct measure of customer willingness to pay for additional demand."*

Figure 4.6 Water into supply – Isle of Wight



4.4.3 The National Metering Trials

Against this background of discussion of future methods of charging The National Metering Trials (as defined in 4.2) took place. One reason for the trials was to obtain information on the effect on demand to assist policy makers in determining the likely impact on customers bills, company turnover and cash flow in the event of a metering programme.

Small scale sites (320-1145 props)

The average reduction in household consumption of the 11 sites was 10.8% due to metering. The results of using different tariffs at the sites were inconclusive. The reductions were determined by comparison with control areas where there was no metering. The individual reductions ranged from Bristol (+1.6% ie. an increase) to East Worcs (-17.2%). The impact of the metering did not seem to change with time, ie. there was no '*bounce back*' although it was recognised that three years was perhaps too short a duration to reach a conclusion.

Isle of Wight (50,000) props

The Isle of Wight was not intended as a specific test of the impact of metering but to assess the problem of switching to metering on a large scale. As a result there was no control area so comparisons had to be made with historical data.

During the installation phase 15% of supply pipes were replaced because they were defective. There was an overall reduction of 'Distribution Input' of 20% of which approximately half was attributable to the replaced supply pipes and the other half due to the reduction in household demand. The pcc reduced by 21.3 %. The 'Water into Supply' for the Isle of Wight 1988-94 is shown in figure 4.6.

Effect on peak demands

From all the trial areas, an average 30% reduction was recorded in peak, month, week, day and hour demand. This was evident in years with hot, dry summers. In wet summers the reduction in the peak demand was typically 15%.

The significance of this reduction in peak demand can be seen in Fig 4.7 where Herbertson and Burrow (1994) applied data to a typical water company in the south east of England that is largely dependent on groundwater sources. A 70% domestic metering scenario represented a new source postponement of 13 years based on average demands but postpones a new source indefinitely on the basis of peaks.

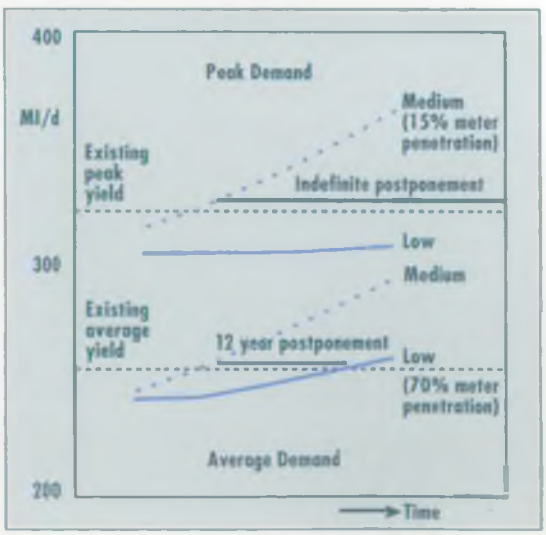


Figure 4.7 – Impact of metering on average and peak demand

Other metering issues from the Trials

Installation Costs: £165 internal and £205 external for 95% of properties. The remaining 5% cost over £1000 each (1992 prices).

Operating Costs: £19.08 per property/year (92/93 prices) over and above the rateable value charging method.

Customer Acceptability: OFWAT conducted '*A Survey of customers in the Water Metering Trial Areas (Jan 1992)*' which showed that 71% of customers in the trial areas regarded metering as reasonable system of charging. The majority of customers had lower bills but 4% suffered social or financial hardship as a result of the change. The survey also showed that in 59% of households there had been attempts to reduce water use.

Accuracy/faults: 20% of meters removed at random and tested failed to meet the in-service test requirements. The majority of these under recorded, either by very small amounts or were completely jammed (water will continue to pass a jammed meter). A small percentage over-registered consumption, but only at one flow rate and then by a minor amount. Where under and over registering occurred it was considered to be so minor that the effect on a customers bill would be negligible. Where jamming occurred, obviously there would be no increase in consumption at all. 40% of the failed meters were due to jamming.

4.4.4 Other Studies

Currently South East, Mid Kent, Essex and Suffolk Water Companies and Anglian Water Services are currently carrying out studies to assess the effects of metering on demand.

4.4.5 The Current Situation

With regard to household metering, currently 7% of properties are metered (in England and Wales). Based on water company predictions in the report '*Future Levels of Demand and Supply of Water, OFWAT Occasional Paper 1, November 1994*' this is set to rise to 14% by 1999/2000 and 33% by 2014/15. The predicted coverage is very variable between the companies, ranging from 1% to 95%, and reflects the different policies that they have adopted.

Despite Anglian Waters' aim to compulsorily meter all properties, on 14th October 1994 it was announced that a comprehensive review of the compulsorily element would be undertaken to address the concerns of their customers who were unconvinced of the benefits of metering and objected to the idea of compulsion.

Mid Southern Water have addressed this problem in Alton (7,000 properties) by the following method (press release 27/10/94).

1. New stoptap boxes (with space for a meter) and separated supplies will be installed at all properties.
2. For all customers who voluntarily choose to have a measured water supply a meter will be installed free of charge and the appropriate charge will be levied from 1st April 1996.
3. Where an unmetered property changes ownership, a meter will be installed as a matter of course and future water bills will be determined on a measured basis.

By the adoption of this method no existing customers will be compelled to change to the metered method of charging.

On 15 December 1994 Anglian Water announced they would be proceeding with a revised metering programme, as follows:

- when a meter is installed under the programme, customers will be able to switch to metered charges when they choose to do so
- once a customer opts for metered charging they cannot revert to an unmeasured charge in future
- customers compulsorily metered since April 1994 will be able to pay rateable value charges on request
- when a property changes hands, customers moving into a property to which a meter has been fitted will be charged at the metered rate

Anglian Water regard the water conservation aspects of metering as one of its principal benefits.

Since 1st April 1993, domestic customers in Scotland have been able to take their supply of water by meter, an option previously not available to them, which is still the case in Northern Ireland.

4.4.6 Non-household metering

For non household metering currently 70% of non households are billed by meter, but this represents 90% of water delivered as the majority of the water is used by a small number of industries. By 2014/15 the water companies predict that 93% of non households will be metered, accounting for 95% of the demand.

4.5 Leakage

4.5.1. General

In the mid 1970s it was estimated that in the UK, water company/authority leakage rates were of the

order of 25%, due to an ageing distribution system of cracked and corroded mains and leaking joints. The overall average masked some high regional variations of sometimes as high as 50%. It would be accurate to say that leakage control was very much 'the Cinderella of the profession' with the glamour assigned to large reservoir projects. It simply was not given priority by the industry.

Many large industrial complexes, with their own distribution networks, have also experienced high leakage rates. Despite being metered, water charges are still a small proportion of total business costs, so often there is little incentive to investigate high consumption. This also applies even more to industries who abstract their water directly (rather than via a water company) where the cost is even less.

4.5.2 Standing Technical Committee Report 26

"*Leakage Control Policy and Practice*" known in the water industry as Report 26 was published by the National Water Council and the DoE in July 1980 and provided invaluable guidance to the water industry. The report included a manual which explained how a water authority could determine the leakage in a particular area, how to calculate the amount of effort worth putting in to leak location and how to find the leaks themselves most efficiently. It defined five standard approaches to leakage control:

- passive control – responding only to customer complaints.
- regular sounding – teams of waste inspectors systematically walk the streets of an area, listening for the sound of escaping water with listening sticks.
- district metering – meters measure the flow into an area of 4-5,000 properties. The meters are read on a weekly basis and unusually high flows would be investigated by sounding.
- waste metering – meters covering smaller areas of up to 500 properties, either mobile or in-situ, put in to operation at night. The night flow is a good indicator of the level of leakage and would provide information on the most productive areas to carry out sounding activity.
- combined metering – a combination of district and waste metering.

Also mentioned was pressure reduction which reduces leakage by,

- reducing the flow from existing cracks and joints
- reducing burst frequencies

a method of calculating the reduction in leakage by the installation of a pressure reducing valve was included.

One of the major contributions of Report 26 was that it showed that leakage control could be cost effective which had, until then, been doubted by many in the water industry.

The report prompted a renewed interest in leakage, particularly as around this time at public inquiries for new reservoir schemes water authorities leakage rates were coming under close scrutiny.

4.5.3 The National Leakage Control Initiative (NLCI)

Due to the privatisation of the water industry in 1989 and the creation of the regulators (NRA and OFWAT) allied to improvements in district metering technology Report 26 gradually became less relevant to the industry's needs. The issue of leakage has a high profile in the media and with the public particularly in the context of recent droughts. As a response in 1991 the WSA and WCA set up the National Leakage Control Initiative to review and update guidance to the water industry on the issue of leakage.

One of the first achievements of the NLCI was to produce a glossary of terms that could be understood throughout the industry (Fig.4.8). The concept of water delivered has since been adopted by OFWAT (rather than water produced) and used as an efficiency measure, so that in theory, the greater the water not delivered the lower the efficiency.

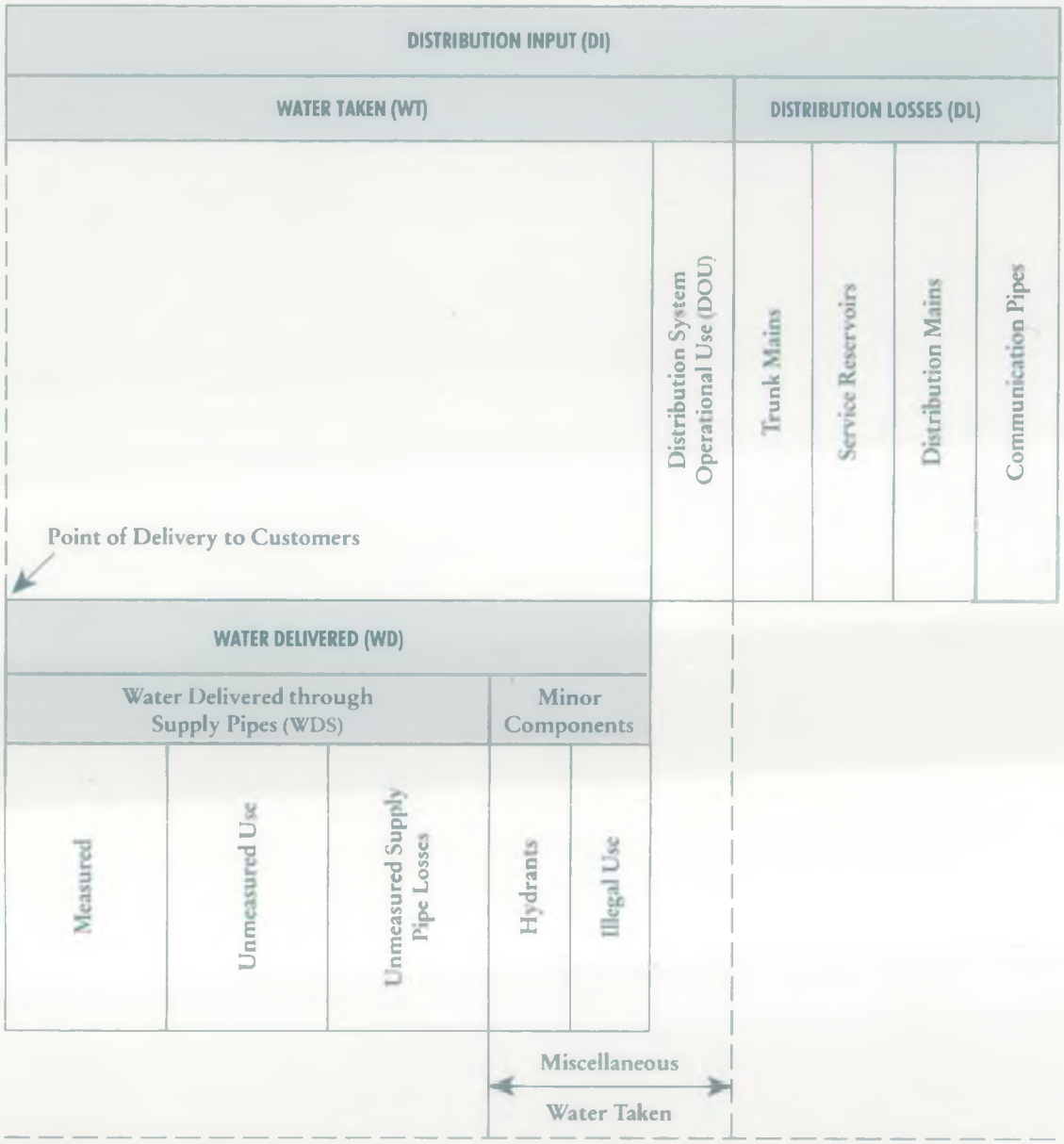
The NLCI consisted of nine project groups consisting of over fifty water industry professionals and on the 20th October 1994 at the Royal Aeronautical Society in London the Report and Recommendations were launched. The report entitled 'Managing Leakage' comprises a summary and eight reports as follows:

Summary Report, provides guidance on which volume to select for further detail and sufficient information for a senior manager to direct his/her operations and strategy.

Report B, 'Reporting Comparative Leakage Performance' addresses the specific objective of developing a methodology which will allow comparison of distribution losses on an equitable basis. The report recommends the use of losses in cubic metres per kilometre of distribution system per day (including lengths of communication pipes), but not to the exclusion of former measures for example l/property/hour. The report shows how comparative positions change depending upon which measure is used.

Report C, 'Setting Economic Leakage Targets' deals with the economic appraisal of leakage. A methodology is outlined for the calculation of the optimum level of leakage and although social and

Volume per Day (Not to Scale)



Simplified Breakdown of Distribution Input (DI)

DISTRIBUTION INPUT (DI)				
WATER TAKEN (WT)				DISTRIBUTION LOSSES (DL)
Water Delivered (WD)			DOU	Distribution Losses (DL)
Water Delivered through Supply Pipes (WDS)			Miscellaneous Water Taken (WTM)	Distribution Losses (DL)
Measured (WDSM)	Unmeasured Use (WDSU)	Unmeasured Supply Pipe Losses (WDSL)	Miscellaneous Water Taken (WTM)	Distribution Losses (DL)

Figure 4.8 Glossary of Terms (from 'Managing Leakage')

environmental costs are mentioned there is no attempt to put values on such costs.

Report D, 'Estimating Unmeasured Water Delivered' is concerned with the calculation of per capita consumption and other elements that make up the water balance.

Report E, 'Interpreting Measured Night Flows' describes how the measurement of night flows can be effectively used for the management of losses, by appropriate methods of data analysis and interpretation.

Report F, 'Using Night Flow Data' is the practitioner's guide to Report E and includes a step-by-step process to prioritising leakage detection.

Report G, 'Managing Water Pressure' includes a design methodology for pressure controlled districts and assists with the selection of pressure reducing valves.

Report H, 'Dealing with Customers' leakage' details standard procedures to be followed in the water industry for dealing with leakage that is the customer's responsibility.

Report J, 'Leakage Management Techniques, Technology and Training' addresses training requirements in addition to a review of available techniques.

With the production of this documentation there is little doubt that the UK is the world leader in the understanding of leakage and how it should be tackled and managed. At the launch of the seminar it was stated that it would take water companies two to three years to implement the recommendations.

The principal concept of the NLCI was the Bursts and Background Estimates (BABE) concept, which breaks leakage down into its components of background, unreported bursts and reported bursts. A commercially available spreadsheet was produced, which enables the user to estimate the loss of treated water from a water distribution system and customer supply pipes. The spreadsheet is particularly useful for devising leakage control strategies as the sensitivity (and cost effectiveness) of different leakage policies to the level of leakage can be assessed.

One criticism that can be made of 'Managing Leakage' is that it concentrates on the company owned distribution system. All losses downstream of the abstraction point need to be assessed and reduced. Where water is transferred over long distances, e.g. Thirlmere and Elan Valley aqueducts, losses could be significant.

4.5.4 The Current Situation

As far as 'total losses' are concerned (with powers to enforce repairs it is reasonable to expect water companies to have an interest in reducing customer leakage) in terms of litres/property/hour (the most commonly used measure at present) leakage currently ranges from 4.6 to 18.5 with an industry average of 11.9. Without a detailed economic analysis as described in Report C of Managing Leakage it is difficult to be precise about whether companies are operating at economic levels of leakage, although with the reductions in staffing levels that accompanied and followed privatisation it is probable that many are not.

There has been considerable debate within the industry as to what is the correct measure to define leakage. Percentages are readily understood by the public but not favoured by the industry. Report 26 recommended litres/property/hour for urban areas and litres/km of main/sec for rural areas, but litres/property/hour became the commonly accepted measure. '*Managing Leakage*' recommends m^3/km of distribution system/day. With reference to Table 4.1 it can be seen that the new measure has little effect on 'league table' positions when compared with losses per km of main. This is perhaps not surprising since the length of communication pipes will always be a relatively small proportion (compared to mains) of the total length of the distribution system.

In the Southern Region of the NRA, it has been made clear to water companies that they will be expected to achieve leakage levels of 6 litres/property/hour or better before new licence applications or variations will be considered.

This value is considerably less than the industry average of 11.9 litres/prop/hr. Some companies have achieved this level which is believed to be close to their economic level.

4.6 Agricultural and Industrial Demand

With 49% of all water abstracted being for industrial and agricultural use there is considerable scope for demand management in direct industrial and agricultural abstractions.

Of all water abstracted, 36% is used by the Power Generation Industry. As most of this water is used for non-evaporative cooling or for hydro electric power generation it is a non consumptive use and once discharged is available for use downstream. Industrial demand can be either by direct abstraction or via the water company's mains whereas agricultural demand is generally by direct abstraction. Agricultural and Industrial demand account for 1% and 12% of water directly abstracted respectively (Fig 4.1). Agricultural demand is of particular importance since it is predominantly consumptive use (i.e. not returned to water courses/ aquifer after use), is required most in times of drought and tends to be concentrated in areas that do not have a large resource surplus.

Table 4.1 Distribution loss ratios expressed as % of median values

Water company	losses as % of distribution input	losses per property	losses per km of mains	losses per km mains plus communication pipe* *assumes an average of 3 metres of communication pipe per property
Bournemouth	41	56	47	49
Bristol	52	57	51	53
Suffolk	58	60	39	42
Hartlepool	59	94	93	94
Portsmouth	66	72	78	77
Tendring Hundred	70	50	46	47
Sutton	78	64	95	87
South Staffs	79	84	100	97
Anglian	79	80	52	56
Wrexham	81	84	49	53
North East	83	83	77	78
South East	89	81	58	61
Essex	90	94	118	113
Cambridge	93	98	66	70
Chester	97	96	101	100
East Surrey	100	111	87	91
Northumbrian	100	127	94	100
York	103	100	100	100
Mid Southern	105	129	101	105
Southern	109	113	110	111
North Surrey	111	116	120	120
Three Valleys	124	133	151	148
Folkestone	126	149	129	133
Severn Trent	129	134	131	132
Thames	142	171	238	223
Wessex	145	194	112	122
South West	156	173	105	114
Yorkshire	175	204	181	185
Welsh	178	238	150	162
East Worcester	188	211	149	158
North West	224	293	260	268

Ref: Demand Management Bulletin, Issue 8, Dec '94 and Managing Leakage (1994)

4.6.1 Industrial Demand

26% of the public water supply is for non-household (i.e. commercial) use. Industrial demand by direct abstraction has declined by 15% over the last decade, caused by:

- contraction of major water using industries
- more efficient use
- re-cycling and re-use

As stated in 4.4.6 the majority of industry supplied by water company's mains pay for their water by volume (meter) and hence there is an incentive to economise. However, despite the often large sums spent on water they can typically, represent less than 1% of total business costs. As a consequence water charges are not always an obvious candidate for industry efficiency drives as for the majority of companies water is still a very cheap commodity.

However, as far back as 1979 Anglian Water Authority commissioned Industrial Market Research Ltd. to carry out a survey of metered water consumers. Eighty per cent of companies claimed to practice some form of water re-use or re-circulation but such an interest is not considered to be representative of the UK as a whole around that time.

The last few years have seen a number of waste minimisation studies taking place in the UK. The

primary aim of such studies is for industries to reduce waste by adopting cleaner technologies, and a by-product is often reduced water consumption as the following examples show:

Aire and Calder Project

This project was launched in March 1992 with a £300,000 budget raised from the BOC Foundation for the Environment, Her majesty's Inspectorate of Pollution (HMIP), the NRA and Yorkshire Water Services. Eleven companies, all discharged (either directly or via the public sewer) to the Aire and Calder rivers. The project was initiated by the Centre for Exploitation of Science and Technology (CEST) a charity funded by predominantly industry but with a contribution from government. The original focus of the project was on the reduction of emissions through waste minimisation and on the adoption of cleaner technology. However, most of the savings arose from a reduction in the use of inputs, such as water, energy and raw materials. In the interim report of February 1994 9% of the total annual savings of £2.1M were due to a reduction in water supplies, and the potential to save a further 22% of another £2.1M on any annual basis by reducing water consumption, was identified.

One of the conclusions from the study was that the case for implementing waste minimisation programmes is so strong that, in general, industry should not need further encouragement from government in the form of a subsidy.

Project Catalyst

The project was initiated to achieve and promote cleaner production through waste minimisation in the region's businesses including manufacturing and service industries to improve the Mersey Basin. The study was jointly funded by the DTI, the BOC foundation for the Environment and the participating companies at a cost of £1m. Following a systematic audit all 14 participating companies identified savings far in excess of the costs involved. Four companies made significant water savings, reducing annual demand by 1,900 ML.

In 1994 the DTI and DoE jointly launched the Environmental Technology Best Practice Programme which aims to 'promote better environmental performance and increase the competitiveness of UK industry and commerce' generally by waste minimisation and cost effective cleaner technology. Available are an environmental helpline, environmental performance guides and good practice guides to advise industries.

In 1995 CEST produced a report "*Waste minimisation and cleaner technology, an assessment of motivation*" which examined studies undertaken to date. Most respondents cited cost savings as being more important than environmental concerns. The challenge is, by disseminating the results of previous studies, to persuade companies to carry out their own waste minimisation studies. This is particularly relevant to small companies where the costs of employing consultants to carry out an audit may be prohibitive. CEST are particularly keen to promote the '*club*' concept whereby companies with similar processes, but not competing in the same markets, exchange information on their work.

The NRA is sponsoring other demonstration projects – Humber Forum, Dee, Don/Rother/Dearne and Medway – in order to provide a series of local foci and to increase the range of industries which can be shown to profit from waste minimisation.

In the Public Sector the Audit Commission has powers to investigate public sector organisations to make sure that they are efficiently run. Cuthbert (1994) reported that from auditing 200 NHS hospitals savings of £10 million had been identified. At £50,000 per audit this gave a payback period of one year. At one site a leak of 120Ml/annum was identified that had been running for at least 15 years, costing £1.5 million at today's prices. In addition to leaks; the following were all contributing to excessive water use; urinal flushing, x-ray processors flushing when not in operation, taps running permanently to drain, faulty cisterns and ornamental ponds overflowing.

4.6.2 Agricultural Demand

Although only 1% of water abstracted in England and Wales is for spray irrigation this can have important consequences for water resource availability:

- it is a consumptive use.
- most of the demand is concentrated into a relatively short period, typically 8-12 weeks/year.
- it is concentrated in particular areas, notably Anglian region (49%, by volume) and Severn Trent (24%).
- it varies greatly, peaking in dry years when resources can be scarce.

Between 1982-90 the annual growth in area irrigated was 1% and 2% in the volume of water used. The most likely prediction for growth in volumetric demand is 1.7% per year from 1996 to 2001 and 1% per year from 2001 to 2021 for the 'dry' year (from the NRA's R&D Report 14 '*Demand for Irrigation Water*'). Irrigation is necessary to increase yield, quality, reliability and continuity of production.

All abstractions for spray irrigation from surface or groundwater require a licence under the Water Resources Act 1991, administered by the NRA. In setting the abstraction charges the NRA's duty is to meet the costs of carrying out its water resource

functions. Currently a licence is not required for trickle (drip) irrigation, which accounts for only 1% of irrigation water.

It is recognised that the strain on water resources could be reduced if farmers used inter seasonal storage (storing water when it is available, during the wetter winter months). This is already encouraged by lower charges for winter only abstraction and spray irrigation from stored winter rainfall is not subject to restrictions or bans by the NRA.

For agricultural demand there do not appear to have been significant attempts at demand management other than in droughts (restrictions and bans).

4.7 Levels of Service Indicators/ Water Use Restrictions

The Director General of Water Services uses seven 'Levels of service indicators' to assess the performance of water companies. Two of these, *DG1– Raw Water Availability* and *DG4 – Water Usage Restrictions* effectively report on the use of demand management techniques to reduce demand in droughts.

4.7.1 DG1 Raw Water Availability

This indicator shows the adequacy of a company's water resources situation. It is expressed as the percentage of population supplied by the company which is at risk of receiving more frequent water restrictions than a reasonable reference level. Although companies are permitted to use their own reference level the following definition has been used and is currently accepted by the Director General:

- hosepipe bans, on average, once every ten years
- a major publicity campaign requesting voluntary savings of water once every 20 years.
- a risk of Drought Orders imposing the use of stand pipes or rota cuts (i.e. water not supplied constantly) on average once in 100 years.

In 1993/94 6.1 million customers were at risk of water shortages as defined by the DG1 reference level. 5.5 million of these were in Thames Water's area.

A collaborative research project (UKWIR & NRA) "*Unified methodology for DG1*" commenced in April 1995 with a completion date of March 1996. The overall objective of the project is to develop a methodology which is robust for the full range of water and water service companies, usable for the planning of water resources, acceptable to the Regulators and readily understood by customers.

4.7.2 DG4 Water Usage Restriction

This indicator shows the percentage of a company's population that has experienced water usage restrictions. Water usage restrictions can be divided into a number of categories:

- voluntary reductions, encouraged by a publicity campaign
- hosepipe restrictions
- Drought Orders restricting non-essential use of water (Ordinary)
- Drought Orders imposing stand pipe usage, rota cuts and water tanks (Emergency).

DG1 defines the acceptable frequency of use of temporary demand management measures. Water Companies are likely to augment their resources to reduce their number of properties at risk of water shortages (as defined by DG1) to zero, and by doing so will correspondingly reduce the likelihood of reporting any properties against the DG4 reference level.

This encourages water companies to build in additional capacity to their water resource planning in order to improve their level of service indicators. A less stringent definition would allow the use of these temporary demand management measures on a more frequent basis, thereby reducing the need to build in the extra capacity.

Alternatively, restrictions could become less frequent by the use of effective and more permanent demand management measures. The NRA's R&D report "Surface Water Yield Assessment" (1995) defines a methodology for defining surface water yields in a variety of ways. A lower yield per source would appear to bring forward the need for new resources (or demand management) but this may not be the correct response where the assessment of yield has taken account of the effect of drought management procedures.

4.8 Tariffs and Incentive Charging – The Price Mechanism

There is little doubt that where the price of water is a consideration, an individual's or company's choice of equipment and behaviour is influenced. This demand is then passed on to the manufacturers of low water using products. There are three points at which the price mechanism for using water can be applied; at the point of abstraction, the point of supply to the water company customer and at the point of discharge of effluent to the environment (ref. NRA (1992), Sustaining our Resources).

4.8.1 At the point of abstraction

Prior to 1965 there was no abstraction licensing system and abstractions made before this date are effectively authorised by 'licenses of right'. No conditions (for example maintaining a river flow or level) can be applied retrospectively to them without the payment of compensation for loss of rights; only to variations subsequently requested. Post 1965 a licensing system came into being as a result of the Water Resources Act 1963 and these licenses can have conditions applied to them retrospectively. In setting the charges, the NRA's duty is only to meet the cost of carrying out its water resources functions. Where over abstraction may be occurring the NRA can revoke or vary a licence, but has to pay compensation to the licence holder, for financial loss or damage, if they appeal to the Secretary of State.

Within these constraints, the NRA does operate a form of incentive charging which is related to the annual licensed volume, and not the amount abstracted. So once the licence is paid for there is no incentive for the abstractor to economise provided they use less than the annual licensed volume. Current charges are standard unit charges which are variable across the NRA regions from £6.29/ML (0.63p/m^3) in Yorkshire to £16.22/ML (1.62p/m^3) in Northumbria Region (1995/96 charges). Factors are applied to the annual licensed volume to determine the cost. For example, water from a supported source (requiring augmentation) is three times as expensive as from an unsupported source (not requiring augmentation). Water abstracted during the winter only is one-tenth of the cost of a summer only abstraction. Consumptive use is more expensive than non-consumptive.

Despite this, the charges bear no relationship to the full community costs imposed by particular abstractions, in particular the cost to the environment. Abstraction charges are typically 3% of the cost of purchasing the same volume of water from a water company (albeit without treatment and distribution system maintenance).

In the demand management debate there has been considerable discussion about abstraction incentive charging. Proponents of demand management view it as an area where the charges should be raised to reflect the value of the commodity. In 'Water for Life', CPRE suggest that a charge should be made up of three components:

1) access fees: a flat rate standing charge
2) availability charge: the environmental and capital costs of providing or reserving the units of water and levied on quantities authorised to be abstracted.
3) actual charge: on the units of water taken.

with the expectation that 2) would constitute the largest amount. CPRE also suggest that permit trading should take place where a licence is not fully utilised, which would create a water market that would ensure that available resources went to those users who valued the water highly.

4.8.2 At the point of supply to the Water Company customer

The introduction of household metering would provide incentives for householders to reduce their domestic demand. As detailed in 4.4.3 the results from the National Metering Trials show a reduction in demand of 10.8% from the small trial sites and over 21% on the Isle of Wight. There was some evidence that the multi-rate tariffs (where premium amounts are charged for higher seasonal/peak consumptions) had a greater effect than simple, one rate tariffs. There is scope for further investigation, particularly on the use of seasonal tariffs and rising block tariffs to curb non-essential use.

From the NRA's recent survey of domestic consumption monitoring the only investigation into the use of multi rate tariffs is the Anglian Water study.

4.8.3 At the point of discharge of effluent to the environment

The charges levied for discharges are currently based on the volume, content and location of the discharge, but like the charges for abstractions are limited to recovering the NRA costs involved. Further development of the charge could provide greater incentives to economise on water use (by raising the charge) by recycling and discharging upstream of the point of abstraction.

4.9 Re-cycling, Re-Use and Use of Non-Potable Water

4.9.1 Definitions

Wastewater reclamation is a term applied to the treatment or processing of wastewater to make it usable. This definition covers both re-use and recycling. Water re-use is the use of treated wastewater for a beneficial use such as agricultural irrigation and industrial cooling. If the re-use is direct then pipes or conveyance facilities are required. If the re-use is indirect the reclaimed wastewater is discharged to receiving waters for re-abstraction and use downstream. Re-cycling refers to the use of that water again by the user and is generally applicable to industry (for example the paper industry) and is covered in section 4.6. Use of non-potable water applies to water that is not reclaimed wastewater, for example sea water, that could be used for non-potable uses.

4.9.2 Indirect Wastewater Re-Use

Indirect wastewater re-use is practised to a considerable extent in the UK in that effluents are essential in ensuring that minimum acceptable flows are maintained in many rivers and to provide sufficient water for private abstractions.

In the Thames basin effluent is also used indirectly for the public water supply, where it represents 13% of the river abstraction used for that purpose. To supplement the water supply high quality treated effluent needs to be discharged upstream of the abstraction point; this may incur additional capital investment and higher operating costs.

Another example is at Winchester, Hampshire where the chalk aquifer is re-charged by treated wastewater effluent. Frequent testing has shown no evidence of any bacterial contamination.

4.9.3 Direct Wastewater Re-Use

There are no known examples of direct wastewater re-use in the UK. It has been dismissed largely on the basis of the possibility of cross contamination between the potable and non-potable systems and the consequent risk of harm to public health. For this reason it has also been assumed that direct re-use would not be acceptable to the public.

4.9.4 Domestic Re-cycling

In 1993 Thames Water Utilities Ltd. funded a study, carried out by BSRIA to investigate the possibility of using 'grey water' (washing water from baths, showers and hand washing) for toilet use. The installation and operating costs were high in relation to the projected savings, the payback period being of the order of 10-20 years. It was concluded that there may be potential for grey water recycling in larger scale residential accommodation such as hotels. The study is reported in greater detail by Crawford (1994).

In spite of this; a domestic greywater recycling system is now available in the UK. Although it is being offered as an optional extra with new homes it can also be retrofitted to an existing property.

4.9.5 Use of non-potable water: the South West Water Authority Household Studies

In 1975, in the face of public opposition to its plans to develop new sources (Roadford), the South West Water Authority (SWWA) commissioned two feasibility studies into methods of reducing household demand as reported by Herrington (1987). The first was the possibility of connecting every house in Plymouth to a sea water toilet flushing system. It transpired that the unit cost of non-potable water would be nine times the cost of water from a conventional source. The second study investigated the use of using rainfall to meet the non-potable household demand. It was estimated that the non-potable use was 100 litres/head/day and a tank would be required to store enough water for forty days without rainfall, giving a volume of 10,600 litres. Because of the weight it would have to be stored at ground level requiring a pump in addition to a separate plumbing system rendering it uneconomic.

4.9.6 The future

Recycling is normally associated with non renewable resources but it is becoming increasingly recognised that water, although a renewable resource via the hydrological cycle, is too precious to be used only once before being returned to the cycle. Although direct wastewater re-use and domestic recycling are currently uneconomic this may change with the inclusion of the environment into the cost benefit equation.

4.10 Water Saving Technology

Currently there is limited interest in water saving technology in the UK. Unfortunately '*green consciousness*' is not enough to influence the majority of peoples' behaviour, except in exceptional circumstances such as the 1988-92 drought when the public responded to appeals for voluntary restraint. Until householders pay for their water by volume there is little incentive for them to economise in water use and seek to purchase water efficient appliances. The obvious contrast is with the electricity industry which, because of its duty to conserve, promotes energy efficient appliances to electricity users who are interested in cutting bills.

Nevertheless many water efficient devices are available to reduce consumption.

'flush controllers' for urinals; either simple timing devices or more sophisticated '*people detectors*' ensure that urinals flush only when people are using them.

self closing and spray taps. There are a number of self-closing push operation taps which cut off the supply after a short time. Spray taps can reduce water consumption by up to 50% but they do require regular attention to ensure that the spray head does not become blocked by soap, grease or limescale.

low volume shower heads can be fitted to existing showers and reduce water consumption by 10%.

toilet bags and cistern dams by displacing part of the cistern volume, reduce the flush volume of a WC. Both can easily be added to existing WC's, cistern dams costing around £5 each and toilet bags less than this.

permamanent reductions to WC cistern volume. A 9 litre flush WC can be converted to a 7.5 litre flush by simply drilling a hole in the siphon. Or it can be readily converted to dual flush (9 litre 'long' flush and 5 litre 'short' flush). To reduce the flush volume to six litres or less for all flushes would probably require a different pan design and hence a new WC, the most expensive option.

In the commercial sector (and metered properties) there are examples where such devices have been used to good effect.

British Telecom have recently installed infra-red urinal controls in approximately 2000 buildings and estimate an annual reduction of 1136 Ml.

The Royal Borough of Kingston has saved 222 Ml and £38,200/year since they fitted a range of water control devices in a number of their buildings.

Oxfordshire County Council, installing a combination of urinal controls, cistern dams and tap regulators at most of the 300 schools in the county, have cut their annual water consumption by 204 Ml and their water and sewerage charge by over £260,000. Tap regulators alone were estimated to have saved about 27Ml in 1991/92.

Kirklees Metropolitan Council have followed an intensive water management programme since 1990. the use of retrofit devices has managed to save the Council 127 Ml and £336,000 annually. For individual buildings water use was reduced by between 20% and 40%.

The Ecolabelling scheme was launched throughout the European Community on 1 July 1993. On the 23 November 1993, the very first Ecolabels were awarded to washing machines and dishwashers by the UK Ecolabelling Board. The criteria for washing machines include 'best practice criteria' which deals with clear user instructions and 'performance criteria' dealing with stain removal and also 'key criteria' which sets standards for energy, water and detergent consumption.

4.11 Water Byelaws

The purpose of the water byelaws is to prevent waste, undue consumption, misuse or contamination of water supplies by a water undertaker, which has a power to make, and a duty to enforce them, under section 17 of the Water Act 1945. The byelaws deal specifically with water supply installations from the boundary of the property to the point of use. The Building Regulations govern waste water disposal and drainage within the curtilage of the property.

All water undertakers in the United Kingdom have water byelaws, based on the Model Byelaws drawn up by the DoE in conjunction with the Water Industry and published in 1986.

The powers of the water companies to make byelaws were repealed in the 1989 Water Act as it was considered inappropriate for private sector companies to have such powers, and that the byelaws would be replaced by national regulations made by the Secretaries of State for similar purposes under what is now section 74 of the Water Industry Act 1991. In January 1995 the DoE issued a consultation document '*Replacing the Water byelaws*' which considered a number of options for new water regulations.

In relation to demand management the principal area of interest is supply pipe leakage. Under section 73 of the Water Industry Act 1991 it is an offence for the owner of any premises to waste water from a defective fitting and the water company has legal powers to enforce a repair. The extent to which water companies are prepared to use these powers, which are often viewed as aggressive by their customers is variable across the UK. Other areas where water byelaws could influence demand management and where the DoE sought views in '*Using Water Wisely*' are as follows:

- requirement for all new houses to have a shower
- prescribed maximum water use volumes for toilets, dishwashers and washing machines.
- maximum flow volume for shower heads.
- better design of hot water systems (no long pipe runs)
- compulsory metering of houses with swimming pools
- whether hoses should be actuated by a spring loading trigger mechanism.
- minimum urinal control systems to be made mandatory

Of particular concern is the recent trend of purchasing "power showers" which increase water flows by the use of a pump. Manufacturers literature boasts of "a range of between 30ft and 95ft head of pressure, with flow rates from 3.5 gallons to 10.5 gallons per minute" (9 to 29 metres pressure with flows of 16 to 47.8 litres/minute). At the lower range a 5 minute shower is almost equivalent to a bath volume.

The current thinking is that the replacement (new byelaws and amendment/replacement/deletion of existing) of the water byelaws will be introduced by 1 January 1997.

4.12 Education/Awareness

Despite the drought of 1988-92 which did impact upon public consciousness the public perceive the UK, due to its regular rainfall, to be plentiful in terms of water. As shown in 1.3 this is not the case.

The need for an education programme can be illustrated by the waste of water that occurs by garden watering during the day when the temperature is highest and consequently much of the water evaporates and does not benefit the plants. Education can also cover inside the home on matters such as dripping taps, use of shower rather than bath, only using dishwashers and washing machines when on full load etc.

Most water companies have produced educational leaflets on water saving measures in the garden and some (mostly in the south of England) on water saving measures in the home. However, these were in response to the 1988-92 drought when all water companies were experiencing some difficulties, if not resource shortages due to the difficulty of meeting peaks caused by due to constraints of the distribution system. Whilst some water companies have forged educational links it is apparent that there is no long term programme to educate the public on the general need to conserve water on a continuous basis, which is perhaps not surprising as it conflicts with their duty to supply (2.5). With the passing of the Environment Act in July 1995, which imposes a duty on water undertakers to promote the efficient use of water by their customers, the water companies will need to rethink their position.

The NRA and the CPRE also produced leaflets on the need to conserve as a response to the 1988-92 drought.

Anglian Water, to explain its pre-December 1994 compulsory domestic metering policy to its customers produced leaflets explaining the virtues of metering. In addition to stating that it is the fairest way to pay for the service, it also explained that another benefit was that metering reduces consumption. The CPRE have also produced leaflets stating the case for metering.

5. Demand Management Overseas

5.1 Policy/Legislation

In a number of developed countries, policy statements have contributed to interest in demand management as a means of modifying future demands. In general such statements have been in response to either periods of water shortages or a growing realisation that future demands cannot be met except by expensive supply augmentation.

For example in 1974 the Safe Drinking Water Act in the USA resulted in expensive treatment costs, which allied to environmental legislation making the construction of new dams difficult placed demand management firmly on the agenda. In **Japan** a Water Conservation policy was formulated in the 1970's promoting water saving measures and the commercialisation of water saving equipment. Also in 1974 the Ministry of Health and Welfare set the Water Bureaux a national target that 90% of distribution input should be delivered to customers (i.e. maximum of 10% leakage).

The Federal Water Policy of 1987 in **Canada** put considerable emphasis on water demand management as a major new direction for managing Canada's water resources. In response to this Environment Canada (the equivalent government agency to the proposed UK Environment Agency) have actively sponsored and promoted a Canadian demand management strategy as detailed in Tate (1990). In the **USA** there is no cohesive Federal Policy but there are several statutes that are central to the federal government's efforts to encourage and guide water conservation activities, or which serve, even on a project basis, as models for future conservation programmes. In **New Zealand** the management of water resources is governed by the Resource Management Act of 1991, the purpose of which is to "promote the sustainable management of natural and physical resources." Under the terms of the act Regional Councils are expected to produce water allocation and management policies and to administer usage permits. In **France**, the Water Law of 1993 institutes compulsory Regional Water Plans which are designed to find a balance between the various water users. Also in **Canada**, in 1990, a byelaw adopted by the Regional Municipality of Waterloo made it illegal to discharge to the sewer system cooling water that had only been used once.

In **Singapore** there is a water conservation tax on industries using more than a specified amount. New factories that require greater than 500m³/month must get City approval before they start operating. Officials work with the developers from the planning stages to help them incorporate conservation, recycling and possible use of low quality water.

Also Water Pollution Control Acts in the 1970s/80s in the **USA, Japan** and **Germany** stimulated an interest in reducing wastewater discharges which indirectly contributed to a reduction in demand.

By contrast, **Spain**'s response to water shortages caused by extremely uneven rainfall between the wet north and the dry south is a National Hydrological Plan costing $54 billion to be spent on inter basin transfers and more than 100 dams. Although these plans are considered controversial it would not appear that demand management measures have been considered as part of the plan.

5.2 Metering and Charging Policy

In most countries, unlike the UK, the majority of domestic households are metered and bills are paid on the amount of water consumed. The only countries in Europe where the majority of households are not metered are the UK and **Norway**. In the **Netherlands** 24% of properties are charged a flat rate with the remainder metered. In **Sweden**, where 1.5 million meters serving a population of 8.8 million are not compulsory there are moves afoot to give municipalities more flexibility to fix rates on the basis of actual costs rather than consumption. This is because where meters are used the law requires them to be accurate and badly drafted new implementation regulations, designed to bring Swedish practice into line with European Union norms, have persuaded many users to abandon meters.

In **France** all properties must be equipped with a metering system to allow both operator and consumer to know the amount of water they have used. The metering of potable water is an obligation through the 1947 *Code de l'eau* (water regulations) and every local community which is ultimately responsible for the water supply in its area, has to adopt them. Tariffs vary considerably from one part of the country to another often because the local mayor and municipal council have a say.

Where meters have been installed in recent years some very significant reductions in both average and peak demands have been recorded. Reductions in average household demands have been typically of the order of 10-20% (**Hamburg, Canada, Copenhagen**) which accords with the UK National Metering Trials although some greater reductions have been realised, **Toowomba, Australia** (41%), **Manakau, New Zealand** (35%), **Philadelphia, USA** (45%), **Gothenberg, Sweden** (33%). In 1988 in the city of **Leavenworth, Washington, USA** (1700 population) it was announced, to encourage water conservation, that a metering programme was planned and a charge based on consumption would replace the existing flat rate charge. Before a single meter was installed the average demand fell by 18%, as water conservation attempts were made in readiness. In the summer of 1990, with meters and charging system in place the demand fell by a further and spectacular 43%.

Countries where some cities have been metered historically have often employed declining block rate tariffs, generally for commercial users. There has been a move in recent years to move to volumetric or increasing block rate tariffs to discourage non-essential use (**Canada, USA**). In Europe, the CRI report (1995) examined 17 European cities which offered a metered household tariff. The majority set their variable tariff such that the same charge was levied for all units of consumption, a so-called 'neutral tariff'. Some cities, however, e.g. Athens have set a rising block tariff.

Whilst generally where metering is in place the per capita demand seems to have stabilised (albeit it at different levels in different countries, due to the variation in water using habits) there appears to be a strong link between the demand management influence of metering and the price of water. This has been recognised by Roseberg (1994) who showed a distinct relationship between per capita consumption and price of water as % of disposable income (Figure 5.1).

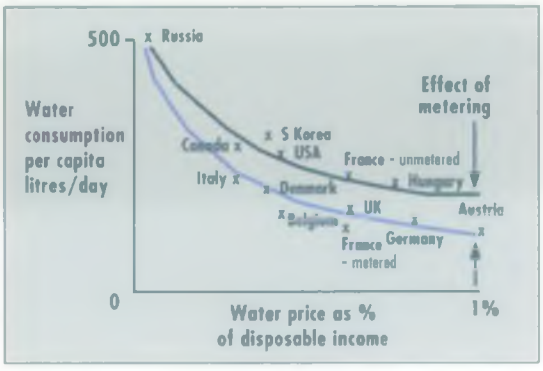


Figure 5.1 Water consumption vs disposable income

At one extreme in **Russia** (where water is heavily subsidised, less than 0.05% of disposable income) the pcc is 500 l/hd/day whereas in **Germany**, where the cost is high (0.8% of disposable income) and allied to 'green consciousness' the pcc is 144 l/hd/day which has remained stable for the last decade following the installation of meters in the 1970s.

Studies undertaken in **Australia, Canada, Israel** and the **USA** show that domestic use decreases by between 3 and 7% with a 10% increase in price.

In **Beijing, China** a new pricing system links charges to the amount of water used and regulations that came into force in November 1992 set quotas on consumption and fines for exceeding them.

Various instruments are in place to curb non essential use and to protect low income families for reasons of health and hygiene. In parts of **France** and in **Israel** a recommended limit is set, above which the charge rises steeply. Tate (1990) suggested a lifeline allowance which would specify a small amount of water which would be free and then the volumetric price would be applied above this subsistence level. This amount would be sufficient for essential hygiene purposes (figures of 90-100m³/annum have been suggested) although he neglected to say on what basis it would be determined. In **Japan** there are subsidies for low income families.

5.3 Leakage

Leakage, as in the UK, is an area that has frequently been neglected as engineers have preferred high profile supply augmentation solutions to resolve water resource problems. As stated by Herrington (1987) what constitutes an acceptable level of leakage is also variable (**USA** 10-15%, **New Zealand** 12%, **France** 7-8% and **Germany** 3%). Only **Japan** has set a national target for the Water Bureaux to achieve a target of 10% which is likely to be reduced to 5% in future and no economic consideration has been made in the setting of this target.

Elsewhere a cost effectiveness approach is adopted. If the cost of leakage detection and repair is less than the cost of water saved then leakage detection is practised. However, no environmental costs of leakage are included in this equation although savings of the capital costs of future source developments frequently are.

The majority of countries are not as advanced as the UK in terms of Leakage Control methodology and general understanding, possibly due to the fact that the UK water industry is well organised and more coherent than its counterparts. In the **USA** the approach is one of a detailed leak location survey every 'optimal cycle' (every 2-3 years) rather than continuous monitoring and immediate response to increased leakage levels. The survey involves mobile metering and step testing to determine the leakage levels. A similar approach is adopted in **New Zealand** and **Japan** although in Japan 10% of the total water undertakings manpower is allocated to leakage. For carrying out detailed leak detection surveys the leak noise correlator is widely used in addition to the traditional 'listening stick'.

From Herrington (1987) and Merlo (1992) there are numerous examples of high leakage levels in developed countries in recent times:

France 40%(1992), **Norway** 55%(1981), **Manila** 50%(1983), **Boston** 36%(1982), **Malaysia** 43%(1987), **Portugal** 30%(1987), **South Africa** 29%(1987), **Sweden** 21%(1987).

One of the main causes of leakage is the poor condition of mains 50-100 years old and the rate of renewal of such pipes will be an important factor in controlling leakage. In **Germany** where the leakage rate is approximately 9% the current rate of mains renewal is approximately 2% per year compared to the UK's 1%.

The problem is also evident in the developing world, where although the distribution system may be more recent, maintenance of the system is perhaps lower. The cities of **Cairo, Jakarta, Lagos, Lima** and **Mexico** all have had in excess of 50% leakage in recent years.

Another factor that has aided **Japan** in reaching the target of 90% of water delivered is the fact that the network operates at pressures of only 15-20 metres. It is difficult to obtain data on the average pressures in UK and **USA** water distribution systems but it is probable that it is somewhere around 40 to 50 metres.

5.4 Agricultural and Industrial Use

In many countries (e.g **USA, Japan, Canada, Australia, Germany**) charges for water abstracted are predominantly volume related. In **Spain, Portugal** and **Italy** recent legislation has been passed to introduce a volume related charge. In parts of **Canada** and **Japan**, for agricultural use the charge is based upon the area to be irrigated rather than the volume of water to be abstracted.

In 1990, in 50% of the provinces in **Canada** there were no charges for direct industrial abstraction. In the other provinces the charges were of a declining block tariff structure offering no incentive to economise.

In **France, the Netherlands** and **Germany** the abstraction charges are set to allow some of the proceeds to further environmental objectives such as promotion of low water use technologies by abstractors and to compensate farmers for set aside. In **Germany** charges are typically 2-4 times greater than in the UK. In contrast, in **Australia** the charges cover only the administrative costs and take no account of any resource depletion costs (as in England and Wales).

France has experienced particular problems of irrigation demand outstripping supply in some parts of the country. A response to this has been a switch from high water using crops (maize) to low water using crops (oilseed) and irrigation bans on certain days of the week.

In **Israel** where water resources are at a premium, there is a strong incentive to economise as all abstractions are metered and payment made on the amount of water used.

One technique that can result in water savings is the use of trickle or drip irrigation techniques rather than the more conventional spray irrigation methods. Drip irrigation can be up to 95% efficient whereas with spray irrigation this can be as low as 35% due to evaporation losses. **Australia, Israel, Mexico, South Africa** and the **USA** were all using methods of drip irrigation by the mid 1970s.

5.5 Recycling, Re-Use and Use of Non-Potable Water.

Around the world there are numerous examples of dual supply systems in operation where lower quality non-potable water is used to meet a variety of needs:

Germany: At Braunschweig 44.5 ML/day of wastewater is used for irrigation and this has been operating since 1954.

Israel: Israel's reclamation rate of 65% of its wastewater is the highest in the world. Re-use for irrigation has been practised in Israel since the 1950's, for cotton, citrus field crops and fruit orchards (covering 19,000 hectares). Research is now underway to determine the feasibility of reclaiming wastewater for urban uses (municipal flush toilets and fire hydrants, irrigation of parks and golf courses and small industry) with a view to achieving a target of reclaimed wastewater supplying more than 16% of Israel's total water needs.

France: On the Mediterranean island of Porquerolles 60% of the trickle irrigation demand is met by treated wastewater.

Hong Kong: In 1976 one-sixth of the demand for toilet flushing was met from sea water.

Venice, Florida: Reclaimed water has been used for urban irrigation (parks and golf courses) since 1991 via a distribution system of 2-8" pipes. It was expected that the demand on the potable resource would be reduced by 20% and that effluent discharge limits would also be met. A survey showed that 73% of respondents would use reclaimed water.

Also in USA dual systems are in operation in Utah, Idaho, Washington, California, Montano, Wyoming and Colorado using lower quality non potable water.

El Paso, Texas: Highly treated wastewater is injected through wells into an aquifer, where it travels 3km for 2-4 years before it is recovered by the city's water supply wells.

Northern Territory, Australia: All treatment works have been designed with the goal of producing an effluent of quality suitable for restricted municipal re-use as defined by National and Medical Research Council "Guidelines for Use of Reclaimed Water in Australia – 1987".

Windhoek, Namibia: Treated wastewater is directly added to the potable supply and has been since 1976.

Tarif, Saudi Arabia: Two-thirds of the anticipated 2020 demand of 185 ML/day will be supplied by non potable water in a new dual supply system. The water will be used for WC flushing, garden watering, irrigation of public parks, street flushing and fire fighting.

Despite these encouraging examples, worldwide only 1% of wastewater is used for irrigation.

5.6 Pollution Control

The drive to meet pollution control targets, in most cases set by legislation, has brought about some significant reductions in water consumption. In **Sweden** the aim of the Environmental Protection Act 1969 was to ensure that firms had the best available technology. Under the terms of the act new and existing industrial enterprises requiring a change to production or processing methods had to obtain permission from the 'National Franchise Board for Environmental Protection'. With the availability of grants the policy brought about significant increases in re-use and between 1964-77 direct industrial abstraction fell by 56%.

In the **USA** the Federal Water Pollution Control Act of 1972 and in **Japan** the Water Pollution Control Act of 1971 resulted in detailed specific water conservation measures. In order to meet the effluent standards required by the Act water demand was reduced by the adoption of efficient technologies including the use of recycling systems. In **Germany** the 1981 Effluent Charge Law imposed a volumetric charge on effluents which has some effect on reducing demand. Similar arrangements apply in **The Netherlands** and **France**.

There are numerous examples of industries making considerable water savings. Epton Industries in **Canada**, a manufacturer of rubber and plastics reduced its water use by 60% when it started to re-circulate its cooling water. In **San Jose, California** in the mid eighties seven companies achieved payback periods of less than one year on water savings by adopting a range of recycling measures. As previously stated (5.1), in **Singapore** conservation and recycling measures are incorporated into new factories at the design stage.

5.7 Water Saving Technology

There are generally two methods of approach to bring about the replacement of inefficient high water using appliances with more efficient low water using appliances. In some countries plumbing and building codes are used to restrict consumption of certain appliances e.g. low flush WCs (parts of **USA, Australia** and the UK). The alternative approach is to leave it to market forces (eg **France, Japan, Netherlands, Sweden** and **New Zealand**) whereby the householder will change to a lower water using appliance because they will save money from doing so and hence regulation is deemed unnecessary.

There are examples in the USA where Water and Wastewater Utilities have initiated plumbing fixture replacement programmes. In 1992 in **Santa Monica, California** it was planned to replace 12,000 WC's. Prior to 1980 WC's in the USA typically used 20-30 litres per flush. The replacement of these with a WC with a 1.6 gallon (7.3 litres) flush would obviously have a very significant impact upon demand. In 1988 the state of **Massachusetts** became the first to require that all new toilets installed use no more than six litres per flush. Since then, 14 other states have followed suit, most adopting efficiency standards for showers and taps also.

In a similar vein 350,000 WC's were replaced in **Mexico City** with 6 litre per flush models which saved enough water to meet the needs of 250,000 residents.

The **USA (California)** is the only country to have plumbing codes for Dishwashers and Washing machines that specify a maximum volume per cycle.

Also much work has been done in the **USA** on tap aerators and restrictors, trickle and drip irrigation systems for domestic use, low volume shower heads and timers on sprinklers so they operate in the early morning when the amount lost to evaporation will be minimised.

5.8 Conservation Manuals

In 1984 the American Water Works Association (AWWA) produced a practical design handbook for a local water conservation plan following droughts and consumptions close to the reliable yield in several major cities. The water industry is very fragmented in the USA; water supply being the responsibility of a large number of small public and private local water utilities. Although water conservation activities take place at federal, state, regional and local level it is at the local level that the need for a conservation programme is first recognised and the AWWA handbooks provide the necessary guidance and information for successful implementation. Other practical AWWA design manuals include:

- Controlling Water Demand in Apartment Buildings (1993)
- The Water Conservation Managers Guide to Residential Retrofit (1993)
- Evaluating Urban Water Conservation Programs – A Procedures Manual (1993)

These publications place emphasis on reducing the customer demand by the following means:

- setting mandatory standards for use of low flow fixtures in new or replacement plumbing and prohibiting the use of fixtures that do not meet the standards.
- subsidised 'retrofit' of heavy water using domestic appliances by "customer kits", free replacement, water audits, advice etc.

- public education campaigns
- market place strategies to discourage inefficient uses of water and give economic incentives to encourage efficient use.

The Guides explain in detail how to implement the conservation program and how to calculate the cost including the impact upon revenue from the consequent reduction in demand. It would appear that such publications are currently unique to the USA.

5.9 Demand Forecasting

In most developed countries there is an emphasis on national forecasts undertaken by a central government ministry or agency with responsibility for water resource planning. Such forecasts are required for national resource planning. Due to the fragmented nature of the water industry in many countries this is often a summation of a number of regional forecasts.

As in the UK, the emphasis is very much on component based forecasting as opposed to extrapolation techniques.

In **Australia** in 1982 the Government commissioned a large study called 'Water 2000' in which the influence of changing real water prices, structural changes in industry, the growth in recycling and the effects of a pricing strategy were all considered.

As in the UK, the major difficulty arises in predicting the change in pcc, where assumptions are made on future changes to the standard of living. In **Sweden** and **Switzerland** recent forecasts predict no growth in the pcc which supports the theory that a satiation level is reached for high income countries with a temperate climate.

There is evidence that countries build contingency into their demand forecasts. For example, the **Netherlands** add 10-20% onto their calculated forecast and in **Denver, USA** the forecasts are carried out for a 'dry' year.

There is evidence of differing approaches to leakage in inclusion of demand forecasts. In **Australia, Canada, France** and **Germany** it is not built into the forecast (as a separate component). In **Japan** there is a clearly stated policy to achieve 90% 'effective water' (i.e. 10% leakage), and in **Norway** and **Sweden** it is also an explicitly considered component.

To emphasise the importance of demand forecasting, a forecast carried out for **Denver** in 1980 showed a projected deficit by 2010. A decision was taken, primarily on economic grounds to resolve the problem by the adoption of demand management techniques rather than supply augmentation.

Namely:

- installation of meters in remaining unmeasured customers
- shallow trap toilets
- shower flow restrictors
- price increases but with larger 'free (or lifeline) allowance'
- 6% leakage to be achieved and maintained

Demand management is increasingly being recognised in demand forecasts, at a strategic level, in **Australia, Canada, France, Germany, Japan, Norway, Switzerland** as well as in England and Wales.

5.10 Education/Awareness

Many of the conservation initiatives outlined in this chapter have been supported by extensive education programmes, without which, it is doubtful that such initiatives would have been successful. In particular the WC replacement programmes of the **USA** and **Mexico City** and the water price increases of **Singapore** and **Waterloo, Canada.**

There appears to be two educational approaches. In the **USA** public education forms part of the local water conservation plan and the AWWA water conservation manual suggests how to run public information campaigns and how to form contacts with schools etc. The AWWA market a range of educational material. In **Canada** there is a national approach with the publication of the Environmental Citizenship Series of books and leaflets. The goal of the Environmental Citizenship Initiative is to help provide Canadians with the means to make environmentally responsible decisions. There is a series on Freshwater in which water conservation features strongly.

5.11 Summary

It is clear that although there are significant developments in demand management, worldwide, they are often on a piecemeal basis. Few countries appear to have coherent national strategies covering the whole range of demand management options. **Canada** has a national strategy but may experience difficulty applying it to a fragmented water industry based on municipalities. **Israel** manages its water resources on a national basis and incorporates demand management measures due to scarcity, but is able to do so because the country is small (similar land area to Wales). The UK is in a good position to implement a National Strategy by virtue of having a coherent and well organised water industry.

6. Demand Management Potential in England and Wales

6.1 General approach

Having reviewed the demand management options there is a need to assess the potential for their application in the UK. By comparing the cost of applying the demand management technique with resource development, treatment and distribution costs for an equivalent volume of water it is possible to appreciate the potential of applying that technique, in cost terms. It is, of course simplistic to only consider these costs and it is recognised that environmental costs should also be considered in the analysis. For example, if the demand management option is twice as costly as the resource development option, but the resource development option would cause long lasting ecological damage to a river system or involve unacceptable risks then it would seem prudent not to choose the resource development option. Other costs not included are the savings in capacity at effluent treatment works that would accrue due to the reduced throughput.

Because this analysis is only an initial attempt at gaining a broad understanding of the comparison of costs and in the absence of a method to include 'average' environmental costs and benefits, these have been omitted. The NRA and water companies are currently attempting to quantify environmental costs and benefits for use in a framework to assess resource developments versus demand management options (see 9.1.4).

It is not possible to determine the effectiveness of some of the demand management options as either the potential for application is not known (for example, recycling in industry) or possible demand management effects have not been accurately quantified (for example, education/awareness).

Options assessed	Options not assessed
Reduced leakage	Education/Awareness
Low flush WCs	Waste minimisation
Shower installation	Incentive abstraction charging
Low volume shower heads	Pricing
Domestic metering	Direct and indirect wastewater re-use
Controllers on urinals	
Residential use of grey water	

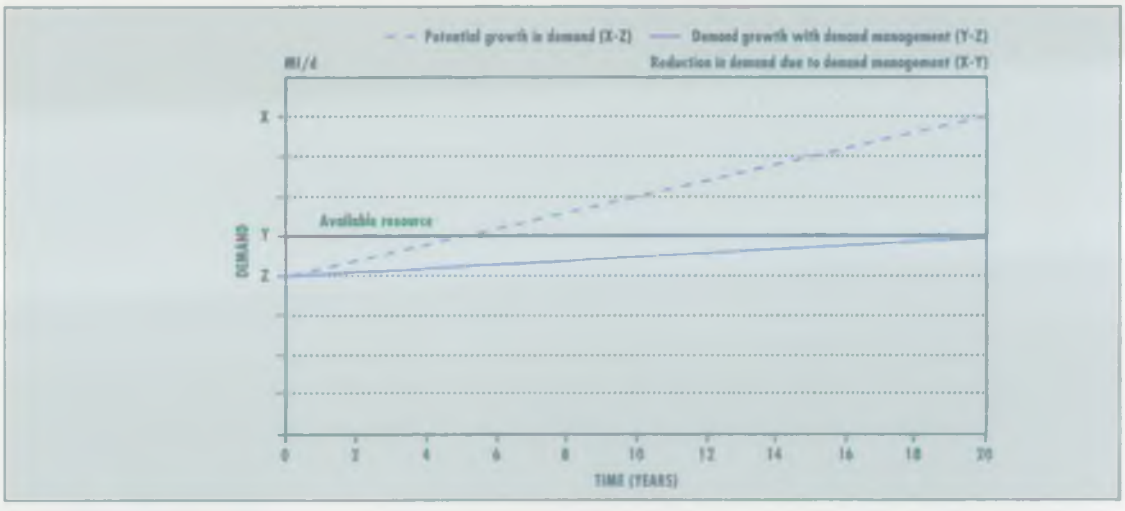


Figure 6.1 Demand management option

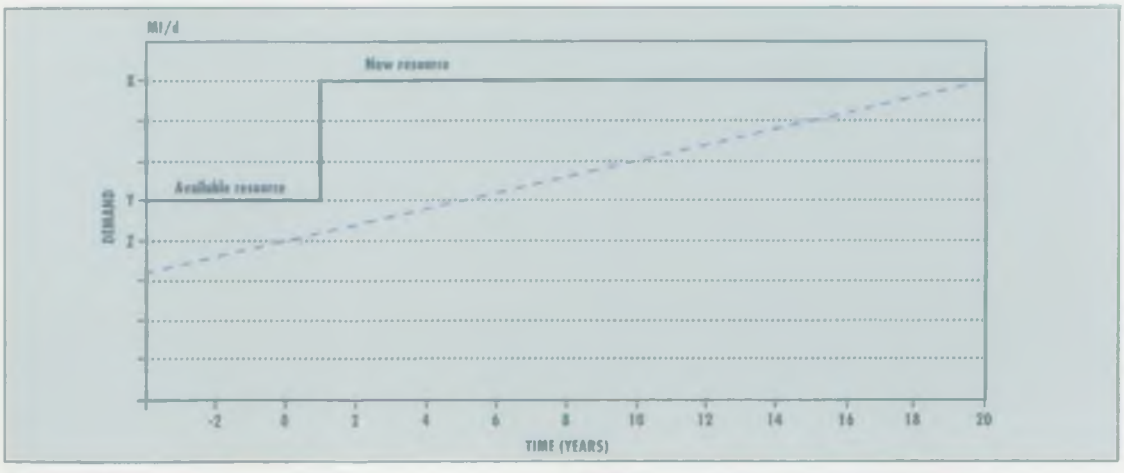


Figure 6.2 Traditional resource development option

NOTE: New resource 'on-stream' at end of year 0; i.e. year 1

6.2 Methodology

For each demand management option assessed it has been assumed that the programme of implementation would take twenty years (Fig 6.1). If the programme was not implemented it has been assumed that a resource would be required for an equivalent volume of water (X-Y) and would need to be developed such that it would be available at the time that the demand management programme would otherwise begin. With reference to figure 6.2 it has been assumed that four years would be required to develop the resource i.e. years -3 to 0. For the demand management option it is assumed that the sum of twenty annual increments of the programme is sufficient to reduce the growth in demand, keeping the demand line below the available resource. By using a "net present cost" analysis (with a 6% discount rate) over a 40 year time horizon it is possible to make a direct comparison of costs which considers maintenance costs of demand managment options, savings in operating expenditure in addition to capital costs. Whilst it is recognised that such an approach has shortcomings, i.e. no account is taken of regional differences, it does nevertheless provide a useful initial comparison.

For the purpose of this analysis resource development costs include the costs of treatment bulk transfer and losses of the additional water produced. In calculating the resource development cost for the same volume of water that would be saved by a demand management option a lower bound of £0.75m/Ml/day and an upper bound of £1.5m/Ml/day have been used. (Source: NRA/OFWAT, consistent with OFWAT periodic review). The additional operational expenditure associated with increased demand has also been allowed for.

The use of a lower and upper bound give a corresponding range of ratios of demand management to resource development for different demand management options.

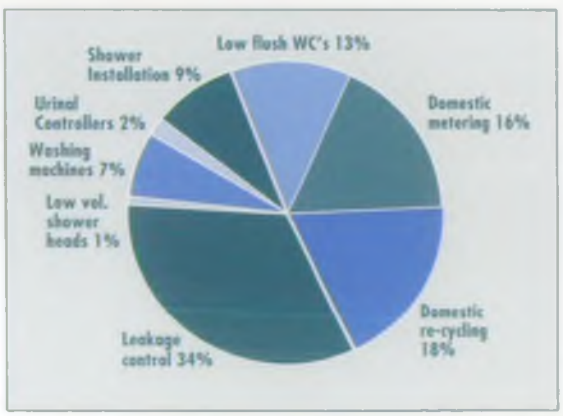


Fig. 6.3 Potential Water Savings by Demand Management Option

An explanation of assumptions made and the basis of the calculations can be found in greater detail in Appendix A.

6.3 Results

The results of the analysis of water savings for various demand management options are shown in Table 6.1 which clearly shows there is considerable potential for demand management in England and Wales. The table has broken down the potential saving into the drier south and east (NRA Regions Anglian, Severn Trent, Southern, Thames and Wessex) and the wetter north and west (NRA Regions Northumbria, Yorkshire, North West, Welsh and South West). The potential for saving is 6760 Ml/day, some 42% of current distribution input.

Demand managment Option	Saving S&E Ml/d	Saving N&W Ml/d	Total Ml/d
Leakage Control	900	1440	2340
Domestic Re-cycling	1260 (820)	710 (460)	1970 (1280)
Domestic metering	650	410	1060
Low flush WC's – Opt.3	550	300	850
Shower Installation	390	220	610
Efficient washing machines	280	160	440
Controllers on Urinals	90	50	140
Low volume shower heads	25	15	40
Total	3705	3055	6760

Table 6.1 Demand management options. (England & Wales) in order of water saving potential.

If a domestic re-cycling programme was applied to existing WC's water demand could be reduced by 1970 Ml/day. If the programme was introduced following conversion of WC's to dual flush (low flush WC's – Option 3) the demand would be reduced by the lower amount of 1280 Ml/day. To avoid double counting the latter figure has been used in determining the total water saving potential. Out of this total of 6760 Ml/day, the two most generally accepted demand management options, leakage and domestic metering represent 34% and 16% respectively, as shown in Fig. 6.3.

In 'Water – Nature's Precious Resource (1994)' the difference between the low forecast (moderate demand management and no growth) and the high forecast (no demand management and some growth) is 4,500 Ml/day. Table 6.1 shows that with 6760 Ml/day available this gap can be bridged by demand management techniques. And because there are potentially more savings available than the size of the gap the most cost effective options can be chosen first. Table 6.2 shows the results of a financial assessment of the different techniques.

Demand Management Option	Demand Management Costs p/m3	Ratio to Resource Development Costs		Cumulative Savings		
		low	high	S&E Ml/d	N&W Ml/d	Total Ml/d
Efficient Washing Machines	0	0.0	0.0	280	160	440
Controllers of Urinals	9	0.3	0.1	370	210	580
Leakage Control	13	0.4	0.2	1270	1650	2920
Low flush WC's – Option 3	18	0.6	0.3	1820	1950	3770
Low flush WC's – Option 1	28	0.9	0.4	–	–	–
Domestic Metering (universal)	89	2.7	1.3	2470	2360	4830
Shower installation	94	2.9	1.4	2860	2580	5440
Low volume shower heads	102	3.1	1.6	2885	2595	5480
Low flush WC's – Option 2	172	5.2	2.6	–	–	–
Domestic re-cycling (existing WCs)	321	9.8	4.9	–	–	–
Domestic re-cycling (following WC Opt.3)	493	15.0	7.5	3705	3055	6760

Table 6.2 Demand Management Options in order of cost effectiveness (excluding environmental costs and benefits).

From Table 6.2 it is apparent that for resource development costs (including treatment and distribution) of £0.75m/Ml/day leakage control, fitting Controllers on urinals, low flush WC's (Options 1 & 3) and efficient washing machines are more economic than resource development costs for an equivalent volume of water (i.e. ratio to resource development costs is < 1). This situation remains unchanged when more expensive resource development (£1.5m/Ml/day) is considered. The evaluation of costs is shown in greater detail in Appendix A. By applying the demand management options in order of cost effectiveness the table shows that by applying the first five options the resource shortfall between the high and low forecast of 4500 Ml/day can be found. (This is not strictly correct as the NRA's low forecast already allows for some metering and leakage control so there is an element of double counting of approximately 2,000 Ml/day. The additional need could be met by increased leakage control, the more costly demand management options or some of the options not assessed, for example education/awareness (which is relatively inexpensive), pricing (following metering) and waste minimisation).

Water Nature's Precious Resource also identified the 'do nothing deficits' in 2021 (i.e. no resources developed) by NRA region for the high, medium and low scenarios. Table 6.2 gives an indication of the demand management options that may be required to avoid the predicted deficit. For the north and west, under the high scenario, this deficit is 696 Ml/day in 2021. A combination of leakage reduction and a specified maximum washing machine volume of 80 litres/cycle would be sufficient to avoid this deficit.

The picture is quite different for the south and east, where under the high scenario the do-nothing deficit in 2021 is 1992 Ml/day. From Table 6.2 efficient washing machines, leakage control, controllers on urinals and conversion of WCs to dual flush (all less expensive options than developing resources) are almost sufficient to avoid the deficit. The remaining 172 Ml/day would be required from either domestic metering or resource development subject to a more detailed economic appraisal.

This analysis take no account of the cost to the environment. With the inclusion of environmental costs the ratios of demand management options to resource development costs will change and other options may become economic, notably metering. Although domestic metering appears not to be cost effective (although for resource development costs of £1.5m/Ml/day it is only marginally more expensive than developing resources), once the initial capital outlay has been made it is the ultimate control and further reductions in consumption can be made by increasing the tariff which costs very little. The contrast is leakage control which starts off very cheaply, but as leakage is reduced the law of diminishing returns applies in that it becomes increasingly expensive to achieve further reductions. It is noteworthy that even with a 40 year time horizon, where the expenditure on leakage control has to be maintained to keep leakage at a specified level, it is still significantly cheaper than developing resources.

The most uneconomic options are replacement of WC's with 6 litre models and the installation of a domestic recycling system for WC flushing (although this particular option could generate a large saving). As shown in Section 4, metering can delay the development of new resources to meet peak demands indefinitely which adds to its cost effectiveness as a technique by delaying the need for a new source until it is required to meet increased average demands. Also if metering is done selectively, in accordance with NRA policy, it is likely to be cheaper than universal metering.

The demand management costs in p/m^3 have been calculated on the basis of a twenty year implementation programme and a forty year time horizon; the cost being derived by dividing the net present cost of the demand management option (40 years) by the net present value (in m^3) of the water saved over 40 years. It is important to note that for the majority of options

in Tables 6.1 and 6.2, unless user habits change, the savings are permanent for no additional cost. The exceptions are leakage control where the expenditure has to be maintained, and the maintenance costs for domestic metering and domestic recycling.

The reason for conducting this analysis is to give an indication of what could be achieved and at what cost. It is not intended to be a recommendation that demand management policies be vigorously pursued in areas where there are no resource shortfalls and it is clearly uneconomic to do so or where for example low leakage levels are already being achieved.

For any particular water company the potential for demand management must be viewed against the current and projected resource surplus and the economics of the particular options.

6.4 Demand Management Priorities

The economic analysis indicates that a number of demand management options are likely to be viable purely on economic grounds, without any consideration of the environment, as an alternative to resource development.

The following priority areas should be the water saving focus of a national Demand Management Strategy:

- Leakage reduction
- Selective domestic metering
- Education
- Water efficient appliances and byelaws

7. Towards a Demand Management Strategy

7.1 Why Demand Management Now?

Sustainable development was the main concept on which the principles outlined at the Earth Summit in Rio in 1992 were based. With reference to water management Agenda 21 states:

> "By the year 2000 all states should have national action programmes for water management, based on catchment basins or sub basins, and efficient water use programmes. These could include integration of water and other resource planning with land use planning development and conservation, demand management through pricing, regulation, conservation, re-use and recycling of water."

The British Government has shown its commitment to the principle by the publication of 'Using Water Wisely (1992)', 'Sustainable Development, the UK strategy (1994)' and 'Water Conservation – Government Action (1995)'. The proposed Environment Agency is founded on the Governments commitment to sustainable development. Water conservation and demand management make a major contribution to sustainable development. The NRA's duty to *'conserve, redistribute or otherwise augment water resources and to secure their proper use'* is also a duty of the proposed Environment Agency. Demand management is necessary to fulfil this duty.

Also, it is currently NRA policy, and it is likely to be Environment Agency policy to *promote and encourage the efficient use of water.*

In addition to the political and environmental reasons for implementing demand management policies there are a number of sound, practical reasons as defined in NRA's (1992) 'Sustaining our Resources':

- short time scale (2-3) years to implement in an area
- reduced consumption and hence reduced abstraction from rivers and aquifers
- can be staged flexibly in time and by area
- the present downturn in consumption provides a window of opportunity to implement demand management and water conservation measures before demand picks up again
- as section 6 has indicated it is an economically sound approach

In Section 6 it was shown that there is considerable scope for demand management in the UK, as a means of balancing demands and resources. The extent to which demand management options are utilised will depend upon a number of factors such as legislation, co-operation between and commitment from all organisations involved, water availability (the 1995 drought should promote demand management), the use of environmental costs in an economic analysis and whether there is a clearly defined national strategy (as there is in Canada).

7.2 Components of a National Demand Management Strategy

A water conservation and demand management strategy should be a coherent whole and not a number of isolated, un-coordinated options. For example, an education policy covering water efficient appliances and possible savings would be appropriate now but even more so following the installation of domestic meters. By consideration of the supply of water over its cycle i.e. from 'source to tap' and discharge to the environment the location and relationship between the various demand management options is shown in Figure 7.1.

7.2.1 General Components for Public Water Supply

In July 1995 the Environment Act was passed which includes a requirement for water undertakers to promote the efficient use of water by its customers (3.7). In accordance with this duty this could be achieved as follows:

Abstraction Licences; New and Existing

- new – For licence applications water companies will be required to carry out a full assessment of the range of demand management measures before licences are granted. This will not simply mean leakage and metering in isolation, but consideration of the full range of possible measures as may be defined in a Water Conservation Manual.
- existing – For existing licences, where resources are stressed, water companies will be expected to implement demand management measures within an agreed timescale, to avoid increases in licensed abstraction. Where the measures are not implemented, despite an agreement to do so, the NRA may not grant an increase in the licensed abstraction.

Leakage Reduction: Leakage is an area where in knowledge, the UK is without doubt the world leader, but in practice with some of the highest leakage rates in the developed world. The NRA feels that greater effort is needed in applying the knowledge to the problem. This should be done as follows:

- water companies to make vigorous efforts to reduce leakage in line with their new duty to promote the efficient use of water.

- water companies to implement the recommendations of 'Managing Leakage'.
- water companies to set their own leakage targets, to be agreed with NRA/OFWAT. Leakage targets could form part of the companies Asset Management Plan (AMP) submissions.
- NRA/OFWAT to monitor the progress of water companies in achieving those targets.

The NRA believes that this would undoubtedly lead to increased leakage detection effort by water companies. The current OFWAT approach of measuring efficiency by comparison of costs of water delivered whilst an improvement on comparing costs at 'water into supply' still does not encourage companies to significantly reduce their leakage and ignores the value of leaving water in the environment. For example, a company with high leakage but low pumping costs and low staffing levels can have low operating costs and therefore appear to be efficient.

Domestic metering is an important component of a strategy as it is the pre-requisite to most other demand management options as well as a conservation measure in itself. Meters should preferably be installed externally and so reduce supply pipe leakage by location of leaks at installation and from then on as high consumptions on customers bills. To minimise the cost of meter installation initial efforts to be concentrated upon:

- new properties. Metering is the most logical form of charging for new properties. The economic opportunity to install a meter box can be taken irrespective of whether the company charges by meter immediately or in the future.
- the meter option scheme. The Director General of Water Services to continue to ensure that water companies offer an attractive scheme that is widely publicised.
- areas where water mains refurbishment is taking place.
- where repair work is carried out on service pipes. (To avoid the situation where on the same street some houses are metered and others are not, it may be more appropriate at this stage to just install the meter box).
- in accordance with current NRA policy, in areas where resources are stressed.

Following on from meter installation, the following components to be introduced:

- A pricing structure that discourages non essential use.
- An education/awareness package that makes householders aware of the savings that can be achieved by the sensible use of water and by the installation of water efficient appliances.
- With greater domestic metering better demand forecasts can be obtained by more accurate calculation of per capita consumption. More accurate demand forecasts will result such that water company planners will be more certain of future needs. Also a more accurate determination of leakage will result to be reduced by water companies in line with their new duty to promote the efficient use of water.

Byelaws and Building Codes: New water byelaws to require new water using appliances to meet water efficiency criteria. Efficient plumbing procedures to be written into Building codes.

Education/awareness is a principal component of a strategy, which can be broken down into four specific programmes:

a) The Public:

- to explain the need to conserve water, particularly when it appears plentiful.
- the reasons for domestic metering.
- how householders can economise on their water use (particularly relevant following a metering programme).
- potential savings for commercial and industrial users

b) Schools:

- to explain the value of water and the need to conserve it. The possibilities of direct and indirect waste water re-use to be included in the traditional water cycle approach.

c) Designers of buildings:

- to ensure that the use of water efficient technology is given high priority in the design of buildings.

d) Water Distribution Engineers, Planners and Managers:

- to emphasise to water companies' that demand management options are given serious consideration as a means of balancing demands and resources (consistent with their new duty).

A Water Conservation Manual: At present in the UK, demand management has become synonymous with leakage control and domestic metering. A textbook (similar to the American Waterworks Association manuals) to be written which includes a compendium of techniques available to the practitioner who wishes to implement a water conservation programme.

Economic Instruments – Abstraction: Whilst the NRA's current licensing system does offer incentives for abstraction near to tidal limit, from unsupported sources, non-consumptive uses and winter use the overall costs need to be raised to send the correct

signals to the market. Because only the cost of the NRA carrying out its water resources function is recovered from the charges, which are relatively low – typically 0.5 to 1.5 p/m³, the water itself is effectively a free good. A change in legislation is required to allow abstraction charges to be significantly raised to encourage water companies, industry and agriculture to use water more efficiently. Such a scheme would generate revenue that could be used to support water conservation activities.

7.2.2 Industrial and Commercial Components of the Strategy

- an annual compendium of water efficient products and practices distributed free of charge to industries, to include case studies that show such practices make good business sense.
- a Water Audit Service. A service, that would at relatively low cost, visit commercial buildings and carry out water audits.
- waste minimisation. To ensure that the potential benefits of waste minimisation are disseminated to as wide an audience as possible and to sponsor studies in certain cases.

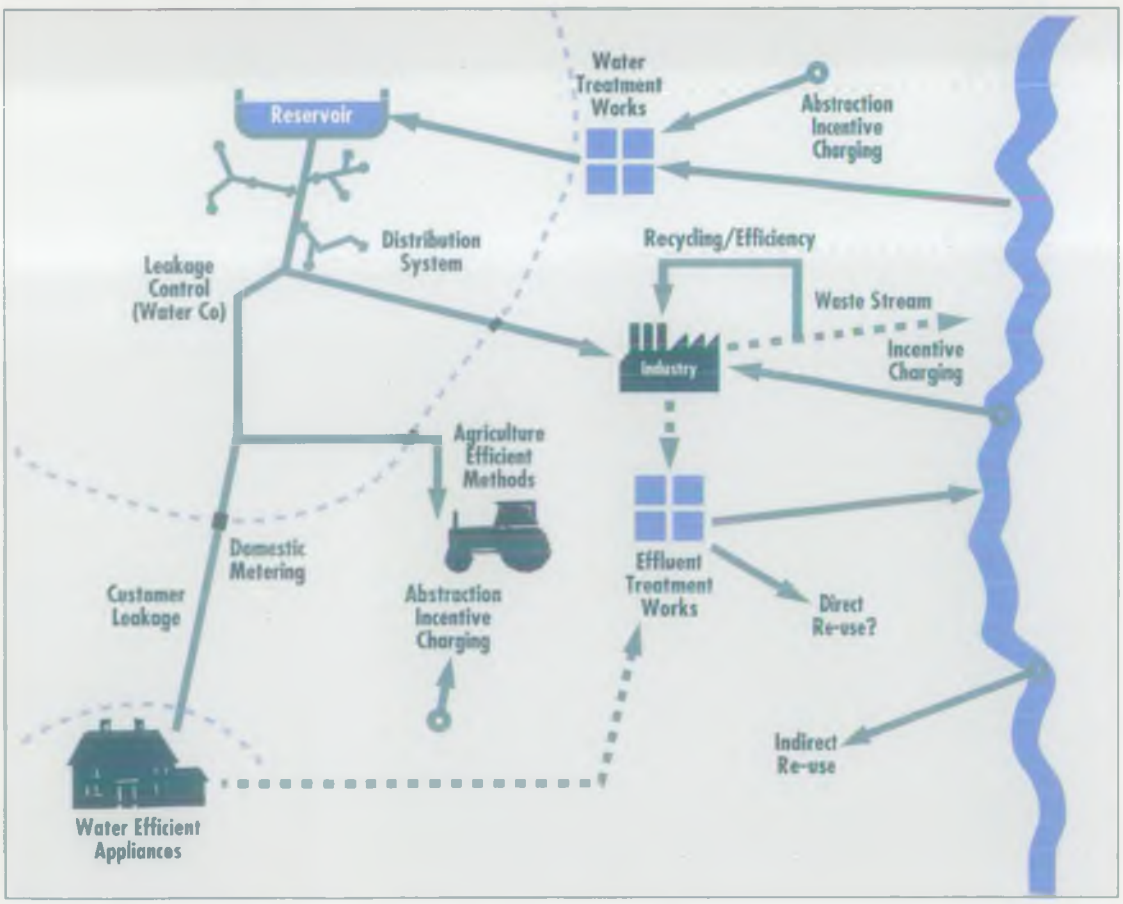
7.2.3 Agricultural Components of the Strategy

- research into agricultural 'best practice'.
- educational programme for farmers to be taught best practice. (Dissemination of the above).
- investigation of ways of assisting farmers to construct on-site storage where appropriate, so abstraction can be confined to the winter months or for set aside.
- research into the possible use of treated wastewater for agricultural purposes.

7.2.4 Research and Development

Research and development programmes are essential to ongoing strategy development. From this review of current demand management practice it is apparent that in the majority of economic analyses water is treated as a 'free good'. The true marginal cost of water (financial and environmental) needs to be calculated for licensing, water pricing, economics of leakage control etc. Many of the projects described in the NRA's R&D programme (9.1.4) are directed towards this objective.

Figure 7.1 Demand management opportunities



7.3 Relationships between Components

Figure 7.2 attempts to show the responsibilities of different organisations regarding demand management and the way in which these responsibilities overlap.

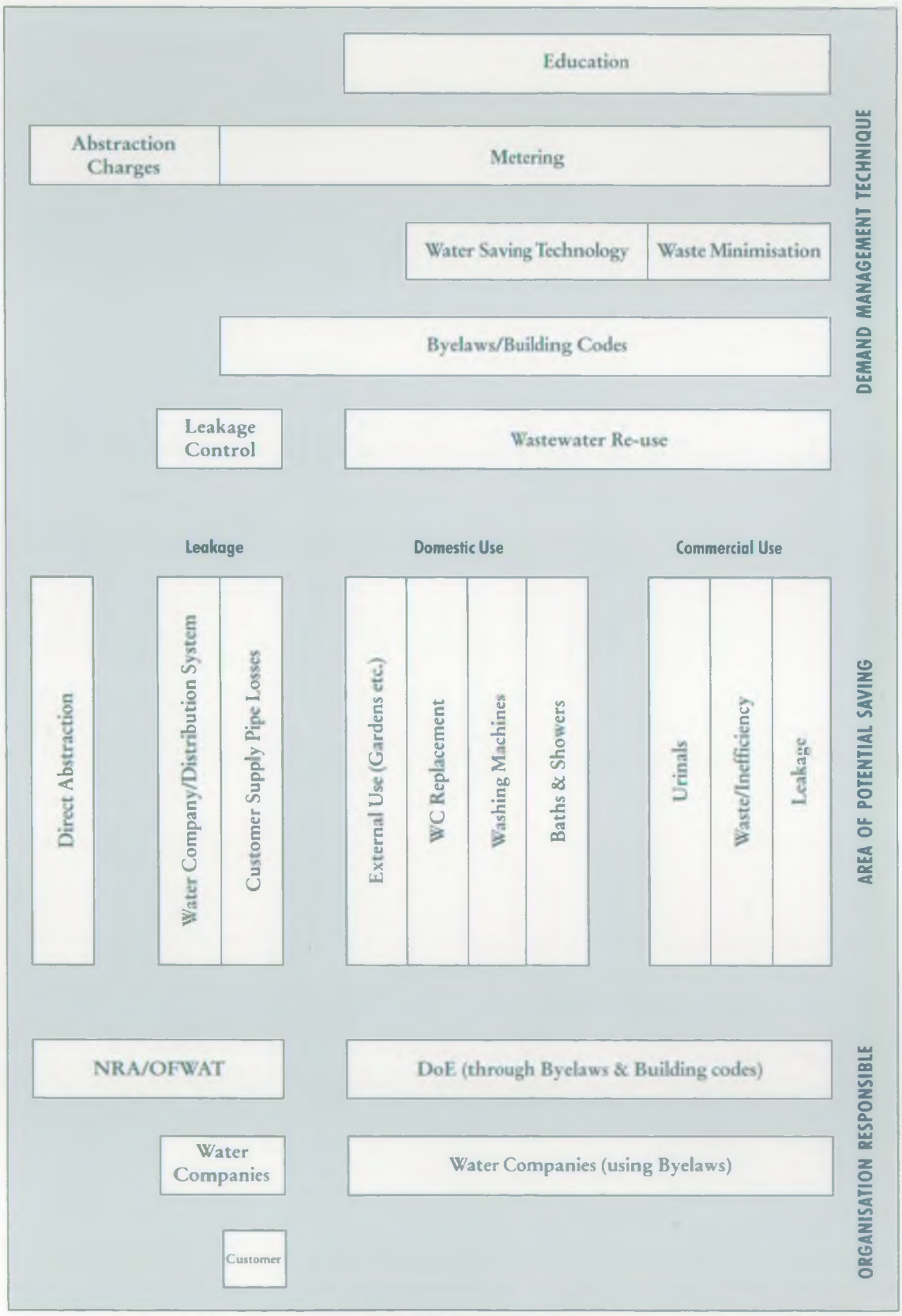


Figure 7.2 Relationships between demand management components for public water supply.

8. Roles and Responsibilities

8.1 Current situation.

The strategy outlined in the previous chapter details a possible way forward for demand management in England and Wales. Whilst the NRA's practical involvement is limited, it has a key role to play in actively influencing demand management by the licence determination process. The NRA also believes it should take a more positive stance alongside those organisations which have a more direct role to play. As an example, in August 1995 the Department of the Environment and Welsh Office published 'Water Conservation – Government Action' as the Government's response to the consultation exercise prompted by 'Using Water Wisely (1992)'. A summary of the proposed government action is as shown in Table 8.1. The table shows in which actions

- the NRA has a direct interest and an influential role
- the NRA has an indirect and more peripheral interest, but can nevertheless still exert influence.

Due to the way the water industry is organised in the UK water conservation and demand management is the responsibility of a number of organisations (as listed in Section 2). Progress can only be made by these organisations taking on specific roles and responsibilities to promote water conservation and demand management.

The responsibilities for achieving water savings in the public water supply is shared between four groups (fig 8.1):

- Government and regulators
- Water supply companies
- Water users
- Opinion shapers (e.g. CPRE, CBI)

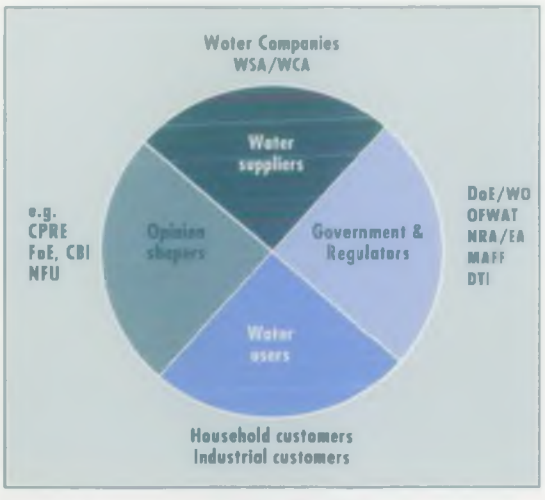


Figure 8.1 The four main responsibilities and interests

8.2 Suggested Roles and Responsibilities

Table 8.2 shows suggested roles and responsibilities for progressing specific demand management options. Any responsibilities assigned to the NRA should be assumed to be synonymous with the Environment Agency. The NRA would particularly welcome comments on these suggestions.

8.3 Steering the Strategy

If the roles and responsibilities as suggested in Table 8.2 are accepted the NRA suggests that consideration be given to the formation of a coordinating committee to represent organisations from the four main responsibilities and interests. It is suggested that the group could be chaired by a representative of the DoE with the Environment Agency providing the Secretariat.

The terms of reference for such a water conservation committee could be as follows:

1. To produce and publish a national Water Conservation and Demand Management Strategy for England and Wales.
2. To monitor the progress of the strategy, to resolve issues and to adapt the strategy to changing circumstances.
3. To conduct five year periodic reviews of progress in saving water.

Members of the Committee could be drawn from the organisations shown in Fig 8.1.

Comments on the value of such a committee, the willingness of organisations to participate in such a group, the terms of reference and its suggested composition would be particularly welcome.

Table 8.1 Summary of Government Measures in 'Water Conservation – Government Action'

	NRA Role	
	Direct	Indirect
1. Efficient Use of Water		
(i) Additions to the Environment Act 1995.		
(a) DG powers to:		
require companies to achieve overall standards of performance.		●
give water companies a duty to promote efficient use of water supplied to customers.		●
(ii) Publish a consultation paper on abstraction charging.	●	
(iii) NRA and OFWAT to monitor reductions in leakage.	●	
(iv) Consideration of economics of replacing water using appliances with low volume models before developing new resources.	●	
(v) Promotion of efficient use of water in industry through DoE/DTI Environmental Technology Best Practice Programme (FTBPP) (Waste Minimisation).	●	
2. Regulation		
(vi) Revised Water Byelaws in 1997, with review of		
(a) reduced volume wc's, low water use dishwashers and washing machines;		●
(b) low volume shower heads;		●
(c) waste from unvented hot water systems;		●
(d) waterless sanitary conveniences;		●
(e) inspection and enforcement.		●
(vii) NRA powers to control effluent discharges to the environment are considered sufficient.	●	
3. Water Fittings		
(viii) Review of flow rate for showers in Byelaws.		●
(ix) Shower manufacturers to give information on water consumption.		●
(x) There will be no grants for replacement low flush WCs.		●
(xi) Garden hose manufacturers to promote spring loaded trigger mechanism.		●
(xii) Dissemination of cost benefits of tap rewashering and urinal flush controls and consider for byelaws.		●
4. Metering and Charging		
(xiii) Water companies to install meters & meter boxes when communication or service pipes are replaced.		●
(xiv) Water companies to identify environmental benefits of metering for inclusion in abstraction licence applications to NRA.	●	
(xv) No change to DG powers over water company charging schemes.		●
(xvi) Guidance to local authorities and housing associations on water efficient housing.		●
(xvii) Statute will be amended to continue RV charging beyond 2000.		●
(xviii) Council tax banding information will not be provided as a basis for water charging.		●
(xix) Water companies to progress shared metering reading systems.		●

Table 8.2 Suggested Responsibilities for Water Conservation and Demand Management options.*

Programme/Product	Who delivers	Who receives	Responsibility
Assessing licenses	NRA	Water Companies Industry &Agriculture	NRA
Revoking licences	NRA	Water Companies Industry & Agriculture	NRA
Duty to conserve	OFWAT	Water Companies	DoE
Reduced leakage	Water Companies	Water Companies	Water Companies
Domestic metering	Contractors & meter manufacturers	Householders	Water Companies
Pricing (after metering)	Water Companies	Householders	OFWAT/NRA
Water Byelaws	DoE	Water Companies	DoE
Education	Media Consultant	Householders, Schools etc.	WSA/WCA/NRA
Water Audit Service	NRA	Commercial water users	NRA
Helpline for industry	DTI	Industry	DTI
Water Conservation Manual	Consultant	Water Companies	WSA/WCA, NRA
Compendium of water efficient products/practices	Contractor	Industry	DTI
Use of 'grey' water	BSRIA or similar	Householder	DoE (through byelaws)
Shower installation	Plumbing Contractor	Householder	DoE (through byelaws)
Controllers on Urinals	Contractors	Offices, schools	WSA/WCA,NRA
Low flush WC's	BSRIA or similar	Householders	DoE (through byelaws)
Efficient washing machines	Washing machine manufacturers	Householders	DoE (through byelaws)
Incentive abstraction charging	NRA	Water Companies Industry & Agriculture	DoE
Waste minimisation	Contractor	Industry	DTI, DoE, CEST
Research into agricultural best practice	Contractor	Farmers	MAFF, NRA
Financial assistance programme for farmers abstraction	MAFF	Farmers	MAFF/NRA (financed from incentive charging)
General R & D programme	Contractor	NRA/Water Co's DoE Industry Agriculture	NRA/Water Co's/ DoE/ Industry/Agriculture

*for NRA read EA after April 1996.

9. The Next Steps – Towards The Environment Agency

9.1 The NRA's Role and Programme

9.1.1 Introduction

In suggesting a national strategy for water conservation and demand management, the NRA has shown that it is by no means the only responsible body and it has suggested a National Water Conservation Committee as a way forward to co-ordinate the various interests. However, the NRA has clear duties and policies for water saving which it must continue to implement. This final chapter sets out the NRA's own programme for water conservation and demand management as it moves towards the Environment Agency.

9.1.2 Priority Programmes

In section 6.4 (page 46) resulting from the economic analysis, four priority areas were identified that should be the focus of a national demand management strategy.

Three of these (leakage, domestic metering and education/awareness) are substantial enough to form specific NRA work programmes. To these three other programme areas have been added for the reasons defined below.

These six programme areas are expected to form the basis of the NRA/Environment Agency's work for the next five years:

1. Leakage programme

The Water Companies have recently launched 'Managing Leakage', a comprehensive manual to assist managers and practitioners to implement cost effective leakage policies. As an area with considerable scope for demand management (and at least cost, as shown in section 6) this is an area that the NRA, through the Demand Management Centre needs to develop, both in understanding and disseminating key messages to NRA regions and in the forum of national discussion and research. Of particular importance is the need for the NRA to develop an understanding of the economic levels of leakage including an assessment of environmental costs and benefits.

2. Demand Forecasting and Monitoring Programme

The NRA and the Environment Agency have a duty to collate and publish information about present and future demands for water resources. This is central to the national water resources strategy and relies heavily on demand management. With the aggregate of water companies' demand forecasts from their Strategic Business Plans being less than the NRA's 'low' forecast (Water – Nature's Precious Resource (1994)) it is essential that companies are closely monitored to assess whether forecasts are achieved.

3. National Co-ordination Programme

A National Water Conservation Committee is proposed to ensure that water conservation and demand management is promoted nationally by the NRA and the Environment Agency, together with other responsible organisations, such as WSA/WCA, OFWAT, DoE.

4. Research and Development Programme

The NRA's contribution to the research and development of demand management. The proposed strategy identifies seven projects (9.1.4) approved for 1995/96 starts, that would make valuable contributions to realising water savings at various stages in the water cycle.

5. Education/Awareness Programme

A successful education/awareness programme is the key to effective long term water conservation and demand management by making the public aware of the need to conserve water. A programme would need to extend beyond the general public to schools, industry, farmers and water company planners and engineers. It includes publication of water conservation manuals and development of water audit advice for industry and commercial buildings.

6. Selective domestic metering programme

As has been shown elsewhere in this document, domestic metering is an important demand management option. The Government has extended the use of rateable values beyond 2000, but metering is still the Government's favoured long term option for charging. Against a background of opposition to metering there is a need to fully explore all the issues to enable informed debate on the subject.

The NRA/Environment Agency will continue to monitor Government and OFWAT policy on metering and will need to consider if it should take further steps to promote domestic metering in appropriate circumstances.

9.1.3 Developing the Demand Management Centre

Through the NRA's national Demand Management Centre (DMC), demand management will continue to be a focus for expertise by continued promotion of the subject through links with government, WSA/WCA, OFWAT, academics and industry and through its newsletter 'The Demand Management Bulletin.' NRA expertise will be developed throughout all the regions.

The DMC is currently defining the six priority programmes in greater detail and evaluating the anticipated workloads.

The work will be carried out at the DMC in Southern Region supported by secondments other regions.

The DMC will continue its role in supporting Head Office and Regions in negotiations with and monitoring of, water companies.

9.1.4 Research and Development

It is essential that the NRA takes a lead in developing water conservation and demand management as a subject by initiating and carrying out a number of projects.

The following projects form part of the NRA's 1995/96 R&D programme:

- Water Consumption and Conservation in Buildings

To investigate how water is consumed in commercial buildings and assess the scope for reducing consumption.

- Effective Methods of Water Saving Education

To produce a package of educational material to encourage water conservation and to test the effectiveness of the material.

- Water Saving in Industries Dependent on Direct Abstraction

To develop and apply water saving management methods within industries reliant upon direct abstraction and to investigate the cost benefit balance of such methods in the context of NRA abstraction charges.

- Abstraction Incentive Charging

To assess the practical implications of introducing a system of incentive abstraction charging given a change in legislation.

- Economics of Demand Management

A collaborative project (UKWIR & NRA) that seeks to develop a framework, usable by the industry and acceptable to NRA & OFWAT, to facilitate the optimum balance between demand management investment and deferral of water resource development and water supply/distribution enhancements.

- Autonomous Technologies

The NRA is a sponsor of this BSRIA project which aims to identify opportunities to conserve resources, minimise waste and prevent pollution associated with the use of buildings through the application of autonomous technologies (independence from centralised services).

- The Hydrological Effects of Demand Management on the Environment

To identify the scale and nature of factors affecting downstream abstractors and the water environment following implementation of measures to manage demand within the catchment, and to focus the NRA's water conservation and demand management efforts to where they will do the most environmental good.

9.1.5 NRA Training Needs

For the NRA to actively pursue a demand management strategy it is essential that all its water resources staff are fully trained. Areas of particular importance are:

- Leakage Control: To disseminate the key messages of 'Managing Leakage' which provides a framework for the NRA and Water Companies to work around and particularly important for licence determinations.
- BABE (Bursts and Background Estimates) Software: which incorporates the assumptions and methodologies of 'Managing Leakage.' A very useful tool for NRA staff in assessing the sensitivity of different water company leakage policies. The DMC will act as a 'help desk'.
- Demand Forecasting: To train NRA staff in the use of the forecasting methodology that will arise from the UKWIR/NRA project (section 4.1). The DMC will act as a 'help desk'.
- General Water Conservation and Demand Management Awareness: Demand Management has become synonymous with leakage control and domestic metering and there is a need to make NRA staff more aware of other possible options and the role of water conservation and demand management in demand forecasting.

9.2 Ways to maintain the momentum

A key to the success of demand management is coordination of the activities of the respective parties which can influence the process. Possible steps for maintaining the momentum of demand management could be:

- publication of responses received on this document
- preparation of a revised conservation and demand management strategy, taking into account the comments received
- formation of a National Water Conservation Committee as outlined in section 8.3
- coordination of future initiatives through the National Committee

10. Responses

The NRA would welcome views on all aspects of this report. Comments are particularly sought on the following:

1. The suggested roles and responsibilities (Table 8.2)
2. The value of a National Water Conservation Committee, the willingness of organisations to participate, the suggested composition and its proposed terms of reference (8.2 & 8.3)
3. The NRA's role and programme (9.1).
4. Ways to maintain the momentum (9.2)

Copies of this consultation report have been sent to the organisations listed in Appendix C.

11. References

Binnie, C.J.A. and Herrington, P.R. (1992) *'Possible Effects of Climate Change on Water Resources and Water Demand'.* Symposium on Engineering in the Uncertainty of Climatic Change. Institution of Civil Engineers, London 28 October 1992.

Bowers J.,O'Donnell K. and Whatmore S.,(1988) *'Liquid Assets – The Likely Effects of Privatisation of the Water Authorities on Wildlife Habitats and Landscape'.* A Report commissioned by Council for the Protection of Rural England, Royal Society for the Protection of Birds with the support of the World Wide Fund for Nature.

CEST (1994) *'A Route to Profit and Cleaner Production – an Interim Report on the Aire and Calder Project'.*

CEST (1995) *'Waste Minimisation and Cleaner Technology. An Assessment of Motivation'.*

CRI (1995) *'European Water Charges: A Comparison of 17 Cities'.*

Central Water Planning Unit (1977) *'Technical Note no. 19. Public Water Supply in 1975 and Trends in Consumption'.*

Council for the Protection of Rural England/ Royal Society for the Protection of Birds/ Worldwide Fund for Nature (1988) *'Liquid Assets'.*

Council for the Protection of Rural England (1991) *'Water on Demand – the Case for Demand Management in Charging Policy'.*

Council for the Protection of Rural England (1993) *'Water for Life – Strategies for Sustainable Water Resource Management'.*

Crawford Z. (1994) *'The Recycling Potential of Domestic Waste Water'.* Building Services April 1994, p37-38.

Cuthbert G.C. (1994) *'Progress on the Waterfront'.* The Audit Commission Report.

Department for Education (1993) *'Saving Water'.*

Department of the Environment and Welsh Office (1992) *'Using Water Wisely – A Consultation Paper'.*

Department of the Environment (1992) *'Development Plans and Regional Planning Guidance'.* Planning Policy Guidance Note 12.

Department of the Environment (1994) *'Sustainable Development – the UK Strategy'.* HMSO

Department of the Environment, Ministry of Agriculture Fisheries and Food and Welsh Office (1995) *'Guidance to the Environment Agency under the Environment Bill on its Objectives including the Contribution it is to make towards the Achievement of Sustainable Development'.*

Department of the Environment and Welsh Office (1995) *'Replacing the Byelaws – A Consultation Paper'.*

Department of the Environment (1995) *'Water Conservation – Government Action'.*

Environment Council (1992) 'Who's Who in the Environment: England'.

Herbertson P.W. and Burrow G.A. (1994) *'Demand Management – NRA Perspectives'.* IWEM/NRA Symposium 20th April 1994.

Herrington P.R. and Tate J.C. (1971) *'The Metering of Residential Water Supplies: Some Empirical Evidence'.* Water Demand Study Progress Paper S.2 (revised), University of Leicester, Dept. of Economics.

Herrington P.R. and Webb, M.G. (1981). *'Charging Policies for Water Services'.* Water Services, Vol.85, No. 1025.

Herrington (1987) *'Improved Water Demand Management. A State of the Art Report'.* OECD Paper no.7

International Water Supply Association (1986). International Water Statistics.

Merlo, Giorgio (1992) *'Water Losses, Detection and Assessment'.* IWSA Workshop, Water Metering in Municipal Supply Systems – Technical and Economic Aspects.

National Farmers Union (1993) 'Better Use of Water, the NFU's Proposals'.

National Rivers Authority (1993) R&D report *'Economics of Water Resource Management.'*

National Rivers Authority (1994) *'Water Nature's Precious Resource – An Environmentally Sustainable Water Resources Development Strategy for England & Wales'.*

National Rivers Authority (1995) *'Domestic Consumption Monitoring Survey'.* DMC Report no. 5.

National Rivers Authority (1992) *'Sustaining our Resources. Southern Region Water Resources Development Strategy'.*

National Rivers Authority (1994) *'Demand for Irrigation'.* R&D Report 14.

National Rivers Authority (1994) *Demand Management Bulletin, Issue 8, Dec 1994.*

National Rivers Authority (1995) *'Surface Water Yield Assessment'* R&D report.

National Metering Trials Working Group (1993) *'Water Metering Trials Final Report'.*

National Water Council/Department of the Environment (1980) *'Leakage Control Policy and Practice (Standing Technical Committee Report No. 26)'.*

OFWAT (1991) *'Paying for Water: the Way Ahead. The Director General's conclusions'.*

OFWAT (1992) *'A Survey of Customers in the Water Metering Trial Areas. Meter Installation Report'.*

OFWAT (1993) *'Paying for Growth. A Consultation Paper on the Framework for Reflecting the Costs of Providing for Growth in Charges'.*

OFWAT (1994) *'Future Levels of Demand and Supply for Water'.* OFWAT Occasional Paper No.1.

OFWAT (1994) *'1993/94 Report on the Levels of Service of the Water Industry in England and Wales'.*

Parliamentary Office of Science and Technology (1993) *'Dealing with Drought – Environmental and Technical Aspects of Water Shortages'.*

Pearce F. (1982) *'Watershed – The Water Crisis in Britain'.* Junction Books, London.

Plester HRF and Binnie CJA (1994) *'The Evolution of Water Resource Development in Northen Ireland'.* IWEM/NRA Symposium 20th April 1994.

Postel S. (1992) *'The Last Oasis, Facing Water Scarcity'.* Worldwatch Environmental Alert Series. WW Norton & Co.

Rees, J.A. (1982) *'An Economic Approach to Waste Control: A Second Look'.* Paper delivered at the IWES Symposium on an Understanding of Water Losses (London).

Roseberg P. (1994) *'Reducing Demand for a Limited Supply: Demand Management vs. Infrastructure Capital Investment'.* Water and Wastewater International Feb. 1994.

Royal Society for Protection of Birds (1995) *'Water Wise – the RSPB's Proposals for Using Water Wisely'.*

Scottish Office (1995) *'An Assessment of Demands and Resources at 1994'.*

Swinnerton C.J. and Sherriff J.D. (1993) *'National Rivers Authority National Strategy and Planning for the Future'.*

IWEM Journal Aug 1993.

Tate, D.M. (1990) *'Water Demand Management in Canada: A State of the Art Review'.* Environment Canada, Social Science Series No. 23.

Water Research Centre/UK Water Industry (1994) *'Managing Leakage'.*

Water Resources Act 1991, HMSO

Water Industry Act 1991, HMSO

Water Resources Board (1973), *Water Resources in England & Wales.*

Waterfacts '92 and '93, WSA.

Webster (1979) *'New Measures for Economy in the Use of Potable Water'.* Chartered Institute of Building Services Symposium. March 1979.

Wright P (1995) *'Water Resources Management in Scotland'.* CIWEM Journal vol 9, no. 2 April 1995.

Appendix A – Assumptions made in Calculation of Costs of Demand Management Options

As stated in 6.2 all demand management options are assumed to be introduced in equal incremental and annual steps over a twenty year period.

1. Domestic Metering

- Domestic properties metered over 20 year period to achieve 95% of all properties metered
- Actual cost of meter installation = £200.
- £12/prop/year for meter reading, billing enquiries, and replacing meters. This figure includes £40 of the initial installation so the capital element is £160/property.
- Where meters are installed average demand is reduced by 10%.
- Where meters are installed supply pipe leakage is reduced by 1.5 l/prop/hr (30 l/prop/day).

2. Leakage Detection and Repair

- Water Companies with total losses (including supply pipe losses) currently less than 6 l/prop/hr remain at that level.
- Water Companies with distribution losses currently greater than 6 l/prop/hr achieve that level in incremental steps over 20 years.
- Using the equation of the curve representing the cost of leakage control from 'Managing Leakage' (p.96) Report C to achieve 6 l/prop/hr requires increasing annual marginal costs from 4.7 p/m^3 (Year 1) to 17.0 p/m^3 (Year 20) and maintained at this level until year 40.

3. WC Replacement/Conversion

- Average volume per flush (England & Wales) = 9.5 litres
- Average no. of flushes/household/day = 10.5
  Source: Waterfacts 1992
- 10% of households have either dual flush or 7.5 litre flush WC's. in the following proportions

pre 1981	90%
dual flush (9/5 litre)	7%
7.5 litre flush	3%

- For pre 1981 WC's the volume/flush = 9.83 litres.

  (assumes that for the 10.5 flushes/day of a dual flush, 3 are long (9 litre) and 7.5 are short (5 litre) giving average of 6.15 litres/flush).

- In all of the following three options investigated it is assumed that the 90% of WC's (average flush volume = 9.83 litres) are replaced and the 10% of dual flush and 7.5 litre WC's remain unchanged.
- 20% of households have 2 WC's *(18% from FWR study of Domestic Water Use in Scotland 1991).*
- 25% of non-household use is domestic, of which 43% is WC flushing, the equivalent of 5.052 million WC's. It is assumed that uses/day and volume/use are the same as their domestic equivalents.

Option 1:
Convert pre-1981 WC's with 7.5 litre flush.
By drilling small hole in siphon. Cost £30/WC

Option 2:
Replace pre-1981 WC's with 6 litre flush.
Cost £300/WC

Option 3:
Convert pre-1981 WC's with a 9 litre/5 litre dual flush, with average 6.15 litres/flush.
Cost £30/WC

4. Use of 'grey water' for WC flushing.

Water used for WC flushing:

= Av. volume/ flush (9.5 litres)

x av. no. of flushes/day (10.5 litres)
x no. of households

if any of the WC replacement/conversion options are implemented the potential saving is correspondingly reduced.

Capital cost/household = £1,000 (Approximate cost of recycling system). Cost of annual maintenance = £15/prop/year.

5. Shower installation.

- A bath uses 80 litres of water per use.
- A shower uses 35 litres of water per use.
- From *Waterfacts 1992* 95% of households have baths at 0.6 uses/day/household and 25% of households have showers at 0.55 uses/day/household.
- 75% of households to have showers installed over a twenty year period.
- Showers would be used totally at the expense of baths and at the rate of 0.55/day/household.

(Education programme would be required which is not costed in this assessment).

- £200 per shower installation.

6. Low volume shower heads.

- Applied to all households as part of installation programme (as above) or as retrofit programme.
- Volume/use of shower reduced by 10%.
- Cost = £10/shower.

7. Controllers on Urinals.

- 20% of non-household use is used for urinal flushing (Webster 1979).
- 20% of non-households have urinals.
- Of those, 75% do not have controllers and so flush at equal time intervals, day and night, and over weekends.
- Controller reduces consumption by 79% (DFE booklet, Saving Water).
- Cost/controller = £200.

8. Efficient Washing Machines

- Washing machine use assumed to be 110 litres/cycle. (Waterfacts 92).
- Water efficient washing machines now use 80 litres/cycle and it is stipulated in the water byelaws that all new machines must not exceed 80 litres/cycle.
- Although ownership levels of 85%, total saving is calculated on the basis of every household having a washing machine. Households without washing machines will be using machines at a launderette
- Uses/household/day at 0.75 and a saving of 30 litres/cycle (110-80)
- The cost of this option (to the undertaker) is zero as water efficient washing machines would be introduced as householders replace their existing machines.

9. Efficient Dishwashers

- From published figures a household with a dishwasher uses only 7.1 litres/day more than a household without one. At 25 litres/use (Which Magazine) there is probably little scope for efficiency improvements.

10. Car Washing/External Use

- Currently comprising some 3% of per capita demand it is assumed that this will reduce largely due to meter installation (and education) and so has not been separately evaluated.

11. Resource development Costs

- Resource development costs include treatment and distribution costs. Depending on availability of water resources a range from £0.75m/Ml/day to £1.5m/Ml/day has been assumed. made up as follows:

Low resource costs (£0.75m/Ml/day)

£500,000 per Ml/d of capacity, resources and treatment + £100,000 per Ml/d of bulk transfer costs + 25% (corresponding with 20% losses) on costs to allow for leakage and operational use.

High resource costs (£1.5m/Ml.day) are simply double this cost.

Source: NRA/OFWAT – and consistent with OFWAT periodic review).

12. Operational Expenditure (OPEX)

- Increased demand (associated with resource development) incur additional operational expenditure of 10p/m^3 (OFWAT periodic review)

Appendix B – Water Conservation and Demand Management – Proposed Actions

1. From "Using Water Wisely" (1992)	Reference
Measures in hand	
Develop Code of Practice for long term leakage targets (not yet done)	para 5.7 p.13
Pressure on water companies to reduce leakage, from OFWAT, NRA (ongoing).	para 5.11 p.14
Liaison with WSA and BSI over European Standards (progress not known).	para 9.14 p.23
Environmental statements for WR projects to include assessment of metering and leakage reduction (OFWAT, NRA) (not yet done – NRA to take on).	para 10.15 p.26
Publish OFWAT Guidelines on domestic metering extension (not yet done – NRA role?)	para 11.19 p.28
Next Steps	
*Maximising water savings by industry and agriculture (Waste Minimisation in hand)	para 12.3(i) p.30
*Discussions (OFWAT/NRA/WSA/WCA) on economic criteria for metering and leakage, including environmental benefit (not yet done – NRA priority.	para 12.3(iv) p.30
*Trials of low volume dual flush toilets etc (DoE progressing?)	para 12.3(v) p.30
*Super low flush (< 6 litres) and BREEAM system (DoE progressing?)	para 12.3(vi) p.30
*Guidance to building and estate managers on efficiency water use (DMC task to coordinate?)	para 12.3(vii)
An assessment of use of untreated water (DMC task to coordinate?)	para 12.3 (viii)
*Review Bye-Laws (DoE progressing)	para 12.3 (ix)
*Report on Social impact of water metering (needs progressing – DMC task to coordinate?)	para 12.3 (xi)
Measures on which Views are Sought	
*Re-washering customers' taps. (no action).	para 12.4 (iii) p.30
*Showers in new houses (no action).	para 12.4 (iv)
*Reduction of water usage in toilets, dishwashers, washing machines (no action – DMC to pursue?)	para 12.4 (v)
*Better design of hot water systems.	para 12.4 (vi)
*Metering for swimming pools and garden hoses.	para 12.4 (vii)
*Urinal control systems.	para 12.4 (ix) p.31
*Byelaw enforcement.	para 12.4 (x)
*Promoting recycling and re-use.	para 12.4 (xii)
*Replacement of water byelaws.	para 12.4 (xiii)
*Promotion measures for water metering.	para 12.4 (xiv)
Ongoing Public Education	
*Ongoing public information and education programme; especially schools (DMC to take lead?)	para 12.5 p.31

2. From "Dealing with Drought" (1993)

Summary of options. Table 5.3. p.77

*DoE	– replacement of byelaws
	– tighten byelaw specification for appliances
	– water audits, efficient water use in industry
*DTI/DoE	– labelling water consumption for appliances.
*DoE/WCo's	– Education on efficient water use.
DoE/NRA/OFWAT	– methodology for environmental benefits with leakage/metering economics
NRA	– monitor leakage control programme
	– incentive charges for abstraction
*OFWAT	– duty to promote water efficiency
	– mandatory leakage targets
	– meter reading cooperation with other utilities.
*Water Co's	– duty to encourage efficiency water use
	– enforcement powers for customers waste
	– byelaws compliance checks.

3. From "Water for Life" (1993)

*Policies to address environmental, economic and social dimensions of sustainability.	(1) p.91
Evaluate all options to derive optimum local mix.	(2)
*Water Co's and OFWAT to have duty to promote efficient use of water.	(4)
*Give water companies incentives to save, not sell, water	(5)
*Byelaws and retrofit, information and meter meters.	(6)
*Companies to consider taking responsibility for customer pipes.	(8)
Evaluate re-use ('grey' water) – priority in Thames Gateway.	(9)
More pro-active demand management strategy for NRA	(10)
– incentive abstraction pricing	
– water trading systems	
– water conservation and auditing	
– redistribute abstraction revenue to promote water efficiencies	
Planning Guidelines for local planning authorities on water resources.	(11)
Change cost recovery legislation for NRA to allow realistic incentive charging.	(12)
(NB Significant water saving promotion costs could be charges to WR account with Ministerial approval).	
Consider 'trading' treated effluent for non-portable use.	(15)
Investigate tradeable abstraction permits.	(16)

*Suitable topics for the proposed National Water Conservation Committee.

Appendix C – List of Organisations Consulted

Water Industry Bodies

Board for Education and Training in the Water Industry (BETWI)
United Kingdom Water Industry Research Ltd (UKWIR)
Water Companies Association
Water Companies of England And Wales
Water Education Trust
Water Training International
Water Research Centre Evaluation and Testing Centre
Water Services Association

Water Companies

Anglian Water Services
Ardleigh Reservoir Committee
Bournemouth & West Hants Water Company
Bristol Water Plc
Cambridge Water Company
Chester Waterworks Company
Cholderton & District Water Company
East Surrey Water Company
Essex and Suffolk Water Company
Folkestone & Dover Water Services Ltd
Hartlepools Water Company
Isle of Man Water Authority
Mid Kent Water Company
Mid Southern Water Company
North East Water
North Surrey Water Company
North West Water
Northumbrian Water Ltd
Portsmouth Water Company
Saur UK Ltd
Severn Trent Water Ltd
South East Water
South Staffs Water Company
South West Water Services Ltd
Southern Water Services Ltd
States of Guernsey Water Board
Sutton District Water Company
Thames Water Ltd
Tendring Hundred Water Services
The Jersey New Waterworks Co Ltd
Three Valleys Water Services
Welsh Water Plc
Wessex Water Plc
Wrexham & East Denbighshire Water Company
York Water Works Plc
Yorkshire Water Services Ltd

Trade, Professional and Other Bodies

Acer Environmental
Agricultural and Food Research Council
Agricultural Development and Advisory Service
Agricultural Society
Agricultural Training Board
Alexander Gibb & Partners
Amalgamated Engineering & Electrical Union (EETPU Section)
Angling Foundation (The)
Architects and Surveyors Institute
Architectural Association
Association for the Conservation of Energy
Association of British Chambers of Commerce
Association of British Insurers
Association of Building Engineers
Association of CCTV Surveyors
Association of Consultant Architects
Association of Consulting Engineers
Association of Consulting Scientists
Association of Drainage Authorities
Association of Flow Survey Contractors
Association of High Pressure Water Jetting Contractors
Association of Independent Businesses
Association of Manufacturers of Domestic Electrical Appliances
Association of Manufacturers of Domestic Unvented Supply Systems Equipment
Association of Professional Fire consultants
Binnie and Partners
Biotechnology and Biological Sciences Research Council (BBSRC)
British Automatic Sprinkler Association
British Bathroom Council
British Board of Agrement
British Canoe Union
British Car Wash Association
British Coal Corporation
British Combustion Equipment Manufacturers Association
British Drilling Association
British Geological Survey
British Hydrological Society
British Institute of Architectural Technologists
British Non-Ferrous Metals Federation
British Organic Farmers
British Plastics Federation
British Plumbing Fittings Manufacturers Association
British Society of Dowsers
British Standards Institution
British Steel Plc
British Technology Group
British Trout Association
British Water
British Water Industries Group
British Water Ski Federation
British Waterways
BSI
BSI Quality Assurance
Builders Merchants Federation
Building Control Consortium of Wales
Building Employers Confederation
Building Employers Confederation (Welsh Branch)
Building Regulations Advisory Committee
Building Services Research and Information Association
Bullen Consultants
Central Council of Physical Recreation
Centre for Exploitation of Science and Technology (CEST)
Centre for the Study of Regulated Industries
Chamber of Commerce
Chartered Institute of Arbitrators
Chartered Institute of Purchasing and Supply
Chartered Institution of Building
Chartered Institution of Building Services Engineers
Chartered Institution of Water and Environmental Management
Chemical Industries Association

CIPFA (Chartered Institute of Public Finance and Accountancy)
Clay Pipe Development Association
CNS Scientific & Engineering Service
Company of Water Conservators
Concrete Pipe Association
Confederation for the Registration of Gas Installers
Confederation of British Industry
Confederation of Shipbuilding and Engineering Unions
Construction Industry Council
Construction Industry Research and Information Association
Construction Industry Training Board
Consumers Association
Construction Europe
Council for the Protection of Rural England
Country Landowners Association
Countryside Commission
Department of Trade and Industry
District Surveyors Association
Ductile Iron Pipe Association
Dynamco
Eco Environmental Education Trust
Economic Development & Environmental Planning
Electrical Electronic Telecommunications and Plumbing Union
Electricity Association
English Nature
Environment Council
Environmental Change Unit
Environmental Data Services Ltd
Environmental Resources Ltd
ERP Environment
Ewan Associates Ltd
Farmers Union of Wales
Federated Union of Managerial and Professional Officers
Federation of Civil Engineering Contractors
Federation of Master Builders
Federation of Small Businesses
Fibre Cement Manufacturers Association Limited
Fire Brigade Union
Flood Hazard Research Centre
Forum of Private Business
Freshwater Biological Association
Friends of the Earth
Fusion Meters
GAMBICA
Greenpeace
Guild of Incorporated Surveyors
Guild of Water Conservators
High Performance Pipe Association
Horticultural Trades Association
Housebuilders Federation
Housebuilders Federation (Welsh Branch)
Housing Corporation
Howard Humphreys & Partners Ltd
Industrial Water Society
Inland Waterways Amenity Advisory Council
Inland Waterways Association
Institutes of Arable Crops Research
Institute of Baths and Recreation Management
Institute of Biology
Institute of Building Control
Institute of Building Control (Welsh Branch)
Institute of Corrosion
Institute of Directors
Institute of Fisheries Management
Institute of Freshwater Ecology
Institute of Horticulture
Institute of Housing
Institute of Hydrology
Institute of Plumbing
Institute of Professional Soil Scientists
Institute of Wastes Management
Institution of Chemical Engineers
Institution of Agricultural Engineers
Institution of Civil Engineers
Institution of Engineering Designers
Institution of Environmental Health Officers (The)
Institution of Fire Engineers
Institution of Gas Engineers
Institution of Mechanical Engineers
Institution of Mechanical Incorporated Engineers
Institution of Plant Engineers
Institution of Structural Engineers
Institution of Water Officers
International Association on Water Quality
International Commission on Irrigation and Drainage – British Section
International Society for Trenchless Technology
International Water Supply Association
Local Government Management Board
London Rivers Association
March Consulting Group
Meteorological Office
Middlesex University of Business School
National Association of Plumbing, Heating and Mechanical Services Contractors
National Association of Shopfitters
National Association of Water Power Users
National Consumers Council
National Council of Building Material Producers
National Economic Research Associates
National Environmental Tech. Centre
National Farmers Union
National Federation of Anglers
National Housebuilding Council
National Joint Council for the Building Industry
National Power
National Power (Technology and Environment)
National Resources Institute
National Society for Clean Air and Environmental Protection
National Trust
Natural Environment Research Council
Nuclear Electric Plc
Otter Conservancy
Pipeline Industries Guild
Plaid Cymru (Welsh Nationalist Party)
Plastic Pipe manufacturers Society
Plastic Tanks and Cisterns Manufacturers Association
Powergen
Pressure Gauge and Dial Thermometer Association of Europe
Public Utilities Access Forum
Pure Rivers Society
REDR – Registered Engineers For Disaster Relief
Royal Botanic Gardens
Royal Commission on Environmental Pollution
Royal Horticultural Society

Royal Institute of British Architects
Royal Institute of Chartered Surveyors
Royal Institute of Public Health and Hygiene
Royal Meteorological Society
Royal Society for Nature Conservation
Royal Society for the Protection of Birds
Royal Town Planning Institute
Salmon and Trout Association
SCI – Society of Chemical Industry
SCI; SCI Water and Environment Group
Scottish Association of Directors of Water and Sewerage Services
Sir Frederick Snow & Partners Ltd
Sir William Halcrow & Partners Ltd
Small Farmers Association
Soap and Detergent Industry Association
Society for Underwater Technology
Society of British Gas Industries
Society of British Water Industries
Society of Engineers
Society of Fire Safety Engineers
South Wales Institute of Engineers
Southern Consumer Consultant Committee
Southern Science Ltd
Sports Council
Stewarts and Lloyds Plastics
Tecnecon
The Prince of Wales Committee
The Well Drillers' Association
Thomas Telford Ltd
UK Irrigation Association
UK Centre for Economic and Environmental Development
Union of Construction Allied Trades and Technicians
Unison
United Kingdom Association of Professional Engineers (UKAPE)
University of Salford – Environmental Institute
Volume Housebuilders Study Group
WRc
WRc (Aqualine)
W S Atkins
Water Briefing
Water Dynamics
Water Resources Systems Research Unit
Water Services International
Wateraid
Waterheater Manufacturers Association
Welsh Federation of Housing Associations
Wildfowl and Wetlands Trust
Wildlife Trust
Women's Environmental Network
World of Water
World Wide Fund for Nature
Worshipful Company of Plumbers

Regulators

Clyde River Purification Board
Forth River Purification Board
Highland River Purification Board
North East River Purification Board
Office of Water Services – Chairman Customer Services
Office of Water Services – Chairman North West (CSC)
Office of Water Services – Chairman Norhtumbrian (CSC)
Office of Water Services – Chairman South West (CSC)
Office of Water Services – Chairman Southern (CSC)
Office of Water Services – Chairman Thames (CSC)
Office of Water Services – Chairman Wessex (CSC)
Office of Water Services – Chairman Yorkshire (CSC)
Office of Water Services – Chairman Central (CSC)
Office of Water Services – Chairman Eastern (CSC)
Office of Water Services – Charges Control
Office of Water Services – Consumer Affairs
Office of Water Services – Deputy Director General
Office of Water Services – Director General
Office of Water Services – Media and Information
Scottish River Purification Boards Association
Solway River Purification Board
Tay River Purification Board
Tweed River Purification Board

Local Authority Bodies

Assembly of Welsh Counties
Association of County Councils
Association of District Councils
Association of Local Authorities of Northern Ireland
Association of London Authorities
Association of Metropolitan Authorities
Avon County Council
Barking & Dagenham Borough Council
Barnet Borough Council
Barnsley Borough Council
Bedfordshire County Council
Berkshire County Council
Bexley Borough Council
Birmingham Borough Council
Bolton Borough Council
Borders Regional Council
Bradford Borough Council
Brent Borough Council
Bromley Borough Council
Buckinghamshire County Council
Bury Borough Council
Calderdale Borough Council
Cambridgeshire County Council
Camden Borough Council
Central Regional Council
Cheshire County Council
Chief Assistant Chief Fire Officers Association
Cleveland County Council
Convocation of Scottish Local Authorities
Cornwall County Council
Council of the Isles of Scilly
Council of Welsh Districts
Countryside Council for Wales
Coventry Borough Council
Croyden Borough Council
Cumbria County Council
Derbyshire County Council
Devon County Council
District Planning Officers Society
Doncaster Borough Council
Dorset County Council
Dudley Borough Council
Dumfries and Galloway Regional Council
Durham County Council
Ealing Borough Council
East Sussex County Council
Enfield Borough Council
Essex County Council

Fife Regional Council
Gateshead Borough Council
Gloucestershire County Council
Grampian Regional Council
Greenwich Borough Council
Hackney Borough Council
Hammersmith & Fulham Borough Council
Hampshire County Council
Haringey Borough Council
Harrow Borough Council
Havering Borough Council
Hereford & Worcester County Council
Hertfordshire County Council
Highland Regional Council
Hillingdon Borough Council
Hounslow Borough Council
Humberside County Council
Isle of Wight County Council
Islington Borough Council
Kensington & Chelsea Borough Council
Kent County Council
Kingston Upon Thames Borough Council
Kirklees Borough Council
Knowsley Borough Council
Lambeth Borough Council
Lancashire County Council
Leeds Borough Council
Leicestershire County Council
Lewisham Borough Council
Lincolnshire County Council
Liverpool Borough Council
London Boroughs Association
London District Surveyors Association
Lothian Regional Council
Manchester Borough Council
Merton Borough Council
National Association of Fire Officers
National Association of Local Councils
Newcastle upon Tyne Borough Council
Newham Borough Council
Norfolk County Council
North Tyneside Borough Council
North Yorkshire County Council
Northamptonshire County Council
Northumberland County Council
Nottinghamshire County Council
Oldham Borough Council
Orkney Islands Council
Oxfordshire County Council
Redbridge Borough Council
Richmond upon Thames Borough Council
Rochdale Borough Council
Rotherham Borough Council
Salford Borough Council
Sandwell Borough Council
Sefton Borough Council
Sheffield Borough Council
Shetland Islands Council
Shropshire County Council
Society of Chief Architects of Local Authorities
Society of Chief Building Control Officers
Solihull Borough Council
Somerset County Council
South Tyneside Borough Council
Southwark Borough Council
St Helens Borough Council
Staffordshire County Council
Stockport Borough Council
Strathclyde Regional Council
Suffolk County Council
Sunderland Borough Council
Surrey County Council
Sutton Borough Council
Tameside Borough Council
Tayside Regional Council
Tower Hamlets Borough Council
Trafford Borough Council
Wakefield Borough Council
Walsall Borough Council
Waltham Forest Borough Council
Wandsworth Borough Council
Warwickshire County Council
West Sussex County Council
Western Isles Islands Council
Westminster City Borough Council
Wigan Borough Council
Wiltshire County Council
Wirral Borough Council
Wolverhampton Borough Council

Government Departments and Agencies/Political Parties

Audit Commission
Building Research Establishment
Conservative Party
Crown Estate
Department of Agriculture Northern Ireland
Department of Environment
Department of Environment (Water Services)
Department of Environment (Water Resources & Marine Division)
Department of Health
Department of the Environment, Northern Ireland
Department of the Environment, Northern Ireland (Western)
Department of the Environment, Northern Ireland (Northern)
Department of the Environment, Northern Ireland (Eastern)
Department of the Environment, Northern Ireland (Southern)
Department of Trade and Industry
Development Board for Rural Wales
Drinking Water Inspectorate
Ecolabelling Board
Green Party
Health and Safety Executive
Her Majesty's Inspectorate of Pollution
Home Office
Housing for Wales
Labour Party
Liberal Democrat Party
Ministry of Agriculture, Fisheries and Food
Ministry of Defence
NHS Estates
Parliamentary Office of Science and Technology
Scottish Office, Environment Department
Treasury
Welsh Development Agency
Welsh Office

Appendix D – NRA Regional Water Resources Strategies

The following documents are available from the NRA regional offices as listed on the inside back cover:

'Regional Water Resources Strategy – Severn Trent Region'. November 1993

'Future Water Resources in the Thames Region. A Strategy for Sustainable Management'. June 1994.

'Regional Water Resources Strategy – Northumbria and Yorkshire'. July 1994.

'Water Resources in Anglia – A Sustainable Strategy for Secure Water Supplies and a Better Water Environment'. September 1994.

'Sustaining our Resources – The Way Forward'. NRA Southern Region, November 1994.

'Water for Welsh Region – A Consultation Document'. February 1995.

'Tomorrow's Water – Water Resources Development Strategy'. NRA South West Region, April 1995.

The North West Region of the NRA is due to publish its water resources strategy early in 1996.

Glossary of Terms

Abstraction	The removal of water from any source; either permanently or temporarily.
Abstraction licence	The authorisation granted by the NRA to allow the removal of water from a source of supply.
Abstraction charges	The charges payable to the NRA under the terms of the abstraction licence.
Active leakage control	Water Company operating practices of detecting leakage from knowledge of night flows, pressure etc.
ACORN groups	A Classification of Residential Neighbourhoods. A property based classification often used by water companies for extrapolating the results of domestic consumption monitoring experiments to a company wide average.
Aquifer	A porous water bearing underground formation of permeable rock, sand or gravel capable of holding significant quantities of water.
Asset Management Plan	Initiated by OFWAT as part of the periodic review of the adjustment of water company k factors.
Audit Commission	A commission that has powers to investigate public sector organisations to make sure that they are efficiently run.
BABE	A concept from the National Leakage Control Initiative, Bursts and Background Estimates.
Background leakage	The background level of leakage is due to a large number of small leaks deemed to be uneconomic to locate and repair.
Brundtland Report	Report of the 1987 World Commission on Environment and Development.
BSRIA	Building Services Research and Information Association.
Burst – Reported	A burst on a water main reported to the water company by a member of the public.
Burst – Unreported	A burst on a water main found by active leakage control methods.
Byelaws	The water byelaws exist to prevent the waste, undue consumption, misuse or contamination of water. They are due for review in 1997.
Capital costs	Costs expended on something (e.g. a reservoir) that will remain permanent fixtures and find continuous use on site over a long period.
CBI	Confederation of British Industry.
CEST	Centre for Exploitation of Science and Technology.
CLA	Country Landowners Association.
Communication pipe	The length of service pipe from the company owned water main to the boundary of the customer's property. Responsibility of the water company.
Consumption	The sum of customer use and plumbing losses.
Consumptive use	Use of water that is not returned either directly to an aquifer or to a river via a sewage works. e.g. garden watering.
CPRE	Council for the Protection of Rural England.
CPRW	Campaign for the Protection of Rural Wales.
CWPU	Central Water Planning Unit.
Demand Forecasting	A prediction of demand in the future.
Demand Management	The management of the total quantity of water abstracted from a source of supply using measures to control waste and consumption.
DMC	The NRA's national Demand Management Centre.
DG1	An OFWAT level of service indicator that shows the adequacy of a company's water resources situation.
DG4	An OFWAT level of service indicator that shows the percentage of a water company's population that has experienced water use restrictions.
Director General	The Director General of Water Services.
Discharge consent	A licence granted by the NRA to discharge effluent of specified quality and volume.
Distribution costs	The costs to a water company of managing the water distribution system.
Distribution Losses	The total water loss from the water company distribution system.
DoE	Department of the Environment.
Domestic consumption	Methods by which water companies assess unmeasured per capita monitoring consumption for a sample of their population.
Drought order	A means whereby water companies and/or the NRA can apply to the Secretary of State for the imposition of water restrictions.
DTI	Department of Trade and Industry.
Dual flush WC	A WC with two flush settings, typically 9 litres for the long flush and 5 litres for the short flush.
Earth Summit	The meeting of world leaders at Rio in 1992 to discuss global environmental problems.
Economic instruments	Means of controlling the demand for a product by using the price mechanism e.g. a volume related charge.
Economic level of leakage	The level of leakage where the marginal cost of active leakage control equals the marginal cost of leaking water.

Environment Agency	A non departmental public body due to come into being in 1996 as the amalgamation of NRA, HMIP the Waste Regulation Authorities and some functions of DoE.
Environment Bill	The Bill that gives the Environment Agency legal status. The Bill was given Royal Assent in July 1995.
Flush Controllers	Devices that can be installed on urinals to prevent flushing when they are not being used.
FoE	Friends of the Earth.
Greywater	Used wash water from baths, showers and hand washing.
Groundwater	Water held in aquifers.
HMIP	Her Majesty's Inspectorate of Pollution.
Incentive charging	Uses charges as incentives to achieve a particular objective. e.g. raising abstraction charges to reduce licensed volumes.
July return	An annual return from the water companies to the Director General of Water Services of key performance data.
K factor	The amount over and above inflation which water companies can charge their customers.
l/h/d	Litres per head per day. (This is a way of expressing per capita consumption).
l/km/sec	Litres per km of main per second. (A way of expressing leakage rates in rural areas).
l/prop/hr	Litres per property per hour. (A way of expressing leakage most suitable to urban areas).
m^3/km/day	cubic metres per km of distribution system per day. A composite measure recommended by *'Managing Leakage'* and deemed to be suitable to urban and rural areas.
MAFF	The Ministry of Agriculture, Fisheries and Food.
Managing Leakage	The guidance and recommendations of the National Leakage Control Initiative.
Marginal cost	The cost at the 'margins' e.g. the cost of supplying an additional unit of water.
Median value	The middle value when a series of numbers are placed in ascending order.
Minimum night flow	The minimum flow into a discrete distribution area during the night. Used by water companies to determine the leakage level.
Ml	Megalitres or 1 million litres.
Ml/day	Megalitres per day. (one megalitre is equal to 1 million litres or approximately 220,000 gallons).
Ml/annum	Megalitres per annum.
National Metering Trials	Metering Trials that took place 1988-92 at twelve sites in England to determine the costs and benefits of widespread domestic metering.
Net present cost	The total cost of future expenditure discounted to present values.
NFU	National Farmers Union.
NLCI	National Leakage Control Initiative.
non-household	An industrial or commercial property.
NRA	National Rivers Authority.
OFWAT	Office of Water Services.
OPCS	Office of Population Census and Surveys.
pcc	Per capita consumption or the quantity of water used for normal household domestic purposes expressed as a volume per person.
Peak demand	The highest demand that occurs either hourly, daily, weekly, monthly or yearly.
Per annum	Per year.
POST Report	The report entitled 'Dealing with Drought – Environmental and Technical Aspects of Water Shortages' published by the Parliamentary Office of Science and Technology in 1993.
Precautionary Principle	Where significant environmental damage may occur, but knowledge on the matter is incomplete, decisions made and measures implemented should err on the side of caution.
Pressure Reduction	Reducing the pressure of water in the distribution system.
PWS	Public Water Supply.
Recycling	Use of water again within the premises where it was first taken.
Report 26	Standing Technical Committee Report 26 'Leakage Control Policy and Practice' published by the DoE and the National Water Council in 1980.
Resource development costs	The costs associated with developing a new water resource.
Re-use	The use of treated wastewater for beneficial purposes.
RSPB	Royal Society for the Protection of Birds.
Selective metering	Household metering in selective areas.
SEPA	Scottish Environment Protection Agency.
Service pipe	The communication pipe plus the supply pipe.
Strategic Business Plan	An alternative title to Asset Management Plan 2 (AMP2).
Supply pipe	The length of service pipe from the boundary of the property to the curtilage of the property for which the householder is responsible.

Supported source	A water resource that is artificially augmented to maintain an environmentally acceptable river/ groundwater level/flow.
Surface water	Water which flows or is stored on the ground surface.
Sustainable Development/ sustainability	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Tariff	A charging rate.
Total Losses	The sum total of the loss of water from water company distribution systems, customer supply pipes and general domestic leakage.
Treatment costs	The costs associated with the treatment of water.
UKWIR	United Kingdom Water Industry Research Limited.
Waste	Can mean either wasted water (i.e. leakage) or a by-product from industrial processes that needs to be disposed of (as in waste minimisation).
Waste minimisation	The reduction of waste by the adoption of more efficient and cleaner technologies.
Wastewater	Water that has been 'used' by households and industry.
Water Conservation	Actions to improve the efficiency of the storage, conveyance, distribution, or use of water, exclusive of dams, reservoirs or wells.
Water Delivered	Water delivered to the customer at the limit of the Water Company's responsibility. (Water Delivered includes supply pipe losses).
Water Order	A means whereby a Regional Council in Scotland acquires water rights from the Secretary of State for Scotland.
WCA	Water Companies Association.
WSA	Water Services Association.
WRB	Water Resources Board
Welsh Office	The Office of the Secretary of State for Wales.
WRc	Water Research Centre.
Yield	The reliable rate at which water can be drawn from a resource.
£M	Million pounds sterling.

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The NRA is committed to the principles of stewardship and sustainability. In addition to pursuing its statutory responsibilities as Guardians of the Water Environment, the NRA will aim to establish and demonstrate wise environmental practice throughout all its functions.

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