FUTURE WATER RESOURCES IN THE THAMES REGION

A STRATEGY FOR SUSTAINABLE MANAGEMENT

JUNE 1994

NRA

National Rivers Authority
Thames Region

THE NATIONAL RIVERS AUTHORITY

The NRA was formed as a result of the Water Act 1989 (later consolidated into the Water Resources Act 1991) as a major environmental agency responsible for safeguarding and improving the total natural water environment, including not only the quantity and quality of water in rivers, streams and lakes but also underground water. As Guardians of the Water Environment its statutory duties and responsibilities include :

WATER RESOURCES: The management of resources to achieve the right balance between the needs of the environment and those of abstractors, through the licensing system.

WATER QUALITY: To achieve a continuing overall improvement in the quality of rivers, estuaries and coastal waters through the control of pollution; and ensure that dischargers pay the costs of the consequence of their discharges.

FLOOD DEFENCE: Provide effective defence for people and property against flooding from rivers and from the sea; provide adequate arrangements for flood forecasting and warning.

FISHERIES: The maintenance, improvement and development of fisheries; restoration or rehabilitation of damaged fisheries.

CONSERVATION: The conservation and enhancement of wildlife, landscape and archaeological features associated with inland and coastal waters in England and Wales.

RECREATION: To develop the amenity and recreational potential of inland and coastal waters and associated lands.

NAVIGATION: To improve and maintain inland waters and their facilities for use by the public where the NRA is the navigation authority, supervise navigation, river-based events and safety inspections.

THE NRA MISSION STATEMENT IS:

"We will protect and improve the water environment by the effective management of water resources and by substantial reductions in pollution. We will aim to provide effective defence for people and property against flooding from rivers and the sea. In discharging our duties we will operate openly and balance the interests of all who benefit from and use rivers, groundwater, estuaries and coastal waters. We will be businesslike, efficient and caring towards our employees".

Under other legislation the NRA has an important role as a statutory consultee in relation to:

- development plans;
- various applications for planning permission;
- waste disposal site licensing;
- the authorisation of industrial processes controlled by Her Majesty's Inspectorate of Pollution (HMIP).

In order to fulfil this role as statutory consultee the NRA carries out:

PLANNING LIAISON: Conservation and enhancement of the water environment through multi-functional influence on development planning and control at strategic and local levels; supports sustainable development via prevention (new development) as well as cure (redevelopment).

CATCHMENT PLANNING: The process to create, implement, monitor and review an NRA vision and Action Plan for sustainable management of the river catchment in terms of the total water environment, in partnership with other stakeholders.

DUTIES & POWERS

Management of Water Resources

The NRA must take such action as it considers necessary to conserve, redistribute, augment and secure proper use of water resources.

Publish Demand and Resources Information

The NRA must publish information about the demand for water and available resources. It has powers to obtain information from abstractors.

Setting of Minimum Acceptable Flows and Volumes

The NRA may ask the Secretary of State to set minimum acceptable flows, levels or volumes for inland waters.

Administration of Abstraction and Impoundment Licensing System

The NRA must administer the system for licensing abstractions and impoundments. The NRA has wide powers as to whether or not to grant a licence and if so on what terms; but in doing so must protect existing abstraction rights. It may apply for exemption of sources of supply from abstraction control. It may also issue consents for groundwater investigation and abstraction of small quantities and, by service of conservation notices, control dewatering activities. The NRA has powers to vary abstraction licences subject to the payment of compensation where necessary. Applicants for licences may appeal to the Secretary for State if they are not satisfied with the Authority's decision.

Drought Orders

The NRA may apply to the Secretary of State for 'emergency' or 'ordinary' drought orders, which enable measures to cope with water shortages. These may grant wide powers, including modification of abstraction licences. Drought orders may involve payment of compensation to affected parties. The NRA may restrict abstraction for spray irrigation licences without compensation.

Recovering Costs

The NRA may charge for carrying out its water resources functions. This is done under a scheme approved by the Secretary of State. Special arrangements may be made eg. in relation to spray irrigation, the abstractor carrying out works and British Waterways. The NRA may revoke licences where charges are not paid.

Provision of Public Register

The NRA must keep a register recording all applications relating to licences, how these have been dealt with and details of successions to licences. The register, and copies of entries on it, must be available to the public. Certain other information relating to an application or subsequent utilisation of a licence is also publicly available.

Enforcement

Abstraction without a licence and other contraventions of the water resources legislation is usually an offence. The NRA is responsible for enforcement.

Enabling Powers

The NRA has a general power to take such action as may be necessary to carry out its functions. There are also specific powers to assist management of water resources. These include powers of entry for enforcement, works, survey and other purposes; making works agreement; laying pipes; and applying to the Secretary of State for compulsory works orders.

Environmental and Recreation

The NRA has general duties to further the conservation and enhancement of the natural environment and regarding the conservation of heritage sites and promoting recreation which must be taken into account in its activities or through others with whom it works.

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Thames Water Utilities Ltd
Three Valleys Water Services Plc

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EXECUTIVE SUMMARY

INTRODUCTION

In March 1994, the NRA published "Water : Nature's Precious Resource", a document which addresses the future management and development of water resources in England and Wales. A number of key policies and messages are identified including:

- *in developing a sustainable water resources strategy, the NRA's main concern is for environmental sustainability; this implies that there should be no long-term systematic deterioration in the water environment owing to water resource development or water use; where in doubt a precautionary approach should be adopted;*
- *the strong possibility that demands can be managed to avoid the need for large scale water resource developments over the next 20 years or so;*
- *water companies must be required to achieve economic levels of leakage and metering before new abstraction licences are granted for strategic developments;*
- *the NRA must take a proactive role in promoting water use efficiency in industry, commerce, agriculture and the home;*
- *environmental considerations will be crucial in the consideration of any scheme.*

The document identified the need for a robust yet flexible strategy to respond to the uncertainties of forecasting demand for water, the long-term reliability of some sources and the successful promotion of new schemes. In view of the risks and uncertainties envisaged for the 30-year planning period, the document proposed early investigations and planning of major water resource schemes which might be required under higher demand scenarios. In particular it mentioned the need for a thorough comparison of the issues surrounding the possible construction and operation of a reservoir or inter-regional transfer schemes for the Thames Region, based on the principles and criteria of sustainability.

FOCUS ON THE THAMES REGION

This document provides a regional focus on the issues raised by the national review, reflecting current views of water resources in the Thames Region and providing a strategy for the sustainable management of the region's resources to meet future demands to 2021.

The strategy aims to:

- *provide a framework for the future planning and sustainable management of water resources within the Thames Region to meet the reasonable needs of public water supplies, industry and agriculture;*
- *secure proper safeguards for the water environment;*
- *identify opportunities to enhance the water environment, particularly in association with new schemes or the alleviation of low river flows;*
- *respond to the reasonable expectations of social and economic development;*
- *sustain the long-term potential of the natural resource for future use.*

WATER RESOURCES, LAND USE AND CATCHMENT MANAGEMENT PLANNING

The provision of new water resources can have a critical impact on the timing and viability of local authority plans for development. In many cases, even localised developments might require the provision of new sources, new infrastructure and additional sewage treatment capacity to maintain essential services.

Actions:

- *In liaison with Strategic and Local Planning Authorities, the NRA Thames Region will aim to ensure that full account is taken of water resources, supply, sewerage and sewage treatment issues in the location, timing and extent of any new development proposals, particularly in the case of major new developments;*
- *The NRA Thames Region will continue to monitor areas where local and strategic development may be of concern and to provide advice to local planning authorities and developers;*
- *The publication of catchment management plans by the NRA will also provide an important vehicle to influence planning and land use decisions.*

MANAGING FUTURE DEMAND

We make increasing and often conflicting demands on the water environment; none more so than in the Thames Region which supports the demands of 11.5 million people including those in the nation's capital, London. Approximately 80% of the water abstracted in the region is used to meet public water supply demands, the remainder is for direct industrial, agricultural and private use. Managing future demand for water will require a combination of methods including leakage control, pressure reduction, domestic metering and generally improved awareness of, and attention to, water efficiency. The scale and timing of any new water resource development will depend upon progress with, and the success of, this approach.

Three scenarios of future demand for public water supply have been considered:

- **HIGH** - *the growth in demand assuming relatively high rates of growth in domestic and non-domestic consumption an no (or negligible) increase in current demand management activity.*
- **MEDIUM** - *the growth in demand assuming moderate growth in domestic and non-domestic consumption, limited domestic metering and reduced leakage.*
- **LOW** - *the growth in demand assuming moderate growth in domestic consumption, no increase in non-domestic consumption, moderate domestic metering and further reduced leakage.*

These together with those proposed by the water companies, illustrate the potential for reducing growth in demand particularly through controlling losses through leakage. If the range of demand management measures can be successfully implemented within the Region, there will be little need to consider the development of major new strategic water resource schemes within the planning horizon to 2021.

Actions:

- *The NRA Thames Region will require water companies to demonstrate that they are doing all they can towards reducing leakage to economic levels before any new licences are considered;*
- *The NRA Thames Region will continue to work closely with the water companies to monitor and evaluate the companies' demand management programmes in relation to the strategy;*

- *The NRA Thames Region believes there may be a place for selective domestic metering in areas where resources are stressed, and will expect companies to provide an assessment of the economics of metering against new resource development prior to the consideration of any major new abstraction licence;*

- *The NRA Thames Region will promote the efficient use of water in industry, agriculture and in the home.*

- *The NRA Thames Region and Thames Water Utilities should investigate the potential multi-functional benefits of new surface water management techniques, particularly in areas of new development and redevelopment.*

MAKING THE BEST USE OF EXISTING RESOURCES

In addition to managing growth in demand, we need to be sure that the best use is being made of existing resources.

Actions:

- *Abstractors should ensure that the best use is made of existing licensed sources before seeking licences for new schemes. This might include:*

  - *re-allocating or sharing any spare capacity from existing licensed sources;*

  - *new source-works to improve source output, within existing licence and environmental constraints;*

  - *exploring opportunities for more conjunctive use of surface and groundwater resources.*

- *The NRA Thames Region will review under-utilised or disused sources with a view to revoking licences or relicensing acceptable quantities to new uses.*

LOCAL OR 'TACTICAL' RESOURCE DEVELOPMENT OPPORTUNITIES

Local or 'tactical' water resource development may still be required. The strategy identifies a number of potential local schemes - mainly groundwater - for the Middle and Lower Kennet, the Middle Thames area (for transfer upstream), the North Downs, the middle and lower River Colne and opportunities from the Lower Greensand aquifer. In each case, an assessment of impact on the water environment will be required and where necessary an environmentally acceptable flow regime will be established to protect the water environment.

Actions:

- *Potential abstractors will need to undertake test-pumping at each site to establish the likely yield characteristics and any effects on water levels, river flow or water related habitats;*

- *Prior to licensing, the NRA Thames Region will require an environmental assessment to be carried out;*

- *The NRA Thames Region will establish environmentally acceptable flow regimes or other support measures necessary to protect watercourses and water-dependent habitats that may be affected by new abstraction;*

- *Further joint investigations between the NRA Thames Region and water companies will be required to establish the feasibility of these sources, possible operational arrangements, opportunities for conjunctive management of sources and timing of need;*
- *The NRA Thames Region should review the possibilities of strategic or local use of the West Berkshire Groundwater Scheme to provide river support for additional abstraction (if required) during drought periods for the Newbury and Reading areas;*
- *Thames Water Utilities should aim to secure supply for the Reading area by investigation of an emergency source (bankside storage or groundwater abstraction). Currently, Reading is reliant on unprotected surface water abstraction from the River Kennet;*
- *The NRA Thames Region and Thames Water Utilities should investigate the longer-term opportunities for artificial recharge of the confined aquifer to the south-west of Reading.*

THE NEED FOR STRATEGIC SCHEME DEVELOPMENTS

Some strategic schemes are already being developed or investigated within the Region. These include artificial recharge schemes in North and South London and possible use of the rising groundwater levels under Central London.

In the longer term, if growth in demand cannot be successfully managed, the development of major new strategic water resource schemes may be required for the region to meet future demands for water, particularly in the Greater London and Upper Thames areas. **A key issue for the Region is to establish a firm position on the choice between the leading scheme options. These are:**

- a possible new reservoir in south-west Oxfordshire;
- a possible transfer from the River Severn to the River Thames and the possible requirement to develop additional storage capacity in Wales, and associated river regulation of the River Severn;
- a possible transfer into the east of the Region supported by new reservoir storage in the Anglian Region;
- the potential for further re-use of treated sewage effluent (either as 'grey water' for lower grade uses or higher grade treated effluent for use in conjunction with existing public water supplies), particularly in the London area.

Each option will need to be considered against the principal sustainability criteria: environmental, social and economic, in addition to further considerations of engineering feasibility.

There are a number of environmental concerns regarding each of the main options, principally related to the potential impacts of flow and water quality changes on the environmental quality of the Region's rivers. The Region has already commenced investigations to establish the baseline environmental conditions of the River Thames in those areas potentially affected by the development of these schemes, and the range of impacts, including benefits, that may result from their development and operation.

Actions:

- *South West Oxfordshire Reservoir Proposal:*
  - *The NRA Thames Region plans to continue baseline investigations to establish habitat, and water quality relationships and any constraints on water resource operations in order to protect the ecology and form of the River Thames;*
  - *Thames Water Utilities will need to address a number of key environmental issues before any formal promotion of this scheme, including the potential environmental impacts of construction of a resevoir on the proposed site and the operational regimes required to manage reservoir water quality, abstraction and augmentation in order to protect or improve the River Thames.*
- *A Severn to Thames Transfer:*
  - *The NRA Thames Region has identified a number of further investigations to establish the environmental feasibility of this scheme. These include investigations of the physical, chemical and ecological implications of transferring and mixing water from the River Severn into the River Thames, particularly at times of otherwise low flow;*
  - *Further joint work by the NRA Thames Region and water companies will be needed to establish the infrastructure and water treatment implications, costs and feasibility of an inter-basin transfer of different river water qualities;*
  - *In the longer term if the environmental feasibility of transfer schemes can be adequately proved, a full environmental impact assessment of supporting reservoir storage and river regulation on the Wye and/or Severn will be required.*
- *Transfers from the Anglian Region:*
  - *Further investigations of new schemes or of possible re-allocation of existing resources may be required in association with new developments to the east of London, for example the East Thames Corridor;*
  - *In the longer term, the development of new schemes in the Anglian Region may provide opportunities to review existing exports of resources from the Thames Region. However, a full financial, engineering and environmental appraisal will need to be undertaken with the cooperation of those water companies concerned.*
- *Re-use of Water:*
  - *A number of potential opportunities for the re-use of treated sewage effluent have been identified to date. The NRA believes that current research on effluent quality and treatment requirements should be re-appraised so that a firm position can be established on the potential for further indirect re-use of effluent as a resource;*
  - *Uses of water of a lower quality should also be explored jointly by Thames Water Utilities and NRA Thames Region as a potential means of releasing potable quality resources for more essential uses. These may include:*
    - *more intensive recycling by industry and power generation;*
    - *'grey water' use for toilet flushing or outside uses (car washes, parks, sports grounds and irrigation).*

PLANNING FOR UNCERTAINTY

In providing a framework for the future planning and sustainable management of water resources within the Region, the NRA recognises that the strategy must be flexible in order to respond to risks and uncertainty about changes in demand, available resources and environmental processes which may affect the need and timing of new resource development. The main areas of uncertainty are:

- the success of demand management and extent of savings in demand that may be achieved and sustained, recognising the economic limits of leakage control or domestic metering;
- the effects of land use planning, development and future economic activity on demand for water within the Region;
- the reassessment of reliable yields following future drought events;
- changes which may occur in natural groundwater and surface water quality and which may reduce the yield available from abstractions either on a permanent or temporary basis;
- the potential effects of climate change on demand and on available water resources;
- the environmental acceptability of each of the options considered.

Actions:

- *Given the long lead time taken to promote and develop new strategic water resource schemes, the NRA Thames Region will initiate now investigations into the key features of the strategic options;*
- *Water quality, particularly of groundwater, remains a key concern for the public water supply companies. The NRA Thames Region will continue to work closely with the water companies to monitor and minimise the impacts of pollutants on groundwater or surface water sources.*

THE WAY FORWARD

The successful implementation of demand management strategies and the promotion of water efficiency are priority elements of this strategy for the sustainable management of the Region's water resources. The extent to which leakage from mains can be controlled or growth in demand 'managed' is critical to the need and timing of any further water resource development.

Recognising the uncertainties of need for new resources, the time needed to promote any major new scheme and the potential environmental impacts, a number of further investigations have been identified to establish a position on each of the key water resource development options. The NRA Thames Region is committed to completing the major part of its strategic options investigations over the next five years. During this time and in cooperation with others, we intend:

- to identify further opportunities for the sustainable management of water resources;
- to monitor and review the extent to which demand management measures can curtail the need for new water resource developments for public water supply;
- to continue challenging the water companies to improve the efficiency of their distribution systems within acceptable economic and practical limits;
- to establish a strategy to promote water efficiency and raise awareness of water resources and issues affecting the water environment of the Thames Region;
- to monitor and review the need for additional water resources to meet non-public water supply demands;
- to establish the environmental acceptability, benefits or risks of each of the strategic and local water resource development options;
- to establish the Region's preferred strategy for long-term water resource scheme development should any new schemes be required.

This strategy will be reviewed and built upon as new information becomes available, in order to ensure the security of water supplies and a healthy, sustainable water environment for the Thames Region.

SECTION 1

INTRODUCTION

1 INTRODUCTION

Water, so often taken for granted, is arguably our most valuable resource. Although in England and Wales we have enough water in general to meet our needs, areas of high rainfall rarely coincide with areas of high population. The south east of England, subject to high population density, experiences rainfall below the national average.

In "Water Resources Development Strategy - A Discussion Document" (1992) the NRA reported on the national balance of the demand and availability of water resources and the need for new schemes to be developed to meet increasing demands within the south-east of England. More recently (March 1994), the NRA's "Water : Nature's Precious Resource" has identified a number of key issues which include:

- *in developing a sustainable water resources strategy, the NRA's main concern is for environmental sustainability; this implies that there should be no long-term systematic deterioration in the water environment owing to water resource development or water use; where in doubt a precautionary approach should be adopted;*
- *the strong possibility that demands can be managed to avoid the need for large scale water resource developments over the next 20 years or so;*
- *water companies must be required to achieve economic levels of leakage and metering before new abstraction licences are granted for strategic developments;*
- *the NRA must take a proactive role in promoting water use efficiency in industry, commerce, agriculture and the home;*
- *environmental considerations will be crucial in the consideration of any scheme.*

Regionally the following issues are of prime importance:

- *the need to promote water efficiency by encouraging demand management and effective use of existing resources;*
- *the need for a thorough comparison of environmental, social, and economic issues surrounding the construction and operation of reservoir development and inter-regional transfer schemes for the Region;*
- *the need to investigate thoroughly the leading development options for the Thames Region bearing in mind the lead time for promotion of large schemes and the need for a flexible strategy;*
- *the probable economic advantage of inter-regional transfer schemes over local reservoir developments compared with the potential environmental risks of inter-regional transfers to the Region's rivers.*

In the Thames Region, we face an intensity of challenges which is unique in the UK, if sustainable development is to be achieved. In supporting a population of 11.5 million, we use a greater proportion of the effective rainfall than any other region in the country. Water resources are sustained by a significant amount of re-use, taking advantage of the return of treated effluent from several hundred sewage treatment works and the natural purification capacity of our rivers. At times of very low flow, treated effluent can account for up to 70% of the resource available locally.

Drought and low flow rivers have been high on the agenda since the formation of the NRA in 1989. Most people in the region were affected by supply restrictions of varying severity as a result of the drought between 1989 and 1992. In addition, of the twenty nationally identified priority low flow rivers, five are within the Thames Region and another, the River Darent, is closely linked with the London supply system.

Against a background of steadily increasing demands over the last thirty years and potentially continued increasing demand into the future, a strategy for the sustainable management of water resources must be in place if the NRA are to manage and protect water resources effectively for generations to come.

1.1 OUR VISION

The NRA will seek to promote the sustainable management of water resources through a process of communication; sharing views and ownership of issues with other stakeholders. Future options for water resource developments will be appraised, based on the best scientific knowledge, against the principles and criteria for sustainability and in the spirit of partnership, in open forums. This process will be set in the context of management of the total water environment through the NRA's catchment management plans, the development plans of local authorities and the asset management plans of water utilities. As Guardians of the Water Environment the NRA Thames Region will therefore adopt a stance based on:

- *the conservation and enhancement of the water environment;*
- *the identification of the essential needs of the aquatic ecosystem;*

  and, therefore:

- *the capacity for use over and above that required to sustain the natural environment and existing uses.*

It is believed that only through adoption of this approach can water supplies be secured without compromising the essential needs of the water environment or those of future generations.

This document provides a regional focus on the issues raised within the NRA's "Water : Nature's Precious Resource". In the spirit of partnership which is central to sustainability, we are issuing it to the stakeholders - major abstractors, organisations representing water users, planning authorities, regulatory and advisory agencies and others with legitimate interest in the outcome. The document reflects current views of water resources in the Thames Region and will be reviewed in the light of future demand forecasts and resource investigations. In sharing our vision, we seek your views on all the issues raised.

SECTION 2

WATER RESOURCES IN THE THAMES REGION

2 WATER RESOURCES IN THE THAMES REGION

2.1 THE THAMES REGION

The Thames Region is one of the most intensively used water resource systems in the world. It is unique in the context of England and Wales in that it is dependent in the main on only one river - the River Thames. It supports a population of 11.5 million people and meets an average demand for public water supply of approximately 3800 Ml/d. Some 56% of this total demand is met by abstractions from the River Thames, the majority of which are between Windsor and Teddington but there are significant abstractions at Farmoor near Oxford and also on the Lower River Lee.

The River is also used for a variety of other purposes including the transfer and natural treatment of treated (sewage) effluents which, on average, make up about 12% of the total abstracted for supply purposes. River management decisions taken at one point can have significant implications for downstream uses. This is especially true in managing water resources. Water that is abstracted upstream is returned for subsequent re-use downstream. This practice, requiring substantial efforts in effluent treatment, maintains the resources of the region. The exception is London; water abstracted for supply is in the main returned as treated effluent to the Thames Tideway.

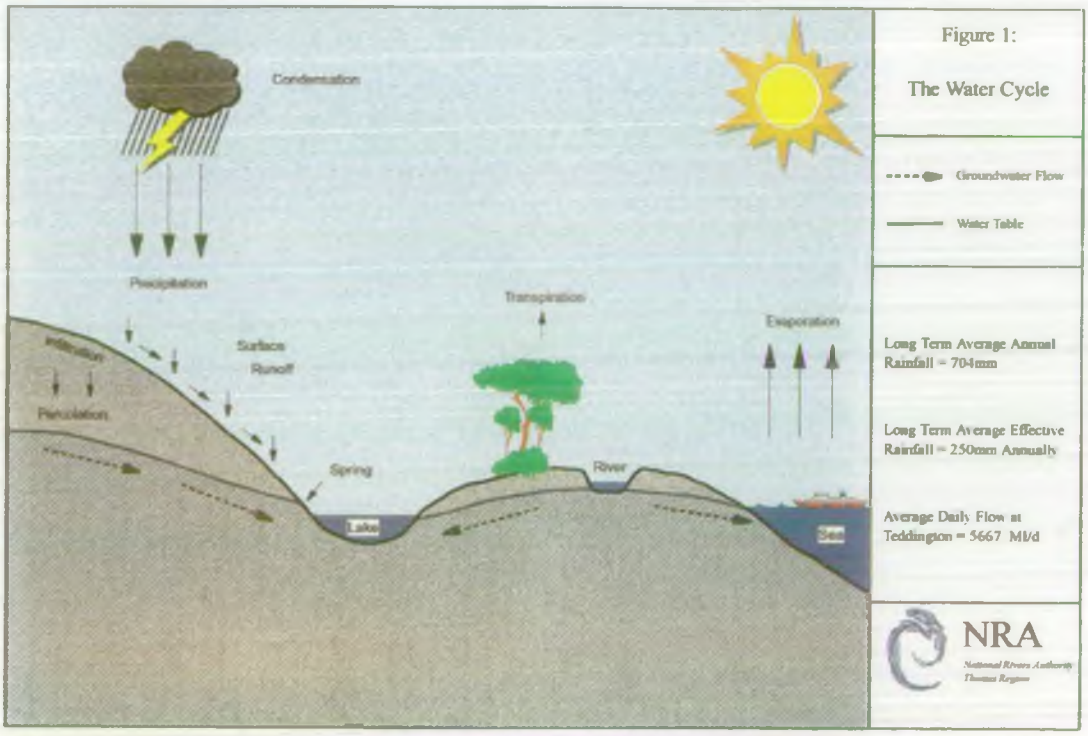
2.2 HYDROLOGY AND GEOLOGY - THE NATURAL CYCLE

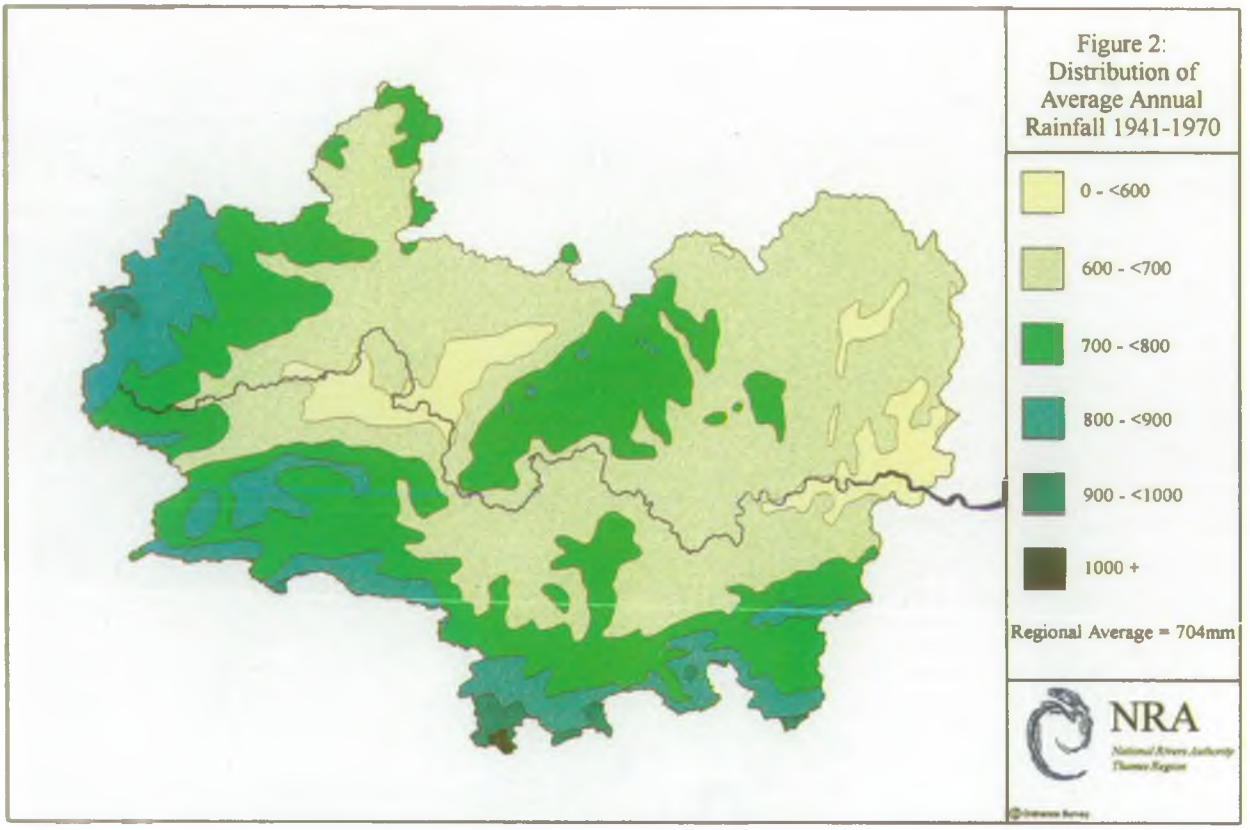
Figure 1 shows the hydrological cycle along with some typical data for the Thames Region.

Average annual rainfall over the Thames Region (based on the standard 1941-70 period) is 704 mm but it is not distributed uniformly (Figure 2).

Not all rainfall is available for use, most is evaporated. It is generally only during the winter period, when temperatures are low and plant growth is dormant, that soils can become saturated and allow rainfall to percolate to underground strata (recharge) or to run-off in significant quantities to rivers.

The effective annual rainfall over the region that is available to sustain flow in rivers and replenish natural underground storage is approximately 250 mm (Figure 3). Under drought conditions this figure can be as low as 100 mm, emphasising the need for the precautionary approach when decisions about abstractions are being made.





2.2.1 AQUIFERS AND RIVERS

A substantial area of the Region's geology is composed of permeable water-bearing strata or aquifers. The major aquifers are the Chalk, Jurassic (Oolitic) Limestone, Lower Greensand and river gravels (Figure 4). Of the water supplied to the 11.5 million people in the Thames Region, about 43% is derived from groundwater.

Aquifers are replenished mainly in winter where they are exposed at the surface. Water percolates down to the 'water table' below which the rock is fully saturated. Large volumes of water are held in storage in the fissures and pores in the rock. Extensive areas of aquifer are covered by impermeable strata and are said to be "confined". These areas are recharged from the unconfined areas by movement through the rock, not by direct percolation.

Groundwater contributes to river flow throughout the year as a baseflow and is particularly important in keeping rivers flowing through dry periods. In some cases the headwaters of rivers naturally dry progressively through the summer as the water table falls; such rivers are often known as bournes or winterbournes to indicate that their upper reaches flow for only part of the year.

Rivers which drain the impervious clay areas are much quicker to rise than those fed by groundwater, but are quicker to fall once rainfall ceases because they are not sustained by baseflow; this response can be exacerbated or lessened by the surface water management applied.

The location and type of water resource development can be strongly influenced by the characteristic behaviour of the aquifers and rivers.

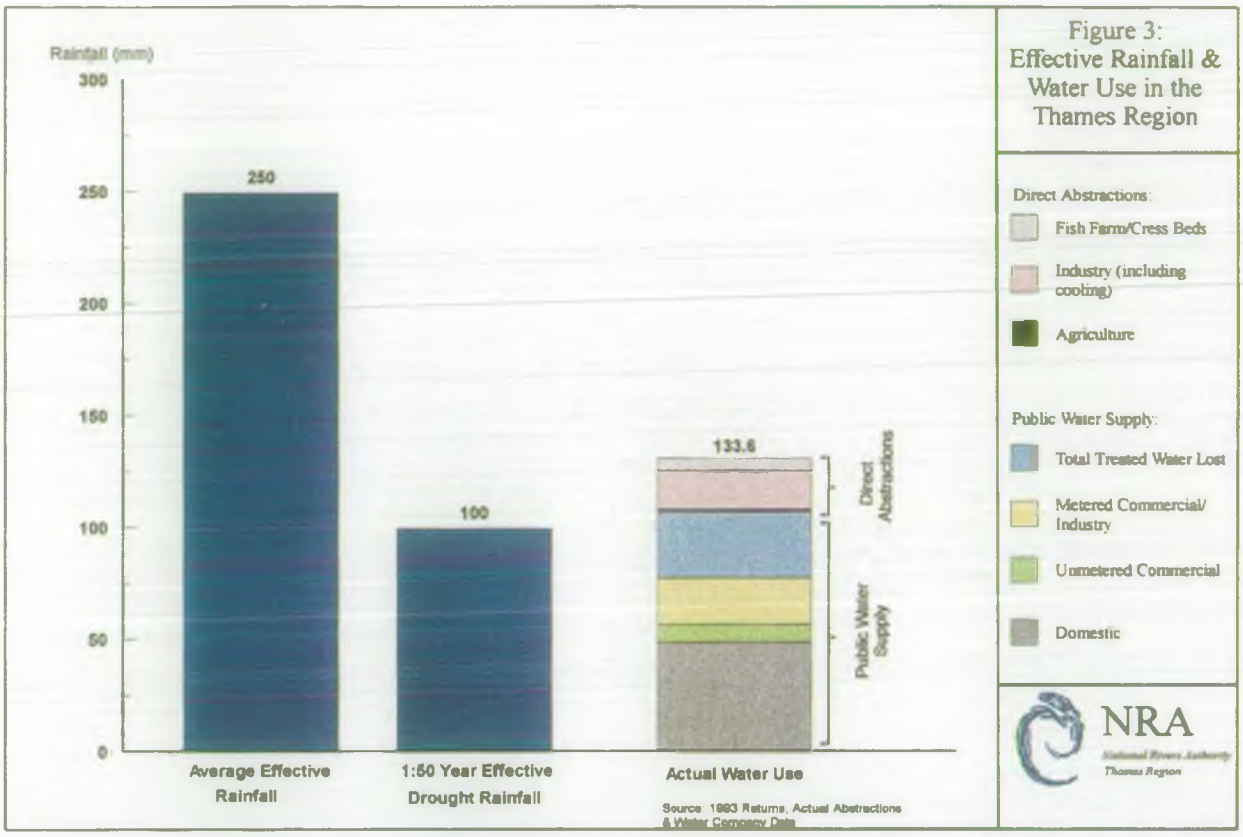


Figure 3: Effective Rainfall & Water Use in the Thames Region

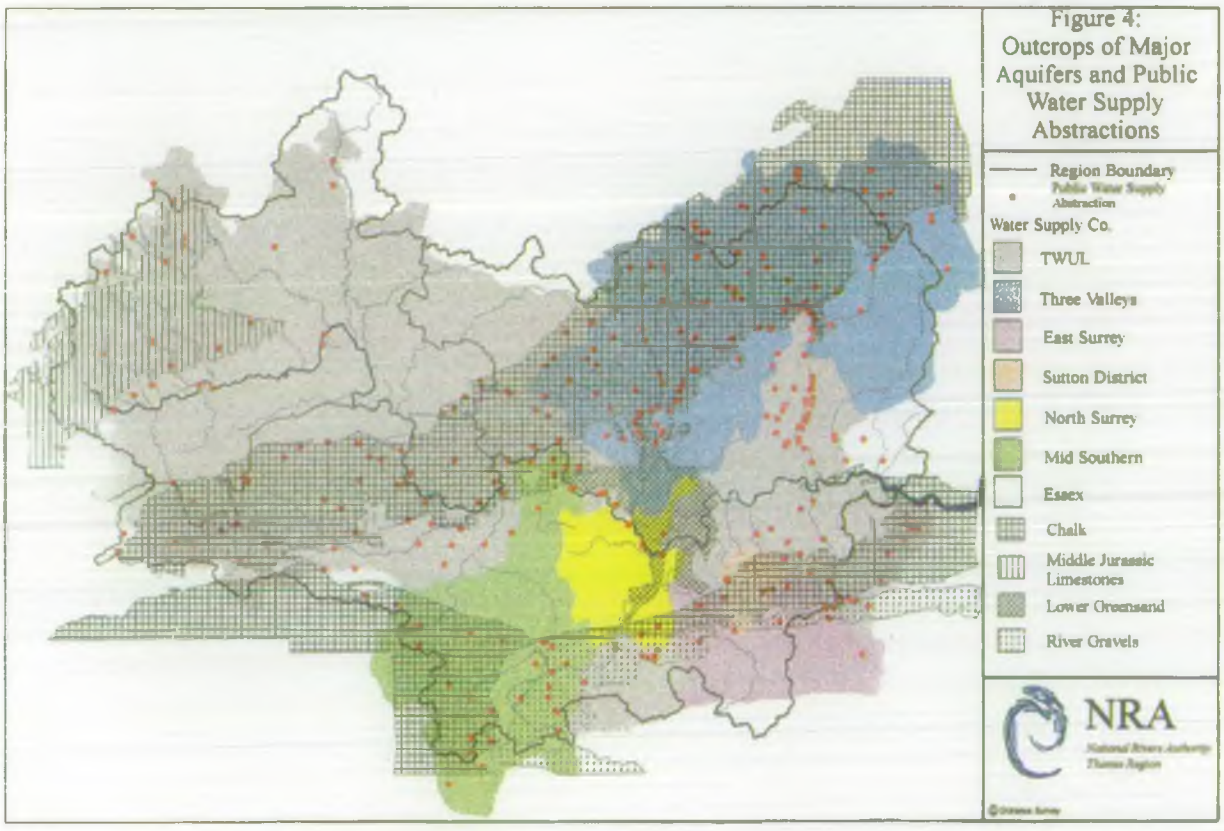


Figure 4: Outcrops of Major Aquifers and Public Water Supply Abstractions

2.3 DROUGHT

Droughts are a natural phenomenon caused by long periods of low rainfall. The south-east of England is likely to become increasingly vulnerable to droughts because of heavy use of resources associated with increasing demand. The recent four-year drought between 1989 and 1992 highlighted this point. Historic records suggest that there have only been four other similar periods since the Middle Ages, the last being around the turn of the century. More recently we have experienced shorter and in some cases more intensive drought periods within the Thames Region; for example during 1921/22, 1933/34, 1943/44, and 1975/76.

The pattern and duration of rainfall determines how surface water and groundwater sources will respond during a drought. During the 1975/76 drought, recharge of groundwater was low because of the very dry winter of 1975/1976. Consequently, during the hot, dry summer of 1976, river baseflow was very low. With little summer rainfall, this led to very low flows in the main River Thames and to many of the smaller tributaries drying up. Both groundwater and surface water resources were severely affected across the region.

During the 1989/92 drought, although each individual year was not as severe as the 1975/76 drought, the cumulative effect of prolonged low rainfall led to the progressive reduction of groundwater resources to historic minima (Figure 5) and to very low flows throughout many of the region's rivers. However, light rainfall in spring and summer during most years boosted river flows and enabled reservoir storage in the region to be maintained, limiting the potential impact of the drought to those areas mainly dependent on groundwater.

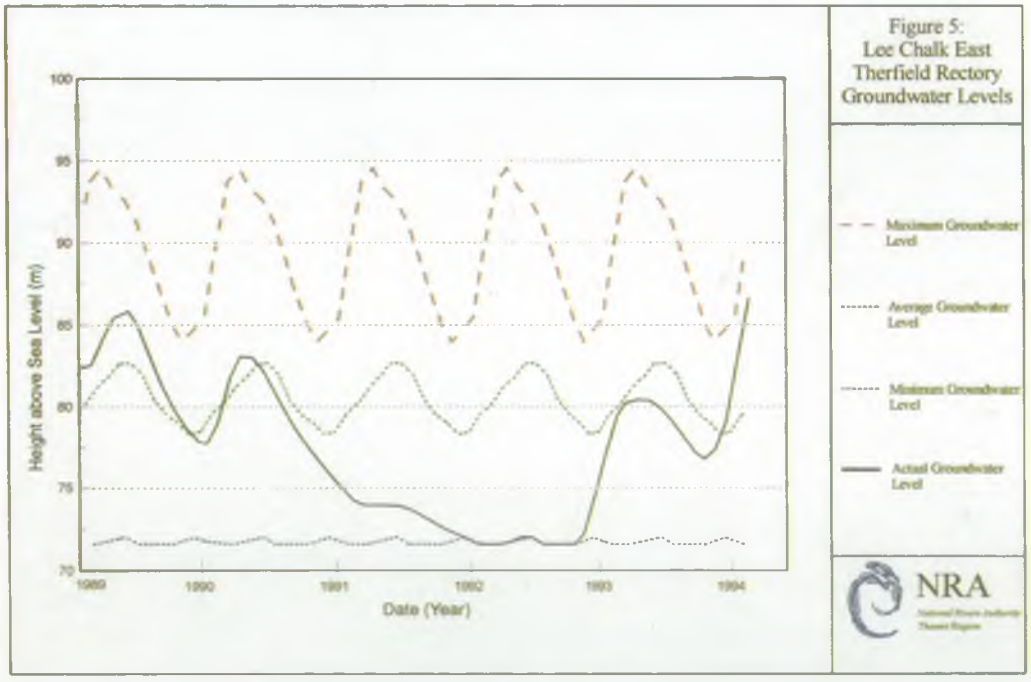


Figure 5:
Lee Chalk East
Therfield Rectory
Groundwater Levels

In most of the region, water supply systems have been developed over the years to maintain water supplies during all but the most severe droughts. In a number of cases this is achieved through effective management of reservoirs, river and groundwater abstractions. However, many other abstractors may be affected by limits on their licensed operations relating to local river flows or groundwater levels.

Planning to meet all water use throughout the worst conceivable drought would be unrealistic; the costs and potential environmental consequences would not be acceptable to developers, regulators or customers. During severe drought, therefore, there has to be a balance between maintaining environmental requirements, maintaining essential supplies and the imposition of restrictions on some uses.

2.4 PUBLIC WATER SUPPLY RELIABILITY AND LEVELS OF SERVICE

Water resources from individual sources are assessed in terms of a "safe" or reliable yield. This is the level of abstraction (within the limits of the abstraction licence) that can be sustained during dry periods. In addition, target levels of service, (as proposed by the Office of Water Services (OFWAT)), relating to restrictions on water use, can also be taken into account. These are defined by OFWAT as:

- *Initial publicity campaign and hosepipe bans on average not more than once in 10 years;*
- *Need for voluntary restrictions, pressure reduction plus extensive publicity on average not more than once in 20 years;*
- *Implementation of Drought Orders on average not more than once in 50 years;*
- *Risk of rota cuts or use of stand pipes on average not more than once in 100 years.*

In order to determine current available resources within a company area it is essential to understand how water could be used and managed in a serious drought. Despite the normally available yield there may be operational constraints on the use of individual sources during drought periods.

2.5 WHO USES THE WATER?

The total quantity of water abstracted in the Thames Region in 1993 from non-tidal rivers, reservoirs and underground sources was approximately 4750 Ml/d (equivalent to 133 mm of rainfall across the region). Water use in the region (Figure 3) can exceed the amount of water naturally available during drought periods. There is however a considerable proportion of water re-use in the region, which the figures do not take into account.

By far the majority of water used in the region is for public water supply (78.7%), the remainder being used for agriculture, including spray irrigation (8.8%) and industry, including Power Generation (12.5%) (Figure 6).

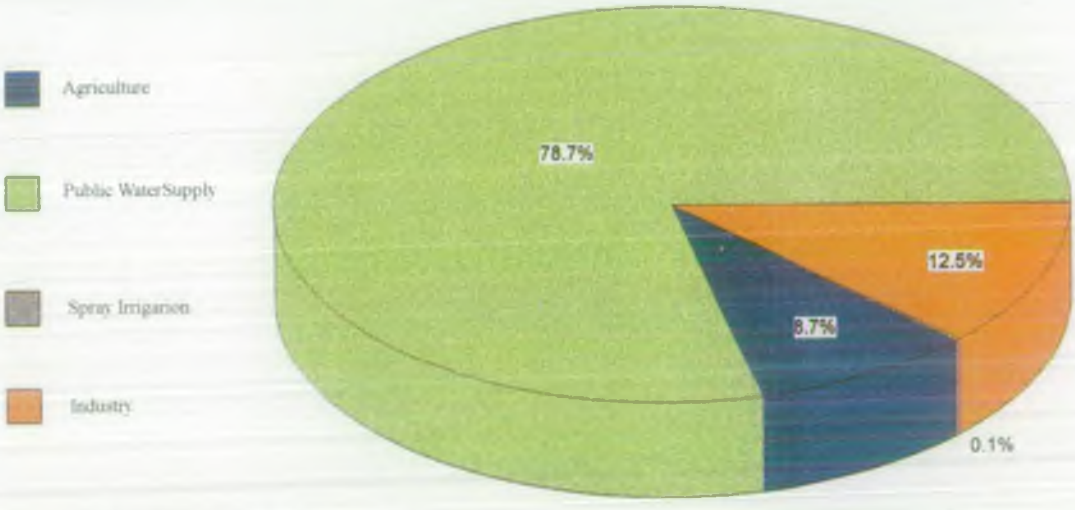


Figure 6: Water Use in the Thames Region

From 1993 Actual Abstractions

2.5.1 AGRICULTURE

Agricultural use within the region, abstracted mainly from private boreholes and springs as opposed to mains water, accounts for only a small percentage of the water used. There are also some river abstractions mainly for fish farming - most of which is returned nearby. During 1993 only 0.1% of the total water abstracted was used for spray irrigation. This reflects the fact that the summer of 1993 was relatively wet; in previous years spray irrigation still only accounted for 0.3 % of the total water abstracted.

2.5.2 INDUSTRY

There is a wide range of industrial use from private abstractions within the region, covering sand and gravel washing, direct manufacturing industries, offices and other commercial buildings, and brewing. There is one large power station on the non-tidal Thames at Didcot, which abstracts water for cooling - most of it which is returned to the river. The power stations on the tidal river which also abstract water for cooling have no significant implications for freshwater resource management.

2.5.3 PUBLIC WATER SUPPLY

Public water supply is used to provide treated water to domestic households, commercial buildings and industry. Most of it is provided by the statutory water companies though a small percentage (0.9%) is also supplied by private abstractors. There are six statutory companies in total (Table 1), by far the largest being Thames Water Utilities supplying 68.9% of the total water used for public water supply in the region. Regionally 56% of public water supply comes from surface resources (Figure 7) while the division between surface and groundwater for individual companies is shown in Figure 8.

TABLE 1 : WATER COMPANY SUPPLY AREAS, POPULATION AND DISTRIBUTION INPUT

WATER COMPANY	SUPPLY AREA	POPULATION ('000s)	DISTRIBUTION INPUT (Ml/d)
SUTTON DISTRICT WATER Plc	North East Surrey and Southern London Boroughs	280	63
EAST SURREY WATER Plc	East Surrey, Croydon and West Sussex	328	100
NORTH SURREY WATER Ltd	North Surrey	468	133
MID SOUTHERN WATER Plc	Hampshire, Berkshire and West Surrey	719	216
THREE VALLEYS WATER SERVICES Plc	Hertfordshire, Bedfordshire, Buckinghamshire and North-West London Boroughs	2344	670
THAMES WATER UTILITIES Ltd	London Boroughs, Kent, Gloucestershire, Oxfordshire Buckinghamshire, Wiltshire, Berkshire and South-West Surrey	7286	2613

Source : OFWAT (1993) "The cost of water delivered and collected 1992-1993"

Note : Essex and Suffolk Water demands are addressed within the NRA Anglian Water Resource strategy

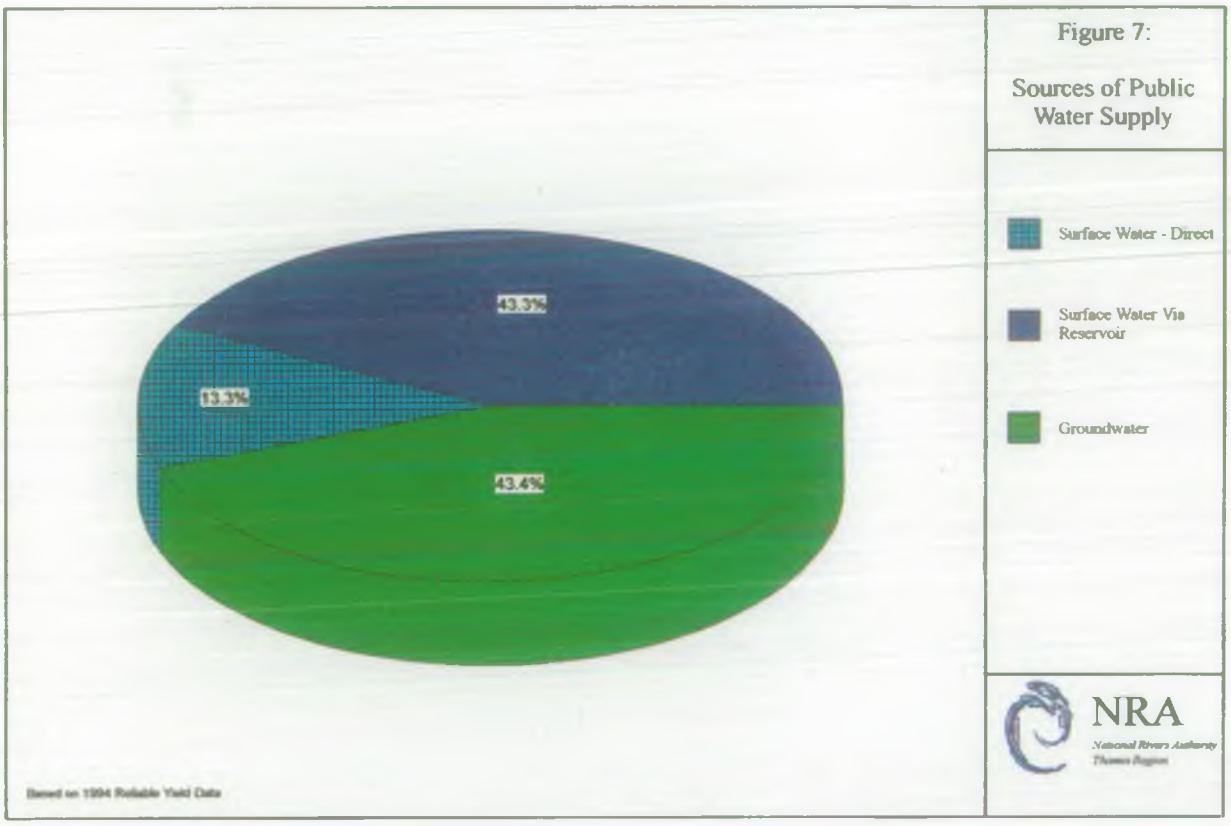


Figure 7:

Sources of Public Water Supply

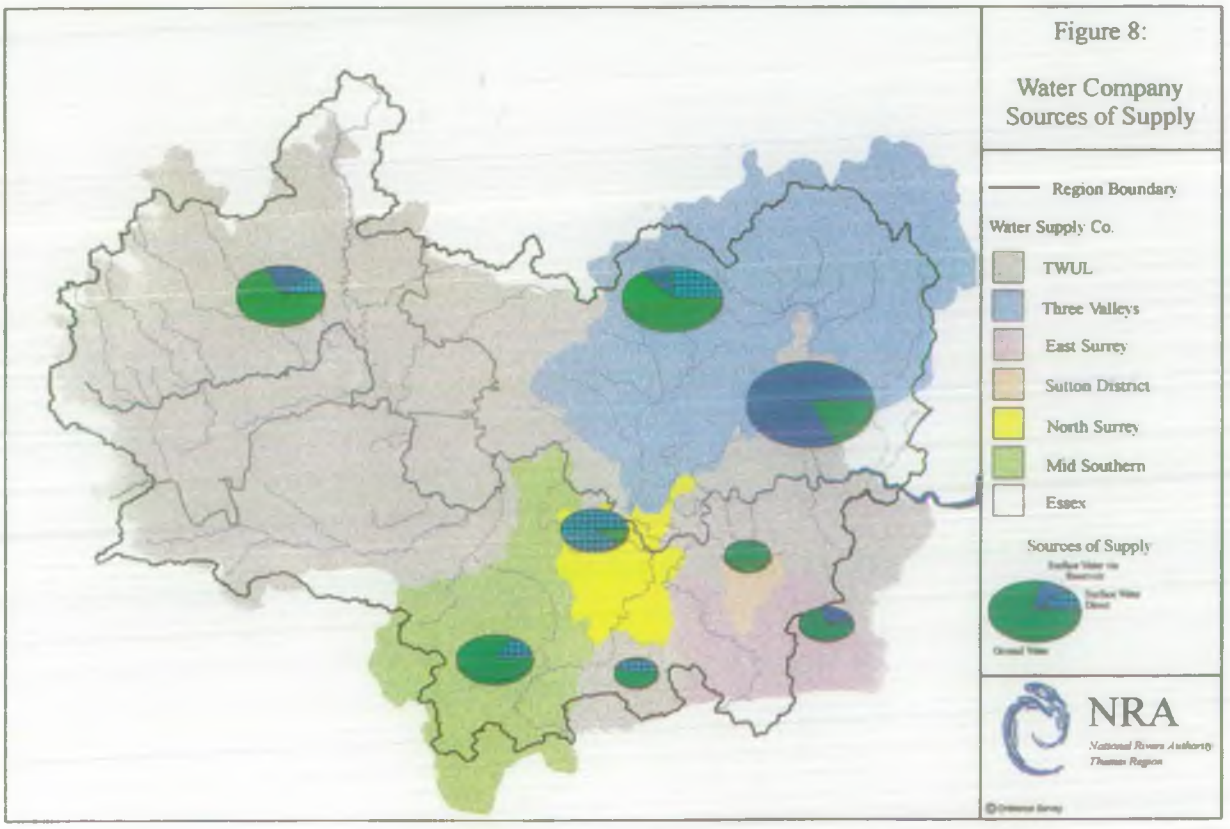


Figure 8:

Water Company Sources of Supply

2.6 PRESENT WATER USE

Public water supply can be broadly divided into 5 main demand components:

- *unmeasured domestic demand;*
- *measured domestic demand;*
- *measured industrial/commercial demand;*
- *unmeasured industrial/commercial demand;*
- *total treated water losses (TTWL).*

In the home, on average we use approximately 150 litres each per day, the majority of which is used to flush toilets, take baths and/or showers and use the washing machine (Figure 9). Only a small proportion of our water use annually is used for garden watering, although in the summer, especially under hot dry conditions, this can take up a significant proportion of daily domestic water use.

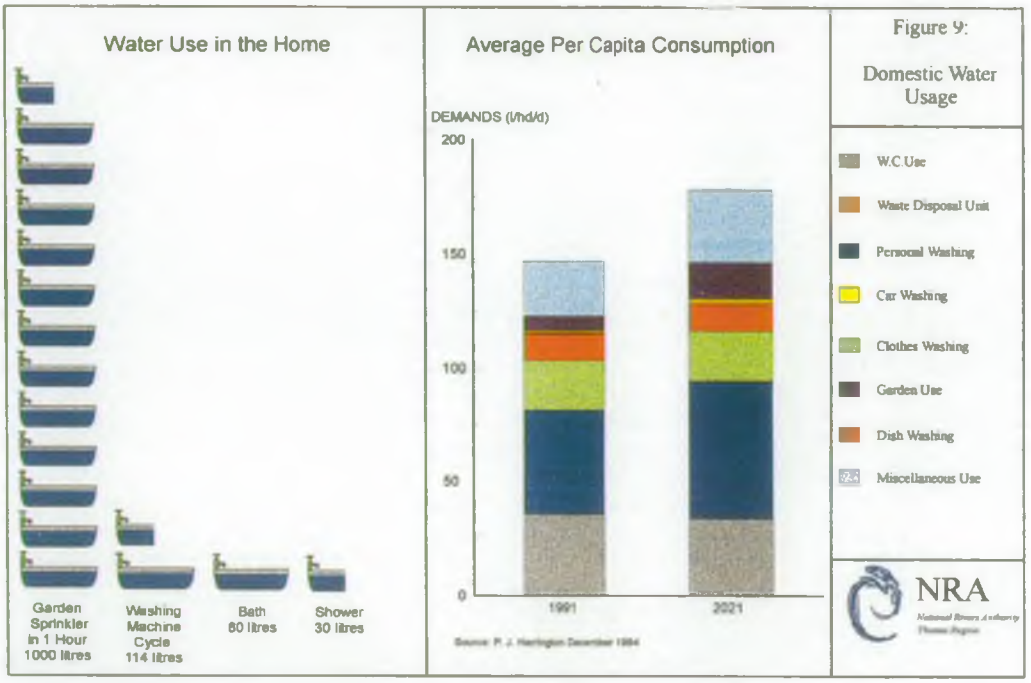


Figure 9:

Domestic Water Usage

Industrial and commercial demands (most of which are metered) account for approximately a quarter of the total water put into supply.

A significant proportion of water abstracted for public water supply is lost through leakage from distribution and trunk mains systems, and supply pipes on customer premises. Although total treated water losses have been reduced significantly over recent years, losses still account for just over a quarter of the total water put into supply.

SECTION 3

SAFEGUARDING THE WATER ENVIRONMENT

3 SAFEGUARDING THE WATER ENVIRONMENT

3.1 INTRODUCTION

We make increasing - and often conflicting - demands on the water environment. The main aim for the NRA in relation to the management of water resources, therefore, is to achieve the right balance between the needs of the environment and those of abstractors. The challenge to the Region is to plan for the sustainable management of water resources, ensuring adequate safeguards for the water environment and securing proper use of resources through the NRA's roles in abstraction licensing and water quality management.

3.2 SUSTAINING OUR RESOURCES

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs"

The Brundtland Report (1987)

Sustainability is a relatively new term in planners' vocabulary, especially water resource planners. In 1992 the concept of sustainability was brought to the fore with the 'Earth Summit' - United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. At this conference the UK government signed up to Agenda 21 which sets out a global initiative for sustainable development and has more recently published its views in "Sustainable Development : The UK Strategy" (HMSO,1994).

Chapter 18 of Agenda 21 refers specifically to freshwater resources with an overall objective "...to satisfy the freshwater needs of all countries for their sustainable development", but also recognises that "freshwater management must be holistic ... and based on a balanced consideration of the needs of people and the environment".

Sustainable development is a global debate covering social, economic and environmental issues going far beyond the scope of this document. In acknowledging changing perceptions, an attempt has been made to incorporate some of the new thinking within this document.

Undoubtedly, the capacity of the water environment to provide secure supplies of potable water is fundamental to sustainable development. The challenge is to review our approach and to recognise any elements of 'compromise' in our decision-making which may reduce the ability of future generations to meet their needs.

3.3 IMPLEMENTING SUSTAINABLE DEVELOPMENT

Sustainable development should in principle be achievable by the application of commonsense and good stewardship of resources. In practice, decisions would frequently be based on value judgements which may be difficult to justify. Sustainable development in the fullest sense, however, relies on political decisions taken at national and international levels.

In terms of water resources at the region or catchment scale, it may be more appropriate to consider the sustainable management of resources within an overall political and economic framework. This emphasises the need for strategic planning within the region to manage the use, development, protection and improvement of the water environment in order:

- *to meet the reasonable needs of social and economic development;*
- *to avoid, or mitigate, any potential impacts on the water environment;*
- *to sustain the long-term potential of the natural resource for future use;*
- *to safeguard the essential requirements of river corridor wildlife.*

The NRA's duty in relation to water resources is to secure their proper use. This may be re-interpreted as:

- *managing water resources to achieve and maintain the sustainable balance between the needs of the environment and those of abstractors.*

To achieve this aim and develop and promote the concept of sustainable management the NRA will:

- *review existing levels of abstraction and seek reductions to restore a healthy water environment;*
- *seek better use of existing resources by:*
  - *making use of any under-utilised but acceptable source;*
  - *encouraging demand management initiatives by the water companies;*
  - *promoting opportunities for water efficiencies in the home, by agriculture and by industry;*
- *grant abstraction licences in terms which protect the environment, the rights of existing licence holders and safeguard existing users and protect the interests of other potential users of new water resource schemes;*
- *take a precautionary approach where the environmental impact of abstraction or water resource development is uncertain;*
- *ensure that adequate operating agreements are in place to secure the proper use of water resource schemes and to provide adequate environmental safeguards;*
- *ensure that adequate resources are available and operating agreements are in place to balance the needs of water supplies and the environment during periods of drought;*
- *support activities which seek to conserve and enhance the water environment.*

A key step towards achieving sustainable management of the water environment will be the development of our scientific knowledge and procedures to determine environmentally acceptable flow regimes to protect the aquatic environment. Where adequate information is not available the NRA will take a precautionary approach.

3.4 ALLEVIATION OF LOW FLOWS (ALF)

Within the Thames Region of the National Rivers Authority there are five rivers which are formally recognised as having been severely degraded by the effects of groundwater abstraction for public supply (Figure 10). These are the Rivers Ver, Misbourne, Pang, Wey (at Alton) and the Letcombe Brook.

Work on the design and implementation of schemes to improve the flow and ecology of these rivers is continuing, in cooperation with relevant water companies, and good progress is being made. On the River Ver, abstractions from the groundwater source at Friars Wash in the upper catchment have been substantially reduced and arrangements made to bring in water from an alternative source outside the catchment area.

An interim solution for the River Pang has been negotiated with Thames Water Utilities who have agreed to reduce the amount of abstraction from Compton pumping station, with alternative supplies obtained from the major new groundwater source at Gatehampton. The NRA will be seeking to formalise these arrangements. For the Letcombe Brook, part of the

existing West Berkshire Groundwater Scheme has been modified to allow better control of water discharged to the headwaters of the Brook. Peasibility studies and design works are being completed for the River Misbourne and the River Wey at Alton. Progress here will depend on agreement as to appropriate sources of funding.

The River Darent, within the Southern Region of the National Rivers Authority, is also seriously depleted by abstraction from groundwater. The solution to this problem will rely, in part, on replacing water currently exported from the Darent catchment to South-East London with water transferred from the main London sources.

An important part of the initiative for alleviation of low flows is the monitoring of the recovery of the ecosystems of the rivers once an alleviation scheme is in place. Consequently an intensive programme of environmental monitoring has been initiated on the Rivers Ver and Pang. The knowledge gained from this monitoring will be used in the design of future alleviation schemes.

There are concerns about low flows in a number of other small rivers and preliminary assessments of the severity of these conditions have been made for the Rivers Gade, Bulbourne, Cherwell, Beane, Mimram, Wye, Churn, Ampney Brook, Whitewater and the York Stream. Subject to the results of these studies, further detailed investigations of conditions, causes and options for alleviation may follow.

Initial results suggest that more detailed assessments of the River Beane should be carried out. These are programmed for 1994 to 1996.

Figure 10:
Low Flow Rivers

3.5 FURTHER ENVIRONMENTAL REDRESS

A permanent solution for the alleviation of flows in the River Pang, and solutions for the other possible cases in the upper catchment (Churn, Ampney Brook and Cherwell) can only be achieved realistically by the allocation, for environmental needs, of a portion of present or future water resource development in that area. 'Conjunctive' use or management of water resources can improve low river flows significantly in some circumstances. This is achieved by using 'up-river' groundwater abstractions when river flows or groundwater levels are high, but supplementing resources by pumping from reservoir storage or new strategic water resource schemes when river flows and groundwater levels are low.

There are a number of abstractions in the region which might benefit from conjunctive management in order to protect the river environment locally. The scope for conjunctive use will depend on either the release of existing resources (eg. by demand management) or the provision of new strategic resources. Bringing on major new schemes will be costly and will require careful assessment against broad sustainability criteria before embarking on any firm strategy.

3.6 GROUNDWATER PROTECTION POLICY

The management and protection of groundwater is of paramount importance to the security of water resources for supply. There are several hundred private, domestic and commercial boreholes in daily use in the region, over 300 of which are operated by the water companies for public supplies. Groundwater also provides a considerable baseflow to many of the region's rivers. Contamination of groundwater may render some sources unusable, bringing forward the need to develop major new resources unless appropriate water treatment technology can be made available. It is clearly of great importance to ensure that groundwater, whilst usually of a very high quality, is afforded adequate protection from pollution.

The NRA has recently published the "Policy and Practice for the Protection of Groundwater", which covers the following key policy areas:

- *Control of groundwater abstractions eg to avoid over-abstraction and effects on river flows;*
- *Physical disturbance of aquifers and groundwater flows eg quarrying;*
- *Waste disposal to land eg landfill sites;*
- *Contaminated land eg redevelopment of old gas works sites;*
- *Disposal of liquid effluents, sludges and slurries to land eg sewage sludge irrigated to agricultural land;*
- *Discharges to underground strata eg consents will not be issued for direct discharge into groundwater;*
- *Diffuse pollution of groundwater eg nitrate, pesticides, leakage from sewers;*
- *Additional activities or developments which pose a threat to groundwater quality.*

The Policy provides guidance on practices which are not acceptable or need to be restricted because of the risk posed to groundwater resources. Restrictions may be applied depending on the importance of the aquifer as a resource. Additionally, specific protection zones are being defined around each source for which stringent restrictions may be necessary. The size and shape of zones will vary according to the local hydrogeology, rainfall and the quantity of water abstracted. The zones are not statutory and controls will be achieved by influencing organisations such as MAFF, as well as others who carry out activities within these zones.

Maps are being provided to help illustrate how vulnerable groundwater and aquifers may be to polluting activities at the ground surface. These take into account the protection afforded by the type and thickness of soils, and whether the area can be considered a major, minor or non-aquifer. The maps will help increase awareness of where groundwater is at risk and will be available for use in both planning future land use and subsequent development.

For any activities which may pose a risk of pollution to groundwater the principle governing acceptability is that there should be no adverse effects on the groundwater resource. In some cases, for example where contaminated land is being redeveloped, ideally the aim should be to improve poor quality water. The NRA Thames Region is currently establishing a groundwater quality monitoring network which will identify region-wide variation in water quality. This will help assess better the impact of potentially polluting activities and help in the future management and control.

3.7 SURFACE WATER PROTECTION

Surface water resources in the region rely heavily upon the effective management of surface water quality. Changes in river water quality, or of the quality required for potable use, can have significant implications for the utility of the resource, water treatment requirements and cost. Under the Water Resources Act 1991, the NRA is responsible for controlling and consenting discharges to surface waters in order to maintain and improve surface water quality to meet river water quality objectives set by the Secretary of State. Consents are set to ensure that the recipient watercourses will meet river water quality classifications. A number of European Community Directives also set down quality standards related to the discharge of dangerous substances or to specific uses or purposes; for example, nitrate and pesticide limits for surface water abstractions, and managing water quality for freshwater fisheries.

Generally river water quality in the region has improved; the number of river reaches failing their quality objectives has significantly decreased from 90 in 1989 to 35 in 1993. This in most part is due to improvements in sewage treatment and the quality of sewage effluent discharged to rivers.

However, as pressures on the water environment intensify and more stringent standards for drinking water quality and effluent quality are demanded, a number of water quality issues could potentially affect the availability or costs of providing water resources in the future. These include:

- **Nitrates:** *concentrations in the river can exceed the 50 mg/l limit specified by the Surface Water Directive at a number of the surface water intakes particularly during winter runoff. The principal areas of concern are the Upper River Thames and the River Cherwell. This could lead to more complicated and expensive treatment of abstracted water by the water companies. At Farmoor in Oxfordshire for example, reservoir management has become a key feature of nitrate control. At present, steps are under way to limit the use of nitrates particularly in agriculture. Nitrate Vulnerable Zones, for example the Upper Cherwell, are currently being proposed under the EC Nitrate Directive.*

- **Pesticides and Herbicides:** *recent DoE figures on non-agricultural use of herbicides indicated that 21% of total use in England and Wales occurs within this region. The cost of treatment to meet current limits for pesticides and herbicides in public water supplies can be high and could render the use of some smaller sources uneconomic. Region-wide efforts are underway to reduce the use of persistent pesticides*

and, nationally, the Government has withdrawn a number of pesticides from use, e.g. simazine and atrazine. In addition to a regional study of pesticides, liaison with non-agricultural users has been increased to raise awareness of the potential effects on water supplies and the environment.

- **Phosphates and Boron:** *in the Thames Region, five 'Sensitive Areas' recognising problems of eutrophication, have been identified and, under the Urban Waste Water Treatment Directive, major sewage treatment works discharging to them are required to treat their effluent more stringently particularly to remove phosphates. Boron, also largely derived from the use of detergents, may require future treatment or removal prior to discharge to watercourses in order to maintain river water quality for public water supplies.*

- **Oestrogenic Compounds:** *oestrogen and industrial chemicals which react like oestrogen are a relatively new concern in the Thames Region. Information about the levels of these compounds and their effect on humans and animals are only just beginning to become available. However, until the full extent of these effects are known the risk to water resources cannot be accurately assessed.*

Pilot areas for surface water quality objectives (SWQOs) are being established in the region, based on Government policy. The main use of these objectives will be to maintain existing river water quality.

The nature and management of abstractions in the Thames catchment results in the tideway being especially vulnerable to changes in water quality. This is particularly so when intense storms over the urban areas are coincident with naturally low flows in the river releasing large quantities of storm water into the tideway. In order to manage this situation, operating arrangements have been agreed between the NRA and Thames Water Utilities for managing abstractions and safeguarding tideway quality during these times of environmental stress.

3.8 LICENSING POLICY

It is a responsibility of the NRA to ensure that water resources are managed effectively and for the benefit of everyone. The NRA fulfils this role principally through the issue of water abstraction licences.

It is a legal requirement, under the Water Resources Act 1991, that, with a few exceptions, anyone who wants to take water from a surface or underground source must obtain a licence to do so from NRA.

Before granting a licence, the NRA assesses whether the application represents a proper use of water resources. The NRA must be satisfied that the licence will not derogate the rights of other abstractors and will not be detrimental to the needs of the environment and other users. To ensure this, all functions within the NRA are consulted on all licence applications.

The Thames Region has developed a general policy for licensing new abstractions. One key element of that policy is that no new licence will be granted allowing direct abstraction from rivers during the summer months (April - October) for consumptive use. Winter-only abstractions are usually possible but to ensure reliability all year round the licence holder will need to install reservoir storage.

All licences carry a volume limit and, in many cases, new licenses will be constrained by a prescribed flow in the river. Furthermore, new licences, particularly for groundwater abstraction, may be granted for a limited time to allow for the conditions within the licence to

be reviewed subject to any adverse effects over a period of 5 -10 years. If groundwater levels develop a declining trend or an unacceptable depletion of river flows occurs then granting a further licence, where possible, might involve a reduction to the authorised volume or a variation to the prescribed flow.

3.9 ESTABLISHING ENVIRONMENTALLY ACCEPTABLE FLOW REGIMES

Low flows occur naturally, but the effect of abstractions (from both groundwater and surface water) is in general to increase the duration and frequency of low flows in rivers. The NRA has powers under the Water Resource Act 1991 to set minimum acceptable flows to protect public health, lawful uses, navigation, fisheries and land drainage. In the past the NRA has determined prescribed flows by a variety of flow-related methods (such as the 95th percentile flow or the annual mean minimum seven day flow value). These methods do not directly take into account the ecological value of river flows. The NRA has an ongoing research programme to identify a methodology for determining ecological flow requirements. The results of this research will be used in determining policy and practice for the setting of environmentally acceptable flow regimes. The 'regime' element recognises that seasonal instream flow variability, which can be required by river ecology or other existing uses, may not be protected by a single acceptable flow. This will lead to flow regimes being set with regard to the needs of the environment and the existing river uses.

3.10 ECONOMIC INSTRUMENTS AND INCENTIVES

Greater attention is being paid by Government and others towards the use of economic instruments such as incentive charging and tradeable permits. The NRA has already indicated its support for domestic metering in appropriate circumstances and will play its full part in the evaluation and development of any further schemes. The potential impact on this regional strategy will be reviewed in light of any future developments.

Other economic incentives which may benefit water resources in terms of both quantity and quality, such as Countryside Stewardship, Long-Term Set-aside and Environmentally Sensitive Area designation, are all welcome. The introduction of buffer zones and other methods of attenuating or conserving rainfall - runoff will have significance in the longer-term and may therefore contribute significantly towards sustainability.

SECTION 4

FUTURE USE OF WATER

4 FUTURE USE OF WATER

4.1 GROWTH IN DEMAND

Water resources will be required to meet any anticipated growth in demand for public water supply, agriculture and industry, as well as the needs of the environment compared to low flow rivers (section 3.4) and recreational uses such as canals. Whilst there is very little growth anticipated in the agricultural and industrial sectors abstracting water directly from private sources, demands for public water supplies are expected to increase. Possible demand scenarios for each NRA region have recently been published by the NRA in "Water : Nature's Precious Resource" (March 1994) and the individual companies have made demand forecasts in their five yearly review for OFWAT.

A broadly standardised methodology is now used by the industry for forecasting public water supply demands, based on forecasts of individual components (section 2.6 above), which can be further divided into more detailed components of water use such as ownership and frequency of use of appliances. Whilst this methodology is largely standardised, the assumptions used by individual companies and the NRA regarding rates of growth can vary considerably, owing to a number of factors, mostly associated with local conditions.

The key factors likely to influence demand for water are:

- *changing pattern of development;*
- *uptake of household appliances and their level of ownership;*
- *gardening habits;*
- *population growth and household size;*
- *the level of economic activity;*
- *the method of charging for water services and the price level adopted;*
- *the effectiveness of demand management measures, particularly control of losses through leakage;*
- *climate change.*

4.1.1 FORECAST DEMAND SCENARIOS

The NRA has recently consulted with water companies and others on their assumptions, and used combinations of these assumptions to build up future demand scenarios. Table 2 outlines the assumptions used to derive high, medium and low demand scenarios as shown in Figure 11. The range between the high and low demand scenarios demonstrates the significant impact caused by different basic assumptions. Domestic and industrial growth, and particularly demand management measures such as leakage control and domestic metering, could prove to be major influences on the need for new water resource schemes.

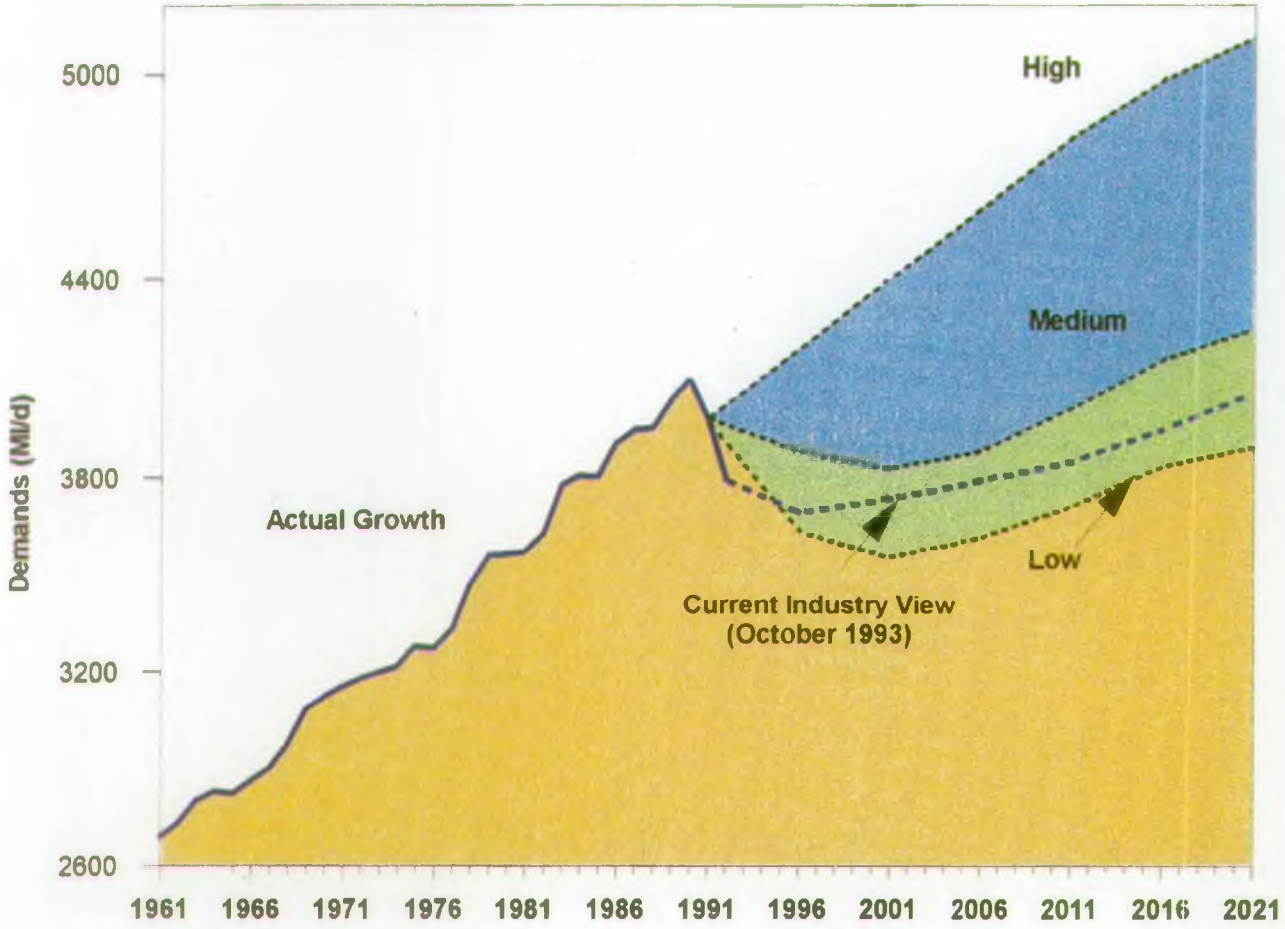


Figure 11: Comparison of NRA and Water Company Demand Forecasts

Scenario Assumptions

High rates of growth in domestic and non-domestic consumption; no increase in current demand management activity.

Moderate growth in domestic and non-domestic consumption; limited domestic metering and reduced leakage.

Moderate growth in domestic consumption and no increase in non-domestic consumption; moderate domestic metering and further reduced leakage.

NRA
National Rivers Authority
Thames Region

TABLE 2. NRA NATIONAL WATER RESOURCE DEVELOPMENT STRATEGY ASSUMPTIONS AND COMBINATIONS WITHIN EACH DEMAND SCENARIO

No.	Assumptions	ASSUMPTIONS FOR EACH SCENARIO			
		High	Medium	Low	Broad area of effect
1.	Growth of per capita consumption by compound annual rate of 1%. Per capita figures are constrained to a maximum of 189 l/h/d. Existing per capita consumption from OFWAT 1992 Returns.	●			Per Capita Consumption Growth
2.	Growth of per capita consumption by compound annual percentage rates derived from Effects of Climate Change on Water Resources and Demands, Binnie and Herrington, 1992. Per capita figures are constrained to a maximum of 180 l/h/d. Existing per capita consumption from returns to OFWAT in 1993 for 1992 consumption.		●	●	
3.	Growth in metered and unmetered industrial/commercial consumption by compound annual rate of 0.75%.	●			Commercial Growth
4.	Growth in metered and unmetered industrial/commercial consumption by compound annual rate of 0.5%.		●		
5.	No growth in metered and unmetered industrial/commercial consumption above 1991 levels.			●	
6.	No increase in the proportion of domestic metered properties subject to metering above 1991 levels. Existing metered properties PCC not reduced by 10% in recognition of the uncertainty associated with such a reduction. Assumed leakage reductions of 1.5 l/prop/hr to account for decreased SPL in existing metered properties.	●			Metering
7.	15% of domestic properties will have meters by 2021 (starting in 1996, with equal phasing each year) leading to a 10% reduction in per capita consumption and a reduction in total treated water losses of 1.5 l/prop/hr to account for reduced SPL in metered properties.		●		
8.	30% of domestic properties will have meters by 2006 (ongoing from 1996, with equal phasing each year) leading to a 10% reduction in per capita consumption and a reduction in total treated water losses of 1.5 l/prop/hr to account for reduced SPL in metered properties.			●	
9.	Leakage levels per property held at 1991 levels to simulate the effect of no improvements being made to reduce leakage levels.	●			Leakage
10.	Leakage control reducing total treated water losses to 7 litres/ property/hour (20 hour day) rate of reduction is 0.5 l/prop/hr/yr.		●		
11.	Leakage control reducing total treated water losses to 6 litres/ property/hour (20 hour day) rate of reduction is 1.0 l/prop/hr/yr.			●	

Notes: - PCC is Per capita consumption

- SPL is Supply pipe leakage (Customer's responsibility)

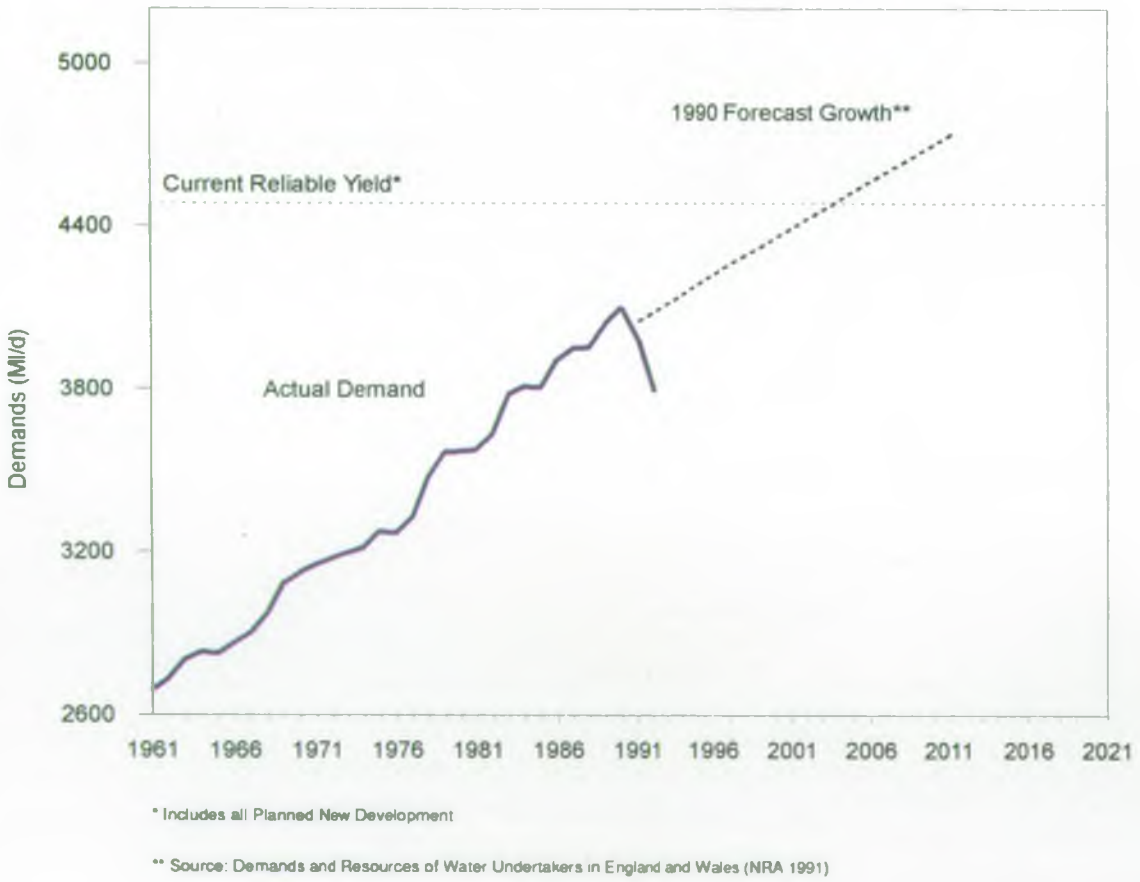
● Denotes assumption adopted for the scenario

4.1.2 WATER COMPANY DEMAND FORECASTS

The summation of individual water company demand forecasts lies between the Low and Medium NRA national demand scenarios (Figure 11). This is largely due to most companies adopting demand management assumptions similar to those adopted by the NRA for the Medium to Low scenarios. However, levels of domestic metering that may be adopted and the different assumed growth rates for domestic, per capita and industrial components still show considerable variation between companies.

Current average daily demands for public water supply are forecast by the Companies to increase from 3795 Ml/d at present to approximately 3900 Ml/d by 2016 (Figure 11). This represents an increase of 4.8% (or 0.2% per annum compound) over this period. Compared to the growth rate in public water supply in the 20 year period up to 1989, which showed an increase in demand of 33%, and previous (1989 based) forecast rates of growth (Figure 12), there has been a significant reduction in forecast demand growth. This has largely been brought about by:

- *an improvement by water companies in leakage control;*
- *the decline in economic activity;*
- *the publicity and restrictions enforced during the recent drought.*



* Includes all Planned New Development

** Source: Demands and Resources of Water Undertakers in England and Wales (NRA 1991)

Figure 12: Public Water Supply Demands & Reliable Yields (Ml/d)

Within the overall area of growth, domestic and industrial demands are currently forecast (again, by the water companies) to increase by 24% and 8% respectively over the next 25 years, with the metered components of these demands (domestic and commercial/industrial) increasing significantly (Figure 13). This change is due to the policy of most water companies now to convert all commercial/industrial properties with significant water use, previously unmeasured, to metered supplies and to meter all new domestic properties. The overall number of domestic connections anticipated within the planning period, however remains relatively low at around 20-30%.

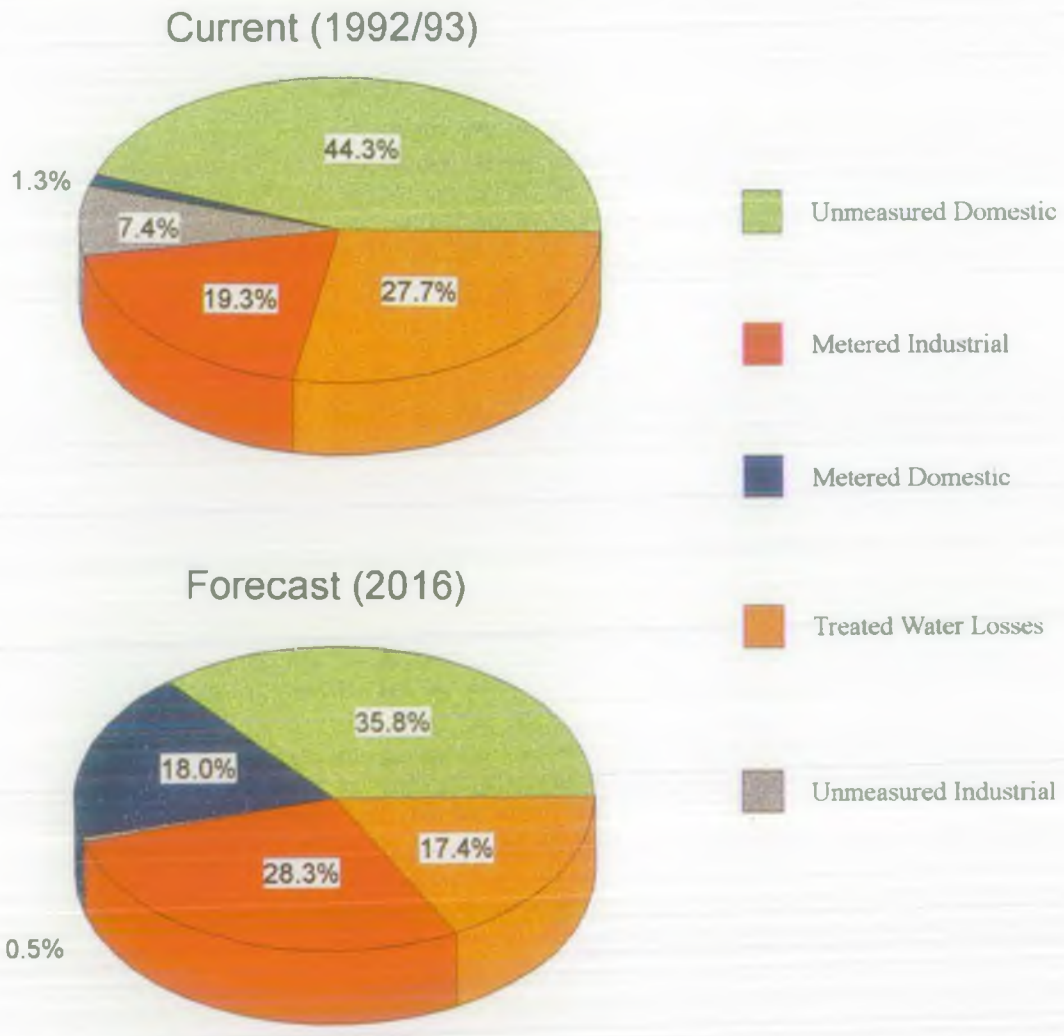


Figure 13: Components of Water Demand

Despite an increase in the overall growth of demands, Total Treated Water Losses are forecast to be reduced over the next few years, from 28% currently to 17% of the total water put into supply by 2016. All water companies now have a target of 6 litres/property/hour, although the date by which the target is to be achieved varies from 2001 - 2011. Reductions below this level may be uneconomic due to the age and location of some of the distribution mains within the region, for example London. The NRA will work closely with the companies to monitor progress and review practical and economical targets.

4.2 BALANCING RESOURCES AND DEMANDS

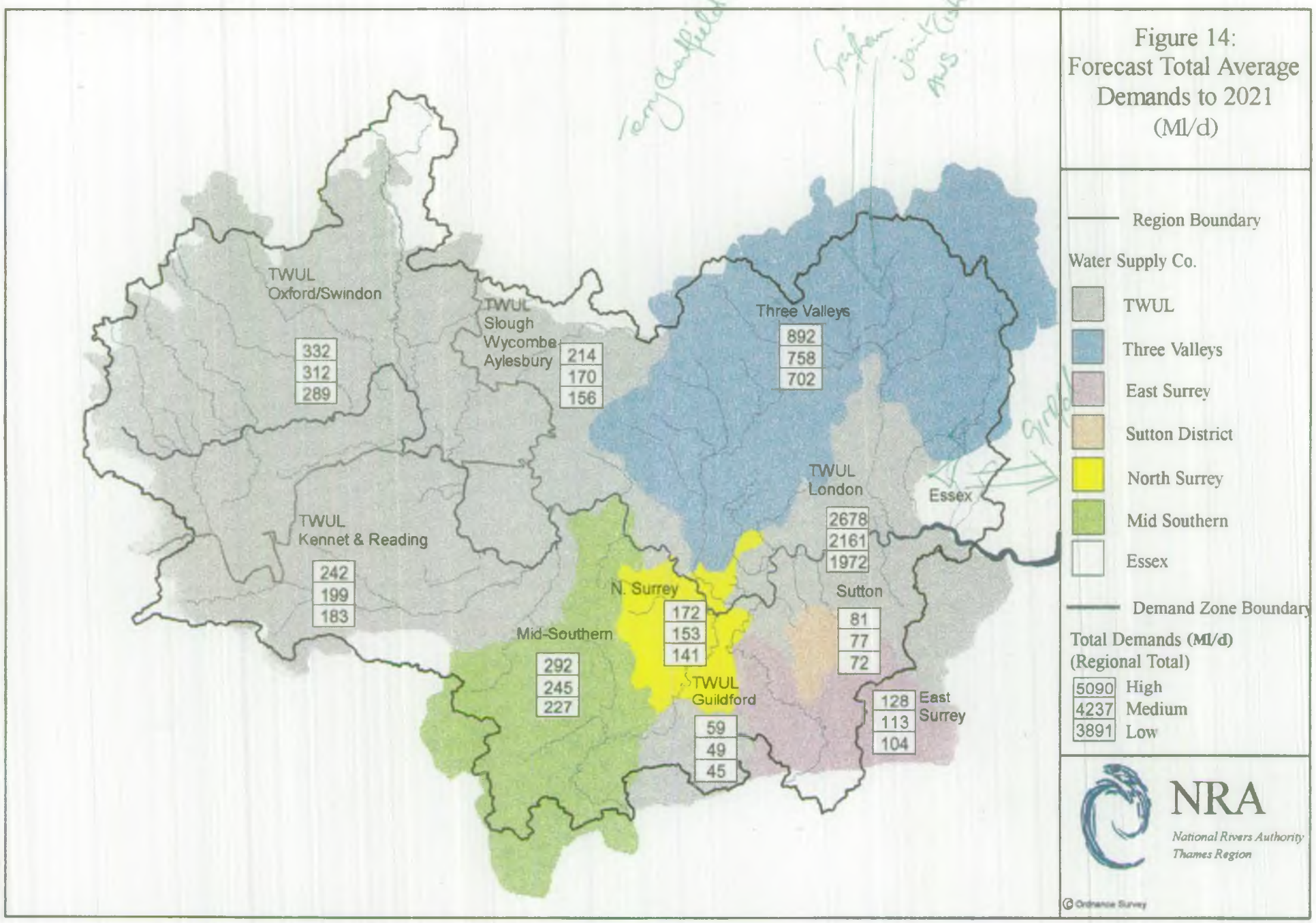
In order to assess the scale of any future water resource deficiency in the region, the three demand scenarios (described above) together with the water companies' forecasts of future demand have been compared with the yields of existing and planned resources (Figures 11 and 12). The resulting deficits between forecast demand for water and available resources, or marginal demands, to the year 2021 are shown in Figure 14, Figure 15 and Table 3 for each of the principal supply areas within the region.

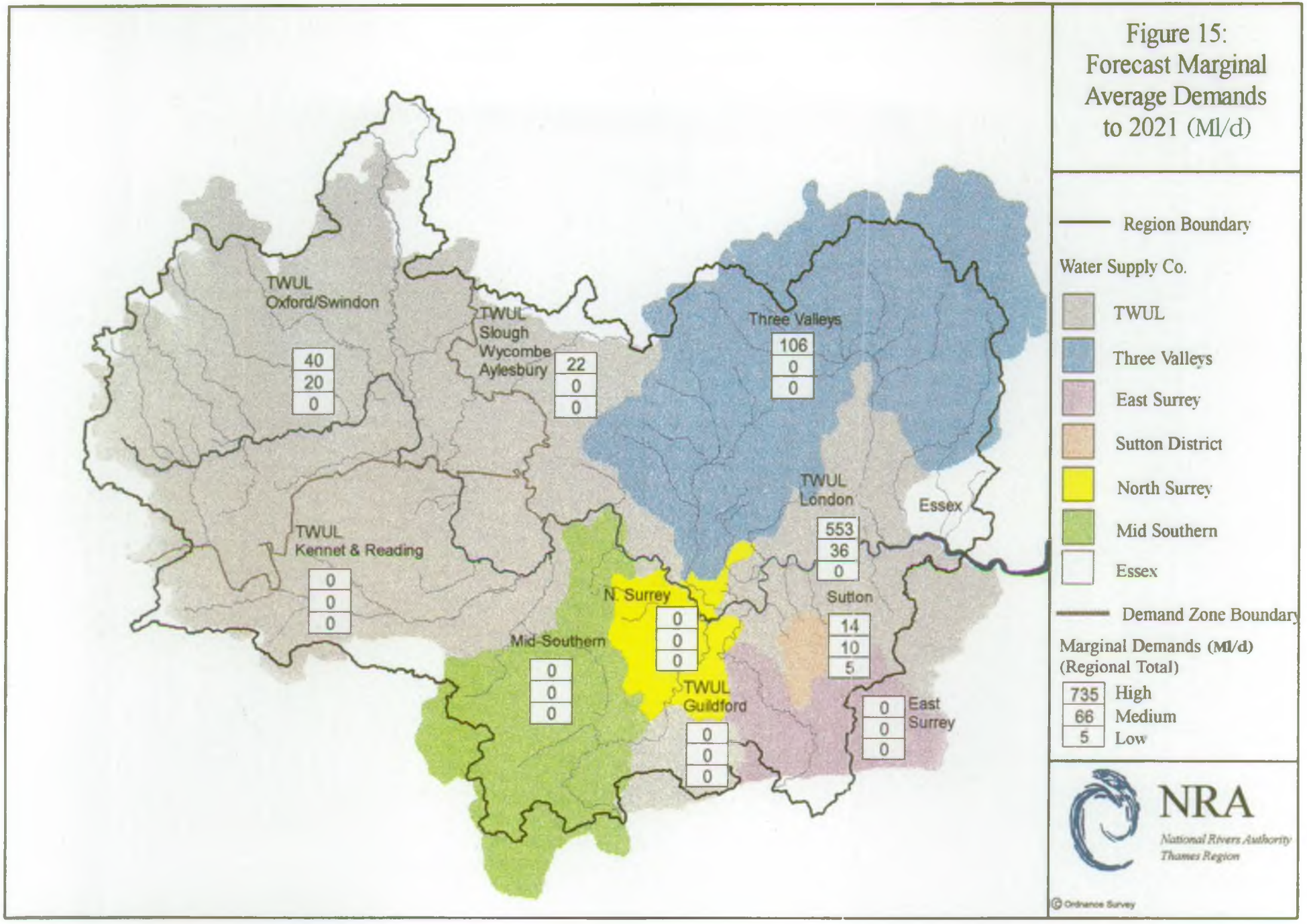
TABLE 3 : MARGINAL DEMANDS (Ml/d)

Demand scenario	Company	1996	2001	2006	2011	2016	2021
High	Sutton District Water Company	2	6	9	12	14	14
	Three Valleys Water Services	0	0	23	60	90	106
	Thames Water Utilities						
	- Oxford/Swindon	0	0	2	20	31	40
	- Slough/Wycombe/Aylesbury	0	0	0	8	15	22
	- London	94	188	298	411	487	553
Total		**96**	**194**	**332**	**511**	**637**	**735**
Medium	Sutton District Water Company	1	3	5	8	10	10
	Thames Water Utilities						
	- Oxford/Swindon	0	0	0	0	13	20
	- London	0	0	0	0	0	36
Total		**1**	**3**	**5**	**8**	**23**	**66**
Low	Sutton District Water Company	0	0	1	3	5	5

In determining these marginal demands, a number of factors have been taken into account regarding possible developments which are currently being planned and which could have an impact on the future availability of water resources. These include:

- *a reduction in yield of 37 Ml/d on account of planned improvements to the five formally recognised cases of rivers with low flow problems (section 3.4).*
- *the inclusion of the potential yields from planned new water resource schemes. These include a number of local or 'tactical' groundwater developments and the development of artificially recharging aquifers in the London area. These schemes are described in detail in the following sections.*
- *the reduction by a 2.5% 'outage' factor (contingency margin) of the total available yield in each area to allow for possible operational failures of sources.*


TWUL
Oxford/Swindon
332
312
289
TWUL
Slough
Wycombe
Aylesbury
214
170
156
Three Valleys
892
758
702
TWUL
London
2678
2161
1972
Essex
TWUL
Kennet & Reading
242
199
183
N. Surrey
172
153
141
Sutton
81
77
72
Mid-Southern
292
245
227
TWUL
Guildford
59
49
45
East
Surrey
128
113
104
Figure 14:
Forecast Total Average
Demands to 2021
(Ml/d)
Region Boundary
Water Supply Co.
TWUL
Three Valleys
East Surrey
Sutton District
North Surrey
Mid Southern
Essex
Demand Zone Boundary
Total Demands (Ml/d)
(Regional Total)
5090 High
4237 Medium
3891 Low
NRA
National Rivers Authority
Thames Region
© Ordnance Survey


TWUL
Oxford/Swindon
40
20
0
TWUL
Slough
Wycombe
Aylesbury
22
0
0
Three Valleys
106
0
0
TWUL
Kennet & Reading
0
0
0
TWUL
London
553
36
0
Essex
N. Surrey
0
0
0
Sutton
14
10
5
Mid-Southern
0
0
0
TWUL
Guildford
0
0
0
East
Surrey
0
0
0
Figure 15:
Forecast Marginal
Average Demands
to 2021 (Ml/d)
Region Boundary
Water Supply Co.
TWUL
Three Valleys
East Surrey
Sutton District
North Surrey
Mid Southern
Essex
Demand Zone Boundary
Marginal Demands (Ml/d)
(Regional Total)
735 High
66 Medium
5 Low
NRA
National Rivers Authority
Thames Region
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The key areas of concern where potential marginal demands may occur are the supply areas covered by Sutton District Water Company and Thames Water Utilities' London and Upper Thames (Oxford and Swindon) Zones.

The marginal demands resulting from each demand scenario clearly demonstrates the potential impact that demand management policies may have across the region wherever they can be practically and cost effectively implemented. The key area where significant reductions may be achieved in the potential imbalance between demands and resources is through control of losses through leakage. This is clearly demonstrated in the scale of reduction in demand to 2001 shown in Figure 11 for the Low and Medium demand scenarios which is related to the achievement of specified leakage control targets.

4.3 PEAK DEMANDS

The need for major new resource schemes is driven by the overall balance of average demand versus available water resources, recognising seasonal influences on the resource system such as the effects of drought. Demand for water does of course vary throughout the year with peaks in demand normally occurring during the summer months. These are usually associated with hot, dry periods when demand for garden watering is at its highest. Clearly, unless we become more aware of the need for water efficiency in our gardening the pressure for water at times of peak demand will increase significantly. Peaks in demand can also occur during the winter months when very low temperatures can have a significant influence on rates of leakage which will increase the quantities necessary to meet supplies.

The scope for marginal demands to meet peak requirements is shown in Figure 16. Data are not shown for the Thames Water Utilities' London supply area, because the large resources provided by surface water and reservoir storage (compared to groundwater resources) tends to reduce the range experienced elsewhere between peak and average demand. The main areas of concern remain the same as those discussed for average demand conditions highlighting the potential need for additional resources in the Upper Thames, London and Sutton under the Medium demand scenario, but with the addition of potential marginal demands within the Three Valleys Water Services area. The key difference, however, is that marginal demands to meet peak requirements tend to be some 5 years in advance of those at average.

Peaks in demand for water become more important when dealing with resources at the local or supply area level. In some areas within the Region, the peak weekly demand can be as much as 50 % above the annual average demand. Water companies will normally design for peak demands through the allocation of service reservoirs or water towers within local distribution systems or by having greater interconnection and flexibility of resources between supply systems. Where this flexibility cannot be provided, additional water resources may be sought for local use.

4.4 INDUSTRIAL DIRECT ABSTRACTIVE DEMANDS

As part of the national water resources investigations, the NRA commissioned the Confederation of British Industry (CBI) to undertake a survey of water demand across all key industrial and commercial sectors of the economy and to provide an indication of possible trends in future demand for water.

Of those companies surveyed, 64% indicated that their likely future demand for water would either remain static or decrease. The key features affecting future patterns of water use included:

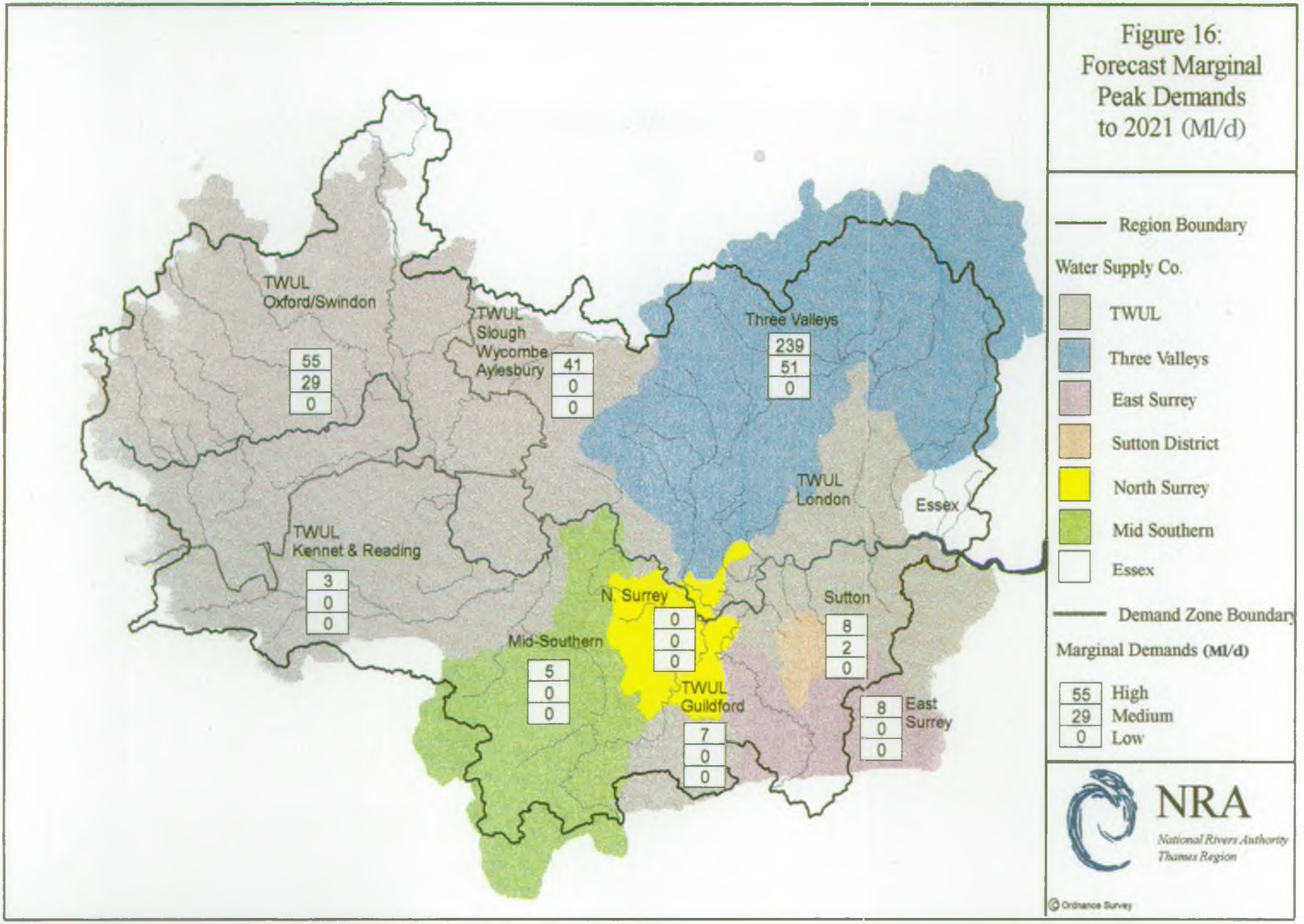
Figure 16:
Forecast Marginal
Peak Demands
to 2021 (Ml/d)
TWUL
Oxford/Swindon
55
29
0
TWUL
Slough
Wycombe
Aylesbury
41
0
0
Three Valleys
239
51
0
TWUL
London
Essex
TWUL
Kennet & Reading
3
0
0
N. Surrey
0
0
0
Sutton
8
2
0
Mid-Southern
5
0
0
TWUL
Guildford
7
0
0
East
Surrey
8
0
0
Region Boundary
Water Supply Co.
TWUL
Three Valleys
East Surrey
Sutton District
North Surrey
Mid Southern
Essex
Demand Zone Boundary
Marginal Demands (Ml/d)
55 High
29 Medium
0 Low
NRA
National Rivers Authority
Thames Region
© Ordnance Survey

- *an increasing awareness of water efficiency, opportunities for recycling and environmental and financial benefits;*
- *the financial incentives of reducing effluent disposal costs;*
- *national and regional economic trends.*

Although, the CBI survey indicated an optimistic outlook for productivity and increasing water demand, over the next 5 to 10 years for this Region, most industrial/commercial water use is already supplied by the public water supply companies. Any anticipated growth, therefore, is already taken into account in the forecast scenarios for public water supplies.

Power generation is not a major demand on the water resources of the region compared with other parts of the country; many of the regional power stations abstract from the tidal river Thames and, therefore, have no direct impact on the freshwater resources available to the region. National Power operates a major power station at Didcot on the middle Thames where approximately 142 Ml/d on average can be abstracted for use as cooling water, the licence requiring between 50 to 66% of that abstracted, depending on prevailing flow conditions, to be returned to the river after use. A temporary variation to the Didcot licence extending to 1999 allows National Power to abstract slightly greater quantities at times of high flow in the River Thames within this annual limit. After 1999, the licence will revert to its original quantities unless a further variation is secured.

4.5 AGRICULTURAL DEMANDS

Agricultural use within the region accounts for approximately 8.7% of the total water abstracted annually, although the main uses are fish farming and watercress growing which are non-consumptive in water resource terms. The principal component of agricultural demand is for spray irrigation although this accounts for only 0.2% of the water abstracted on average each year. Although in overall terms this is insignificant, it can be an important demand locally.

Future agricultural demand for water is expected to depend mainly on changes to agricultural policy. Recent research undertaken for the NRA indicates that for this region there are likely to be only minor increases in spray irrigation demands and that, in general, agricultural use is unlikely to increase significantly.

The NRA will need to keep in close contact with MAFF and the NFU to monitor future trends in agricultural water use within the region.

4.6 OTHER POTENTIAL DEMANDS

As well as providing a means of transferring water resources from one region to another, the restoration of disused canals could equally become a pressure on water resources. A number of restoration projects are currently being progressed; these include the Thames - Severn, Wilts - Berks and Wey and Arun canal projects. The operation of newly restored canal systems, such as the Kennet and Avon canal, during the recent drought has emphasised the need to consider water resources availability at the planning stage of these schemes. The canals can themselves become a demand on water resources, particularly at times of low flow, as a result of evaporation and leakage from the channel and operation of the locks. The security of water resources for canal operation particularly through dry summers will require the development of strategic storage reservoirs or possibly, arrangements to back-pump water through key sections of canal. Some restoration projects may benefit from new water resource schemes. These are discussed later in the document.

SECTION 5

OPTIONS TO MEET FUTURE DEMANDS

5 OPTIONS TO MEET FUTURE DEMANDS

Meeting future demands for water supply will require a combination of demand management, and new water resource development together with the integrated management of the overall water environment. The first priority will be to manage demand through leakage control, domestic metering or other demand saving measures, before the development of major new water resources. The latter becomes progressively more expensive as the more effective options are developed. Also it becomes more difficult to find options which do not significantly affect the environment. The high costs associated with major new schemes, the recent drought, concern for the effects of abstractions on the environment and increasing demand for water have combined to stimulate the need to consider demand management as a more appropriate response to closing the gap between supply and demand.

5.1 DEMAND MANAGEMENT

The NRA has publicly stated that before any new sources are developed, it is essential that water companies make sure they are doing all that is practicable to reduce leakage and carry out effective demand management. Demand management is concerned with waste, undue consumption or misuse of water on customer premises and it is important to the NRA because of the impacts of demand on water resources and hence on the aquatic environment. It is also important to the water companies with regard to saving or deferring expenditure on the development of new water resource schemes and provides greater control over quantities and timing of supplies. Above all it is important on both counts to the public we all aim to serve.

Demand management or improving water-use efficiency, can broadly be categorised as follows:

- *Reducing demand through public education and awareness;*
- *Promotion of water saving devices;*
- *Leakage and pressure control;*
- *Domestic metering.*

A range of opportunities to improve water-use efficiency throughout the water industry and by its customers was recently published for consultation in 'Using Water Wisely' (DOE, 1992).

5.1.1 INFLUENCING DEMAND THROUGH PUBLIC EDUCATION AND AWARENESS

Large quantities of water can be wasted in the home; for example, by taps left running unnecessarily, washing machines switched on when only half full and, particularly in the summer, ineffective or over-use of hosepipes and sprinklers. A garden sprinkler can use significantly more water in an hour than an average family of four would use in a day. There is little doubt that savings can be achieved through more careful use of water.

Information on the cost of water supplies and the impact of abstraction on the environment, particularly during droughts, needs to be more widely available. Attention should be drawn to both the ways in which water is wasted and the ways in which it can be saved.

5.1.2 PROMOTION OF WATER SAVING DEVICES

Promotion and approval by companies/government of water saving devices, (e.g low water use washing machines, showers and toilets) is an important part of encouraging the wise use of water in the home. Water byelaws have been imposed for some water saving devices. For example recently imposed byelaws require all new cisterns to have a capacity of 7.5 litres as opposed to the previous 9.0 litres. 20 Ml/d could be saved if half the properties in the region were fitted with low flush cisterns by the end of the century. Eco-labelling of watersaving

devices such as washing machines and dishwashers, which would require that certain efficiency standards have been met, should also be promoted. Some water companies have taken steps in this direction; a concerted approach will be needed to achieve serious results.

5.1.3 LEAKAGE AND PRESSURE CONTROL

The NRA's responsibility to ensure the proper use of water resources means that its concern is with total water losses from supply systems, wherever they may occur. Total treated water losses as used here refers to leakage losses from trunk mains, distribution systems, and from service pipe connections to consumers. Losses can be controlled through a programme of active leakage detection and repair, (accelerated) mains renewal and by pressure reduction and control. Pressure reduction can also reduce demand indirectly by reducing the rate of flow through taps and thereby, the potential for waste.

Recent work within the water industry has suggested that more than two-thirds of leakage occurs on the service pipe. That is, the communication pipe from the mains to the customer boundary and the supply pipe on the customer's property. This differentiation is important because it determines with whom the responsibility for leakage repairs may lie. Larger leaks from the distribution system tend to be easily spotted and quickly dealt with by the companies. Controlling service pipe losses, however, requires more continuous effort on flow monitoring, active detection and repair of leaks.

Control of leakage becomes progressively more expensive and difficult to achieve as leakage levels are reduced. The practicable and economic limits of leakage control will vary across the region depending upon local circumstances (soil type, topography, pressure, age and type of mains, etc..). As a result, the targets proposed for the demand scenarios must be used cautiously; they set a marker against which progress, costs and commitment can be assessed. Although the assumptions used here are considered to be relatively modest, the true economic levels have yet to be identified; they could be higher or much lower than those proposed here.

Nevertheless, the scope for reducing demand through control of losses is clearly demonstrated by the range in forecast demand between the high, medium and low scenarios. This is particularly emphasised in London (Figure 14), although the practicabilities of active leakage control and repair in a busy capital city should not be underestimated. The NRA recognises and welcomes the commitment now being given to further leakage control by the water companies within their Asset Management Plan reviews. Progress towards these targets will be monitored carefully to ensure that real savings are made.

5.1.4 DOMESTIC METERING

Most industrial and commercial supplies are metered and users pay for the volume of water used. However, the majority of domestic users pay an amount based on the rateable value of their property. The Water Industry Act 1991 prohibits charging by reference to rateable value after the year 2000 and an alternative basis for charging will need to be adopted. Various alternatives are currently being investigated. These include: paying a licence fee; charging related to local council tax; charging by meter; or charging by number of occupants ("Paying for Water:The Way Ahead" OFWAT, 1991).

The argument for domestic metering centres on:

- *providing an incentive to the customer to reduce water consumption and avoid undue wastage;*
- *aiding leakage detection in customer supply pipes;*
- *providing companies with actual information on how much water its customers are consuming, enabling efficient leakage detection in the companies' own distribution system.*

The cost of meter installation is high, particularly in areas such as London, where there are large numbers of properties, especially high-rise flats with shared and multiple connections. Potential average demand reductions through domestic metering have been estimated at around 11% (National Metering Trials, Final report, 1993), though the permanency of these reductions has still to be established. The NRA has stated its view that the economics of selective domestic metering and appropriate tariffs should be assessed against new resource development. Where proper attention has not been given to assessment of selective metering, the NRA will not grant any new public water supply licences.

5.1.5 INTEGRATED SURFACE WATER MANAGEMENT

Further issues of longer-term significance may emerge from open investigations of good practice in the integrated management of rainfall - runoff. Urbanisation has the effect of increasing the rate and volume of runoff, which means that less recharge of groundwater takes place; stream baseflows and aquifers suffer as a consequence. A similar effect can be caused by agricultural and forestry practices.

The traditional approach of surface water disposal (treating water as a waste product) is changing in many countries, from France and Sweden to the U.S.A. and Japan, to surface water management utilising techniques which have yet to be used in the UK to any significant extent. These techniques offer quality and quantity improvements to the balance of relationships between competing uses of the water environment, and reduce the stress on the water environment while enhancing local water resource potential. Such improvements can be cost-effective compared with traditional methods, but require a partnership approach between water companies, NRA, local authorities and developers to bring into effect.

5.2 WATER RESOURCE DEVELOPMENT OPTIONS

Should the demand management measures described above fail to curb growth in demand, a number of possible engineering schemes have been identified which might provide additional resources to the region. Some of these schemes are already being actively investigated, or indeed, developed within the region.

Preliminary studies to identify and appraise all engineering schemes which could be included within a regional strategy have been undertaken. Resource options which have been considered but rejected, at least for the present, on environmental impact or engineering cost grounds, as summarised in Table 4, are:

- *Use of gravel workings for storage;*
- *Re-development of existing reservoirs;*
- *Freshwater storage in the tidal Thames estuary;*
- *Inter-regional transfers from Wales via River Wye, Northumbria (Kielder Water) and Scotland;*
- *Desalination of seawater.*

Options which have been carried forward for further evaluation, some of which are already being actively investigated, include:

- *London basin groundwater including artificial recharge;*
- *(Riverside) Groundwater development opportunities;*
- *Re-allocation of under-utilised resources;*
- *Re-use of effluents presently discharged to the tidal Thames estuary;*
- *Reservoir storage;*
- *Inter-regional transfer from River Severn to River Thames;*
- *Inter-regional transfers from Anglian Region to Thames catchment.*

TABLE 4 : DISCARDED OPTIONS

OPTION	YIELD	COST	ENVIRONMENTAL IMPACT	REASONS FOR REJECTION
Freshwater storage in the tidal Thames estuary ie. Thames Barrier as a barrage	up to 200 Ml/d	MOD-HIGH	HIGH	• rise in groundwater levels could effect stability of buildings and underground services; • restrictions to navigation through barriers; • changes in siltation patterns; • increase in flooding risks; • significant ecological impacts, e.g. Syon Park SSSI; • pollution risk from sewage treatment works and storm outfalls; • change in tidal character of the river; • significant legal implications, i.e., amendment of Barrier Act required to allow change of use.
Transfer from River Wye to Upper Thames - transfers supported by regulating storage; - run of river transfer from Lower Wye without further flow augmentation;	–	MOD	MOD-HIGH	• reservoir in Wye valley only required to supply the Thames Region; • unreliable without regulating storage. River Wye low flows are not well maintained; • engineering feasibility in question; • longer periods when transfer unavailable; • smaller transfer volume than Severn-Thames transfer; • longer, more costly transfer route with greater environmental impact;
Imports from Northumbria (Kielder Reservoir) by river/aqueduct	?	HIGH	LOW	• high transmission costs; • high capital and operating costs - uncompetitive compared to river to river transfers.
Kielder-London Submarine pipeline	200 Ml/d	HIGH	LOW-MOD	• cost makes it only viable in absence of the regional options; • not yet fully investigated
Imports from Northumbria/Scotland by sea - towing butyl drogues behind ocean going tugs	100-200? Ml/d	HIGH	LOW	• more expensive compared to other resource options with few compensating advantages
Redevelopment of existing reservoirs	70-150 Ml/d	HIGH	HIGH	• would require a major new resource substitute during redevelopment; • temporary loss of SSSI; • significant local disturbance.
Desalination	?	HIGH	HIGH	• consistent source water quality required and low pollution risk; • land availability dictates sites away from Thames estuary; • energy intensive; • abstraction of seawater and discharge of brine could create significant environmental impacts; • to produce potable quality water requires blending and chemical dosing, increasing production costs; • high transmission, operation, power and production costs make the option uncompetitive.

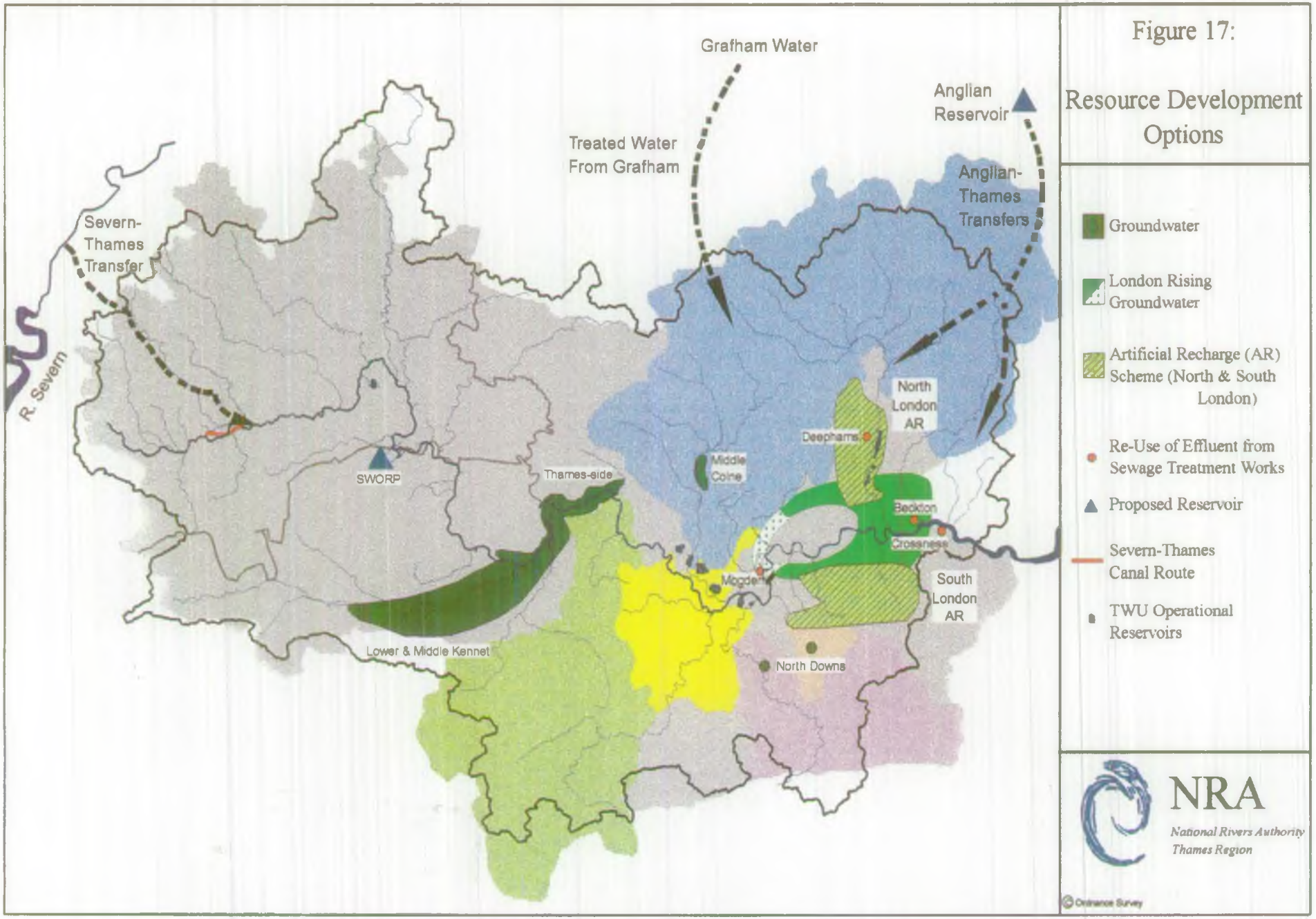

Figure 17:

Resource Development Options

These options are outlined below and shown in Figure 17. The potential environmental impacts of the different engineering scheme options are summarised in Table 5. The impacts are indicated under three main headings: a broad view of the sensitivity to change of the natural environment; the risk of change to the environment due to construction and operation of new schemes; and environmental opportunities for mitigation of impacts are also indicated.

The matrix provides a broad strategic view of schemes for comparison based on available information; it is not intended to be a definitive statement of impacts and benefits. Further investigations will be required of each scheme before the NRA or any scheme promoter would be in a position to make any comprehensive assessment.

Indicative scheme costs are summarised in Table 6. Full details of operating costs not available for all options but will clearly be an important determinand in the choice of scheme development.

5.3 LONDON BASIN GROUNDWATER

Changes in abstraction from the Chalk-basal sands aquifer under London have resulted in new opportunities for groundwater resource development. Due to over-exploitation during the early part of the century water levels in the aquifer fell leaving a large volume of aquifer in North and central London no longer filled with water. In most parts of London, but particularly the central area, water levels are now rising as a result of decreased abstractions. These conditions have prompted the investigation and development of three resource development options:

- *North London Artificial Recharge scheme;*
- *South London Artificial Recharge scheme (including assessment of existing, but under-utilised, licensed sources);*
- *Additional abstraction in Central London which would also serve to control rising groundwater.*

5.3.1 NORTH LONDON ARTIFICIAL RECHARGE SCHEME

As a result of decreased abstractions, the confined aquifer in North London, as elsewhere in the basin, is gradually recharging. This process can be accelerated and the value of the resource increased by additional artificial recharge of treated mains water at times of surplus using dual purpose recharge/abstraction boreholes.

An artificial recharge scheme already exists in the Lee Valley and an extension is nearing completion in the adjacent Enfield-Haringey area. On completion, the additional yield provided by the total North London scheme is expected to be up to 90 Ml/d. The abstracted water will be discharged to either the Lee Valley Reservoirs or the New River for treatment before going into supply for Thames Water Utilities.

5.3.2 SOUTH LONDON ARTIFICIAL RECHARGE SCHEME

An aquifer management scheme, possibly including artificial recharge, is now being investigated in South London. The aquifer could be used conjunctively, in part or whole, with Thames Water Utilities' London Water Ring Main. Conjunctive use of River Thames water via the ring main under 'normal' conditions, with recharge water during dry or drought conditions will provide an overall increase in resources but enable a decrease in river abstractions during dry periods. Investigations are at an early stage and further work is required to confirm the viability of the scheme, its environmental acceptability and quantities available.

5.3.3 RISING GROUNDWATER

Reduced groundwater abstraction, in the London area, since the 1940s has caused water levels to rise posing a threat to foundations and tunnels constructed whilst levels were depressed particularly in central London. Groundwater levels could be controlled by pumping and the water used for supply. The practicabilities, including water quality issues, of using such isolated pockets of groundwater are currently being investigated by Thames Water Utilities. Abstractions for uses other than public water supply is now permitted in all parts of the confined aquifer under the control of time limits in licences. These time limits will provide a means of reducing abstraction if unacceptable decline of water levels subsequently develops.

5.4 GROUNDWATER DEVELOPMENT OPPORTUNITIES

Other limited opportunities for new groundwater development are summarised below. There may also be a number of cases where improved sourceworks, additional treatment or relocation would improve the yield of existing authorised sources. These, in addition to infrastructure improvements, could assist in the alleviation of localised shortfalls in resources, even though some of the potential yields are very small in a strategic context.

5.4.1 THAMES-SIDE (Middle Thames)

Although opportunities for groundwater abstraction elsewhere in the catchment are limited, abstraction from the Chalk adjacent to the middle Thames has been under investigation for a number of years. Abstractions are possible because being so close to the river they do not cause groundwater level problems, there is generally no evidence of impacts on the environmental value of the river. Future investigations will, however, include assessment of possible environmental impacts. With new developments, the water taken would be used upstream so that the effluent return would contribute to river flows down to the point of abstraction and in effect set up a large scale recirculation system.

Pumping tests by Thames Water Utilities in recent years have identified yields of approximately 10-20 Ml/d at each of three additional sites: Remenham; West Marlow; Harpsden and there may be a further site at Reading. Although some of this water may be needed locally, opportunities also exist to pump the water upstream possibly to be used conjunctively with a number of Upper Thames groundwater sources allowing them to be rested in summer to reduce impacts on low flows. At present the total extra yield available from Thames-side groundwater sources may be up to 50 Ml/d.

5.4.2 LOWER AND MIDDLE KENNET

There are a number of opportunities which could be available in this area to increase yields for supply to Thames Water Utilities:

- *Conjunctive use of the main Newbury sources is one possibility. The sources under consideration are Speen in the unconfined aquifer, Bishops Green and East Woodhay in the confined aquifer. Linking sources to an appropriate flow constraint on the Kennet at Newbury could provide additional water for supply and protect environmental needs;*
- *Further down the catchment a range of options might be considered utilisingvarious possibilities for alternative use of the West Berkshire Groundwater Scheme, conjunctive use of confined and unconfined sources and perhaps ultimately by artificial recharge of the confined aquifer.*

Further studies, in particular groundwater modelling, are required as it will be essential to have a thorough understanding of any impacts on the existing streams. Early indications are that potentially up to 20-50 Ml/d could be available in the general area.

5.4.3 NORTH DOWNS

Limited opportunities in this area exist largely in the Wandle and Hogsmill catchments. Small increases in peak and average supply may be available from the Purley and Kenley sources for East Surrey Water Company, with appropriate environmental protection. Additional resources may be available at Leatherhead on the River Mole, again for East Surrey Water Company, but would require a minimum flow constraint to protect the river environment. A time limited variation to the existing licence in the Chipstead Valley for Sutton District Water Company has recently been granted. This variation is valid until 2000 when the provisions will be reviewed. Any other development of the aquifer would be approached on a trial basis with requirements for environmental protection of spring flows. The total yields available from the options is in the range 5-10 Ml/d.

5.4.4 LOWER GREENSAND

The overall utilisation of this aquifer appears to be modest. A research project, currently underway, aims to provide an initial assessment of further resource potential of the aquifer. This is a long term prospect and likely yields from sources are presently unknown. Further investigations including aquifer modelling are likely to be needed.

5.5 EFFLUENT RE-USE

The indirect re-use of effluent is already widely practiced within the Thames Region by virtue of the geography of the River Thames with by far the majority of surface water abstraction occurring at its downstream freshwater limits. The security of supplies for London relies on water abstracted upstream being returned after use as good quality treated effluent. Good quality effluent is a valuable resource and this practice of abstraction, use and return for re-use must continue, relying on the treatment of effluents to the high standards. In recent years, the NRA has advocated that water abstracted should be used and returned as treated effluent upstream of the original abstraction. This approach was used to licence the Gatehampton source (near Goring-on-Thames) which will be mainly used upstream to supply the Oxford area, the effluent being returned to the River Thames via Didcot and Oxford sewage treatment works.

Various options for the further re-use of treated effluent have been explored, including:

- *increased recycling of water by industry;*
- *opportunities for 'grey-water' use and the development of dual supply systems in new housing and commercial developments;*
- *the indirect re-use of effluent from the major sewage treatment works serving London which currently discharge to the Tideway.*

A wide variety of effluent re-use schemes currently in operation internationally have been reviewed. These include soil infiltration/recharge schemes based on the natural treatment capabilities of the soil 'aquifer'; dual supply systems for domestic use; irrigation of non-edible agricultural crops and irrigation of parks and gardens, and direct re-use for potable supplies. The potential for increased re-use within the region will depend on engineering feasibility, environmental impact and safeguarding public health.

The use of 'grey water', or secondary treated effluent, can provide non-potable supplies for use in the home, in industry, and in public parks, gardens and sports grounds. In much of the region, fitting a dual supply system into existing infrastructure (one for potable, the other for 'grey water') is likely to be difficult and, therefore, too expensive to undertake. Installing dual systems into new housing and commercial developments, however, could be significantly cheaper and such developments may provide a good opportunity to evaluate the costs, benefits and risks of constructing and operating such a system in the South-east of England. In the Thames Region, proposals for major new developments such as the East Thames Corridor could provide an excellent opportunity; the location is relatively close to a number of major sewage treatment works; and given the scarcity of resources in the area, this could be a cost-effective method of providing some of the water needs arising from development. However, the development of dual supply systems carries with it a number of public health risks, particularly arising from DIY activities and the risks of interconnection and cross-contamination between the two systems.

The value of re-use has already been realised in many sectors of industry and commerce. Many large water users/dischargers have recognised the cost savings from recycling water, not necessarily from reducing the costs of treated water, but from the savings of reduced trade effluent disposal. At a smaller scale, many vehicle washes in the region now recycle much of the water used.

Secondary treated effluent could also be used to irrigate parks and gardens in the London area. For example, it may be feasible to investigate a pilot scheme at Kew Gardens using treated effluent from Mogden sewage treatment works. A number of other opportunities in and around London should also be explored.

Various options for further re-use of effluent to support resources for public water supplies for London have been considered in the past. Virtually all the treated effluent generated in the London area, on average 2400 Ml/d, is discharged to the tidal River Thames and is therefore lost to the freshwater system; its diversion upstream for re-use could enable a significant enhancement of the resources available to London. Options considered involve the blending of tertiary treated effluent from sewage treatment works with river or reservoir water. Quantities of the order of 100 Ml/d (50% of the dry weather flow from some works) could potentially be available for re-use. Many of the larger works which serve London (i.e Beckton and Crossness) are remote from appropriate river reaches or reservoirs and would require costly engineering schemes to be developed.

There are a number of critical issues which need to be addressed before any re-use scheme could be promoted on the Lower Thames, Lee or Tideway:

- *the effects on the aquatic environment of removing a substantial element of the flow to the River Lee catchment or to the Thames Tideway. In many cases, the biota of watercourses have become reliant on current levels and quality of discharge;*
- *proving that treatment technology would be sufficient to treat certain trade effluents or pollutants which may give rise to public health concerns;*
- *the potential public health or environmental implications of using treated effluent on parks, gardens and sports grounds. Little is known about the environmental sensitivity of parkland wildlife;*
- *encouraging effluent re-use: although a potentially economic alternative, the NRA does not have any powers to control where sewage goes except under its powers to control discharges to controlled waters. Further consideration of this option would require more collaborative research with the water and sewerage undertakings.*

5.6 THE SOUTH WEST OXFORDSHIRE RESERVOIR PROPOSAL

Reservoirs are a traditional method of providing water resources and water supply reliability. A number of direct supply reservoirs already exist in the Thames Region. Reservoir development in the region is heavily conditioned by topography, geology, land use, demography, development planning and environmental constraints. The recent proposal by Thames Water Utilities to develop a site south west of Abingdon, has been identified as best to meet the numerous conditions and constraints of development. Thames Water Utilities has carried out a feasibility study which included environmental and engineering investigations.

Reservoir storage of the order of 150,000 Ml could provide a resource value of approximately 350 Ml/d to serve primarily London but also the Upper Thames. The reservoir would fill by abstraction from the River Thames at times of high flow and would augment the river at times of low flow to London; Upper Thames demands would be met directly from the reservoir. A clear attraction of the scheme is the security it promises; not only is the resource within the same geographical and commercial catchment as the demand and major beneficiary respectively, but abstraction and augmentation operations are under the same hand.

The potential environmental impacts are divided into two key areas:

- *on site, including construction, largely effecting the River Ock;*
- *operational effects on the River Thames.*

The scheme has the potential for very significant positive impacts as well as some negative impacts on the environment. The NRA will identify and promote opportunities for mitigation, environmental enhancement, recreation and conservation. A number of studies undertaken by NRA, several jointly with Thames Water Utilities, are beginning to ascertain the potential level of impact.

Construction impacts, including landtake, noise, dust, increased traffic, and the loss of some buildings, could be significant although many may be temporary or mitigated. One area which would require careful design and mitigation would be realignment of watercourses draining the site, notably Cow Common Brook. The design of realigned watercourses would need to take account of flood flows and should seek to improve and enhance the ecological value of the site. Another issue of interest to the NRA would be control of site drainage to prevent pollution. Forward planning and planting could assist in control of many of the environmental impacts and begin to establish the landscape principles of the scheme.

Baseline surveys of the fisheries, macroinvertebrates and river corridor of the River Ock are being undertaken, while routine water quality sampling is already carried out. A preliminary assessment of land drainage implications has been undertaken by the NRA and discussion has been held with Thames Water Utilities to investigate land drainage implications of construction more closely. There are a number of site specific issues which would require further investigation prior to promotion of the scheme.

The operation and management of the scheme and location of the intake and outfall are of particular concern to the NRA in consideration of abstraction licence and discharge consent applications by Thames Water Utilities. Baseline surveys which have been undertaken are the first step towards developing an environmentally acceptable flow regime. Given the character of the River Thames, a lowland, slow-flowing river which is already heavily managed, this is a complex task. The flow regime will have to be developed to protect the aquatic flora and fauna. This will include development of quality requirements for the discharge to ensure river quality objectives are met.

A series of studies have been undertaken since 1991, several of which may continue for a number of years. Given that the river itself is dynamic, establishing population information has proved challenging and in some cases new techniques have been applied. With the aid of these new techniques, systematic and rigorous data on some elements of the aquatic environment has been collected for the first time, e.g., algae and fisheries. The work carried out to date has included Fisheries, Macroinvertebrates and River Corridor surveys. Some of this work has assisted towards modelling of the water quantity and quality of the River Thames.

A key element of investigation required is to identify how a new reservoir could operate effectively with other water resources within the region. This is necessary to ensure firstly that there is no derogation to current abstractions. Of equal importance is the need to investigate how the reservoir could operate with other sources, for example Farmoor and the Lower Thames Reservoirs, and key groundwater sources, to ensure the most efficient management of resources. This could include operating some sources, particularly groundwater in the upper Thames, conjunctively with the reservoir.

In November 1993, Thames Water Utilities announced that plans for the new reservoir had been deferred owing to the success of leakage control and demand management along with a downturn in commercial demand. Planning application is unlikely to be made for at least five years. A number of studies need to be continued over the coming years if the feasibility of this scheme is to be properly established.

5.7 SEVERN TO THAMES TRANSFER

This option has been one of the key elements of a number of previous water resources planning studies carried out by the Water Resources Board during the 1970's and by the Central Water Planning Unit in the 1980s. Further investigations into this option have not been progressed in the past due to concerns regarding:

- *operational control of resources developed remote from the point of use;*
- *management of water quality, particularly from industrial effluents or pollutants arising from the West Midlands conurbations; and,*
- *the absence of need for major storage in Wales to support the Rivers Severn or Wye, except for the purposes of an inter-basin transfer scheme.*

Many of the routes previously considered, particularly those utilising the Upper Thames tributaries, were rejected in more recent studies as a result of the impact of increasing flows in the receiving channels and the effects of different water qualities on local river ecology.

Our consideration of this option focuses on a transfer from the River Severn in the area of Deerhurst to the main River Thames. Reservoir storage would be required in the Thames Region to provide facilities for blending the two different water qualities and for operational control of transfer and augmentation into the Thames. Storage options might include:

- *the development and after use of gravel workings which have already been identified within county minerals plans, such as that around Down Ampney in Gloucestershire; or more securely,*
- *development in conjunction with a purpose built reservoir such as the South-west Oxfordshire scheme.*

There remain a number of environmental concerns, principally related to the potential impacts of flow and water quality on the aquatic ecology of the receiving waters. The issues are very complex; although changes in water quality could affect a relatively limited part of the aquatic community, the full impact may be much larger because of interactions through the food chain.

The key environmental concerns include:

- *the potential effects of changes in flow and water quality arising from transfer operations on aquatic ecology of the River Thames;*
- *the effects on water quality of mixing lowland River Severn and upper River Thames water concerns include the potential impacts on basic water quality parameters such as temperature and pH, and the possible effects of different or increased concentrations of heavy metals, pesticides or herbicides between the two river waters;*
- *the risk of bioaccumulation and possible effects of heavy metals, pesticides and herbicides on aquatic flora and fauna;*
- *the potential changes to the algal regime of the River Thames arising through the introduction of different or increased species, the effects of flow or water quality changes due to the operation of a transfer and the potential effects of these changes on ecology and fisheries;*
- *the potential impacts of a transfer on river channel morphology, erosion and deposition and visual amenity;*
- *the potential impacts on riparian habitats in the upper Thames through possible changes in groundwater level or quality arising from a transfer;*
- *the effects of further augmentation and abstraction from the River Severn. An environmentally acceptable flow regime will need to be established for the River Severn to identify the seasonal variation in resource availability and the need for additional river augmentation to support a transfer whilst protecting the environment and users of the River Severn;*
- *the environmental impacts arising through the enlargement of Craig Goch reservoir in Wales (if that were part of a transfer scheme);*
- *the security of the supply during dry periods.*

It might be possible to mitigate against some of these concerns and, indeed, gain some environmental benefits from the operation of a transfer scheme. For example, if the key environmental concerns can be 'managed', a transfer may provide the means to maintain flows during drought periods to the benefit of river ecology, fisheries and general recreational use.

An alternative scheme to overcome these environmental concerns may be to transfer water directly by pipe to centres of demand. The option of piping a transfer from the Severn directly to London (via the Lower Thames reservoirs) is discussed in the NRA's "Water : Nature's Precious Resource" publication.

The long-term reliability of this scheme depends upon the redeployment or enlargement of existing reservoirs in mid-Wales to augment flows in the River Severn to support an abstraction for transfer to the Thames Region. In the shorter term, it might be possible to redeploy Vrynwy reservoir, although this would have a knock-on effect on resources available to North-West Water. In the longer-term it might be necessary to enlarge Craig Goch reservoir, although the promotion of such an option would be difficult and have significant environmental impacts. Either option would require further serious study before they can be confidently accepted or rejected.

In addition to environmental concerns, there are also a number of operational concerns regarding the transfer of different qualities of water, the potential implications for water treatment and distribution and the security of supply. These would be particularly relevant if a transfer was piped direct to centres of demand rather than distributed via the river system. Further investigations would be required to establish the possible effects of River Severn derived water on the corrosion and integrity of mains supply pipes, any treatment requirements and costs to the operator. The introduction of 'different' river water might also require treatment for taste and odour effects, and there may also be occasions when demand cannot be met because of constraints placed on abstraction from the River Severn without full augmentation as above.

5.8 ANGLIAN TO THAMES TRANSFER SCHEMES

Two possible reservoir sites are currently being investigated in the Anglian Region; Great Bradley, a 'natural' site on the headwaters of the River Stour, and a bunded reservoir site on the fens at Feltwell. Either scheme would be strategically placed to regulate transfers through the existing Ely Ouse - Essex system. Either scheme could, if appropriate, be constructed large enough not only to provide security to meet predicted demands within the Anglian Region, but also to make some water available to the Thames Region, either directly or by substitution, as follows:

- Transfer to Roding and Stort via Ely Ouse-Essex system

Transfers to the Thames Region via a western extension of the Ely Ouse to Stour and Blackwater transfer scheme could supply Essex and Suffolk Water, Thames Water Utilities and possibly Three Valleys Water Services, if required. Three potential schemes, each of approximately 100 Ml/d, have been considered:

- an augmentation to the River Stort to support abstraction by Thames Water Utilities and, possibly, Three Valleys Water Services in the Lee valley area;
- an augmentation to the River Roding to support abstraction by Essex and Suffolk Water Company; or,
- a direct transfer to Essex and Suffolk Water at Chigwell.

Additional transfers to Essex and Suffolk Water could potentially be used to relieve the current bulk supply export from the region increasing the resources available to Thames Water Utilities in London. The costs and practicabilities of this option require further discussions with the two companies following further feasibility studies of the Anglian strategic options.

Transfers to the rivers Stort and Roding would impact on special landscape areas, Grade 2 agricultural land and an SSSI. Both rivers are EC designated Cyprinid fisheries and could be affected by the increased flow regimes resulting from augmentation. Whilst river augmentation could provide enhancements or rehabilitation of some river sections, particularly on the Roding, the balance between these benefits and the impacts to morphological and other environmental parameters of these river systems will need to be thoroughly assessed.

The potential costs of environmental protection measures which may be required for the river to river transfer schemes, despite the potential benefits, may ultimately favour direct pipeline to supply schemes.

Two further schemes could also be considered in the context of potential transfers within the Anglian Region:

• Transfer via the River Thame

This option, involving the transfer of up to 100 Ml/d from the Ouse, would require the construction of a new reservoir at Waddesdon to provide intermediate storage for augmentation of the River Thame. The environmental impacts arising from the construction and operation of such a scheme would be significant due to the landscape quality and topography of the local countryside. Nearby is the National Trust property, Waddesdon Manor, which is an important historic landscape. The costs of such a scheme would also far outweigh the benefits to water resources. The scheme has not, therefore, been considered further.

• Additional use of Grafham Reservoir to supply Three Valleys Water Services

Three Valleys Water Services already receives treated water supplies from Grafham Reservoir to supply the north of their company area. Further use of Grafham in association with these strategic developments could potentially be used to transfer up to 100 Ml/d into the Thames Region. The feasibility of this option, particularly regarding potential problems associated with water quality and increased level fluctuations will require further exploration with the operating companies.

5.9 USE OF CANALS

The rehabilitation and use of the old Thames and Severn Canal has been mentioned previously as part of the Severn-Thames transfer. Recent investigations by British Waterways suggested that canals can be engineered to carry flows of up to 200 Ml/d without undue impact on navigation. In the NRA's publication "Water : Nature's Precious Resource" large scale transfers via canals were ruled out due to the cost of providing water. Smaller scale transfers of the order of 50 Ml/d could be feasible provided environmental problems could be overcome. These include potential water quality problems and ecological impacts associated with dredging for maintenance.

TABLE 5 : POTENTIAL ENVIRONMENTAL IMPACTS: ENGINEERING SCHEME OPTIONS

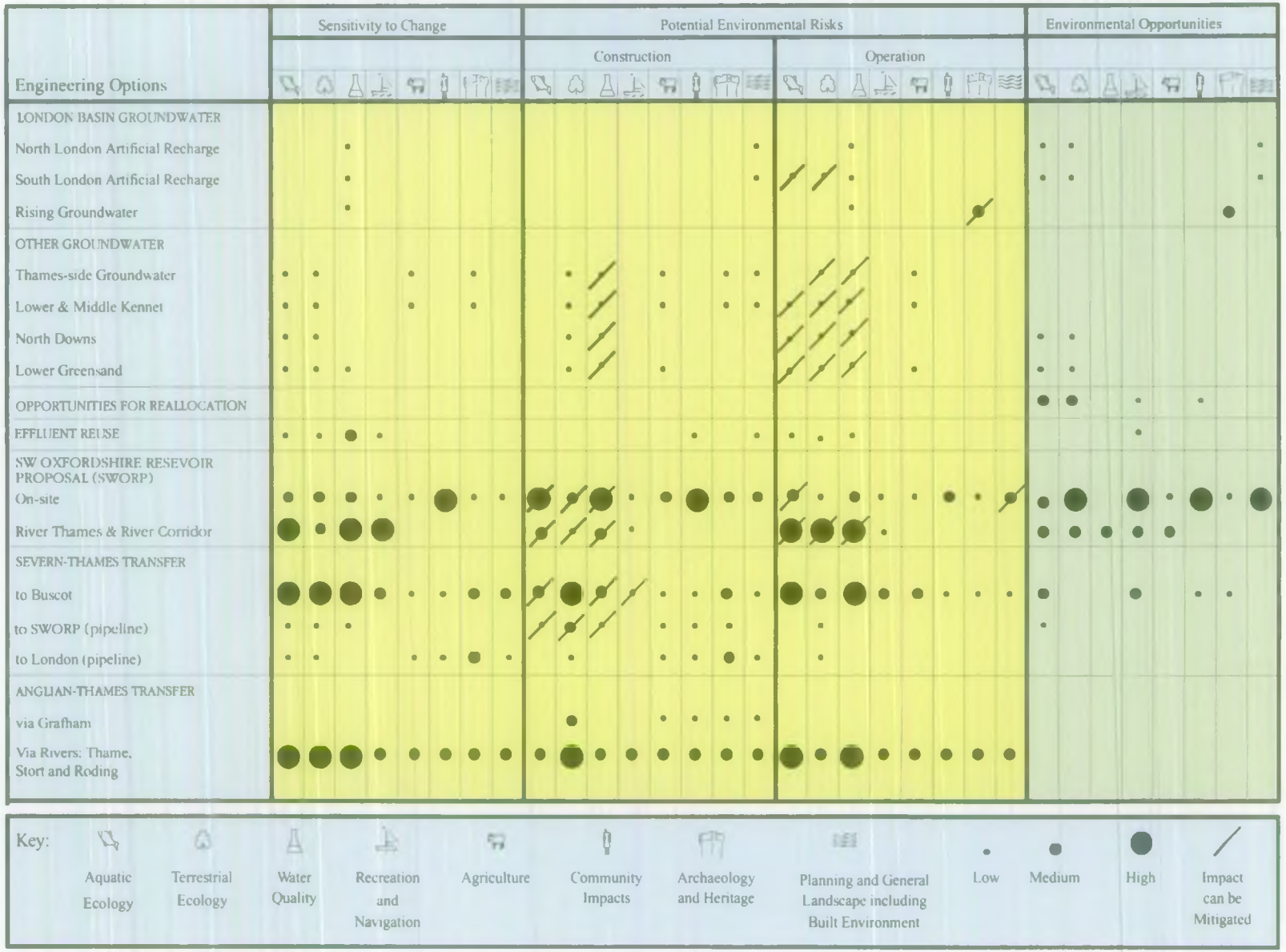

TABLE 6 : ENGINEERING OPTIONS COSTS

Option	Yield (Ml/d)	Indicative Capital Expenditure (£ million)
London Basin Groundwater:		
North London Artificial Recharge	90	11
South London Artificial Recharge	90	16
Rising Groundwater	30	*
Other Groundwater:		
Thames-side	50	1
Lower and Middle Kennet	20-50	4
North Downs	5	*
Lower Greensand	*	*
Effluent Re-use	100	25
South-West Oxfordshire Reservoir Proposal	350	450
Severn-Thames Transfer:		
to Buscot[1] (200 Ml/d)	120	52
to SW Oxfordshire Reservoir[1] (200 Ml/d)	145	62
to London (pipeline)	200?	160
Anglian-Thames Transfer:[2]		
via River Thame (with storage)	up to 100	190
via Grafham		150
via Stort		125
via Roding		125

Further investigations are required for all options to estimate yield characteristics and environmental impacts.

1. Costs from W.S. Atkins (1993)

2. Capital costs do not include alterations to Ely-Ouse-Essex scheme.

* No data available

Full details of operating costs not available for all options but will clearly be an important determinand in the choice of scheme development.

SECTION 6

PLANNING AND PLANNING POLICY GUIDELINES

6 PLANNING AND PLANNING POLICY GUIDELINES

6.1 INTRODUCTION

The NRA is a statutory consultee for planning issues such as structure plans, local development plans, waste disposal, minerals plans and authorisation of industrial processes. Regular liaison is undertaken with a range of planning bodies, including:

- *Local Planning Authorities (105);*

  14 County Councils,

  58 District Councils,

  33 London Planning Authorities;

- *Department of the Environment;*
- *South-East Regional Planning Conference (SERPLAN);*
- *London Planning Advisory Committee (LPAC);*
- *South-West Regional Planning Conference;*
- *Minerals Authorities;*
- *HMIP;*
- *Waste Regulators.*

In recent years, water-related issues have assumed an increasingly important role in strategic planning. The region has seen a continuing programme of mineral extraction and growth in housing and commercial development increasing pressure on land use, water resources and the water environment generally. That trend is expected to continue, albeit at a slower pace, for the foreseeable future.

This region has for some time been working to a series of Model Land Use Policies, now published nationally by NRA as Guidance Notes to Local Planning Authorities. These are designed to assist the Local Planning Authorities in land-use decision making to ensure that water-related issues are integrated into land-use planning at regional, strategic and local levels.

In its role as the Guardian of the Water Environment, the NRA seeks to promote a sustainable approach towards development in relation to the water environment to prevent critical or irreversible changes and to identify and protect environmental features (and their supporting system) which are important currently or may become so for future generations.

6.2 NRA PLANNING GUIDANCE TO LOCAL AUTHORITIES

In liaison with the Local Planning Authorities, the NRA would normally seek to discourage development (unless new resources can be made available in good time), in locations where:

- *water resources are already scarce; or,*
- *additional development is likely to result in less reliable supplies for the existing population and industry .*

Without adequate co-operation between the Planning Authorities and the NRA to identify and avoid such development, the NRA must be concerned that it:

- *may result in pressures for further abstraction with undesirable environmental consequences; and,*
- *may be detrimental to amenity, conservation, water quality, fisheries, navigation, and flood defence.*

6.3 DEVELOPMENT AND WATER DEMAND

As these concerns indicate, the provision of reliable water supplies can be an important factor for consideration in determining the location, extent and timing of possible future development. Where demand for water continues to rise, whether fuelled by new development or by our own capacity to use more water at work and in the home, then new water resources and greater infrastructure development are likely to be required. In the longer-term, increased demand for water may require the provision of large scale reservoir construction or major pumped transfers of water. The environmental and financial costs of these schemes can be high, and experience elsewhere of the promotion of similar schemes indicates that lead times can be up to 15 or 20 years. The provision of major new resources may have a critical impact on the timing and viability of development plans.

Current Government Planning Policy Guidelines (RPG9) state that water resources should not be seen as a constraint on development in the longer term. This provides a target for the various management options to be further examined and implemented, and costs and benefits monitored and assessed. Renewed interest has been stimulated in the potential for extending the management of the overall water environment, from controlling surface water run-off at or near the point of rainfall to re-use of treated effluent either directly or through discharge into polishing lagoons in the upper part of the catchment to recharge either river or groundwater. Further investigations into the potential for such extended management will help to establish a better understanding of the contribution it is likely to make to the sustainable management of the water environment and/or water resources directly.

6.4 POTENTIAL PRESSURE POINTS

If growth in demand can be successfully 'managed' through leakage control measures and generally better use of water by us all, then in most locations there should be sufficient water resources to sustain all reasonable demands. This takes into account the forecast pressures from projected population increase and housing developments up to 2021.

Nevertheless, there may remain a number of areas where local resources will be insufficient to meet future growth even with significant re-use and conservation measures. These areas will require the provision of infrastructure and resources either within the local catchment or remote from the proposed areas of development.

The key areas of concern which may require the development of strategic water resources include:

- *new developments proposed to the east of London affecting the Thames, Southern and Anglian NRA regions;*
- *long-term growth in demand in London if demand management proves less fruitful than hoped;*
- *areas of Sutton District Water Company which will be dependent on new resource and infrastructure provision;*
- *long-term development in the Upper Thames area affecting the Oxford and Swindon areas.*

The principal areas of more local concern are:

- *the middle Kennet, particularly the Newbury area, where further development may require the provision of major new infrastructure to transfer resources remote from the area if local groundwater developments prove to be environmentally unacceptable;*

- *further development of Banbury, where local abstraction already seriously affects river flow, and which will require further infrastructure provision;*
- *development in catchments which would result in over-abstraction based on existing licences.*

Where development proposals impinge on these locations, the NRA will ensure that full account is taken of water resources, supply, sewerage and sewage treatment issues in the timing and extent of any new allocation.

6.5 THE ROLE OF CATCHMENT MANAGEMENT PLANS

In order to manage and sustain the water environment effectively in the future, the NRA has instituted the process of catchment management planning. This entails the preparation of a catchment management plan (CMP) for natural river catchments in England and Wales. The catchment management planning process integrates the concerns of all interested parties in planning for future well being of the catchment through the preparation of action plans.

These Plans will be developed to encourage the sustainable management of each catchment within the region, identifying in advance potential issues, opportunities or constraints for future development; water resources being one such example. The plans will provide a basic reference for forward planning by the NRA, Local Planning Authorities and developers to identify where land use planning decisions may impact upon, or provide benefit to, the water environment.

The CMPs (which are non-statutory) are complementary to the statutory plans of Local Planning Authorities and will make a positive input to the formal planning process. The Region has twenty-one CMPs to be completed before 1998. Water resources, as the fundamental basis of the water environment, will be an integral part of the CMP process.

SECTION 7

A STRATEGY FOR THE SUSTAINABLE USE OF WATER RESOURCES

7 A STRATEGY FOR THE SUSTAINABLE USE OF WATER RESOURCES

7.1 INTRODUCTION

Our aim, in publishing this strategy, is to provide a framework for the future planning and sustainable management of water resources within the Thames Region. We recognise that this framework must be flexible to respond to:

- *the uncertainties of demand forecasting;*
- *the time needed to investigate and promote major new resources;*
- *the reasonable needs of abstractors and water company obligations to provide secure supplies; and,*
- *the need to avoid unnecessary planning blight or work on schemes which may never be promoted.*

7.2 EXISTING USE AND AVAILABILITY OF WATER

The Thames Region already uses a greater proportion of the effective rainfall on average (55%) than any other region in the country. In many areas of the Thames Region existing resources are fully utilised and the scope for further abstraction is limited. The NRA will continue to monitor and review levels of abstraction in terms of sustainability. Essential steps towards making the best use of existing licensed resources should include:

- *Continued investigations by the water companies into the definition of source yields and where practicable into ways to improve source output within existing licence and environmental constraints (although the scope for significant increases in available yield is likely to be very limited);*
- *Monitoring and evaluation by the NRA and water companies of the impact of groundwater pollution on source security and identifying possible operational requirements for treatment, replacement or implications of loss of resources;*
- *Investigations of opportunities to reallocate resources within or between abstractors, for example by transferring under-utilised former industrial abstractions to the water companies or reallocation of spare capacity.*

Experience abroad suggests that new techniques of surface water management can enhance water resource potential, particularly locally, providing benefit to both the quality and quantity of water available.

- *The potential of new techniques of surface water management should be investigated jointly by the NRA, Thames Water Utilities and local authorities, particularly in areas of new development or redevelopment.*

The availability of water for further licensed abstraction within the region will be limited to:

- *flow-constrained winter river water abstraction, which will need to be supported by reservoir storage to be fully effective all year round;*
- *limited local (or "tactical") groundwater development subject to the protection of the local water environment;*
- *strategic development of groundwater, including artificial recharge;*
- *strategic development of surface water schemes, such as inter-regional transfer schemes, reservoirs, and effluent re-use.*

7.3 ALLEVIATION OF LOW RIVER FLOWS CAUSED BY ABSTRACTION

Schemes to alleviate the effects of over-abstraction on the rivers Ver, Letcombe Brook and Pang are being implemented. Proposals and funding arrangements have recently been approved for the River Darent in Southern Region but the solution impinges on the resources of the Thames Region.

Feasibility studies are complete for the rivers Misbourne and Wey and the NRA would hope to see schemes implemented during the forthcoming five year period, as far as possible through the water companies' Asset Management Plans to be agreed with OFWAT or through other processes. The NRA will:

- *establish a programme of monitoring to ensure that the water environment is responding to those alleviation schemes implemented;*
- *continue working closely with the water companies to ensure that environmentally and cost effective solutions are implemented on the rivers Misbourne and Wey;*
- *continue investigations into further cases where concerns have been expressed about the effects of abstraction on river flow. A standard assessment method will be used to establish and prioritise more detailed studies where justified and these will be used as the basis for negotiations for any further action, timing and funding with abstractors, OFWAT and DoE.*

7.4 MANAGING DEMAND

The scope for reducing growth in demand and, therefore, the need for additional resources is clearly demonstrated by the range between the High and Low forecast demand scenarios.

Effective demand management measures can provide both environmental and economic benefits.

Opportunities to achieve savings in demand for water exist in a number of different areas:

- *in public water supply through leakage control, pressure reduction, metering, and the promotion of more efficient water use by customers e.g. garden use, domestic use, commercial use;*
- *in agriculture and industry through auditing existing practices and identifying areas of waste, better practice or opportunities for recycling.*

The latest demand forecasts presented by the water companies, which identify targets for leakage control and selective domestic metering, fall broadly between the NRA's Low and Medium demand scenarios.

- *The NRA has stated that it believes that both the water companies and OFWAT should be given a statutory duty by government to promote water efficiency.*
- *Before any new abstraction licences are considered, the NRA will require the water companies to demonstrate clearly that they are doing all they can towards reducing leakage to economic levels and to promote water efficiency.*
- *The leakage targets and levels of domestic metering currently being proposed by the water companies through AMP II will need to be supported by investment plans agreed with OFWAT and subsequently monitored to ensure real savings are made. NRA will continue to monitor and evaluate the water companies' demand management programmes.*

- *The NRA has stated its support for selective domestic metering, with an appropriate tariff, in areas where water resources are stressed and where the economic and environmental benefits are clear.*
- *The NRA will promote the efficient use of water in industry, commerce, agriculture and the home through the use of water audits, demonstration projects and provision of advice.*

7.5 LOCAL OR 'TACTICAL' DEVELOPMENTS TO MEET FUTURE NEEDS

It is evident that if demand management measures can be successfully implemented in the region, that there may be no need to develop major strategic schemes within the planning horizon to 2021.

However, there may be local exceptions, for example the middle Kennet area, parts of Surrey, Oxfordshire and Banbury which will require the development of local or 'tactical' solutions. Further growth in demand for water across the region will, however, require consideration of strategic scheme developments.

A number of limited local opportunities have been identified together with the need for further investigations. In many cases, new abstractions will be constrained by the requirements of an environmentally acceptable flow regime to protect river flows. Where practicable, the NRA will seek to ensure that any water abstracted is used and returned as treated effluent upstream of the point of abstraction.

The options for local development are discussed below.

7.5.1 KENNET AND READING (THAMES WATER UTILITIES)

A significant increase in demand in this area is not anticipated although localised resource pressures may arise, particularly in the middle Kennet at Newbury.

- *Investigations of conjunctive groundwater management of sources at Speen, Bishops Green and East Woodhay should be carried out jointly by Thames Water Utilities and NRA.*
- *NRA will need to establish an environmentally acceptable flow regime at Newbury to protect the River Kennet.*
- *NRA should investigate the possible 'local' use opportunities of the West Berkshire Groundwater Scheme to support additional abstraction and river flows during drought periods for the Newbury or Reading areas. Alternative Thames-side groundwater support is discussed below.*
- *NRA and Thames Water Utilities should investigate the need, timing and feasibility of piping existing licensed sources in the Reading area to support new growth in Newbury. Key issues to be addressed will include environmental protection measures, operating and capital costs of such piped transfers.*
- *A need has been recognised to develop emergency source provision (bankside storage or emergency groundwater supplies) for the Reading area which is currently reliant on unprotected direct river abstractions from the Kennet at Fobney.*
- *Artificially recharging the confined aquifer to the south-west of Reading should be investigated as a longer term resource development.*

7.5.2 THAMES-SIDE GROUNDWATER (THAMES WATER UTILITIES)

Possible groundwater developments in the middle Thames area for Slough, Wycombe and Aylesbury are unlikely to be required except under the High demand scenario. Possible developments at Harpsden, Remenham and Reading could be utilised to support growth in demand in the Upper Thames area that may materialise under the Medium - High scenarios. These would be used to substitute existing resource commitments from Gatehampton in South Oxfordshire thereby releasing resources from Farmoor (for Swindon and Oxford).

- *Thames Water Utilities will need to carry out test-pumping at each site to establish the likely yield characteristics and any effects on water levels or local environmental features.*
- *NRA will need to investigate the requirement for an environmentally acceptable flow regime to protect the River Thames.*

7.5.3 NORTH DOWNS (EAST SURREY AND SUTTON DISTRICT WATER COMPANIES)

- *The effects of operation of existing time limited provisions of the Chipstead Valley licence (Sutton District Water Company) will need to be monitored and reviewed in the period to 2000. The time limited provisions within the abstraction licence could be revised or made permanent subject to adequate environmental protection. To meet any further increase in demand the company could explore the southern edge of the confined aquifer of the London Basin, otherwise bulk supplies would be needed through Thames Water Utilities, perhaps in conjunction with the development of a new strategic scheme.*
- *Sources at Leatherhead, Purley and Kenley should be test-pumped by East Surrey Water Company to establish the possible effects of increased abstractions on spring or river flows. An environmentally acceptable flow regime will be required for the River Mole; elsewhere, environmental support for spring flows may be required.*

7.5.4 LOWER GREENSAND (MID-SOUTHERN WATER COMPANY)

Limited groundwater development may be feasible in this area.

- *NRA will continue its current programme of research and modelling but additional resources are unlikely to be available in the short - medium term.*

7.5.5 MIDDLE AND LOWER COLNE (THREE VALLEYS WATER SERVICES)

- *Opportunities in this area are currently being investigated by the company to identify substitute resources lost through the alleviation of low flows.*

7.6 STRATEGIC DEVELOPMENT OF GROUNDWATER

The strategic development of groundwater concerns mainly the successful promotion and development of schemes principally by Thames Water Utilities in the London Basin, particularly by enhancing resources through artificial recharge.

Development of the North London artificial recharge scheme is now almost complete. Feasibility studies of the use of South London groundwater are currently underway.

- *The North London artificial recharge scheme will require final authorisation by NRA: abstraction licence, operating agreement, and discharge consents.*
- *The NRA will need to assess the results of Thames Water Utilities investigations in South London. Potential aquifer management schemes for South London will be investigated further by the NRA and Thames Water Utilities.*

The need to control rising groundwater in the central London area may provide opportunities for new public water supply, private or commercial abstractions.

- *The NRA will be developing and advising the Department of the Environment on possible strategies for controlling rising groundwater levels, as a result of which, the practicabilities of utilising the potential resource will be investigated further by NRA and Thames Water Utilities.*

7.7 STRATEGIC SCHEMES TO MEET POSSIBLE FUTURE NEEDS

Should demand management not succeed in reducing future demands new schemes will have to be developed to meet any marginal demands. The following section discusses options for such schemes.

7.7.1 USE OF CANALS

Despite the relatively low costs of improving the capacity of existing canal systems leading into the region, major development of canal based transfers is unlikely owing to the cost of providing a large scale resource in an appropriate location to support such water transfer systems.

Some existing or potentially restorable canal systems could benefit indirectly from other strategic scheme developments if pursued; for example through inter-regional transfer schemes or in association with reservoir development (see below). It may be more appropriate, in this sense, to view canals as a possible future demand on resources rather than a resource development option.

7.7.2 DEVELOPMENTS IN THE ANGLIAN REGION

Schemes being considered for Anglian Region are unlikely to provide any direct benefit to resources in the Thames Region because of the engineering and environmental costs, particularly of transferring water via existing watercourses. However, these schemes may provide additional resources to Essex and Suffolk Water which could reduce the reliance on existing bulk supplies from Thames Water Utilities and release additional resources to the London area.

- *The engineering feasibility and costs of substituting the Thames Water Utilities - Essex and Suffolk Water bulk supply should be investigated jointly by the two companies and NRA.*

7.7.3 INDIRECT RE-USE OF TREATED EFFLUENT

Existing water resources in the Thames Region already rely on the indirect re-use of highly treated effluent further improved through the natural purification processes in the river system. Nevertheless, a number of potential opportunities for more intensive re-use of treated effluent for potable supplies may exist from some sewage treatment works on the lower reaches of the Rivers Thames and Lee. Adequate treatment standards must be achieved to meet drinking water and public health requirements and to provide adequate environmental protection to rivers. Current research on effluent quality, treatment requirements, public health, engineering and operating costs will need to be reviewed in collaboration with the water and sewerage undertakings.

Lower grade uses of (tertiary) treated effluent should also be explored jointly by Thames Water Utilities and NRA as a means of releasing potable quality resources for more essential uses. Possible opportunities might include:

- *more intensive recycling by industry and power generation;*
- *'grey water' use for toilet flushing or outside uses (car washes, parks, sports grounds and irrigation). A number of potential opportunities include planned new developments in the East Thames Corridor or parks and gardens (e.g Kew Gardens).*

7.7.4 SEVERN TO THAMES TRANSFER

A transfer from the River Severn to the River Thames supported by reservoir storage in Mid-Wales has been shown to provide a least cost solution. It can also be relatively quick to develop should the need arise, assuming environmental issues can be adequately addressed and consequent permission given. However, a number of significant environmental risks arising from the operation of a Severn to Thames transfer have been identified which may outweigh the cost-benefit ratio of such a scheme.

- *To address these risks, the NRA plans to continue investigations of:*
  - *the physical and chemical effects of transferring and mixing water from the River Severn into the River Thames, particularly at times of very low flow.*
  - *the possible transfer of pollutants (metals, pesticides, etc.) or biological contaminants (algae, parasites, diseases, etc.) into the River Thames and the areas supported by River Thames water.*
  - *the potential physical, chemical and biological impacts on the aquatic ecology of the upper River Thames.*
- *Further joint work will be required with the water companies in the region to establish the feasibility of a direct-to-supply piped transfer given concerns regarding the effects of potentially different water chemistry on existing infrastructure and treatment plants.*
- *An assessment of the environmental impacts of enlarging Craig Goch reservoir and of increased river regulation on the Rivers Wye and Severn by NRA may be appropriate. This work will need to be carried out following the recommendations of the regional investigations outlined above, all of which are planned to be completed within the next five years.*

7.7.5 SOUTH-WEST OXFORDSHIRE RESERVOIR

The development of a storage reservoir in South-west Oxfordshire could provide the largest potential resource benefit (up to 350 Ml/d) utilising available resources from within the region but remains the most costly of the possible schemes.

A number of environmental issues associated with the construction and operation of a new reservoir have been identified. Further work will be required to establish the constraints on development and operation arising from concerns regarding the water environment.

It is essential to establish:

- *the reservoir water quality and management regimes required to control the discharge of water which may be algal-rich and oxygen-poor into the River Thames.*

The NRA therefore plans further investigations to establish:

- *basic habitat, flow and water quality relationships to protect the existing ecology and form of the River Thames.*
- *the environmental limits on operation of the scheme so that both abstraction and augmentation could proceed without risk to the environment of the River Thames.*

- *the potential benefits of this and other strategic schemes in terms of more flexible operation of existing water resources to provide opportunity for improvement of river flow and environmental quality particularly at times of otherwise low flows.*

Before any formal promotion of this scheme, Thames Water Utilities will also need to address the following key issues:

- *identification of the potential impacts of reservoir construction on local watercourses, land drainage and flooding in Abingdon; identifying a reservoir design that will minimise impacts, together with possible mitigation measures and opportunities for conservation and enhancement of the local environment which may offset unavoidable damage.*
- *the structural integrity of the proposed design and the potential for leakage of stored water into the underlying aquifer and associated impacts on the environmental quality and ecology of the River Ock catchment.*

7.7.6 COMBINED DEVELOPMENT OF NEW SCHEMES

The scale and potential impacts of new reservoir development and inter-basin transfer schemes might be reduced by the combined development of a smaller reservoir and transfer scheme. The operation of a Severn to Thames transfer in conjunction with a smaller reservoir in South-west Oxfordshire might also provide additional flexibility in water resources management and control over the key environmental concerns arising through river regulation described above. This combined approach could allow construction and investment to be staged, responding to longer term uncertainties of growth in demand or success in demand management. However, the potential benefits may be outweighed by the need to manage smaller schemes more intensively, running the risk of more frequent failure during prolonged periods of high demand.

- *The feasibility, costs and benefits of conjunctive development and management of schemes will need to be assessed alongside the further investigations of individual schemes identified above.*

SECTION 8

PROMOTION AND DEVELOPMENT OF NEW WATER RESOURCES

8 PROMOTION AND DEVELOPMENT OF NEW WATER RESOURCES

Although the NRA has duties under the Water Resources Act 1991 to conserve, redistribute and augment water resources, those duties do not relieve the water undertakings of their own responsibilities to develop water resources to secure future supplies.

The NRA has said nationally that it does not anticipate playing a significant role in the financing, development and operation of major new schemes for two further reasons:

- *financial constraints on the NRA's ability to undertake large capital expenditure on major new water resources; although it could undertake projects jointly with developers or under grant aid from the government or European Community; and,*
- *the need to maintain its independence, as Guardian of the Water Environment, in managing water resources to achieve the right balance between the often conflicting interests of river users, abstractors and the environment.*

The NRA's main role is to identify and agree environmentally acceptable schemes and monitor the need for such schemes through the implementation and review of this strategy. In fulfilling this role, the NRA aims to ensure the sustainable management of water resources.

The major strategic schemes identified within this strategy will require the involvement of at least four principal organisations:

- *the NRA in promulgating its strategy;*
- *the water undertaker(s) as the primary beneficiary;*
- *OFWAT as the industry's economic regulator; and,*
- *Government to grant the necessary formal approvals (in the likely event of public inquiries).*

In most cases, new resource development and promotion will be the responsibility of a single water undertaker. In the case of a new reservoir however there may be complex operating agreements involving water companies, the NRA and others to provide adequate support for environmental and other uses.

In the case of inter-basin transfers, there are likely to be several interested parties and the institutional arrangements for promotion, funding and development are far from clear. For example, developing a transfer from the River Severn to the Thames Region would be likely to involve:

- *Thames Water Utilities and maybe other water companies;*
- *NRA Welsh, Severn Trent and Thames Regions;*
- *the Welsh Office, DoE and (possibly) Treasury;*
- *OFWAT;*
- *a number of Planning Authorities;*
- *a variety of interested organisations and individuals (environmental, recreation, etc).*

There are likely to be political, environmental and financial challenges in developing such a scheme; it will clearly not be a simple process! Government has indicated that public financing may be an ultimate fall-back option where all other options are shown to be impractical and, therefore, the NRA's involvement in promoting new schemes will be held as a reserved power.

The NRA will use its powers under Section 20 of the Water Resources Act 1991 to develop operating agreements for new schemes to provide operational and environmental flexibility and to provide for the needs of users other than public water supply in the operation of strategic schemes. This particularly relates to smaller users who may not be in a position to invest the substantial capital sums required for such schemes although the beneficiaries would be expected to meet the full cost of their 'share' of any development both in terms of capital investment and ongoing operational costs through abstraction charges.

The use of operating agreements allows the NRA to take into account the needs of all abstractors in the provision of resources from new strategic schemes. However, the majority of private abstractions tend to be small in comparison to public water supply operations and in most instances will be too remote from major strategic schemes to benefit. New resources for private abstractions are likely to continue to be assessed on a local catchment basis and in most cases, the initiative will lie with individual, or groups of abstractors to develop the necessary resource arrangements.

SECTION 9

THE WAY FORWARD

9 THE WAY FORWARD

9.1 INTRODUCTION

Our aim in producing this regional strategy is to provide a flexible framework for the future planning and sustainable management of water resources in the Thames Region. In doing so the reasonable needs of all water users in the future will be met while ensuring protection and improvement to the aquatic environment.

The provision of water resources to secure public water supplies and their efficient use are key issues facing this region. The successful implementation of demand management strategies and the promotion of water efficiency are essential elements of the NRA strategy for the sustainable management of water resources. The extent to which leakage from mains can be controlled or growth in demand 'managed' is critical to the need and timing of any further water resource development.

At the same time, further aspects of this strategy will be investigated. Strategy flexibility is needed in order to respond to the areas of uncertainty in forecasting any future need for new water resources, while recognising the lead time required to investigate and promote major new schemes.

9.2 RISKS AND UNCERTAINTY

We have recognised a number of areas of risk or uncertainty which may affect future decisions taken within the framework of this strategy. Some of the critical issues are highlighted below.

Demonstrating the Need for New Water Resource Schemes

The central issue for the Region is how far demand management will prove successful before further strategic water resource development schemes are needed. The range in forecast demand scenarios indicates the sensitivity of the forecasts to various factors - principally, demand management through leakage control - which would affect the timing of need for new resources. It will be essential for the NRA to monitor trends in demand forecasts and update this strategy on a regular basis.

Reducing Leakage

Control of leakage becomes progressively more expensive and difficult to achieve as levels are reduced. As the practical and economic limits of leakage control will vary with local circumstances, it is by no means certain that the target levels proposed by the NRA or those being proposed by the water companies in their submissions to OFWAT will be achievable. They may be exceeded; it is also possible that they may not be achieved.

Metering Consumers

Both the level of metering and the extent of potential savings on demand are uncertain, depending upon the tariff imposed, property type and customer willingness or ability to pay. The widespread adoption of metering will depend upon key political and economic decisions regarding future charging policy as we move towards the year 2000. The costs of potential new water resource schemes must be balanced against the savings which may arise through wider metering, as a result of reduced operating costs and deferral of capital investment on large resource/supply schemes.

Economic Change

Economic recovery is likely to affect the level of both domestic and commercial/industrial demand. Current forecasts, with the exception of the high demand scenario, assume relatively modest growth in both of these components or no growth in commercial/industrial water use. Trends in demand growth will need to be carefully monitored and reassessed on a regular basis.

The Performance of Existing Water Resources

The performance of existing licensed sources is likely to be reviewed in the light of experience during recent droughts or as a result of potential future climate change. In the latter case, the evidence is as yet uncertain and, therefore, has not been taken into consideration for this strategy.

The security of resources against pollution risk or other operational problems, particularly of groundwater sources, remains a key area of uncertainty in assessing available resources. The NRA's Groundwater Protection Policy provides guidance on practices which are not acceptable or need to be restricted because of the risk posed to the groundwater resource. However, in the longer term adequate security against such risks may require more flexible infrastructure, additional water treatment capability or additional resources.

The London supply system relies on the large storage reservoirs of the Lower Thames and Lee Valley; their benefit was particularly emphasised during the recent drought. However, as these reservoirs age, their structural integrity may restrict the intensity with which they can be used (and refilled) and could potentially reduce the overall reliability of the London supply system.

The Promotion of New Schemes

Although a number of local schemes have been proposed to improve self-sufficiency within catchments, further investigations will still be needed prior to promotion and even then this development may prove environmentally unacceptable.

Should higher demand growth occur and major new resources be required, the most critical issues of any new strategic scheme development will be the timing and success of promotion. Most of the schemes under consideration will impact on the environment in some way and experience of the promotion of recent schemes suggests that it could take up to 15 to 20 years from starting feasibility studies to the commissioning of a new scheme. Many of these schemes may still prove to be environmentally unacceptable.

Climate Change

Although it is not yet possible to demonstrate conclusively that global warming is taking place, there is international concern that this may lead to climate change occurring over the next 100 years. As a result of the uncertainty of predicting the onset and severity of climate change (it could take 30 years or more to confirm), the possible effects of climate change on water resources have not been directly considered in this strategy.

The NRA is already working with other specialist organisations in this field to monitor the situation and intends to undertake further research to ensure that the potential impact of climate change on water resources can be built into the planning process. In the meantime, however, the additional uncertainty presented by potential climate change emphasises the need for a flexible and robust strategy which takes the precautionary approach when maximising the use of the existing natural resource.

9.3 OUTSTANDING ISSUES AND FUTURE WORK

Clearly, a major feature of this strategy will be the need to monitor trends in demand growth and of the success of demand management options. Essential to this will be the recognition of both the practical and economic limits of leakage control and metering of existing consumers. The NRA will need to work closely with the water companies, OFWAT and others to monitor and review the extent to which these measures may offset the need for new water resources development.

The NRA will continue to challenge the companies to improve their efficiency in using and distributing water resources and will itself seek ways to promote water efficiency and raise awareness about water use and water resources generally.

In terms of new schemes, the key issue for the Thames Region is to establish a firm position on the choice between the SW Oxfordshire Reservoir Proposal (relatively high cost and potentially low net environmental impact) compared to the Severn-Thames Transfer scheme (relatively low cost but potentially greater environmental impact) while the scope for controlling or eliminating overall demand increases is explored.

Our immediate task is to establish the scale and significance of impacts on the environment of those schemes under consideration, reject those schemes we cannot support (i.e those which are not sustainable) and to identify mitigation and enhancement opportunities where we can.

A number of further investigations have been identified; they include:

- *A programme of investigations (already commenced) to establish baseline environmental conditions of the River Thames in response to the Thames Water Utilities proposal for a new reservoir;*
- *Baseline river corridor surveys of the Upper Thames are planned as a forerunner to any major environmental assessment of the impacts of transfer - regulation schemes;*
- *Baseline surveys of fisheries, ecology, river flow and water quality to establish minimum flow requirements and any scope for further development;*
- *Surveys and modelling to establish the potential impacts of transfer and river regulation schemes on the fisheries and ecology of the River Thames;*
- *Comparative investigations to establish the benefits of a regional reservoir within the context of an inter-regional transfer, including issues such as the resilience and reliability of the supply system to be gained through storage of winter flows;*
- *Surveys and modelling to establish the physical effects of river regulation and the potential transmission losses of water to the riverside gravels of the Thames during dry periods;*
- *Development of inter-regional databases and water quality and water resource models to assess the potential effects of inter-regional transfer schemes on the Rivers Wye, Severn and Thames.*

These studies will provide the basic framework for assessing the environmental requirements and limits for new resource development on the River Thames and adjacent catchments. The NRA intends to complete the major part of these investigations within the next five years, working with the water companies to encourage further joint investigations to establish the region's preferred strategy.

During this time there should be a much clearer view of the effectiveness of leakage control, the scope for further demand management and a likely policy on domestic metering; all of which will have a direct influence on the demand for water. The effect of the NRA's recent influence

on local authority development plans in the interests of the water environment may also become apparent during this period.

The region will also monitor trends in direct agricultural and industrial use of water. We will also review needs by others for potential new water resource schemes. Efficiency and better practice will be encouraged where possible.

Many technical issues have been raised in the development of this strategy and will need to be addressed in the context of the sustainable management of water resources. The strategy is an important first step towards what will become much broader discussions with all interest groups regarding the future planning and management of water resources.

GLOSSARY

GLOSSARY OF TERMS

1:50 year Drought	*A drought of a severity which has a 1 in 50 chance of occurring in any one year.*
£M	*Million Pounds Sterling.*
£K	*Thousand Pounds Sterling.*
Abstraction	*The removal of water from any source.*
Abstraction Licence	*Authorisation granted by the NRA to allow the removal of water from a source of supply.*
Alleviation of Low Flows (ALF)	*The National Rivers Authority's national strategy for resolving environmental problems caused by over-abstraction in certain catchments.*
Aquifer	*A layer of permeable rock, sand or gravel capable of holding and transmitting significant quantities of water.*
	Confined Aquifer: *The upper boundary of the aquifer is largely sealed by overlying impermeable strata. Recharge occurs indirectly from unconfined areas.*
	Unconfined Aquifer: *The upper boundary of the aquifer outcrops at the ground surface. Recharge occurs directly from rainfall or runoff.*
Artificial Recharge	*The recharging of an aquifer by other than natural means (e.g. by injection through boreholes).*
Asset Management Plan	*Water companies' strategic business plans - initiated by the Office of Water Services as part of the periodic review of water company charges.*
(River) Augmentation	*To increase, support or regulate river flows by releasing or pumping from stored resources e.g. reservoir or groundwater.*
BMWP	*Biological Monitoring Working Party.*
BOD	*Biochemical Oxygen Demand: A measure of the amount of oxygen needed by microorganisms to break down organic material.*
BW	*British Waterways.*
Bioaccumulation	*The build-up of chemicals (e.g. metals, pesticides) through food chains in an ecosystem.*
Biodiversity	*Having a range/variety of species.*
Brundtland Report	*Report of the 1987 World Commission on Environment and Development.*
Buffer Zone	*Typically unimproved pasture land set aside adjacent to water courses creating a buffer for intercepting runoff and removing nutrients, thereby enhancing the river corridor environment.*
Bulk Supply	*Legal arrangements between supply companies for the transfer of (sometimes large) quantities of raw or treated water.*
CBI	*Confederation of British Industry.*
(Environmental) Carrying Capacity	*The capacity required to safeguard the natural environment.*
Catchment	*The area from which precipitation and groundwater will collect and contribute to the flow of a specific river.*
Catchment Management Plan (CMP)	*The planning process being used by the NRA with the aim of sustainable river basin development at the catchment scale.*

Channel Morphology	*The physical shape or form of river channels arising from hydrologic processes.*
Confined Aquifer	*see Aquifer.*
Conjunctive Use	*Combined use of different sources of water (usually a surface water source and a groundwater source or groundwater sources of different characteristics).*
DoE	*Department of Environment.*
Demand	*The requirements for water by consumers.* Average Demand: *usually refers to the average daily demand (averaged over the year).* Peak Demand: *may refer to the seasonal peak consumption (May - September), peak week distribution demand, or peak daily demand recorded.*
Demand Centre	*A generally discrete area of public water supply demand in which specific sources of supply can be used to meet demand throughout that area.*
Demand Management	*Activities to manage the amount of water required from a source of supply; includes measures to control waste and/or to discourage consumption.*
Direct re-use	*Use of treated effluent from a sewage treatment plant directly as a source of water for a water treatment plant.*
Discharge Consent	*A licence granted by the NRA to discharge effluent of specified quality and volume at a specific point.*
Drought	*A general term covering prolonged periods of below average rainfall resulting in low river flows and/or low recharge to groundwater, imposing significant strain on water resources.*
EIA	*Environmental Impact Assessment.*
EIFAC	*European Inland Fisheries Advisory Committee.*
Ecology	*The relationship between living systems and their environment.*
Ecosystem	*Referring to a biological community and its functioning as a self-sustaining ecological unit.*
Effective Rainfall	*That rainfall 'available' for recharge of aquifers or to support river flows after losses due to evaporation and take up by plants.*
Effluent	*Liquid waste from industrial, agricultural or sewage plants.*
Effluent Re-use	*The use of effluent treated to appropriate (or required) standards for various uses from low grade (grey water) uses to potable supply. The term generally refers to indirect use of treated effluent; effluent mixed to a large degree with other raw water (c.f. Direct Re-use).*
Environmentally acceptable flow regime	*The flow regime required to safeguard the natural water environment and existing uses. The term embraces Minimum Acceptable Flows.*
Eutrophication	*The enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorous, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present, and to the quality of the water concerned.*

Flow Constraint	*A condition contained within an abstraction licence which links the quantity available to be abstracted with river flow.*
Global Warming	*The generic term used to describe the climate changes which may occur for example, as a result of depletion of the ozone layer or through the emission of 'greenhouse' gases.*
Grey water	*The use of partially treated or recycled water for non-potable uses (e.g toilet flushing,outside use).*
Groundwater	*Water held in aquifers.*
ha	*Hectare.*
Habitat	*The customary and characteristic dwelling place of a species or community.*
Hydrology	*The study of water on and below the earth's surface.*
l/h/d	*Litres per head per day. (This is a way of expressing per capita consumption).*
l/prop/day	*Litres per property per day.*
l/prop/day/yr	*Litres per property per day per year (change in the rate of use).*
London Basin	*A particular geological formation beneath the London area.*
MAFF	*Ministry of Agriculture, Fisheries and Food.*
Ml/a	*Megalitres per annum (one Megalitre is equal to 1 million litres or approximately 220,000 gallons). Usually applied to demand for, or use of, water.*
Ml/d	*Megalitres per day (one Megalitre is equal to 1 million litres or approximately 220,000 gallons).*
Macroinvertebrate	*Small organism having no backbone often used as indicator species because of tolerance or vulnerability to water quality changes and pollutants.*
Marginal Demand	*A forecast demand for public water supply which cannot be met from existing resources or new local resources which can be developed. (or Deficit)*
Mitigation	*Refers to the environmental impact of scheme development or operation and the actions which may be taken to reduce or ameliorate such impacts.*
NFU	*National Farmers Union.*
NPC	*Net Present Cost - the total cost of future expenditure discounted to present values.*
NRA	*National Rivers Authority.*
NWC	*National Water Council.*
OFWAT	*Office of Water Services. OFWAT regulates charges of water companies and their service to customers.*
Outage	*A term used by the water companies to describe the loss of public water supply source yields due to planned or un-planned maintenance and the permanent or temporary loss of supply due to pollution.*

PCC	*Per Capita Consumption or the quantity of water used for normal household domestic purposes expressed as a volume per person.*
95th Percentile (Q95)	*The mean daily flow of a river which is exceeded on average for 95% of a flow record.*
Percolation	*The movement of water through aquifers.*
Public water supply (PWS)	*Water treated to potable standards, supplied to domestic and commercial consumers through a system of mains and pipes.*
RAMSAR	*An international convention originally agreed in 1975 to stem the progressive encroachment on, and loss of, wetlands.*
RIVPACS	*River Invertebrate Prediction and Classification System.*
RQO	*River quality objective.*
Recharge	*The replenishment of aquifers through natural or artificial means.*
Regulated River	*A river where the flow is augmented through the addition of water from another source.*
Reliable yield	*The quantity that a source can be expected to supply during a drought period.*
Revoke	*To cancel or withdraw a licence for a given source.*
Rising Groundwater	*Resulting in some locations from the natural recovery of an aquifer following a reduction in groundwater abstraction.*
SEA	*Strategic Environmental Assessment.*
SPA	*Special Protection Area.*
SPL	*Supply Pipe Leakage.*
SSSI	*Site of Special Scientific Interest.*
Sewage	*Liquid waste from cities, towns and villages which is normally collected and conveyed in sewers for treatment and/or discharge to the environment.*
Source works	*The plant associated with abstracting and supplying water from any water source.*
Surface Water	*Water which flows or is held on the ground surface; streams, rivers, lakes and ponds.*
Sustainable Development	*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*
Sustainable Management	*The interpretation of the principles of sustainable development at a local/regional level within the boundaries of national and international political, economic and environmental decisions.*
Total Capital Costs	*All costs of constructing a new water resource scheme.*
Total Treated Water Losses	*The sum total of the loss of water from company distribution systems (trunk mains and distribution losses), customer supply pipes and general domestic leakage.*
Treated sewage effluent	*Liquid waste from a sewage treatment works which has been through several stages of treatment to produce water with considerable lower levels of suspended solids, BOD and Ammonia.*

Water Delivered	*The quantity of water at the point of delivery to consumers, including measured/unmeasured commercial and household uses. Water Delivered to households includes losses on the customers' premises (e.g. supply pipe losses, leaking valves, etc.).*
Water Into Supply	*Or Distribution Input. The total quantity of treated water pumped into the distribution systems. Includes Water Delivered (above), distribution losses and water used by the supply company (Water Not Delivered) and for fire-fighting.*
Water Table	*The level in an aquifer below which the ground is wholly saturated with water.*
Wetland	*An area of low lying land where the water table is at or near the surface for most of the time leading to characteristic habitats.*
Yield	*The rate at which water can be drawn from a water resource.*

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Future Water Resources In The Thames Region reflects current views of water resources in the Thames Region and will be reviewed in the light of future trends in demand and the outcome of resource investigations. It has been issued to major abstractors, organisations representing water users, planning authorities, regulatory agencies and others with legitimate interest in the water resources and the water environment of the Thames Region.

Your views on the document and the key issues would be welcome and should be sent to:

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