NRA

NATIONAL RIVERS AUTHORITY

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY

WATER COMPANY CONSULTATION PAPER

JUNE 1993

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NRA NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY WATER COMPANY CONSULTATION PAPER

1. INTRODUCTION

1.1 Background

The NRA has a general duty to ensure the proper use of water resources. Under Section 188 of the Water Resources Act 1991 it also has a duty to publish information from which assessments can be made of actual and prospective demands for water and actual and prospective water resources in England and Wales. In fulfilment of these duties the NRA is committed to publishing a strategic framework for the development of new water resources for England and Wales to meet demands up to the year 2021.

Development of the strategic framework is a multidisciplinary project, involving yield assessment, demand forecasting, resource engineering, costing and environmental assessment. The principal aim of this Consultation paper is to present our forecasts of demand to the year 2021 and to elicit comments upon these forecasts. In addition, the opportunity is taken to inform companies of the other aspects of the work leading to the development of the NRA's strategy.

The project is being executed in discrete units, with the NRA regions and various external consultants undertaking a series of individual inter-related studies. It is recognised that the support and co-operation of the water undertakers is essential to the success of any water resources strategy developed by the NRA. It is NRA's policy, therefore, to involve the water undertakers in the development of the strategy, keeping them informed of what actions are being taken, providing an opportunity for comment or query and stimulating the provision of relevant data. This consultation paper is the second formal step in this process although most of the undertakers have already co-operated in assisting the NRA through the provision of demand and yield data. The first formal step was the publication of the discussion document in March 1992 entitled 'Water Resources Development Strategy - A Discussion Document'.

1.2 Key Activities and Programme

Figure 1.1 illustrates schematically the key activities and programme for the development strategy. Production of this Consultation paper, (shown at TIME NOW in Figure 1.1) concludes Phase 1 of the project.

The future needs for public water supply, which the development strategy will be required to meet, have been identified through studies of existing and forecast demands and yields. Studies have also been undertaken investigating, at varying levels of detail, the engineering feasibility, costs and environmental impacts of a number of potential strategic resource options.

KEY ACTIVITIES AND PROGRAMME FOR STRATEGY DEVELOPMENT

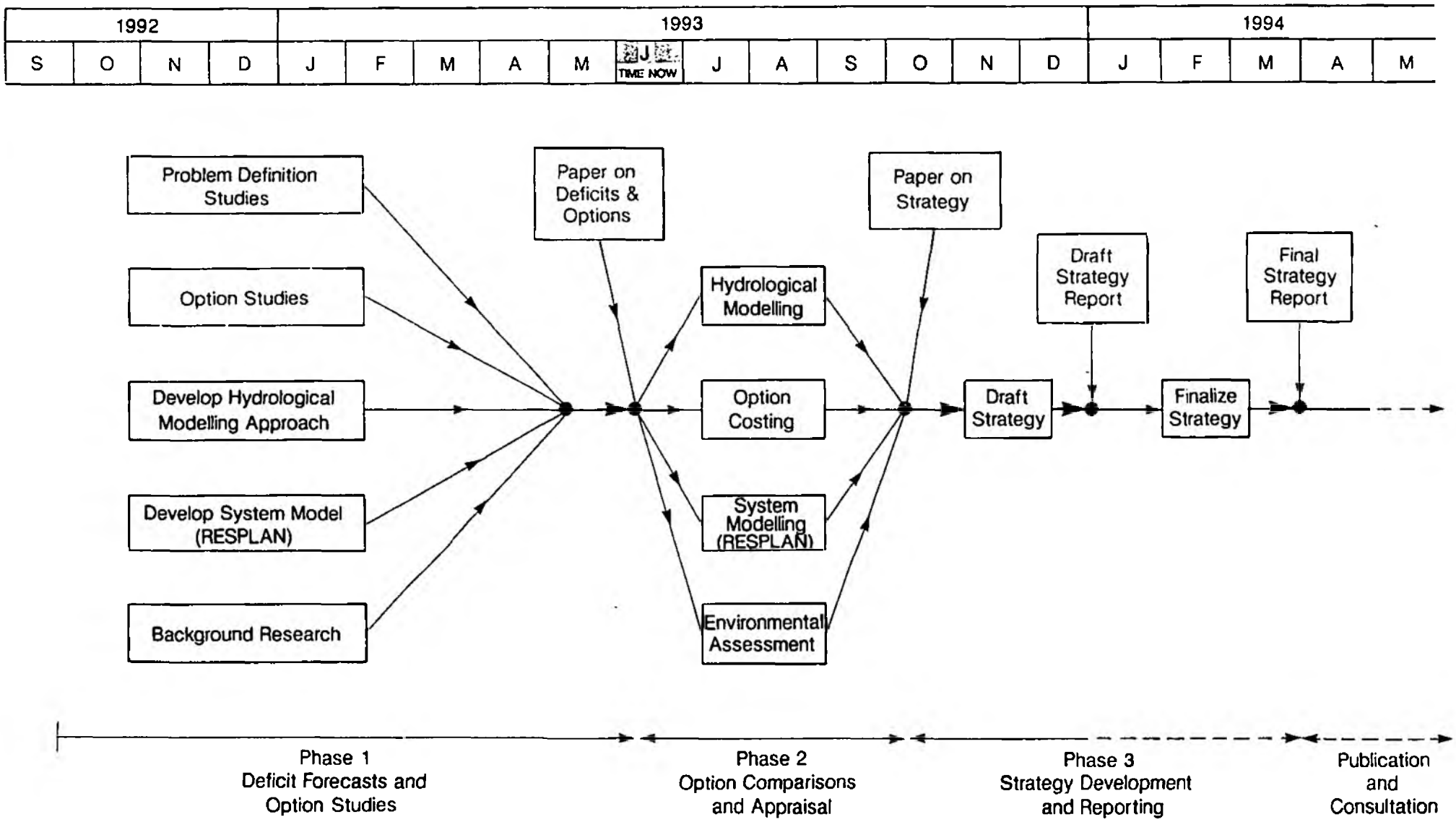


Figure 1.1

Phase 2 comprises comparison and appraisal of the various strategic options. This will include hydrological and systems modelling together with comparison of the likely environmental impacts of the options. Phase 2 will conclude with a second Consultation paper in which preliminary proposals for the preferred combination of strategic options will be presented. These activities are described further in Section 4 of this paper. It is then planned to produce a draft report, setting out the NRA's preferred strategy by the end of December 1993 for progression to final publication in April 1994. The purpose of the national strategy document is not to define in detail when a particular scheme is required, but rather to indicate the sequence of likely developments, their magnitude and probable timing.

2. THE NEEDS

2.1 General

The first step in the development of a national water resources development strategy is the identification of the magnitude, broad timing and geographical location of the resource deficits which the strategy will be required to meet. To obtain this information 'problem definition studies' have been undertaken to quantify existing and forecast public water supply demands and yields. From these data, future resource deficits can be assessed.

Summaries of the information obtained through the problem definition studies are given in Sections 2.2, 2.3 and 2.4 below. Further details of methodology and assumptions, together with data specific to each water company, are given in the Appendices.

2.2 Demands

It is emphasised that the approach which has been taken to demand forecasting for the strategy is to apply a consistent methodology to all company forecasts throughout England and Wales.

It is recognised that in order to achieve the necessary consistency in the demand forecasts which have been produced, there could be some differences between these forecasts and those produced at local level. For example, we have not included a 'planning' margin which may be appropriate in more detailed planning studies. There may also be some differences in the basic assumptions used in the respective forecasts. Clearly gross differences will need to be considered but for the purposes of developing a broad strategy for England and Wales lesser differences are not considered to be as important as achieving consistency.

The NRA has followed a multiple component demand forecasting methodology. Details of the approach and the assumptions made are provided in Appendix A and the specific company forecasts produced are presented in Appendix B.

A series of four forecast scenarios, utilising a broad based suite of assumptions about future demand, have been produced at 5 year intervals between the base year, 1991 and the forecast horizon set at 2021. Figure 2 in Appendix A summarises the forecasting assumptions and combinations within each scenario. These forecast scenarios indicate the range of forecasts between high and low and therefore indicate the predictive demand envelope for the strategy. A regional summary of the demands calculated for each forecast scenario is presented in Table 2.1. This table considers potable water supply only. Whilst the forecasts have been derived for the NRA's particular requirements of strategic planning, they have wherever possible been based on guidelines for the AMP2 review, and will provide the NRA with a basis for discussion with Companies over their AMP2 submissions.

The demand forecasts were designed to cover a wide range of possibilities from high to low growth and thus they indicate the maximum envelope to be considered. Consequently there is expected to be a significant difference between strategies to meet the two extremes of high and low forecast. The NRA proposes to focus upon the 'Managed' forecast in its strategy development although the extremes will also be investigated. It is considered that the Managed forecast represents a realistic basis for the focus of the development strategy work as it is believed that it incorporates realistic assumptions of growth together with readily achievable measures in relation to demand management. In the preparation of the strategy account will also need to be taken of demands for industry and agriculture for direct abstraction.

2.3 Yields

Estimates of yield have been obtained for each source (or group of sources) licensed to a water undertaker, including sources used to supply non-potable water to industrial users. These are summarised by NRA region in Table 2.2. Essentially, the approach adopted was to obtain the best available estimates of yield from existing data, whilst highlighting the need for more research into developing a common methodology for yield assessment. Detailed information on existing source yields, specific to each water company, is presented in Appendix C.

2.4 Regional Surplus/Deficit Analysis

A broad based analysis of the balance between resources and demands within the NRA regions is shown in Table 2.3. An allowance for non-potable water supplied to industrial users from sources licensed to water undertakers is included within the existing and forecast demand figures to make them compatible with the yield estimates.

The analysis of existing yields against the NRA 2021 forecast demands indicates surpluses or deficits which are shown for each company in Table 2.3.

TABLE 2.1 SUMMARY OF NRA DEMAND FORCASTS FOR EACH REGION TO 2021

		POTABLE WATER DEMAND: LOW (Ml/d)						POTABLE WATER DEMAND: HIGH (Ml/d)						POTABLE WATER DEMAND: MANAGED (Ml/d)						POTABLE WATER DEMAND: UNMANAGED (Ml/d)					
YEAR	1991	1996	2001	2006	2011	2016	2021	1996	2001	2006	2011	2016	2021	1996	2001	2006	2011	2016	2021	1996	2001	2006	2011	2016	2021
ANGLIAN	1725	1637	1626	1606	1583	1642	1703	1873	1974	2079	2190	2308	2432	1666	1686	1743	1803	1872	1943	1836	1898	1961	2027	2103	2181
NORTHUMBRIAN	831	758	738	743	748	755	762	852	873	895	918	942	967	779	779	783	788	795	801	835	839	843	847	853	860
NORTH WEST	2495	2238	1990	1892	1913	1939	1967	2546	2606	2665	2731	2795	2866	2238	1990	1998	2018	2043	2071	2508	2523	2538	2556	2577	2602
SEVERN TRENT	2411	2214	2251	2298	2344	2399	2456	2493	2589	2689	2797	2907	3023	2277	2317	2363	2411	2467	2525	2445	2491	2538	2589	2647	2706
SOUTHERN	1220	1141	1130	1112	1092	1129	1168	1317	1382	1450	1522	1598	1679	1167	1172	1207	1245	1288	1333	1291	1330	1369	1410	1458	1507
SOUTH WEST	499	457	436	453	471	491	512	542	572	605	639	674	712	472	477	495	515	537	560	532	552	574	596	620	646
THAMES	3975	3588	3191	3123	3053	3132	3214	4231	4390	4556	4731	4915	5108	3641	3302	3378	3453	3544	3638	4155	4237	4320	4408	4509	4614
WELSH	1132	1028	933	871	886	903	921	1163	1199	1235	1276	1316	1358	1032	906	920	935	952	971	1144	1160	1176	1194	1214	1234
WESSEX	867	827	827	850	874	901	930	934	981	1030	1082	1135	1193	869	889	914	940	970	1001	915	941	967	995	1027	1060
YORKSHIRE	1506	1344	1268	1287	1307	1332	1357	1551	1601	1650	1704	1761	1819	1346	1341	1360	1381	1406	1432	1524	1544	1563	1585	1610	1637
TOTAL	16661	15232	14388	14232	14272	14622	14988	17502	18168	18855	19590	20352	21157	15488	14889	15159	15490	15873	16274	17183	17516	17849	18209	18618	19047

Companies contained within the regions are as follows:

ANGLIAN: Anglian Water, Essex Water, Cambridge Water, Tendring Hundred and Suffolk Water.
NORTHUMBRIAN: Northumbrian Water, North East Water and Hartlepools.
NORTH WEST: North West Water.
SEVERN TRENT: Severn Trent Water, South Staffs Water and East Worcester Water.
SOUTHERN: Southern Water, Portsmouth Water, South East Water, Mid Kent Water and Folkestone & District Water.
SOUTH WEST: South West Water.
THAMES: Thames Water, Three Valleys Water, North Surrey Water, East Surrey Water, Mid Southern Water and Sutton Water.
WELSH: Dwr Cymru, Wrexham & East Denbighshire Water, Chester Water.
WESSEX: Wessex Water, Bournmouth & West Hants Water, Bristol Water.
YORKSHIRE: Yorkshire Water, York Water.

For definitions refer to Appendix A.

Table 2.2

SUMMARY OF EXISTING YIELDS BY NRA REGION

REGION	YIELD (Ml/d)
Anglian	2270
Northumbria	1525*
North West	3086
Severn Trent	2600**
Southern	1517
South West	606
Thames	4333
Welsh	1460
Wessex	1045
Yorkshire	1666
TOTAL	**20108**

* Excludes 525 Ml/d of unallocated yield from Kielder Reservoir

** Excludes 215 Ml/d unallocated Carsington, Shropshire Groundwater and other source yield.

Companies contained within the regions are as follows:

ANGLIAN: Anglian Water Services Ltd, Essex Water Company, Cambridge Water Company, Tendring Hundred Waterworks Company, Suffolk Water company.

NORTHUMBRIA: Northumbrian Water Ltd, North East Water, Hartlepools Water Company.

NORTH WEST: North West Water Ltd

SEVERN TRENT: Severn Trent Plc, South Staffordshire Water Company, East Worcestershire Waterworks Company.

SOUTHERN: Southern Water Services Ltd, Portsmouth Water Plc, South East Water, Mid Kent Water Company, Folkestone and Dover Water Services.

SOUTH WEST: South West Water Services Ltd

THAMES: Thames Water Utilities Ltd, Three Valleys Water Services, North Surrey Water Company, East Surrey Water Plc, Mid Southern Water Company, Sutton District Water Plc

WELSH: Dwr Cymru, Wrexham and East Denbighshire Water Company, Chester Waterworks Company

WESSEX: Wessex Water Plc, Bournemouth and District Water Company, Bristol Waterworks Company, Cholderton and District Water company, West Hampshire Water Company

YORKSHIRE: Yorkshire Water Services Ltd, York Waterworks Plc.

TABLE 2.3 REGIONAL SURPLUS AND DEFICIT ANALYSIS FOR 1991 AND 2021 UNDER NRA DEMAND FORCAST SCENARIOS

COMPANY	EXISTING YIELD (Ml/d)	EXISTING DEMAND (Ml/d)	EXISTING SURPLUS (Ml/d)	2021 HIGH DEMAND (Ml/d)	2021 UNMANAGED DEMAND (Ml/d)	2021 MANAGED DEMAND (Ml/d)	2021 LOW DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - HIGH DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD -UNMANAGED DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - MANAGED DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - LOW DEMAND (Ml/d)
	(a)	(c)		(d1)	(d2)	(d3)	(d4)				
DERIVATION			(a)-(c)					(a)-(d1)	(a)-(d2)	(a)-(d3)	(a)-(d4)
ANGLIAN	1563	1176	387	1666	1501	1330	1170	-103	62	233	393
ESSEX WATER	440	405	35	527	472	419	368	-87	-32	21	72
CAMBRIDGE	125	74	51	114	102	95	83	11	23	30	42
TENDRING	44	32	12	55	50	47	40	-11	-6	-3	4
SUFFOLK	98	77	21	107	95	92	81	-9	3	6	17
REGION TOTALS	2270	1764	506	2469	2220	1983	1742				
REGION SURPLUS								11	88	290	528
REGION DEFICIT								-210	-38	-3	0
NORTHUMBRIAN	990	667	323	739	682	632	613	251	308	358	377
NORTH EAST	484	357	127	415	371	366	346	69	113	118	138
HARTLEPOOLS	51	44	7	50	44	41	40	1	7	10	11
REGION *	1525	1068	457	1204	1097	1039	999	321	428	486	526
REGION SURPLUS								321	428	486	526
REGION DEFICIT								0	0	0	0
NORTH WEST	3086	2591	495	2962	2698	2167	2063	124	388	919	1023
REGION	3086	2591	495	2962	2698	2167	2063				
REGION SURPLUS								124	388	919	1023
REGION DEFICIT								0	0	0	0
SEVERN TRENT	2175	1979	196	2485	2224	2087	2030	-310	-49	88	145
SOUTH STAFFS	357	358	-1	429	384	356	346	-72	-27	1	11
EAST WORCS	68	74	-6	108	99	82	79	-40	-31	-14	-11
REGION	2600	2411	189	3022	2707	2525	2455				
REGION SURPLUS								0	0	89	156
REGION DEFICIT **								-422	-107	-14	-11
SOUTHERN	875	660	215	911	820	724	636	-36	55	151	239
PORTSMOUTH	262	205	57	280	253	227	202	-18	9	35	60
SOUTH EAST	180	158	22	213	192	181	158	-33	-12	-1	22
MID KENT	148	155	-7	204	184	158	139	-56	-36	-10	9
FOLKESTONE	52	55	-3	78	71	55	48	-26	-19	-3	4
REGION	1517	1233	284	1686	1520	1345	1183				
REGION SURPLUS								0	64	186	334
REGION DEFICIT								-169	-67	-14	0

TABLE 2.3 REGIONAL SURPLUS AND DEFICIT ANALYSIS FOR 1991 AND 2021 UNDER NRA DEMAND FORCAST SCENARIOS

COMPANY	EXISTING YIELD (Ml/d)	EXISTING DEMAND (Ml/d)	EXISTING SURPLUS (Ml/d)	2021 HIGH DEMAND (Ml/d)	2021 UNMANAGED DEMAND (Ml/d)	2021 MANAGED DEMAND (Ml/d)	2021 LOW DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - HIGH DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD -UNMANAGED DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - MANAGED DEMAND (Ml/d)	COMPANY 2021 SURPLUS/ DEFICIT WITH EXISTING YIELD - LOW DEMAND (Ml/d)
	(a)	(c)		(d1)	(d2)	(d3)	(d4)				
DERIVATION			(a)-(c)					(a)-(d1)	(a)-(d2)	(a)-(d3)	(a)-(d4)
SOUTH WEST	606	499	107	712	646	560	512	-106	-40	46	94
REGION	606	499	107	712	646	560	512				
REGION SURPLUS								0	0	46	94
REGION DEFICIT								-106	-40	0	0
THAMES	2754	2738	16	3457	3113	2428	2159	-703	-359	326	595
THREE VALLEYS	896	702	194	918	835	670	584	-22	61	226	312
NORTH SURREY	181	139	42	186	168	142	124	-5	13	39	57
EAST SURREY	133	108	25	138	125	98	86	-5	8	35	47
MID SOUTHERN	303	222	81	323	295	230	201	-20	8	73	102
SUTTON	65	66	-1	85	77	70	60	-20	-12	-5	5
REGION	4332	3975	357	5107	4613	3638	3214				
REGION SURPLUS								0	90	699	1118
REGION DEFICIT								-775	-371	-5	0
DWR CYMRU	1364	1198	166	1410	1296	1036	990	-46	68	328	374
WREXHAM	63	45	18	53	47	45	42	10	16	18	21
CHESTER	34	30	4	35	32	31	30	-1	2	3	4
REGION	1461	1273	188	1498	1375	1112	1062				
REGION SURPLUS								10	86	349	399
REGION DEFICIT								-47	0	0	0
WESSEX	448	409	39	580	521	464	427	-132	-73	-16	21
BOURNMOUTH &WH	226	154	72	206	179	179	173	20	47	47	53
BRISTOL	370	325	45	427	381	379	350	-57	-11	-9	20
REGION	1044	888	156	1213	1081	1022	950				
REGION SURPLUS								20	47	47	94
REGION DEFICIT								-189	-84	-25	0
YORKSHIRE	1570	1458	112	1761	1585	1381	1309	-191	-15	189	261
YORK WATER	96	48	48	58	52	51	49	38	44	45	47
REGION	1666	1506	160	1819	1637	1432	1358				
REGION SURPLUS								38	44	234	308
REGION DEFICIT								-191	-15	0	0

1. Existing yields data from revised Halcrow report - Review of public water supply source yields (1993).
2. Where appropriate, the demands figures include any existing supplies of non potable water to industry. Therefore in some instances the forecast demand figures will not match those in Appendix B.
3. * Northumbrian regional total excludes 525 Ml/d of unallocated Kielder yield.
4. ** Excludes 215 Ml/d of unallocated Carsington, Shropshire groundwater and other source yield.

It should be noted that the analysis is only indicative of regional surpluses and deficits because it assumes that any surplus yield available within a company can be used to meet any deficit within the same company. In practice, the scope to do so may be constrained by supply system configuration, or the cost of developing and operating adequate local transfer schemes.

3. THE OPTIONS

3.1 General

Options for meeting deficits would include what may be termed local and strategic developments. The national water resources strategy will focus upon strategic developments based upon the assumption that local developments would be utilised before strategic development would be considered.

The NRA in consultation with water companies has identified a number of strategic resource options for investigation as potential components of the national water resources strategy. The strategic options identified relate both to sources of additional water and schemes for the distribution of water. However, identified local sources will be reviewed to assess their likely yield and prospects of promotion both economically and environmentally. Brief details of proposed strategic sources and transfers are given below.

3.2 Potential Strategic Options

The major strategic resource options identified by the NRA could be combined into an overall national strategic framework in many ways. The major resources under consideration are:-

- River Severn including the redeployment of Vyrnwy reservoir;
- enlargement of Craig Goch reservoir;
- the River Trent;
- Kielder reservoir;
- Carsington;
- Reservoirs in East Anglia; and
- Oxfordshire reservoir.

Vyrnwy reservoir is principally operated as a direct supply reservoir to North West Water. It has been proposed however, that the yield of Vyrnwy could be partially redeployed for regulation of the Severn. The impact of redeployment on the resource arrangements in North West region is the subject of a joint study being undertaken by our North West region and North West Water.

An enlarged Craig Goch reservoir could also be used to provide increased regulation of either the River Wye or, via catchment transfer arrangements, the River Severn. Water could be used in the former case to support increased abstraction from the River Wye which could in turn be transferred to areas of deficit, and in the latter case to support existing abstraction on the Severn or allow for new or increased transfers

to areas of deficit as described below.

Due to concerns over water quality, the River Trent has not in the past been considered as a likely source of water for potable public water supply. However, recent improvements in water quality and treatment technology have led to proposals to use the Trent, as a potential source of water for transfer to demand centres in East Anglia. The resource value of the Trent used in this way could be enhanced by regulation, either by using a Severn-Trent transfer link or possibly temporary use of Carsington.

A major source of water identified as a potential component in the national strategy is Kielder reservoir. NRA Northumbria region has estimated that some of the 525Ml/d of currently unallocated Kielder yield is available as export from the River Tees, supported when necessary by the transfer from the river Tyne, augmented as appropriate by Kielder.

Identification of a source of water to meet forecast deficits is only one aspect of resolving the problem. The water also needs to be available at the point of demand and at the time of demand.

Various proposals for schemes to transfer water from the sources described above are being investigated. The principal proposals are shown below although the details will depend upon the timing of demand and possible requirements for storage of the water. The transfers being considered include:

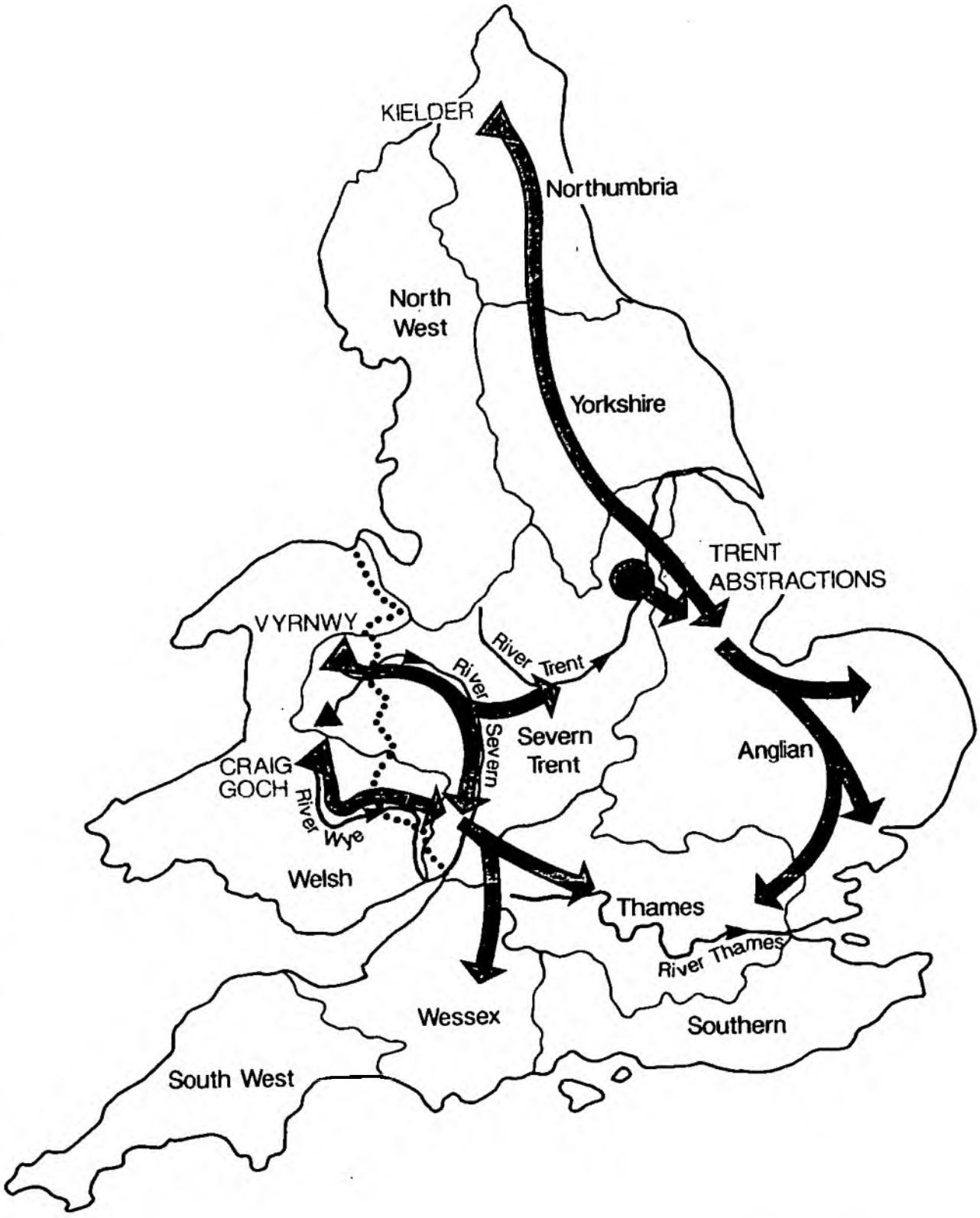
- River Severn to River Thames;
- River Trent to Anglian region;
- River Severn to River Trent to compensate the Lower Trent for the effects of a transfer to Anglian region;
- River Severn to Wessex region;
- River Wye to River Severn if an enlarged Craig Goch were to be developed to regulate the Wye;
- Kielder to Anglian region as an alternative to a Trent to Anglian transfer;
- transfers from the North West to the South and East via the BWB canal system.

Examples of these are shown schematically in Figure 3.1.

The details and sizing of any transfer scheme will depend on the exact location of the demand centres, the timing and magnitude of the deficits to be met and the proposed operating regime for the transfer. For example, a River Severn to River Thames transfer could be used to regulate the River Thames directly or could be used in conjunction with some form of storage such as the proposed Oxfordshire reservoir. In Anglian region, proposals have been put forward for transferring Trent water to enhance the yield of a new reservoir at Great Bradley in Essex. Alternatively, a possible Fenlands reservoir is being investigated.

Detailed investigation of the various sources and transfer proposals will be undertaken during Phase 2 of the strategy development.

Figure 3.1



TRANSFER OPTIONS
Examples of Inter-Regional Transfers

4. NEXT STEPS

4.1 Hydrological Modelling

One of the main tasks for Phase 2 of the project is hydrological modelling of the principal strategic options under consideration. There are four key objectives to this exercise:

- to evaluate yields;
- to identify whether there is contemporaneous availability of water from the 'donor' sources for meeting demands in the recipient regions. This will allow storage requirements, if any, to be identified;
- to provide information on the sizing of capital works and the operational regime required for input to the systems modelling package; and
- to provide information on changes in river flow regimes for input to the environmental studies.

The range of options for modelling has been expressed broadly, rather than identifying every conceivable regulation/storage/capacity combination. The modelling is being undertaken by the NRA and is due for completion in the near future.

4.2 Systems Modelling

The NRA intend to use a systems modelling package, RESPLAN, originally developed by the former Anglian Water Authority, as a tool in the development of the national strategy.

RESPLAN models the patterns and growth in demands for water and the range of developments which could meet them. Its function is to identify a set of developments which will satisfy demands at the same time as meeting some other criterion, such as minimum cost. This financial objective nearly always takes the form of minimising the Total Discounted Cost or Net Present Value.

The RESPLAN modelling work will consider only 'marginal' demands, that is to say, those demand deficits which are forecast to occur with the NRA's demand projections to 2021 after potential regional resource developments have been taken into account.

4.3 Environmental Assessment

An important factor in developing the resources strategy is to ensure that it is environmentally sustainable and that any impacts which are likely to occur are acceptable. Ensuring that any beneficial impacts are maximised is also important.

The NRA has therefore appointed consultants to undertake a strategic environmental assessment of the options being investigated as potential components of the strategy. It is recognised that a detailed environmental impact assessment of every potential component is not feasible or expected at this stage of the strategy development. However, NRA want to be able to identify the likely environmental impacts and their relative importance so that any proposals which are clearly unsustainable can be identified at any early stage, thus avoiding abortive work.

4.4 Strategy Formulation

During Phase 3 of the project (see figure 1.1) the NRA will use the information obtained during the Phase 1 and Phase 2 studies to draw together the various strategic option proposals into a coherent strategy. The overall objective of the strategy is to meet forecast demands to 2021 in a manner which is both economic and environmentally acceptable. A draft strategy report is programmed to be produced, for NRA Board approval, by the end of December 1993.

4.5 Promotion, Finance and Development

The NRA is discussing the promotion, finance and development of future schemes with the Department of Environment and OFWAT and intends to publish its position on these issues as part of the final strategy. There are various matters yet to be resolved, but it does seem clear at present that the Treasury or the NRA is unlikely to finance new developments since one of the objectives of privatising the water industry was to take such investment out of the public sector.

The funding for new schemes is therefore likely to come from the private sector and could involve those companies applying for new abstraction licences or others who wish to enter the market by arrangement with water companies. As the environmental regulator, the NRA will consider the reasonable needs of any new applicants including those for industry and agriculture and will assess the most effective development of resources within the context of the national strategy, taking the collective needs of abstractors into consideration. In this respect, the NRA will examine particularly carefully proposals by companies which do not include demand management measures such as those included within the NRA's demand forecasts.

4.6 Further Consultation

As stated in Section 1.1 this Consultation paper is the second formal step in the consultation process between the NRA and the water undertakers. A further paper will be produced in early October, at the conclusion of the Phase 2 option comparison and appraisal studies. This third paper will outline the preliminary proposals for the preferred combination of strategic options, and will provide the water undertakers with an opportunity to comment on the proposed strategy before the draft report is submitted to the NRA Board at the end of December.

The final strategic development framework report is due to be produced internally for the NRA Board in December 1993 and for publication during April 1994. A period of full public consultation will then follow during which all interested parties will be provided with an opportunity to comment on the proposed strategy.

APPENDIX A

Demand forcasting methodology

NRA

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY

METHODOLOGY & ASSUMPTIONS FOR DEMAND FORECASTING

VERSION 2
May 1993

CONTENTS

METHODOLOGY AND ASSUMPTIONS FOR PRODUCING DEMAND FORECASTS

1. INTRODUCTION

The following paper details the methodology and assumptions which are employed to produce a set of nationally consistent demand forecasts for each Water Service and Water Supply Company in England and Wales.

A multiple component technique is used for calculating current and forecast demand. Forecast scenarios are described by the combination of a suite of broad based assumptions about future demand. These forecast scenarios delimit the range of forecast between high and low and therefore indicate the predictive demand envelope. The base year has been taken as 1991 with the forecast horizon set at 2021.

Regional variations relating to per capita consumption, metering and leakage are recognised with companies being placed into the following groups: (see Table 1).

- North: Companies in Northumbria, North West, Severn Trent, Welsh and Yorkshire regions.
- South: Companies in Anglian, Southern, South West, Thames and Wessex regions.

Within companies in the south only the companies within Anglian, Southern and Thames regions (areas with particular resource pressures and large demand) are considered for inclusion in metering assumptions.

TABLE 1 - North-South Company Groups

Companies regarded as being in the 'North'	
North East Water	Hartlepool Water Company
Northumbrian Water	North West Water
Severn Trent Water	South Staffordshire Water
East Worcestershire Water Works	Welsh Water
Wrexham & East Denbighshire Water	Chester Water Works
Yorkshire Water	Yorkshire Water Works

Companies regarded as being in the 'South'	
Anglian Water	Thames Water
Essex Water	Three Valleys Water Services
Cambridge Water	North Surrey Water
Tendring Hundred Water Services	East Surrey Water
Suffolk Water	Mid Southern Water
Southern Water	Sutton & District Water
Portsmouth Water	Bournemouth & West Hampshire Water
South East Water	Company
Mid Kent Water	Bristol Water
Folkestone & District Water	Cholderton & District Water Company
South West Water	Wessex Water

2. 1991 DEMAND

2.1 Component Modelling and Data Provenance

Figure 1 shows the component build up of the 1991 base demand figure for any one company. For a more detailed description of the calculation of each component please refer to Annex 1. Figure 1 also identifies the data sources necessary for the calculation of each demand component. To summarise these are:-

- OFWAT July Returns to the Director General 1991
- OFWAT Cost of Water Delivered Report 1991
- CACI ACORN Profiles for Water Companies in the South and South East
- Southern Region NRA Control Area per capita consumption data by ACORN Group.

Figure 1

Breakdown of Components for 1991 Demand Calculation

FOR EACH COMPANY

<--- Distribution Input (Ml/d) from Ofwat#2 Table 2 (see Appendix 2) ---->

COMPONENT	DATA SOURCES	COMPONENT CALCULATION	UNITS	NOTABLE ASSUMPTIONS MADE
Unmetered Household	Population : Ofwat#1 Occupancy Rate & Proportion of households metered : Ofwat#1 Companies in the North (1): Ofwat#1 and Ofwat#2; modified to exclude supply pipe losses assumption Companies in the South (1) : Southern NRA region monitor per capita data by ACORN group (see Annex 4) and CACI (2) proportion of population in ACORN groups to generate average weighted PCC	(Unmetered population * average weighted PCC) / 1,000,000	Ml/d	1. July Returns data are accurate 2. Ofwat PCC data based on Severn Trent monitor data are appropriate for companies in the North 3. Southern NRA monitor data for PCC are appropriate for companies in the South
Unmetered Non-household	Ofwat#2 Table 1 and 2	Unmeasured non-household = ((iv) * (a)) / 100 Refer to Annex 2	Ml/d	1. Cost of Water Delivered data are accurate
Total Measured: Metered Household	Total Metered calculated from Ofwat#2	Total Metered = (a) * [1 - ((ii) + (iv))] / 100 Metered Household = (population * proportion of props metered) * av weighted PCC * PCC Supression / 1,000,000 Refer to Annex 2 and 3	Ml/d Ml/d	1. Cost of Water Delivered data are accurate 2. Per capita consumption is supressed by 10% upon installation of a domestic meter (factor 0.9)
Total Measured: Metered Non-household	As above	Total Metered - Metered Household	Ml/d	
UFW	Ofwat#2 and data calculated above	Distribution Input less components derived above	Ml/d	1. Includes supply pipe losses and distribution losses 2. Ofwat#2 data for distribution input are accurate

Key : OfWat#1 - July Return 1992 (see Annex 3)
OfWat#2 - Cost of Water Delivered Report, 1992 (see Annex 2)

(1) Refer to Table 1
(2) CACI Ltd - demographic data consultants
(3) PCC - per capita consumption

2.2 Assumptions Underlying the Calculations of Components of 1991 Demand

Figure 1 identifies a number of principle assumptions about the nature of the data used to calculate the base demand. These assumptions can be addressed as follows:-

2.2.1 North/South Split for Per Capita Data

Analysis of per capita data from the Severn Trent Plc monitor (via analysis of OFWAT Cost of Water Delivered per capita figures derived using Severn Trent Plc data) and Southern region NRA control area figures indicates that there is a difference between average per capita consumption in the north and south, with southern companies figures being some 5% higher in 1991 than those in the north. This disparity may be related to factors such as climate and garden watering, as well as general use associated with differing socioeconomic factors. There is evidence that under more normal conditions, ie, in the absence of drought restrictions and the recession, a greater north-south margin exists.

In the absence of information other than the Severn Trent Plc data inferred from OFWAT and the Southern Region NRA control area data it is considered to be reasonable to assume that this pattern of difference will be approximately consistent for other companies in the north and south. Therefore, the OFWAT derived per capita figures are used for companies in the north, and Southern NRA control data are used for companies in the south.

The OFWAT derived per capita data are already in ACORN weighted average format allowing simple multiplication by unmetered population to achieve the required component figure. However, the Southern area data are in ACORN group format and therefore need to be weighted by the proportion of the total population in each ACORN group. These proportions are indicated by analysis of CACI ACORN profiles for each company in the south of England. Thus a company specific weighted average is derived which can be used in the calculation of the unmeasured household component for those companies.

It should be noted that the Southern NRA control area data are not available for every ACORN group, although the data for the groups which are available account for some 82% of the total population. The missing groups D, G, H and I are therefore assumed to have a consumption figure which is a weighted average of the other groups. This allows all ACORN groups to constitute part of the final company specific weighted average derivation described above. The possible error involved in doing this is not thought to be significant.

2.2.2 Per Capita Consumption Suppression Invoked by Metering

Metered household consumption is assumed to be 10% less than unmetered households in the existing metered properties identified in the base demand calculations. This assumption is consistent for all companies base forecast years.

Preliminary information from the metering trials in the Isle of Wight have indicated that the installation of meters in domestic properties results in an average reduction in household consumption of 20%, of which 10% can be attributed to lower customer demand, and the remainder to reduced supply pipe losses which are identified upon installation of meters. (Parliamentary Office of Science and Technology, 1993). However, preliminary evidence from recent meter trials data analysis suggests that the reduction in household consumption caused by domestic metering may be as much as 20%.

2.2.3 Suppression of Supply Pipe Losses Linked by Metering

For the base year, total treated water losses is derived as the residual of distribution input after other components have been accounted for. Thus, if total treated water losses is reported as a night flow value in l/prop/hr it is an average value with metered properties being assumed to have a lower value commensurate with their reduction in supply pipe losses. In the forecast years total treated water losses is directly calculated on the basis of night flows. A saving of 3 l/prop/hr on the unmetered household night flow figure is therefore assumed for existing and new domestic metered properties.

3. FORECAST DEMAND

3.1 Timeframe

The timeframe for the forecast demands is as follows:-

- Start date is 1991 with planning horizon of 2021
- Calculation intervals are 5 years ie, 1996, 2001, 2006, 2011, 2016 and 2021

3.2 Forecast Demand Assumptions and Combinations

The demand assumptions which can be combined to produce the forecast scenarios are identified in Figure 2. The forecast scenarios which are built up using these assumptions can be described as follows:-

FIGURE 2

FORECASTING ASSUMPTIONS AND COMBINATIONS WITHIN EACH SCENARIO

No.	Assumptions	Data Sources	Assumptions for Each Forecast			
			Low Forecast	High Forecast	Managed Demand Forecast	Unmanaged Demand Forecast
1.	Growth of per capita consumption by compound annual percentage rates derived from Binnie & Herrington (see Annex 5) (Assumed for all ACORN groups and all regions).	Binnie & Herrington, 1992 *Effects of Climate Change on Water Resources and Demands*	•		•	•
2.	Growth of per capita consumption by compound annual rate of 1% (Assumed for all ACORN groups and all regions).	N/A		•		
3.	Accelerated growth or 'bounce back' of growth in per capita consumption between 1991 and 1996 for companies in the South to account for the suppression of growth due to demand management techniques during the recent drought years as well as the effects of recession. (Bounce back accelerated growth rate taken as 1.4% per annum compound, see Section 3.4.4 for calculation details).	Accelerated growth rate based on historic data from Southern NRA and Forecast information from Binnie & Herrington (1992).		•	•	•
4.	No accelerated growth or 'Bounce back' of growth in per capita consumption between 1991 and 1996 in companies in the South.	N/A	•			
5.	Growth in metered and unmetered non-household consumption by compound annual rate of 0.75% (for all companies).	N/A		•		
6.	No growth in metered and unmetered non-household consumption above 1991 levels.	N/A	•		•	•
7.	No increase in the number of domestic metered properties subject to metering above 1991 levels (for all companies).	N/A		•		•

			Assumptions for Each Forecast			
8.	For companies in Anglian, Southern and Thames regions 90% of domestic properties will have meters by 2011 (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 3 l/prop/hr, see Section 2.2.2 for description of principle.	N/A	•			
9.	For companies in Anglian, Southern and Thames regions 30% of domestic properties will have meters by 2001 (Ongoing from 1991, with equal phasing each year) leading to a 10% reduction in per capita consumption and a reduction in total treated water losses of 3 l/prop/hr, see Section 2.2.2 for description of principle.	N/A			•	
10.	Leakage levels per property held at 1991 levels to simulate the effect of no improvements being made to reach leakage targets.	N/A		•		•
11.	Leakage targets achieved effecting a reduction in total treated water losses to the following levels in the companies in the regions indicated:- (rate of reduction is 1 l/prop/hr/yr). 6 litres/property/hour (20 hour day) in Anglian, Southern and Thames; 7 litres/property/hour (20 hour day) in Severn Trent; 8 litres/property/hour (20 hour day) in Other regions.	Based upon information from Report No. 26			•	
12.	A leakage target of 6 l/prop/hr, achieved at a rate of 1 l/prop/hr/yr for all companies.	N/A	•			

3.2.1 Low Forecast Scenario

This can be defined as the forecast line which describes the set of assumptions which indicate the minimum increase (or even decrease) in demand to 2021. This forecast forms the lower boundary of the demand envelope.

3.2.2 High Forecast Scenario

This forecast is defined as the line which describes the maximum feasible increase in demand. This forecast forms the upper boundary of the demand envelope.

3.2.3 Unmanaged Demand Forecast

The unmanaged demand forecast is that which the NRA believes to be the most likely outcome if no action is taken to increase current levels of domestic metering or decrease leakage. It therefore constitutes the line upon which additional assumptions about domestic metering and leakage can be placed.

3.2.4 Managed Demand Forecast

The managed demand line can be defined as the forecast which the NRA believes to encompass an appropriate set of assumptions on per capita growth, metering and leakage.

3.3 Methodology and Data Provenance for Forecast Calculations

A detailed description of the methodology and data provenance for the calculation of each component of demand under each scenario is given in Annex 1.

3.4 Assumptions Underlying Forecast Demand Calculations

Of key importance to the methodology outlined above are a variety of assumptions made about specific data inputs and the derivation of the forecast scenarios noted in Table 1. These assumptions are made as a result of consideration of the various forecast alternatives and the data which are currently available to model these alternatives. The assumptions also take account of the need to forecast on a nationally consistent basis and without bias towards one company or another. During the inception phase of the demand forecasting project, water companies were solicited in order to gain a consistent set of data on current and forecast demand.

This was on the understanding that the information could be inserted into the methodology and therefore reduce the requirement for assumptions to be made. However, this information was either not forthcoming due to incomplete or nil returns or was not found to allow a consistent approach to be taken. A complete set of forecast assumptions have therefore been used. (The principle assumptions used in the calculation of 1991 base demands have already been discussed under Section 2.2 above).

3.4.1 Quality of Input Data Sources

A number of 'fixed' input data are used throughout the demand calculations, particularly in the base demand assessment for 1991. These fixed data sources are as follows:-

- OFWAT (1992) Cost of Water Delivered Report.
- Per Capita Consumption Data from Binnie & Herrington, 1992.
- OFWAT July Returns Data
- CACI Population/Household Forecasts and ACORN profiles for each company to 2021
- NRA Southern Region Control Area Per Capita Data.

The assumption is made that these data represent the best, if not the only, available data on which to base nationally consistent forecasts.

3.4.2 Population Data

Population figures for each company for the 1991 base are taken from OFWAT July returns and CACI estimates for 2021. Population for the years 1996, 2001, 2006, 2011, 2016 and 2021 are calculated by a linear interpolation between 1991 and 2021.

The CACI long term population forecast is based on 1981 census data annually updated with mid year population estimates at local authority level. Each population projection is constrained to agree with the OPCS population projections for the 108 local planning areas in Great Britain. Population projections for smaller areas are derived by estimating the net effects of fertility, mortality and migration on the basis of historic trend data since 1981. Whilst the CACI forecasts are the best available long term data it is nevertheless advisable to recognise the limitations of a projection relating to an uncertain future.

Any population forecast data can only represent a view of the most likely way forward at the time of preparation. It is not possible to make exact predictions of change in fundamental human behaviour and how these will affect future population growth. Nevertheless, the CACI population estimates represent the only consistently produced forecasts extending to 2021.

The linear interpolation between 1991 and 2021 population has been adopted as it will represent the use of best available data for 1991 and 2021 population. In addition, by interpolation any discontinuities year on year are avoided.

3.4.3 Occupancy Rate and Households

Occupancy rates for domestic properties in 1991 are derived from OFWAT July returns data, since this is the best data available to the NRA on occupancy levels for 1991. The rate of change in occupancy level between 1991 and 2021 is derived from an analysis of CACI household and population data over the same period.

This rate is then applied to the known start point at 1991 and occupancy levels for 1996, 2001, 2006, 2011, 2016 and 2021 are calculated. These calculated occupancy levels are then used in combination with the population estimates explained in 3.4.2 above, to derive the household numbers within each forecast year. This was considered to be the best way to obtain household numbers since as with population estimates, any discontinuities year on year are avoided. In all but one company this method resulted in falling occupancy levels through the planning period. Household numbers are important for the calculation of metered household and unmetered household components as well as total treated water losses.

3.4.4 Per Capita Growth and 'Bounce Back'

The growth factors for per capita consumption used in all but the high forecast are derived from data presented in Binnie & Herrington (1992) which indicate how future per capita consumption may be assessed on an individual 'component of use' basis. The data for 1991, 2011 and 2021 given by Binnie & Herrington were described by a line, the equation of which was used to calculate the annual compound percentage growth factors shown in Annex 5. These rates are built into the calculation of metered and unmetered household demand.

The rate of 1% compound growth incorporated within the high forecast is intended to indicate the upper extent of per capita consumption growth suggested by the Binnie & Herrington data.

Implicit within the growth rate for per capita consumption for companies in the south is the assumption of accelerated growth, or 'bounce back' between 1991 and 1996. Available data demonstrate that the demand management regime invoked by the water shortage conditions and the economic downturns between 1989 and 1992 has caused the difference in average per capita consumption between northern and southern districts to decrease from approximately 14.6% in 1988 to 5.2% in 1991. This decrease is assumed to be due to suppressed per capita consumption in the south and south east, since over the same period per capita consumption in companies in the north where monitored data are available has continued to rise.

The use of published forecasts of per capita consumption and growth rates to provide the baseline growth for companies in the south allows the accelerated growth between 1991 and 1996 to be directed towards a target level at 1996. At this target level the difference between per capita consumption in the north and south reflects the re-established demand following the lifting of demand management measures imposed during the period of drought.

This level is also believed to be indicative of the normal extent of the disparity in domestic consumption between the north and the south as evidenced by pre drought data. To reach this level an additional growth rate of 1.4% per annum is added to the existing Binnie & Herrington growth rates shown in Annex 5. This additional growth rate is calculated from an analysis of Southern region NRA control area data and the data in Annex 5.

3.4.5 Growth of Non-Household Demand

Under the high forecast scenario unmetered non-household and metered non-household demand are considered to grow at an annual rate of 0.75%. This is intended to indicate the upper extent of any growth in these components.

3.4.6 Domestic Metering Assumptions

Within the forecast scenarios a number of assumptions have been made about future levels of domestic metering. The suppression of per capita and reduction in unaccounted for water invoked by metering has already been discussed under 2.2.2. However other assumptions about metering need to be considered.

In constructing the forecast scenarios four assumptions about meter penetration were made:

- 90% meter penetration within domestic properties by 2011 in Anglian, Southern and Thames regions only
- 30% meter penetration within domestic properties by 2001 in Anglian, Southern and Thames regions only
- No further metering of domestic properties

In both the 90% and 30% meter penetration assumptions a further assumption is made that this will only occur for companies in Anglian, Southern and Thames regions. The NRA believes that it may not be appropriate for companies in areas without resources pressures to seek to achieve such levels of domestic metering. Therefore companies in regions other than Anglian, Southern and Thames do not have the meter penetration assumption applied.

(i) *90% Metering*

The 90% meter penetration assumption outlined in the low forecast is intended to model the effect of saturation metering of domestic properties. 90% was chosen in recognition that 100% penetration would be difficult to achieve.

(ii) *30% Metering*

The 30% meter penetration assumption outlined in the planning forecast is intended to represent a modest domestic meter penetration.

(iii) *No Additional Domestic Metering*

The 'no further metering' assumption is used in the do nothing and high forecasts show the effect of zero meter penetration as a result of a policy of not metering domestic properties. Existing levels of domestic metering are held constant throughout the forecast period so that, relative to total households, the penetration tends to zero.

3.4.7 Leakage Assumptions

Three alternatives regarding levels of leakage are incorporated within the forecast scenarios, and these can be addressed as follows:-

(i) ***Managed Demand Forecast***

Within the managed demand forecast scenario leakage targets are set for companies in specific regions. These are:-

- 6 l/prop/hr for companies in Anglian, Southern and Thames
- 7 l/prop/hr for companies in Severn Trent
- 8 l/prop/hr for companies in all other regions

The figure of 6 l/prop/hr is an NRA assumed figure based on information contained in WRc Report No. 26 (Leakage Control Policy & Practice) and is considered to be a reasonable target level for companies in areas with resource constraints.

The figures of 7, and 8 l/prop/hr are again NRA assumed figures based on information from Report No. 26. These are more relaxed targets intended to acknowledge and take account of the effect of less stress on resources and factors such as the length of rural mains in companies outside Anglian, Southern and Thames regions.

(ii) ***Low Forecast***

Under the low forecast a universal leakage target of 6 l/prop/hr is assumed for all companies.

(iii) ***Unmanaged Demand and High Forecasts***

An assumption of no decrease in 1991 levels of leakage is used for the unmanaged demand and high forecasts. This is intended to model the effect of a policy of not increasing efforts to reduce leakage.

Under all forecast scenarios any metered properties have their leakage target reduced by 3 l/prop/hr as described in 2.2.3.

4. SUMMARY

There are a number of key points which are critical to the raison d'etre for the above methodology. These have been noted in this report, however it is appropriate to reiterate them at this stage.

- A nationally consistent approach was required for the forecasts. Treating the forecasts for each company in a similar way, based on a set of common assumptions is essential in order to produce balanced forecasts which are appropriate for a national water resources development strategy.

- The use of company forecasts (where available), produced using different assumptions would not have resulted in nationally consistent forecasts.

- The NRA have used information which is currently available in published documents, internal reports or which are commercially available.

- Where necessary input data and assumptions on demand scenarios have been used and formulated pragmatically in order to overcome inconsistencies in or a lack of, appropriate data.

- The forecasts produced using this methodology represent the most consistent set of nationally collated demand forecasts to 2021.

REFERENCES:

BINNIE & HERRINGTON (1992) *Effect of Climate Change on Water Resources and Demands*

OFFICE OF WATER SERVICES (1992) *The Cost of Water Delivered to Customers 1991/92 (OFWAT Birmingham)*

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (1993) *Dealing with Drought (HMSO)*

NATIONAL WATER COUNCIL/DEPARTMENT OF ENVIRONMENT (1980) *Leakage Control Policy and Practice (Standing Technical Committee Report No. 26)*

ANNEX 1

DATA SOURCES AND CALCULATION OF

DEMAND FORECASTS

1. POPULATION

1991 — Actual population from OFWAT July Return (1991/92) by water company (Annex 3) - this value is resident population supplied. Population is apportioned into metered and unmetered using data on proportion of properties metered from OFWAT July Return.

1996 - 2021 — Linear interpolation between OFWAT July Return 1991 values and CACI forecasts for 2020 population. The population in 2021 is assumed to be the same as the population in 2020. These values are total population, total connected population is assumed to be the same as total population.

2. OCCUPANCY LEVELS

1991 — Computed from actual population and number of properties per company (See Annex 3).

1996 - 2021 — Linear interpolation between 1991 and 2021 occupancy rates. The 2021 values is estimated by subtracting the difference between the 1991 and 2021 CACI occupancy rate estimates.

3. PER CAPITA CONSUMPTION

1991 — For the following water companies, values are computed from OFWAT Table 3 (Annex 2), based on Severn Trent Water Plc household monitoring results by ACORN group and adjusted by OFWAT to allow for the ACORN profile in each water company. An adjustment of 50 l/prop/hr which was added by OFWAT to cover supply pipe leakage and any meter under registration has also been subtracted as these are already considered under total treated water losses within the NRA methodology.

Water companies with adjusted figures from OFWAT Cost of Water Delivered Report, Table 3 are:-

North East Water	Hartlepools Water Company
Northumbria Water	North West Water
Severn Trent	South Staffs
East Worcs Waterworks	Dwr Cymru
Wrexham and ED Water	Chester Waterworks
Yorkshire Water	York Waterworks

For the remaining water companies, the results from studies based on Southern Control Area data, again by ACORN group, have been used (see Annex 4).

1996 - 2021 Per capita increased by annual compound percentage rate as specified by Binnie & Herrington (1992) (see Annex 5).

4. UNMETERED HOUSEHOLD DEMAND

1991 - 2021 Product of per capita consumption and unmetered properties, given in Ml/d. Unmetered population is computed by subtracting the product of metered properties and occupancy rate from total population.

5. METERED HOUSEHOLD DEMAND

1991 Computed from the proportion of actual properties metered in 1991 (see Annex 3) multiplied by per capita consumption, and a demand suppression factor (assumed to be 10%).

1996 - 2021 Depending on the forecasting scenario, a meter penetration ratio is assumed, this proportion includes properties already metered in 1991. The number of occupants in the metered properties is then computed using the appropriate occupancy rate and metered population is multiplied by per capita consumption and the suppression factor to give a metered household demand in Ml/d.

6. UNMETERED NON-HOUSEHOLD DEMAND

1991 Computed from OFWAT 'Cost of Water Delivered Report' (see Annex 2). Table 1 viz:

$$\frac{(\%\ \text{unmetered non-household of water delivered} \times \text{water delivered})}{100}$$

1996 - 2021 Depending on the forecast scenario, a compound growth rate, expressed as percentage per annum is applied. (Unaltered in all but high forecast where percentage growth per annum = 0.75)

7. METERED NON-HOUSEHOLD DEMAND

1991 Computed by subtracting metered household demand from total metered demand. Total metered demand is computed from OFWAT, 'Cost of Water Delivered Report' Table 1, (see Annex 2), viz:

$$\text{Water delivered} \times 1 - \frac{(\%\ \text{unmetered household and unmetered non-household})}{100}$$

1996 - 2021 Depending on the forecasting scenario, a compound growth rate, expressed as percentage per annum is applied. (Unaltered in all but high forecast where percentage growth per annum = 0.75)

8. TOTAL TREATED WATER LOSSES

1991 Computed from OFWAT 'Cost of Water Delivered Report' Table 1, (see Annex 2) viz:

Total Treated Water Losses = Distribution input - (metered + unmetered components)

and converted to a rate per property (night flow) assuming a 20 hour day and specified July return occupancy rate (see Annex 3).

1996 - 2021 Depending on the forecasting scenario, total treated water losses may be reduced by two methods. The first represents general leakage savings in the distribution system. This method allows a reduction in night flow at a rate of 1 l/prop/hr/year until a minimum lower limit (leakage target) is achieved. The second saving, of 3 l/prop/hr, from supply pipe leakage may result in night flow values falling below the specified leakage target. This saving is also related to existing metered properties.

A total treated water losses value, in Ml/d, is computed by multiplying the average night flow value (l/prop/hr) by the total number of domestic properties and twenty hours.

9. DISTRIBUTION INPUT LESS TOTAL TREATED WATER LOSSES

1996 - 2021 This is a key step in producing a figure for forecast distribution input. It is the sum of:

Total household consumption + metered non-household and unmetered non-household consumption

10. DISTRIBUTION INPUT

1996 - 2021 This is the sum of 8 and 9 above.

ANNEX 2

Table 1

	(i)	(ii)	(iii)	(iv)				
	Cost to customers	*Cost of operations*	*Cost of capital maintenance*	*Return on capital*	*Unmeasured household water del per person*	*Unmeasured household water del /wat del*	*Unmeasured non-h.hold water del per property*	*Unmeasured non h.hold water del /wat del*
	p/m³	*p/m³*	*p/m³*	*p/m³*	*l/d*	*%*	*l/d*	*%*
Northern region								
Hartlepools	39	24	6	9	175	45	292	1
Northumbrian	42	26	10	6	200	58	429	2
York	48	26	11	11	152	65	387	2
North West	51	27	13	11	140	59	673	4
North East	52	29	10	14	160	66	575	3
Yorkshire	53	26	17	10	162	60	352	1
Regional average	**51**	**27**	**14**	**11**	**154**	**60**	**558**	**3**
Central/Eastern region								
South Staffs	39	24	8	7	179	69	971	4
Severn Trent	48	26	12	11	146	61	968	4
Essex	50	28	9	13	161	66	1042	4
Cambridge	53	29	9	14	152	62	1117	4
East Worcester	57	36	9	11	178	61	394	1
Anglian	59	30	15	14	169	65	523	2
Suffolk	61	35	15	11	153	52	444	1
Tendring Hundred	82	43	15	24	134	67	1060	6
Regional average	**51**	**27**	**12**	**12**	**157**	**63**	**847**	**3**
Wales/South West region								
Bournemouth and W Hants	36	22	5	10	173	47	1482	4
Bristol	42	27	8	6	185	62	1477	11
Wessex	55	33	14	8	152	54	1096	3
South West	56	34	10	12	169	62	1125	5
Chester	57	30	26	1	149	68	1000	3
Wrexham	63	34	21	8	177	63	1333	5
Welsh	65	34	11	19	170	61	1424	6
Regional average	**56**	**32**	**11**	**13**	**169**	**59**	**1344**	**6**
South East region								
Portsmouth	33	20	8	5	174	62	738	2
Thames	40	27	6	7	176	59	2243	15
Southern	43	28	12	4	168	60	1630	3
North Surrey	46	27	8	11	162	66	1266	3
Three Valleys	48	30	11	8	166	71	1036	3
Folkestone	52	37	9	5	183	62	1094	5
Mid Southern	52	29	7	16	180	69	619	1
Sutton District	53	35	11	7	168	83	429	2
Mid Kent	59	37	12	10	176	69	588	2
East Surrey	62	30	19	13	206	70	1429	5
South East	86	42	27	17	173	70	776	4
Regional average	**45**	**29**	**9**	**8**	**173**	**63**	**1905**	**9**
National average	**50**	**28**	**11**	**10**	**163**	**61**	**1190**	**5**

Notes

1 Cost to Customers is the cost of operations, plus the cost of capital maintenance, plus the return on capital.

2 Cost of Operations is total operating expenditure.

3 Cost of Capital Maintenance is current cost depreciation plus the infrastructure renewals charge (the latter being the annualised cost of maintaining the condition of long lived assets).

4 The Return on Capital is current cost operating profit (before the working capital adjustment).

5 The unmeasured non-household per property water delivered figure is derived from company data in the 1992 July Return on water delivered and the number of such properties billed for water.

6 The unmeasured household per person water delivered figure includes an estimate of the leakage from customers' supply pipes. It is derived from company data in the 1992 July Return on water delivered and the population for unmeasured households.

7 Averages are weighted by denominators.

Table 2

	(a)	(b)	(c)	(d)	(e)	(f)
	Water delivered Ml/d	*Distribution losses* Ml/d	*Distribution input* Ml/d	*Water del./ distribution input* %	*Dist. losses per length of main* m^3/d/km	*Connect prop. per length of main* prop/km
Northern region						
Hartlepools	35	4	39	90	7.6	78
Northumbrian	380	55	435	87	6.2	55
York	39	9	48	82	9.1	79
North West	1597	896	2495	64	23.7	74
North East	312	44	357	87	5.7	73
Yorkshire	1110	334	1458	76	10.7	58
Regional total/average	**3473**	**1342**	**4831**	**72**	**15.4**	**66**
Central/Eastern region						
South Staffs	313	43	358	87	7.8	94
Severn Trent	1603	373	1979	81	9.6	76
Essex	338	65	405	83	11.0	101
Cambridge	61	13	74	83	6.3	55
East Worcester	56	17	74	77	9.6	56
Anglian	986	149	1137	87	4.6	51
Suffolk	67	10	77	87	4.6	54
Tendring Hundred	27	5	32	85	5.1	68
Regional total/average	**3450**	**675**	**4135**	**83**	**7.5**	**68**
Wales/South West region						
Bournemouth and W Hants	144	9	154	94	3.5	64
Bristol	292	18	310	94	2.8	70
Wessex	305	96	403	76	9.3	44
South West	376	120	499	75	8.2	46
Chester	25	4	30	85	8.2	79
Wrexham	40	4	45	90	3.2	44
Welsh	743	303	1057	70	12.8	50
Regional total/average	**1926**	**554**	**2497**	**77**	**9.4**	**51**
South East region						
Portsmouth	175	27	202	86	8.1	84
Thames	2086	648	2738	76	21.0	109
Southern	532	117	650	82	9.6	77
North Surrey	110	29	139	79	12.3	74
Three Valleys	536	166	702	76	15.3	83
Folkestone	41	11	55	76	10.5	68
Mid Southern	172	50	222	77	11.3	58
Sutton District	57	9	66	86	8.8	117
Mid Kent	130	25	155	84	6.3	57
East Surrey	92	15	108	85	6.6	59
South East	135	23	158	85	4.8	55
Regional total/average	**4065**	**1120**	**5194**	**78**	**14.6**	**87**
National total/average	**12913**	**3691**	**16658**	**77**	**11.8**	**69**

Table 3

	Cost to customers p/m³	Cost of operations p/m³	Cost of capital maintenance p/m³	Return on capital p/m³	Unmeasured household water del per person l/d	Unmeasured household water del hwat del %	Unmeasured non-h.hold water del per property l/d	Unmeasured non h.hold water del hwat del %
Northern region								
Hartlepools	42	26	6	10	142	40	292	1
Northumbrian	50	30	12	8	146	50	429	2
York	49	27	11	11	149	65	387	2
North West	50	26	13	11	146	60	673	4
North East	56	31	11	15	145	64	575	3
Yorkshire	57	28	18	10	146	58	352	1
Regional average	52	27	14	11	146	58	558	3
Central/Eastern region								
South Staffs	45	28	10	8	144	64	971	5
Severn Trent	48	26	12	11	146	61	968	4
Essex	53	29	9	14	147	63	1042	4
Cambridge	54	30	9	15	149	61	1117	4
East Worcester	63	41	10	13	146	57	394	1
Anglian	64	32	17	15	147	62	523	2
Suffolk	62	36	16	11	150	52	444	1
Tendring Hundred	74	39	13	22	155	70	1060	5
Regional average	53	29	13	12	147	61	847	3
Wales/South West region								
Bournemouth and W Hants	38	23	5	10	153	44	1482	5
Bristol	48	31	10	7	149	57	1477	12
Wessex	56	34	14	8	149	53	1096	3
South West	60	36	11	13	151	59	1125	5
Chester	58	30	26	1	147	68	1000	3
Wrexham	71	38	23	9	146	58	1333	6
Welsh	70	38	12	21	147	57	1424	7
Regional average	60	34	12	14	149	56	1344	7
South East region								
Portsmouth	36	22	8	6	151	58	738	2
Thames	44	30	6	8	148	55	2243	16
Southern	46	29	13	4	150	57	1630	3
North Surrey	49	29	9	11	149	64	1266	4
Three Valleys	52	32	12	8	148	68	1036	3
Folkestone	57	42	10	5	152	58	1094	5
Mid Southern	59	33	8	18	147	65	619	2
Sutton District	58	38	12	8	152	81	429	2
Mid Kent	66	42	13	11	149	66	588	2
East Surrey	77	37	24	16	151	64	1429	7
South East	93	46	29	18	155	67	776	4
Regional average	49	31	10	8	149	59	1905	10
National average	53	30	12	11	147	59	1190	6

Notes

1 Cost to Customers is the cost of operations, plus the cost of capital maintenance, plus the return on capital.
2 Cost of Operations is total operating expenditure.
3 Cost of Capital Maintenance is current cost depreciation plus the infrastructure renewals charge (the latter being the annualised cost of maintaining the condition of long lived assets).
4 The Return on Capital is current cost operating profit (before the working capital adjustment).
5 The unmeasured non-household per property water delivered figure is derived from company data in the 1992 July Return on water delivered and the number of such properties billed for water.
6 The unmeasured household per person water delivered figure includes an estimate of the leakage from customers' supply pipes. It is derived from ACORN adjusted data on water consumption.
7 Averages are weighted by denominators.

ANNEX 3

Annex 3: Water Company Comparisons (OFWAT July Return data 1991/92)

Water Company	Occupancy Level (Persons per Household)	Proportion of Properties metered 1991	Resident Population Supplied 1000's	Adjusted PCC (1) (-50 litres per Household) (2)
Hartlepools	2.50	0.0006	90.5	122.56
Northumbrian	2.46	0.0021	1171.0	125.45
York	2.54	0.0006	174.8	129.21
North West	2.52	0.0107	6802.0	127.26
North East	2.43	0.0055	1295.0	124.45
Yorkshire	2.44	0.0165	4296.0	125.82
South Staffs	2.54	0.0306	1217.0	125.31
Severn Trent	2.56	0.0342	6891.0	127.01
Essex	2.53	0.0054	1408.4	*
Cambridge	2.72	0.0334	273.2	*
East Worcester	2.55	0.1458	232.2	126.46
Anglian	2.60	0.0254	3898.0	*
Suffolk	2.45	0.0341	250.8	*
Tendring Hundred	2.22	0.0309	136.6	*
Bournemouth	2.67	0.0181	424.0	*
Bristol	2.57	0.0252	1021.0	*
Wessex	2.63	0.0370	1121.0	*
South West	2.50	0.0328	1449.0	*
Chester	2.75	0.0182	116.7	129.91
Wrexham	2.67	0.0348	151.1	127.39
Welsh	2.54	0.0276	2760.0	128.43
Portsmouth	2.51	0.0006	642.1	*
Thames	2.37	0.0237	7179.0	*
Southern	2.43	0.0952	2145.0	*
North Surrey	2.61	0.0397	467.0	*
Three Valleys	2.60	0.0174	2341.0	*
Folkestone	2.32	0.0158	146.5	*
Mid Southern	2.79	0.0309	703.7	*
Sutton District	2.50	0.0024	281.0	*
Mid Kent	2.64	0.0165	526.7	*
East Surrey	2.60	0.0154	321.0	*
South East	2.51	0.0331	611.5	*
* Companies in the South use PCC values estimated from Southern Control Area				

(1) PCC : Per Capita Consumption

(2) 50 l/prop was added by OFWAT to account for supply pipe losses and any meter under registration.

ANNEX 4

Annex 4 : Per Capita Consumption for 1991 by ACORN Group Estimated from the Southern Control Area

ACORN Group	Per Capita Consumption (l/h/d) South and South West (1)
A	143.7
B	143.7
C	126.3
D	132.6
E	126.4
F	116.6
G	132.6
H	132.6
I	132.6
J	139.4
K	175.1

Note: These PCC figures are used in the South and South West : Anglian, Southern South West, Thames and Wessex regions

ANNEX 5

Annex 5 : Interpolated per capita consumption data

	EXCLUDING CLIMATE CHANGE	
YEAR	Per Capita Consumption	% Growth Factor
1991	147	
1992	148	0.680
1993	149	0.676
1994	150	0.671
1995	151	0.667
1996	152	0.662
1997	153	0.658
1998	154	0.654
1999	155	0.649
2000	156	0.645
2001	157	0.641
2002	158	0.637
2003	159	0.633
2004	160	0.629
2005	161	0.625
2006	162	0.621
2007	163	0.617
2008	164	0.613
2009	165	0.610
2010	166	0.606
2011	167	0.602
2012	168.3	0.778
2013	169.6	0.772
2014	170.9	0.767
2015	172.2	0.761
2016	173.5	0.755
2017	174.8	0.749
2018	176.1	0.744
2019	177.4	0.738
2020	178.7	0.733
2021	180	0.727

Notes : 1 Actual growth factors used are those calculated for each 5 year step used in the forecasts.
2 Figures are based on linear interpolations between fixed data at 1991, 2011 and 2021.

APPENDIX B

Demand Forcast Data

APPENDIX B

The following data and graph were produced using the NRA demand forcasting methodology detailed in appendix A.

NRA Demand Forecast Summary Data

COMPANY : ANGLIAN WATER SERVICES

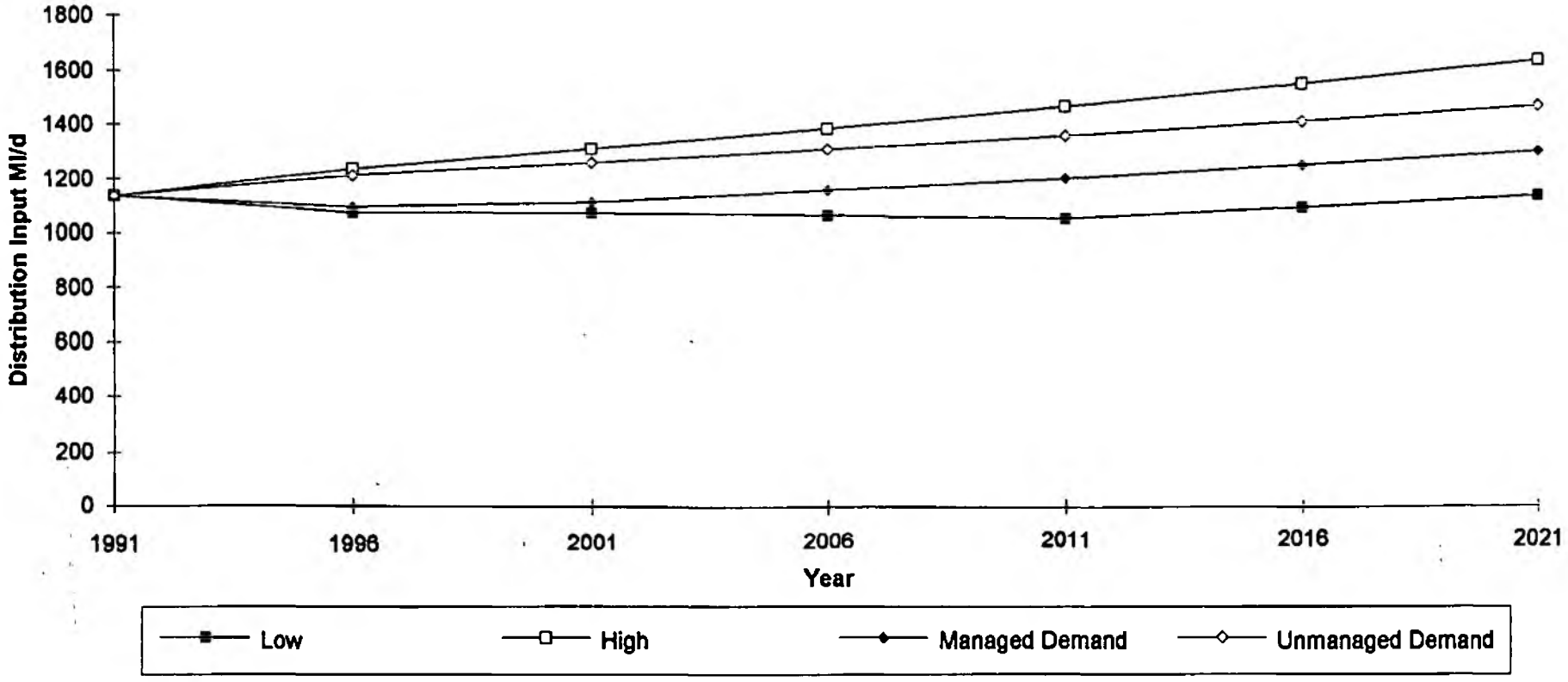
INPUT DATA	1991	1996	2001	2006	2011	2016	2021
Distribution Input 1991 (Ml/d)	1137						
Total Metered 1991 (Ml/d)	325						
Unmetered non-household (Ml/d)	20						
Proportion 1991 properties metered	0.0254						
ACORN weighted average PCC (l/h/d)	134.7						
Population ('000s)	3898000	4003037	4108075	4213113	4318151	4423189	4528227
Occupancy Rate	2.60	2.59	2.57	2.56	2.55	2.53	2.52
1991 BASE	1991						
Metered household (Ml/d)	12						
Metered non-household (Ml/d)	313						
Unmetered household (Ml/d)	512						
Total Treated Water Losses (Ml/d)	280						
Night Flow (l/pr/hr)	9.34						
LOW FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		12	159	337	535	569	605
Metered non-household (Ml/d)		313	313	313	313	313	313
Unmetered household (Ml/d)		543	413	250	66	70	75
Unmetered non-household (Ml/d)		20	20	20	20	20	20
Total Treated Water Losses (Ml/d)		183	163	138	112	115	119
Distribution Input (Ml/d)		1072	1068	1058	1046	1088	1131
HIGH FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		13	14	15	15	16	17
Metered non-household (Ml/d)		325	338	351	364	378	392
Unmetered household (Ml/d)		592	639	689	743	801	862
Unmetered non-household (Ml/d)		20	21	22	23	24	25
Total Treated Water Losses (Ml/d)		285	295	304	313	323	332
Distribution Input (Ml/d)		1237	1307	1381	1458	1541	1628
MANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		80	170	180	191	203	216
Metered non-household (Ml/d)		313	313	313	313	313	313
Unmetered household (Ml/d)		506	442	467	495	526	559
Unmetered non-household (Ml/d)		20	20	20	20	20	20
Total Treated Water Losses (Ml/d)		172	163	168	173	178	183
Distribution Input (Ml/d)		1091	1108	1149	1191	1240	1291
UNMANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		13	14	14	14	15	15
Metered non-household (Ml/d)		313	313	313	313	313	313
Unmetered household (Ml/d)		581	616	652	691	735	782
Unmetered non-household (Ml/d)		20	20	20	20	20	20
Total Treated Water Losses (Ml/d)		285	295	304	313	323	332
Distribution Input (Ml/d)		1212	1257	1303	1351	1406	1462

ANS 5/93 forecast. 1149 1183 1223 1255

ANS 2015 5.8% higher than Managed forecast. overall based on 4.4m people.

Note : Data above produced as outlined in; NRA (1993) *'Methodology and Assumptions for Demand Forecasting'*, Version 2

NRA demand forecast range for Anglian Water Services



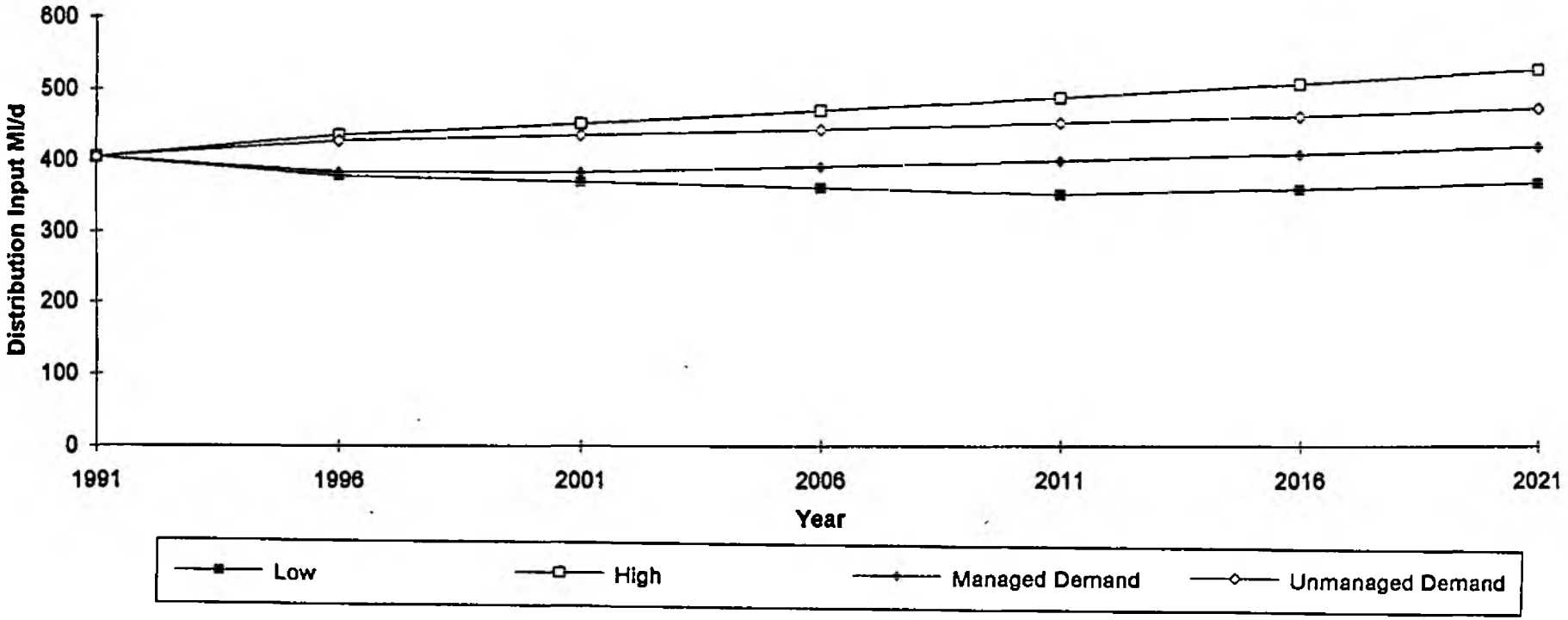
NRA Demand Forecast Summary Data

COMPANY : ESSEX WATER

INPUT DATA	1991	1996	2001	2006	2011	2016	2021
Distribution Input 1991 (Ml/d)	405						
Total Metered 1991 (Ml/d)	101						
Unmetered non-household (Ml/d)	14						
Proportion 1991 properties metered	0.0054						
ACORN weighted average PCC (l/h/d)	135.1						
Population ('000s)	1408440	1412904	1417369	1421833	1426297	1430762	1435226
Occupancy Rate	2.53	2.52	2.52	2.51	2.50	2.50	2.49
1991 BASE	1991						
Metered household (Ml/d)	1						
Metered non-household (Ml/d)	100						
Unmetered household (Ml/d)	189						
Total Treated Water Losses (Ml/d)	101						
Night Flow (l/pr/hr)	9.06						
LOW FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	55	114	177	185	192
Metered non-household (Ml/d)		100	100	100	100	100	100
Unmetered household (Ml/d)		196	143	85	22	23	24
Unmetered non-household (Ml/d)		14	14	14	14	14	14
Total Treated Water Losses (Ml/d)		67	57	48	38	38	38
Distribution Input (Ml/d)		378	369	360	351	359	368
HIGH FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		104	108	112	117	121	126
Unmetered household (Ml/d)		214	225	238	251	264	279
Unmetered non-household (Ml/d)		14	15	15	16	16	17
Total Treated Water Losses (Ml/d)		102	102	103	104	104	105
Distribution Input (Ml/d)		435	451	469	488	507	527
MANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		28	59	61	63	66	69
Metered non-household (Ml/d)		100	100	100	100	100	100
Unmetered household (Ml/d)		179	153	158	164	171	178
Unmetered non-household (Ml/d)		14	14	14	14	14	14
Total Treated Water Losses (Ml/d)		62	57	58	58	58	59
Distribution Input (Ml/d)		384	383	391	399	409	419
UNMANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		100	100	100	100	100	100
Unmetered household (Ml/d)		210	217	225	233	243	253
Unmetered non-household (Ml/d)		14	14	14	14	14	14
Total Treated Water Losses (Ml/d)		102	102	103	104	104	105
Distribution Input (Ml/d)		426	434	443	452	462	472

Note : Data above produced as outlined in; NRA (1993) *'Methodology and Assumptions for Demand Forecasting'*, Version 2

NRA demand forecast range for Essex Water Company



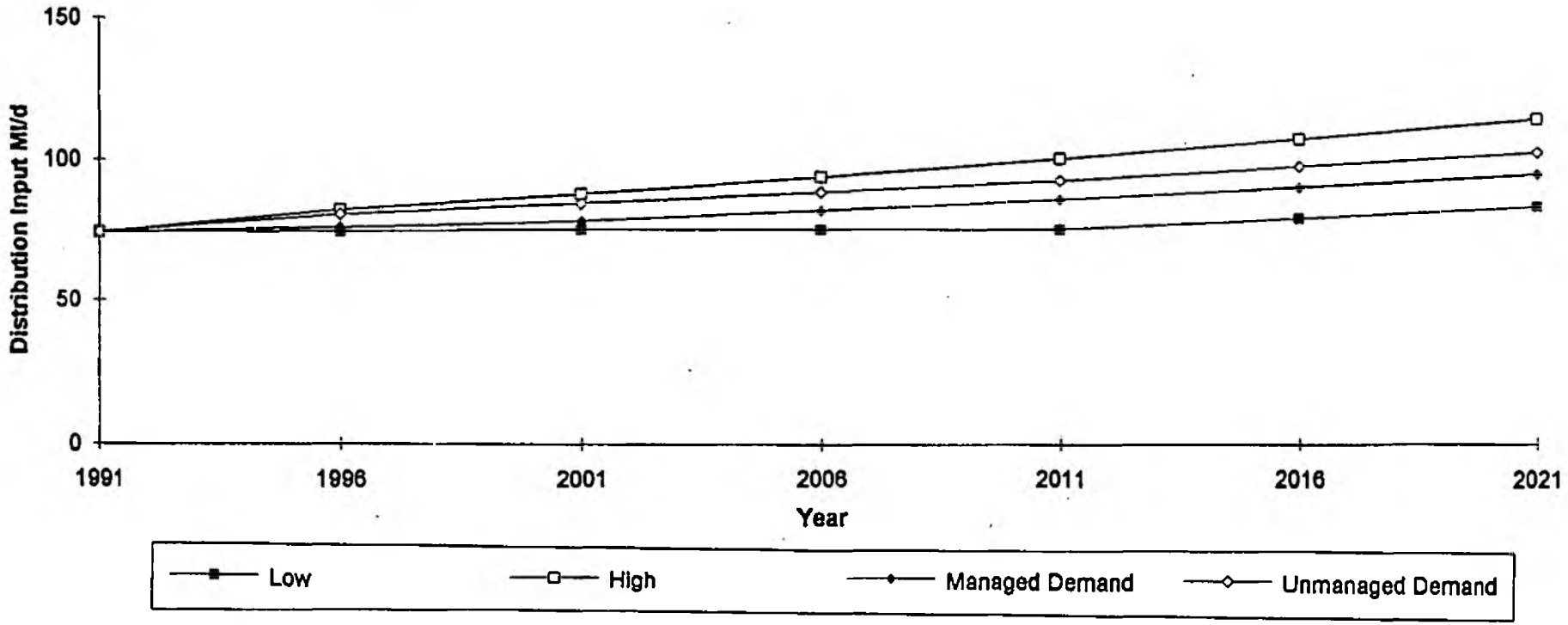
NRA Demand Forecast Summary Data

COMPANY : CAMBRIDGE WATER

INPUT DATA	1991	1996	2001	2006	2011	2016	2021
Distribution Input 1991 (Ml/d)	74						
Total Metered 1991 (Ml/d)	21						
Unmetered non-household (Ml/d)	2						
Proportion 1991 properties metered	0.0334						
ACORN weighted average PCC (l/h/d)	136.0						
Population ('000s)	273210	285156	297102	309048	320994	332940	344886
Occupancy Rate	2.72	2.71	2.70	2.70	2.69	2.68	2.67
1991 BASE	1991						
Metered household (Ml/d)	1						
Metered non-household (Ml/d)	20						
Unmetered household (Ml/d)	36						
Total Treated Water Losses (Ml/d)	15						
Night Flow (l/pr/hr)	7.46						
LOW FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	12	25	40	43	47
Metered non-household (Ml/d)		20	20	20	20	20	20
Unmetered household (Ml/d)		39	30	19	5	5	6
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		12	11	10	8	8	9
Distribution Input (Ml/d)		74	75	75	75	79	83
HIGH FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	2	2
Metered non-household (Ml/d)		20	21	22	23	24	25
Unmetered household (Ml/d)		42	46	51	55	61	66
Unmetered non-household (Ml/d)		2	3	3	3	3	3
Total Treated Water Losses (Ml/d)		16	16	17	18	18	19
Distribution Input (Ml/d)		82	88	94	100	107	114
MANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		6	12	13	14	15	17
Metered non-household (Ml/d)		20	20	20	20	20	20
Unmetered household (Ml/d)		36	32	35	37	40	43
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		12	11	12	12	13	13
Distribution Input (Ml/d)		76	78	82	86	90	95
UNMANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		20	20	20	20	20	20
Unmetered household (Ml/d)		41	45	48	52	56	60
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		16	16	17	18	18	19
Distribution Input (Ml/d)		80	84	88	93	97	102

Note : Data above produced as outlined in; NRA (1993) *'Methodology and Assumptions for Demand Forecasting'*, Version 2

NRA demand forecast range for Cambridge Water Company



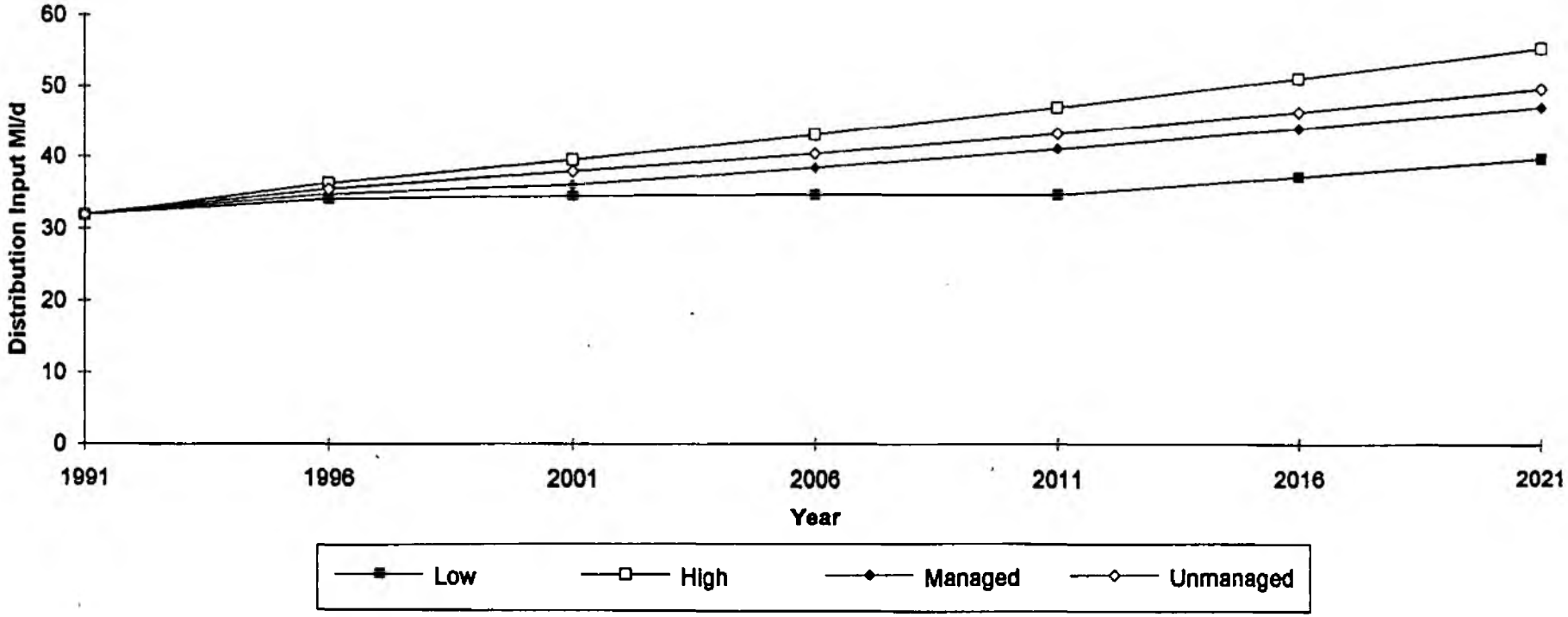
NRA Demand Forecast Summary Data

COMPANY : TENDRING HUNDRED WATER

INPUT DATA	1991	1996	2001	2006	2011	2016	2021
Distribution Input 1991 (Ml/d)	32						
Total Metered 1991 (Ml/d)	7						
Unmetered non-household (Ml/d)	2						
Proportion 1991 properties metered	0.0309						
ACORN weighted average PCC (l/h/d)	144.0						
Population ('000s)	136640	145363	154086	162809	171533	180256	188979
Occupancy Rate	2.22	2.21	2.20	2.19	2.18	2.17	2.16
1991 BASE	1991						
Metered household (Ml/d)	1						
Metered non-household (Ml/d)	7						
Unmetered household (Ml/d)	19						
Total Treated Water Losses (Ml/d)	4						
Night Flow (l/pr/hr)	3.28						
LOW FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	6	14	23	25	27
Metered non-household (Ml/d)		7	7	7	7	7	7
Unmetered household (Ml/d)		21	17	10	3	3	3
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		4	3	2	1	1	1
Distribution Input (Ml/d)		34	35	35	35	37	40
HIGH FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		7	7	8	8	8	8
Unmetered household (Ml/d)		23	26	28	32	35	38
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		4	5	5	5	5	6
Distribution Input (Ml/d)		36	40	43	47	51	55
MANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		3	7	7	8	9	10
Metered non-household (Ml/d)		7	7	7	7	7	7
Unmetered household (Ml/d)		20	18	19	21	23	25
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		4	3	4	4	4	4
Distribution Input (Ml/d)		35	36	39	41	44	47
UNMANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		7	7	7	7	7	7
Unmetered household (Ml/d)		22	25	27	29	32	35
Unmetered non-household (Ml/d)		2	2	2	2	2	2
Total Treated Water Losses (Ml/d)		4	5	5	5	5	6
Distribution Input (Ml/d)		36	38	41	43	46	50

Note : Data above produced as outlined in; NRA (1993) *'Methodology and Assumptions for Demand Forecasting'*, Version 2

NRA demand forecast range for Tendring Hundred Water



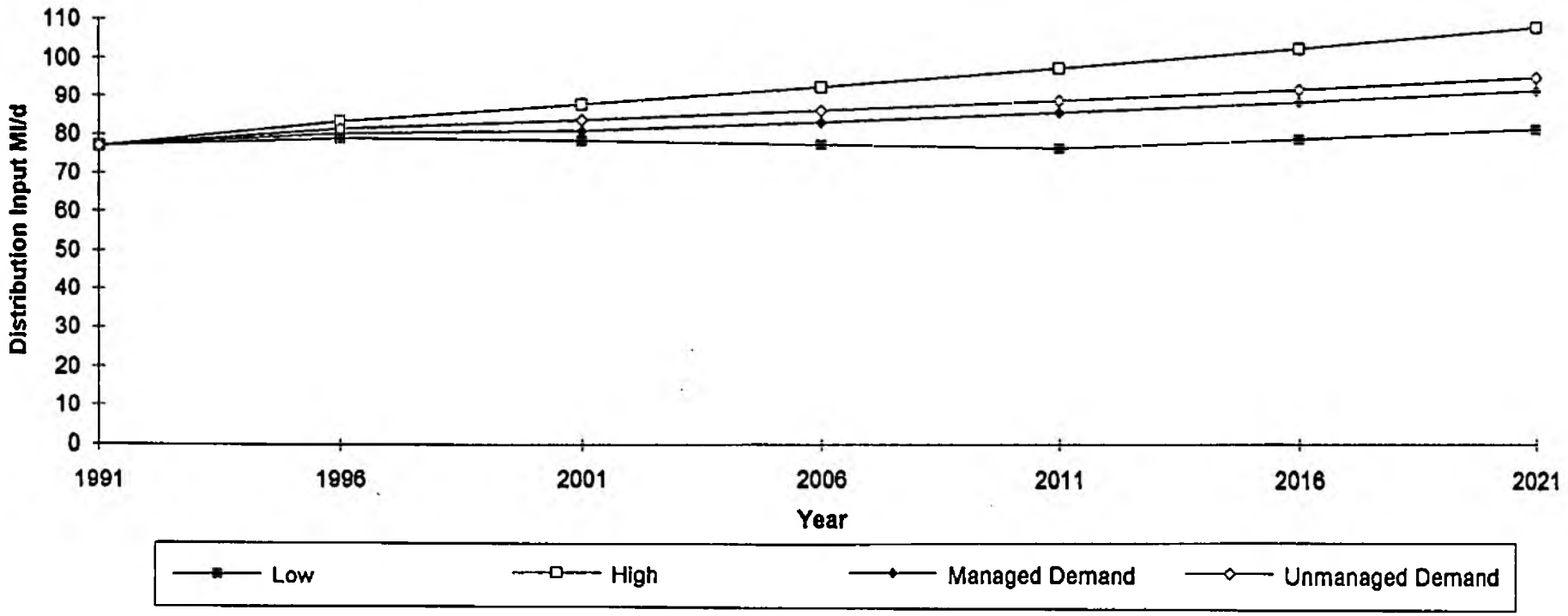
NRA Demand Forecast Summary Data

COMPANY : SUFFOLK WATER

INPUT DATA	1991	1996	2001	2006	2011	2016	2021
Distribution Input 1991 (Ml/d)	77						
Total Metered 1991 (Ml/d)	32						
Unmetered non-household (Ml/d)	1						
Proportion 1991 properties metered	0.0341						
ACORN weighted average PCC (l/h/d)	134.2						
Population ('000s)	250800	256123	261447	266770	272093	277417	282740
Occupancy Rate	2.45	2.43	2.42	2.40	2.38	2.37	2.35
1991 BASE	1991						
Metered household (Ml/d)	1						
Metered non-household (Ml/d)	30						
Unmetered household (Ml/d)	33						
Total Treated Water Losses (Ml/d)	12						
Night Flow (l/pr/hr)	6.00						
LOW FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	10	21	34	36	38
Metered non-household (Ml/d)		30	30	30	30	30	30
Unmetered household (Ml/d)		34	26	16	4	4	5
Unmetered non-household (Ml/d)		1	1	1	1	1	1
Total Treated Water Losses (Ml/d)		12	11	9	8	8	8
Distribution Input (Ml/d)		79	78	78	76	79	81
HIGH FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		32	33	34	35	37	38
Unmetered household (Ml/d)		37	40	43	46	50	53
Unmetered non-household (Ml/d)		1	1	1	1	1	1
Total Treated Water Losses (Ml/d)		12	13	13	14	14	14
Distribution Input (Ml/d)		83	88	92	97	102	108
MANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		5	11	11	12	13	13
Metered non-household (Ml/d)		30	30	30	30	30	30
Unmetered household (Ml/d)		32	28	29	31	33	35
Unmetered non-household (Ml/d)		1	1	1	1	1	1
Total Treated Water Losses (Ml/d)		12	11	11	12	12	12
Distribution Input (Ml/d)		80	81	83	86	89	92
UNMANAGED DEMAND FORECAST		1996	2001	2006	2011	2016	2021
Metered household (Ml/d)		1	1	1	1	1	1
Metered non-household (Ml/d)		30	30	30	30	30	30
Unmetered household (Ml/d)		37	39	41	43	46	48
Unmetered non-household (Ml/d)		1	1	1	1	1	1
Total Treated Water Losses (Ml/d)		12	13	13	14	14	14
Distribution Input (Ml/d)		81	84	86	89	92	95

Note : Data above produced as outlined in; NRA (1993) *'Methodology and Assumptions for Demand Forecasting'*, Version 2

NRA demand forecast range for Suffolk Water



APPENDIX C

Review of public water supply source yields

APPENDIX C

EXISTING YIELD ESTIMATES BY WATER COMPANY

Estimates of yield have been obtained for each source (or group of sources) licensed to a water undertaker, including sources used to supply non-potable water to industrial users. For the purposes of this exercise yield has been defined as:

> "the average rate of supply which can be maintained from the source or sources in a 1 in 50 year drought or historic drought of similar severity".

The drought duration was not specified, but it has been assumed that the critical drought duration for each source type (for example, the critical duration for a river source will be different to that for a reservoir or groundwater source) has been used for the yield assessment.

It is recognised that yield definition is the largest area for possible discrepancies between the yield estimates for each water company. In many cases, particularly for the smaller, groundwater sources, it is not clear how the yield figures obtained from the water companies have been derived. Where the data given are known to differ from the above definition the yield table has been annotated as such. In all other cases the yields area assumed to be, or to approximate to, the 1 in 50 year drought value.

The yield available to some water companies include imports from neighbouring areas. For this exercise an import has been defined as follows:

> - an import is a water source used by a water company which is not under the jurisdiction of the NRA region which licences the source.

Only imports are shown on the following yield tables, that is to say, the yield of a source which is exported to a neighbouring water company does not appear in the listing for the exporting water company but instead appears in the listing for the recipient company.

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	EXISTING SOURCE YIELD ESTIMATES	NATIONAL RIVERS AUTHORITY
NRA REGION: Anglian		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Lincs Chalk and Sandstone				Anglian Water Services		
	Northern Chalk	110.00	GW	Y			
	Southern Chalk	7.94	GW	Y			
	Spilsby Sandstone	31.03	GW	Y			
	Lincs Limestone						
	Northern Limestone	19.51	GW	Y			
	Central Limestone	18.45	GW	Y			
	Southern Limestone	80.10	GW	Y			
	Lincs Minor						
	Lincs Minor	0.00	GW	Y			
	Cambridgeshire Chalk						
	Granta - Unit 5	0.00	GW	Y			
	Cambridge - Unit 6	0.00	GW	Y			
	Lodes - Unit 7	13.03	GW	Y			
	Lark - Unit 8	53.08	GW	Y			
	Little Ouse - Unit 9	26.57	GW	Y			
	Wissey - Unit 10	29.80	GW	Y			
	Nar - Unit 11	22.76	GW	Y			
	Babingley/Gaywood - Unit 12	20.20	GW	Y			
	NW Norfolk Chalk - Unit 13 & 14	3.78	GW	Y			
	Page Sub-Total =	436.25	*Source Type: GW = Groundwater; SW = Surface Water.				

Notified Tim Turner 21-6-93:

Anos', Bunter somewhere

should be in date tables:

500 = 65 tonnes

He agrees.

DS
21-6-93

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	**EXISTING SOURCE YIELD ESTIMATES**	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Lower Greensand Leighton Buzzard - Unit GS1	9.34	GW	Y	Anglian Water Services (Cont'd)		
	Sandy - Unit GS2	21.96	GW	Y			
	Cambridge - Unit GS3	4.55	GW	Y			
	Sandringham - Unit GS4	6.76	GW	Y			
	Central Minor Oolites/Gravels	1.50	GW	Y			
	North Norfolk Chalk Stiffkey - 34/03	6.99	GW	Y			
	Glaven - 34/04	4.11	GW	Y			
	Mun - 34/05	5.08	GW	Y			
	Bure Chalk Bure - 34/06	8.61	GW	Y			Development of Aylsham not included
	Ant - 34/08	5.48	GW	Y			Includes Crag Source at Ludham - in hydraulic continuity with the Chalk
	Bure/Ant - 34/09						
	Wensum Chalk Wensum - 34/11	10.31	GW	Y			
	Yare - 34/13	17.72	GW	Y			
	Tas - 34/14	9.63	GW	Y			
	Tidal Yare - 34/15a	19.18	GW	Y			Incudes Sand and Gravel Source at Kirby Cane - in hydraulic continuity with the Chalk
	Page Sub-Total =	131.22	*Source Type: GW = Groundwater; SW = Surface Water.				Page 2 of 4

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	EXISTING SOURCE YIELD ESTIMATES	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Waveney Chalk Waveney - 34/16	8.82	GW	Y	Anglian Water Services (Cont'd)		
	Waveney - 34/18	2.00	GW	Y			
	Deben Chalk Deben - 35/06	41.80	GW	Y			
	Fynn/Lark - 35/07						
	Gipping Chalk Gipping - 35/08						Sources within 35/6 to 35/10 are linked by aggregate
	Belstead Brook - 35/09						
	Felixstowe Peninsular - 35/10a						
	Stour Chalk Upper Stour - 36/11	10.96	GW	Y			
	Lower Stour - 36/15	34.37	GW	Y			
	Brett - 36/17	8.80	GW	Y			
	Mid Essex Chalk Colne - 37/21	7.40	GW	Y			
	Colne - 37/23	4.11	GW	Y			
	Blackwater/Chelmer - 37/31	19.47	GW	Y			
	Page Sub-Total =	137.73	*Source Type: GW = Groundwater; SW = Surface Water.				Page 3 of 4

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	**EXISTING SOURCE YIELD ESTIMATES**	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Saltersford	20.0	SW	Y	Anglian Water Services (Cont'd)		
IMPORT	River Trent/Barsham WTW	85.0	SW	Y			
	Covenham	64.0	SW	Y			
	Rutland	532.0 rising to 604 by 2011	SW	Y			Rutharnford system. 18 Ml/d of the yield from Rutland is exported to Severn Trent Region
	Pitsford						
	Grafham						91 Ml/d of the yield from Grafham is exported to Thames Region (3 Valleys): Increasing to 136 Ml/d by 2001
	Ravensthorpe/Hollowell	8.0	SW	Y			
	Loke Road	0.0	SW	Y			
	Marham	8.0	SW	Y			
	Stoke Ferry	18.0	SW	Y			
	Foxcote	6.5	SW	Y			
	Clapham	27.0	SW	Y			
	Costessey/Heigham	46.0	SW	Y			
	Alton	30.0	SW	Y			
	Ardleigh	13.08	SW	Y			
	WATER COMPANY TOTAL	1562.78					
	Page Sub-Total =	857.58	*Source Type: GW = Groundwater; SW = Surface Water.				Page 4 of 4

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	EXISTING SOURCE YIELD ESTIMATES	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Thameside Chalk Crouch/Thames - 37/44	0.0	GW	Y	Essex Water Company		
	Crouch/Thames - 37/56	9.06	GW	Y			
	Abberton, Hanningfield and Associated Sources	340.0	SW	Y			Provisional.
IMPORT	Lee Valley Reservoir/London Ring Main (Chigwell)	91.0	SW	Y			
	WATER COMPANY TOTAL	440.06					
	Page Sub-Total =	440.06	*Source Type: GW = Groundwater; SW = Surface Water.				Page 1 of 1

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	EXISTING SOURCE YIELD ESTIMATES	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Cambridgeshire Chalk						
	Little Ouse - Unit 9	3.44	GW	Y	Suffolk Water Company		
	Bure Chalk						
	Bure/Ant - 34/09	4.83	GW	Y			
	Waveney Chalk						
	Dove 34/17	4.49	GW	Y			
	Waveney - 34/18						
	Tidal Waveney 34/19a	20.43	GW	Y			
	Blyth/Alde Chalk		GW				
	Blyth - 35/02a	5.71	GW	Y			
	Alde - 35/04a	4.23	GW	Y			
	Suffolk Crag						
	Lothingland - 35/01	1.23	GW	Y			
	Yox & Minsmere - 35/03	4.47	GW	Y			
	Tidal Alde & Ore - 35/05	0.25	GW	Y			
	Shipmeadow	21.0	SW	Y			
	Belaugh & Horning	23.0	SW	Y			
	Lound	5.0	SW	Y			
	WATER COMPANY TOTAL	98.08					
	Page Sub-Total =	98.08	*Source Type: GW = Groundwater; SW = Surface Water.				Page 1 of 1

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	**EXISTING SOURCE YIELD ESTIMATES**	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Cambridgeshire Chalk				Cambridge Water Company		
	Rhee - Unit 3	24.44	GW	Y			
	Cam - Unit 4	15.23	GW	Y			
	Granta - Unit 5	16.23	GW	Y			
	Cambridge - Unit 6						
	Lodes - Unit 7	42.33	GW	Y			
	Little Ouse - Unit 9	23.34	GW	Y			
	Lower Greensand						
	Cambridge - Unit GS3	3.49	GW	Y			
	Central Minor						
	Oolites/Gravels	0.00	GW	Y			
	WATER COMPANY TOTAL	125.06					
	Page Sub-Total =	125.06	*Source Type: GW = Groundwater; SW = Surface Water.				Page 1 of 1

NATIONAL WATER RESOURCES DEVELOPMENT STRATEGY	EXISTING SOURCE YIELD ESTIMATES	NATIONAL RIVERS AUTHORITY
NRA REGION: **Anglian**		DATE: JUNE 1993

Licence Number	Source Name/Location	Yield (Ml/d)	Source Type*	Yield Est. Agreed with Undertaker	Water Company Name	Supply Area	Comment
	Stour Chalk Brett - 36/17	28.50	GW	Y	Tendring Hundred Waterworks Company		Sources within Brett, Stratford/Flatford and Stour estuary catchments are linked by aggregate
	Stratford/Flitford - 36/18						
	Stour Estuary - 36/19						
	Tendring Gravels Tendring Peninsular - 37/25	2.60	GW	Y			
	Ardleigh	13.0	SW	Y			
	WATER COMPANY TOTAL	44.1					
	Page Sub-Total =	44.1	*Source Type: GW = Groundwater; SW = Surface Water.				Page 1 of 1