

# Hydrological summary

## *for Great Britain*

### General

March was another warm month - continuing a remarkably mild sequence - with significantly below average rainfall for Britain as a whole. Nonetheless, overall surface water stocks remain very healthy and March river flows and groundwater levels were generally well within the normal range. But in parts of the English lowlands rainfall over the ten weeks beginning in early February was only around 50% of average; with accelerating evaporation rates - March losses were, typically, 10-15% above average - the onset of seasonal recessions in river flows and groundwater levels is likely to be early this year. This is of particular importance in those, relatively restricted, areas where groundwater levels are still well below average.

### Rainfall

The unsettled weather patterns of late February continued into March when frontal systems produced sustained rainfall in the west (e.g. 88 mm on 1<sup>st</sup> & 2<sup>nd</sup> at Capel Curig, Wales) and substantial snowfall on high ground in Scotland. A very persistent low pressure system centred to the east of the British Isles produced notable rainfall accumulations in parts of north-eastern England - at Church House on the North York Moors a 227 mm total was recorded over seven days (return period > 500 years); severe flooding ensued. From mid-month high pressure became more dominant and rainfall totals in much of the English lowlands were very modest. In Scotland most regional precipitation totals for March were a little below average. England showed much less regional coherence with over three times the March average in parts of the North York Moors but below 50% in some central southern districts. In many southern catchments February was dry also and the combined Feb/Mar rainfall was only around 40% of average in some areas (e.g. parts of the North Downs and Oxfordshire) it was the second driest Feb/Mar since 1976. However, at the regional scale, rainfall totals for the year thus far are below average only in southern England and north-eastern Scotland. For the winter half-year, regional totals exceed the average throughout Britain - this is true of the last 12 months also with exceptional April-March totals in much of Scotland and parts of north-eastern England.

### River Flows

Runoff rates during March demonstrated considerable variation both spatially and temporally. Spate conditions were common early in the month, in Wales especially, and local flooding was reported in a number of western catchments. The sustained rainfall in Yorkshire (augmented initially by modest snowmelt) resulted in a major flood event on the River Derwent - flooding was severe and protracted (e.g. at Malton); around 200 properties were affected and inundation of agricultural land delayed the sowing of crops. The peak flow at Buttercrambe was the highest in a series from 1973 and exceptional flow rates characterised many streams draining the North York

Moors on the 8-12<sup>th</sup>. The March runoff for Buttercrambe was the highest on record (for any month) and the Witham and Trent totals rank second and third highest respectively for March. Elsewhere, monthly runoff totals were well above average in north-west Scotland but below average in most rivers draining to the North Sea. In percentage terms the lowest flows were in southern England where a few rivers (e.g. the Medway, Wallington and Hampshire Stour) recorded below 70% of the March average. By early April, recessions were well established in most rivers but long term runoff accumulations are generally well above average - new April-March maxima were established for in a significant minority of index rivers (including the Clyde, Cynon and Great Ouse - the latter in a 66-year record).

### Groundwater

The limited rainfall and seasonally high evaporation rates caused soil moisture deficits to increase briskly over late March and early April; in the absence of substantial late April rainfall, this may signal the end of the recharge season in the east and south. Groundwater levels are in recession throughout most of the Chalk. Fortunately, the lagged response to substantial infiltration over the winter has restored previously depressed water-tables in the eastern Chalk to within the normal seasonal range - in the Chilterns and Hertfordshire levels have returned to around average for the first time in well over three years. Following heavy early March recharge, groundwater levels are substantially above average in the more northerly outcrops. Levels in most major limestone outcrops and many minor aquifers (e.g. the Norfolk Drift and Suffolk Crag) are also above average - although recent recessions in the limestones have been relatively steep. Regional rainfall contrasts together with differing response times make for a much more varied picture in relation to the Permo-Triassic sandstones aquifers but levels in most index wells are within the normal range.

March 1999

# Rainfall . . . Rainfall . . . Rainfall . .

## Rainfall accumulations and return period estimates

Area	Rainfall	Mar 1999	Jan 99-Mar 99 RP	Oct 98-Mar 99 RP	Apr 98-Mar 99 RP	Apr 97-Mar 99 RP			
<b>England &amp; Wales</b>	mm	64	230	539	1016	1954			
	%	89	103	2-5	113	5-10	109	5-10	
North West	mm	91	341	778	1359	2517			
	%	95	116	2-5	113	5-10	105	2-5	
Northumbrian	mm	89	239	523	1115	1974			
	%	126	112	2-5	115	2-5	131	40-60	116
Severn Trent	mm	67	231	503	920	1743			
	%	110	125	5-10	127	5-15	122	10-20	116
Yorkshire	mm	99	233	509	962	1810			
	%	145	114	2-5	116	2-5	117	5-10	110
Anglian	mm	55	153	372	745	1379			
	%	116	114	2-5	125	5-10	125	15-25	116
Thames	mm	38	160	418	832	1510			
	%	68	97	2-5	115	2-5	121	5-15	110
Southern	mm	41	173	478	868	1717			
	%	65	88	2-5	108	2-5	111	2-5	110
Wessex	mm	48	211	528	995	1940			
	%	69	95	2-5	111	2-5	119	5-10	116
South West	mm	67	291	766	1356	2653			
	%	68	86	2-5	107	2-5	116	5-10	113
Welsh	mm	88	396	897	1556	2962			
	%	82	114	2-5	115	2-5	119	5-15	113
<b>Scotland</b>	mm	116	477	1054	1708	3158			
	%	93	126	5-10	126	20-30	119	20-30	110
Highland	mm	161	660	1336	2006	3776			
	%	99	138	15-25	124	10-20	114	5-10	107
North East	mm	57	223	559	1157	2189			
	%	73	92	2-5	105	2-5	119	10-20	112
Tay	mm	84	409	921	1533	2767			
	%	77	118	2-5	127	10-20	125	25-40	113
Forth	mm	75	310	820	1454	2566			
	%	80	107	2-5	131	20-30	131	80-120	116
Tweed	mm	63	261	624	1186	2157			
	%	80	106	2-5	118	5-10	122	15-25	111
Solway	mm	115	437	1059	1784	3216			
	%	98	117	2-5	129	10-20	126	30-50	113
Clyde	mm	138	551	1245	1938	3572			
	%	94	121	5-10	124	10-20	114	5-10	105

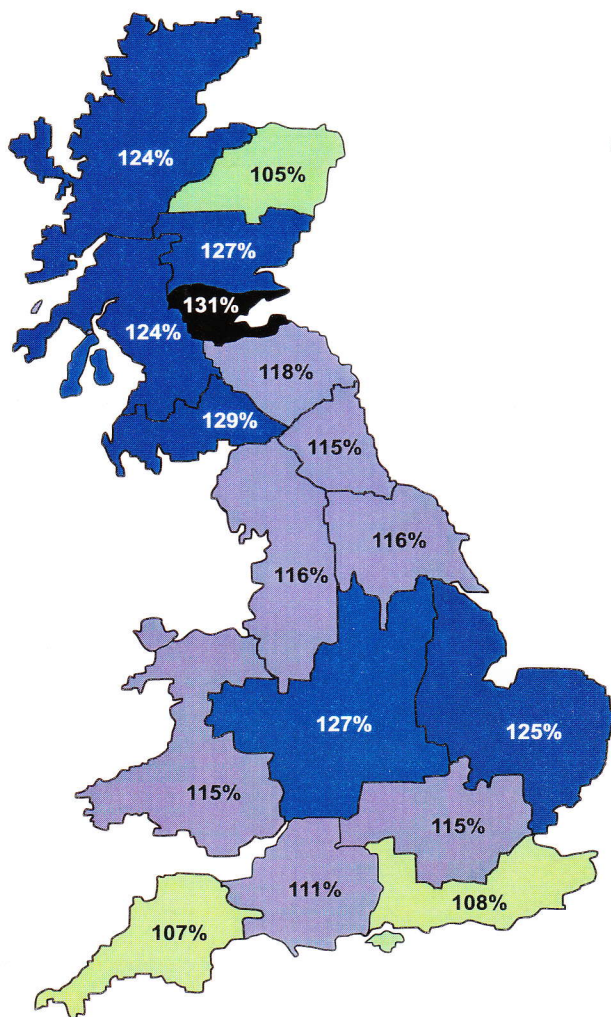
RP = Return period

The monthly rainfall figures\* are copyright of the Met. Office and may not be passed on to any unauthorised person or organisation. **All monthly totals since July 1998 are provisional (see page 12).** Recent monthly rainfall figures for the Scottish regions have been compiled using data provided by the Scottish Environment Protection Agency. The return period estimates are based on tables provided by the Meteorological Office (see Tabony, R.C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only, (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered). The tables reflect rainfall over the period 1911-70 and assume a stable climate. Artifacts in the England & Wales and Scotland rainfall series can exaggerate the relative wetness of the recent past. \*See page 12.

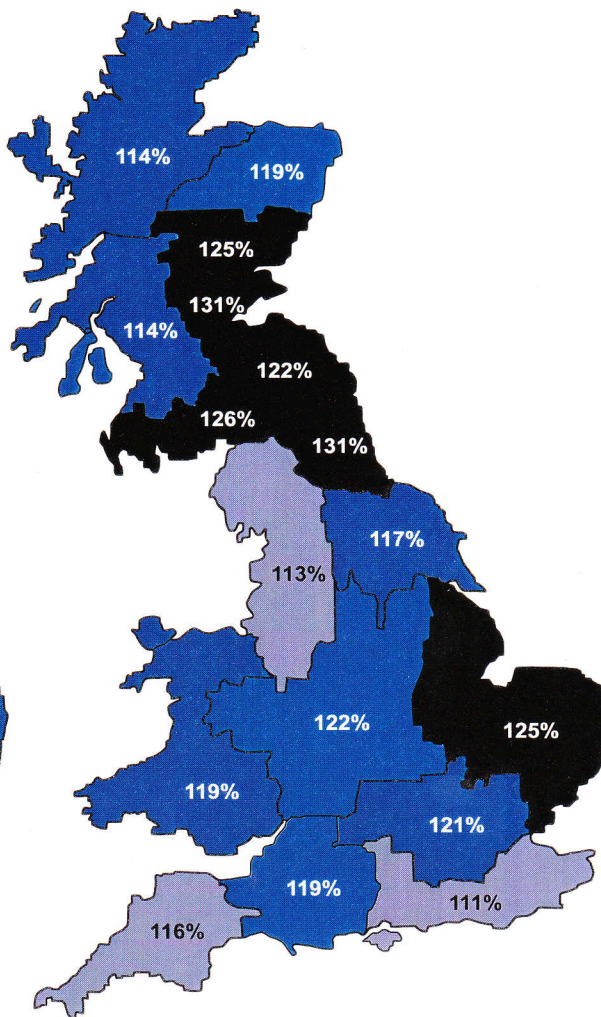
# Rainfall . . . Rainfall . . . Rainfall

## Key

00%	Percentage of 1961-90 average		Normal range
	Very wet		Below average
	Substantially above average		Substantially below average
	Above average		Exceptionally low rainfall



**October 1998 - March 1999**



**April 1998 - March 1999**

## Rainfall accumulation maps

The provisional winter half-year rainfall total for Britain is around 18% above average - placing it amongst the wettest dozen in the last 60 years and adding to the cluster of notable wet October - March periods in the recent past. In the 12-month timeframe, the April - March rainfall total for Britain ranks amongst the highest ten on record in a series from 1869.

# River flow . . . River flow . . .

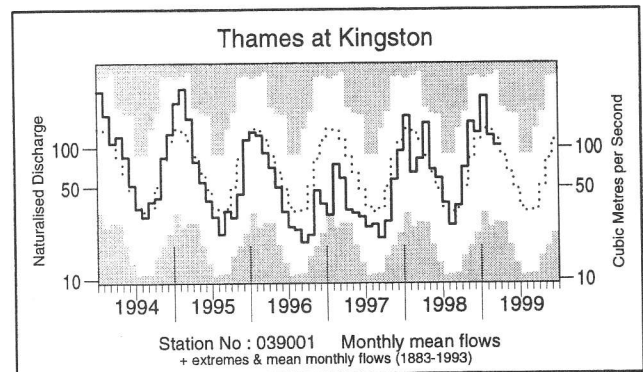
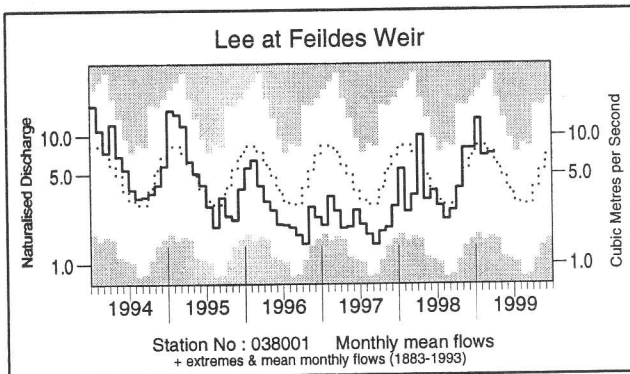
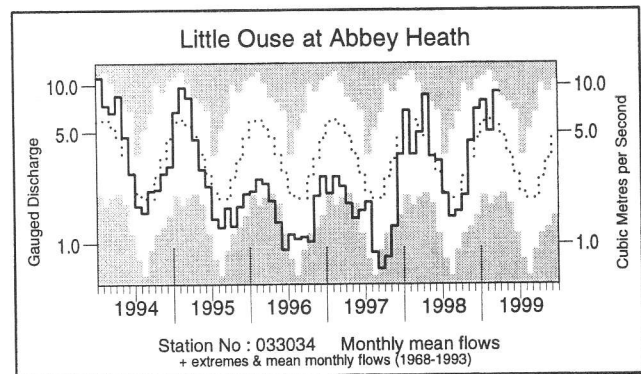
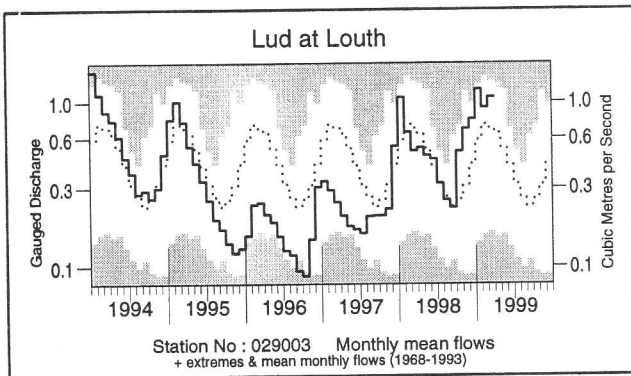
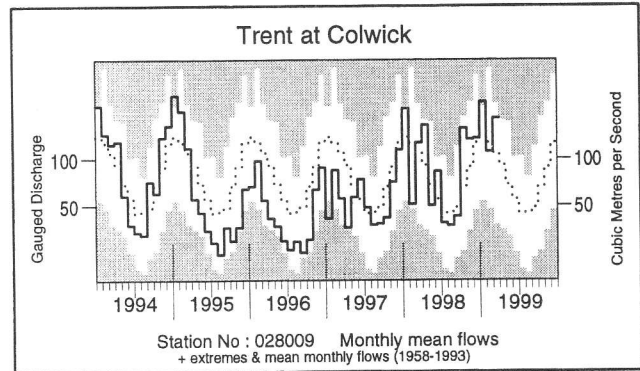
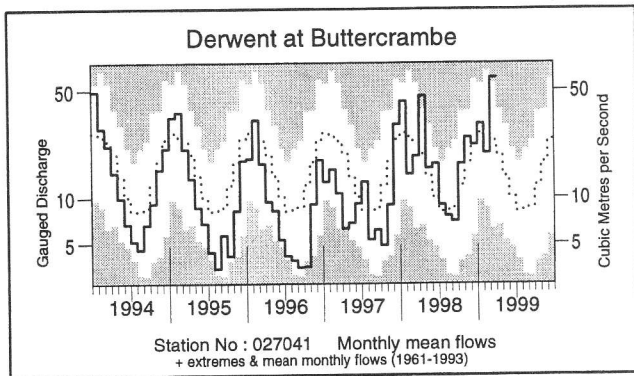
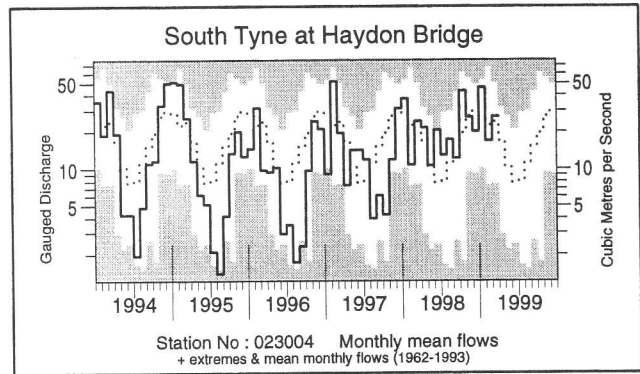
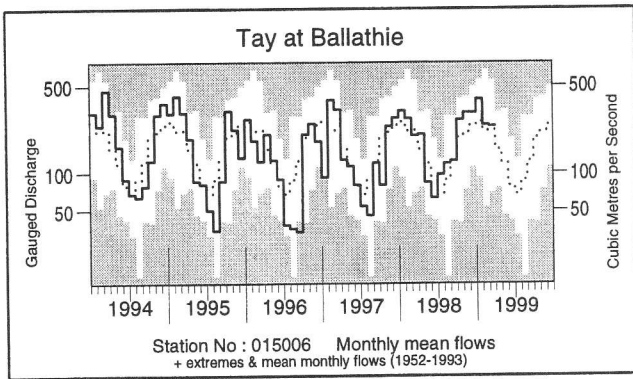


## River flows - March 1999

\*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater.

# River flow . . .

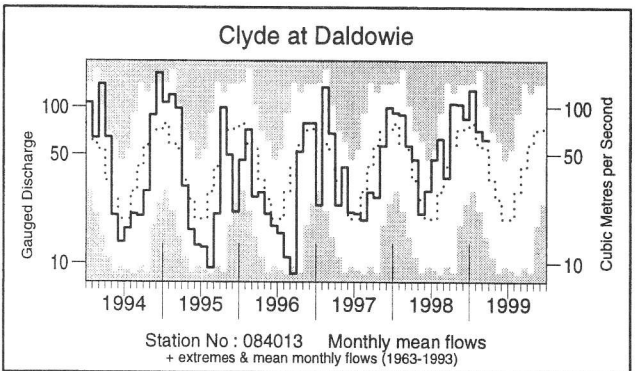
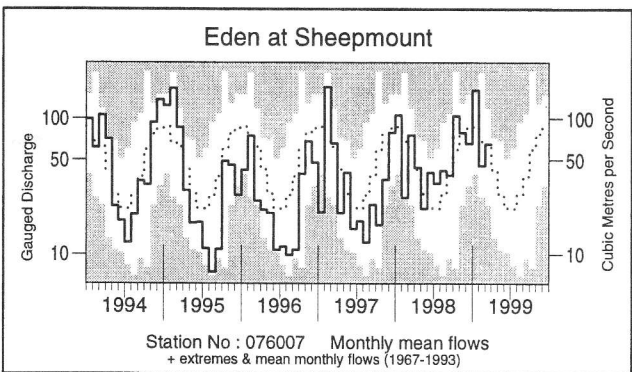
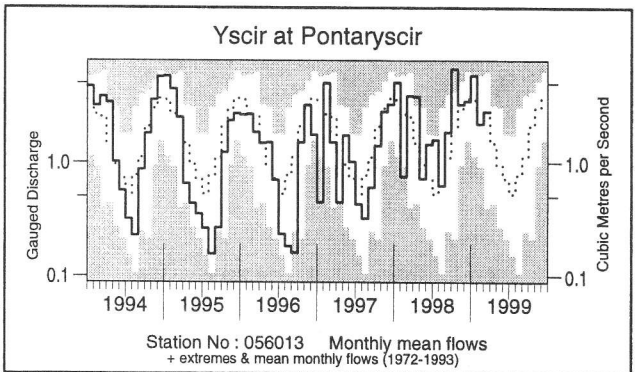
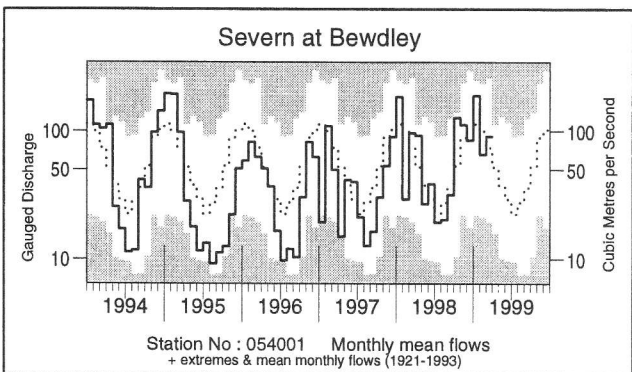
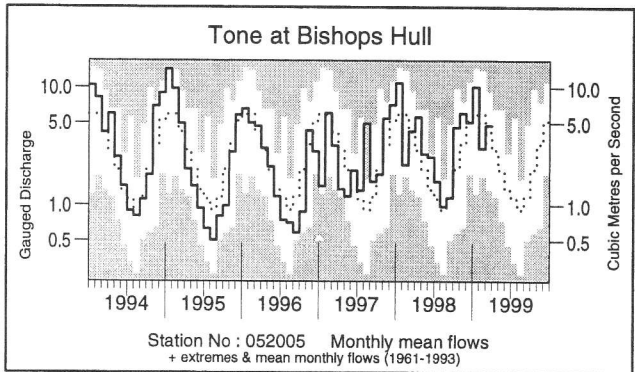
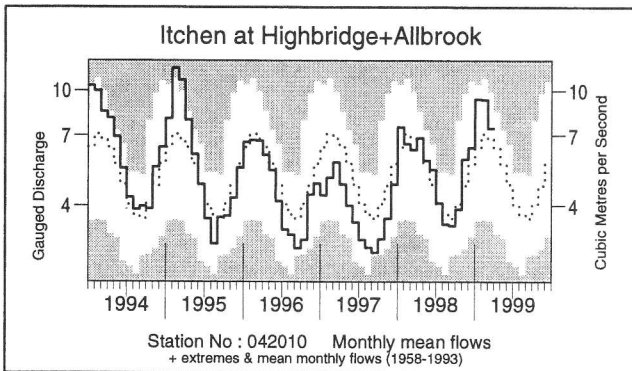
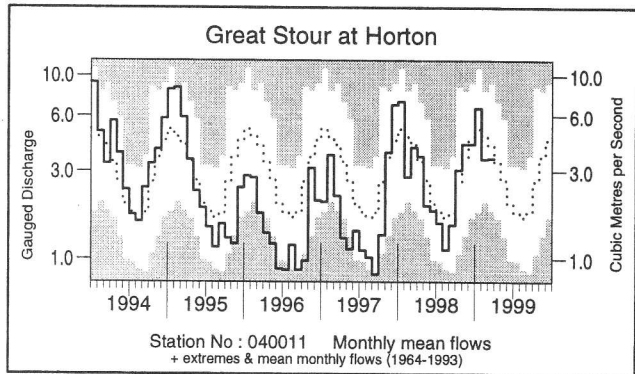
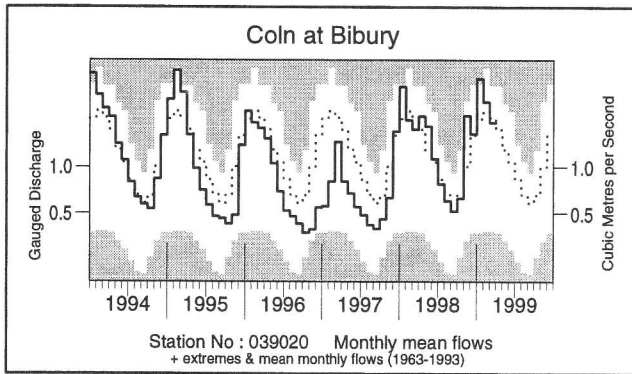
# River flow . . .



## Monthly river flow hydrographs

The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1994 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

# River flow . . . River flow . . .

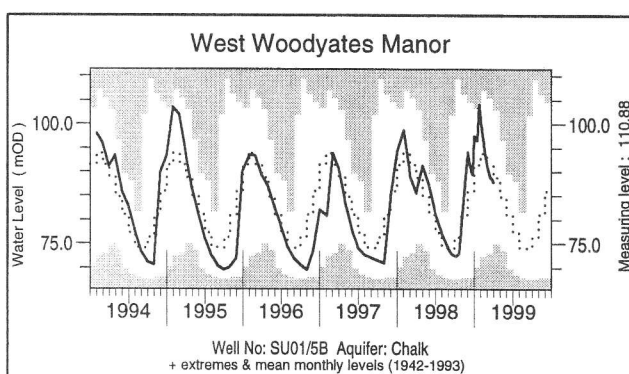
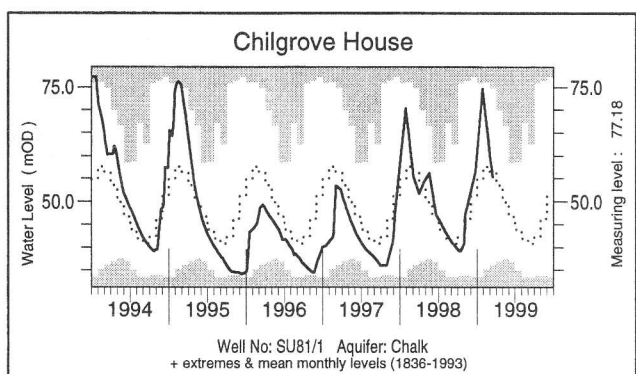
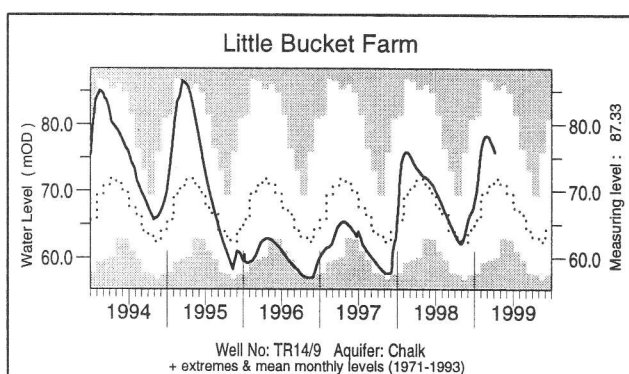
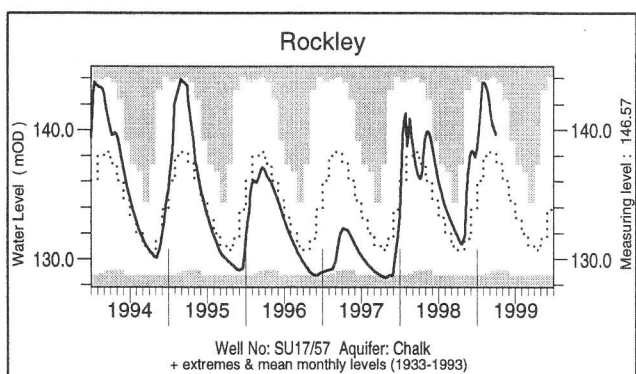
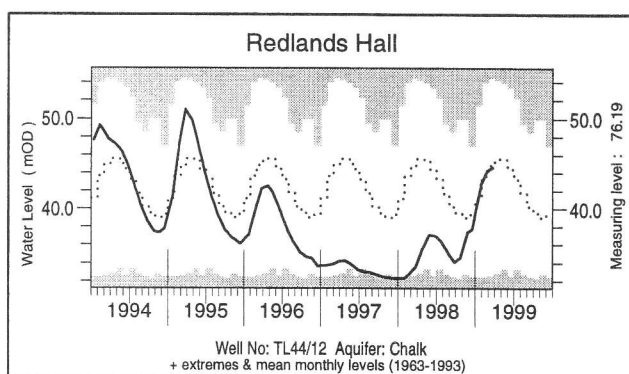
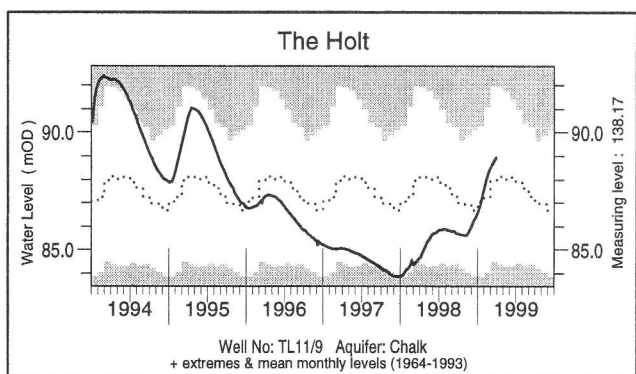
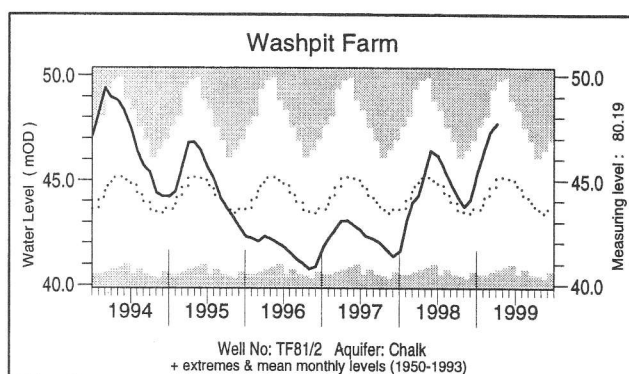
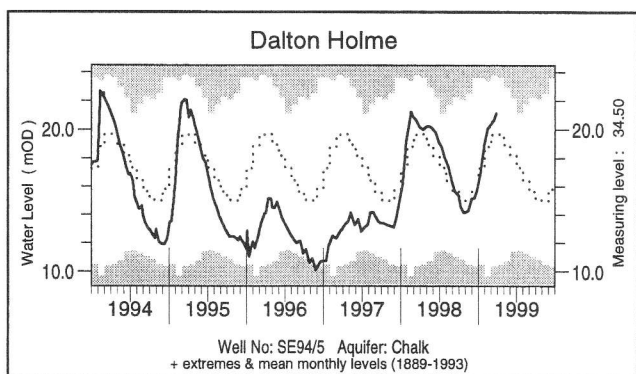


## Notable runoff accumulations October 1998 - March 1999 (a); April 1998 - March 1999 (b)

(a) River	%lta	Rank	(b) River	%lta	Rank	River	%lta	Rank
Earn	130	47/51	Spey	121	41/46	Exe	139	40/42
Trent	146	39/41	Whiteadder	153	29/29	Yscir	146	26/26
Witham	186	38/40	Trent	137	39/40	Cynon	138	39/39
Warleggan	135	28/30	Witham	177	39/39	Teifi	130	38/39
Yscir	135	26/26	Ouse	179	66/66	Clyde	138	35/35
Clyde	137	35/36	Coln	124	31/35	Naver	121	20/21

*lta* = long term average  
*Rank 1* = lowest on record

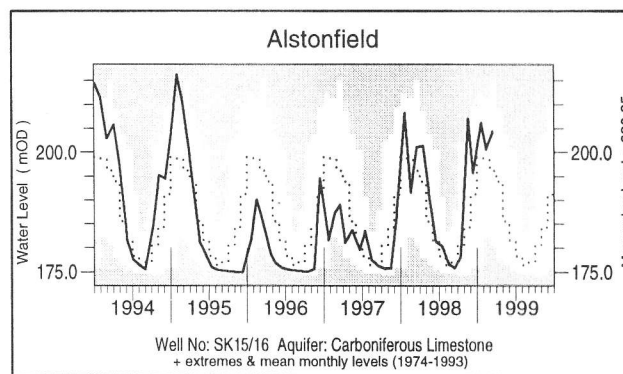
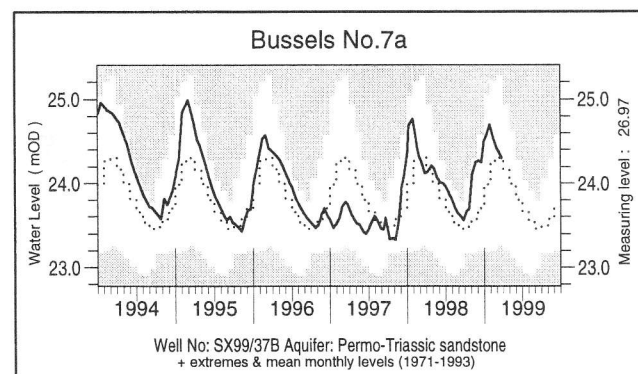
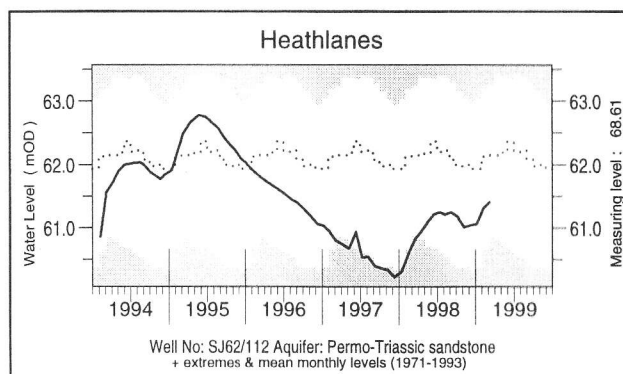
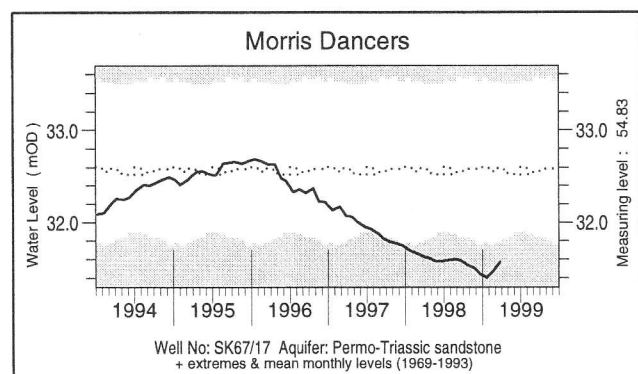
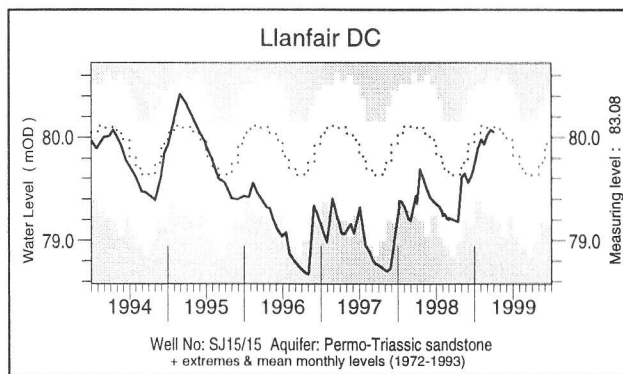
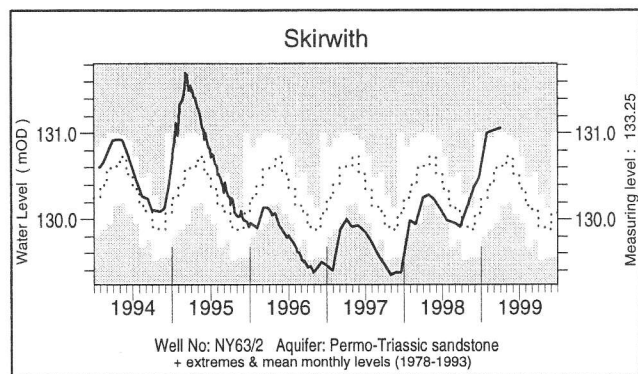
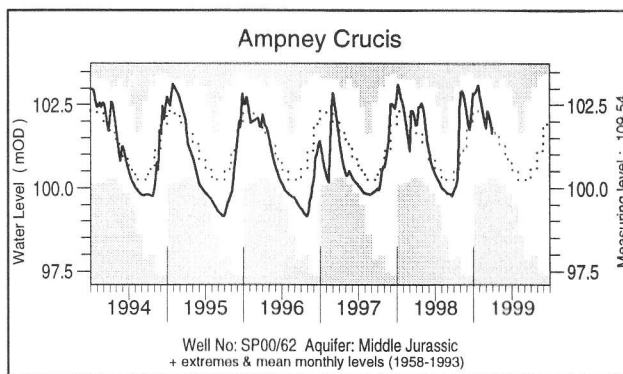
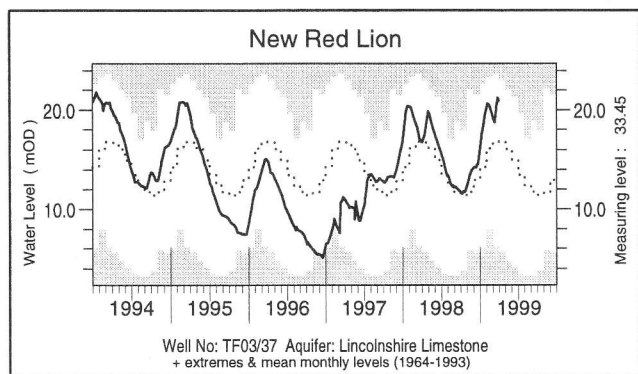
# Groundwater . . . Groundwater



## What is groundwater?

Groundwater is stored in the natural water bearing rock strata (or aquifers) which are found mostly in southern and eastern England (see page 11) where groundwater is the major water supply source. Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly max., min. and mean levels are displayed in a similar style to the river flow hydrographs, note that most groundwater levels are not measured continuously — the latest recorded levels are listed overleaf.

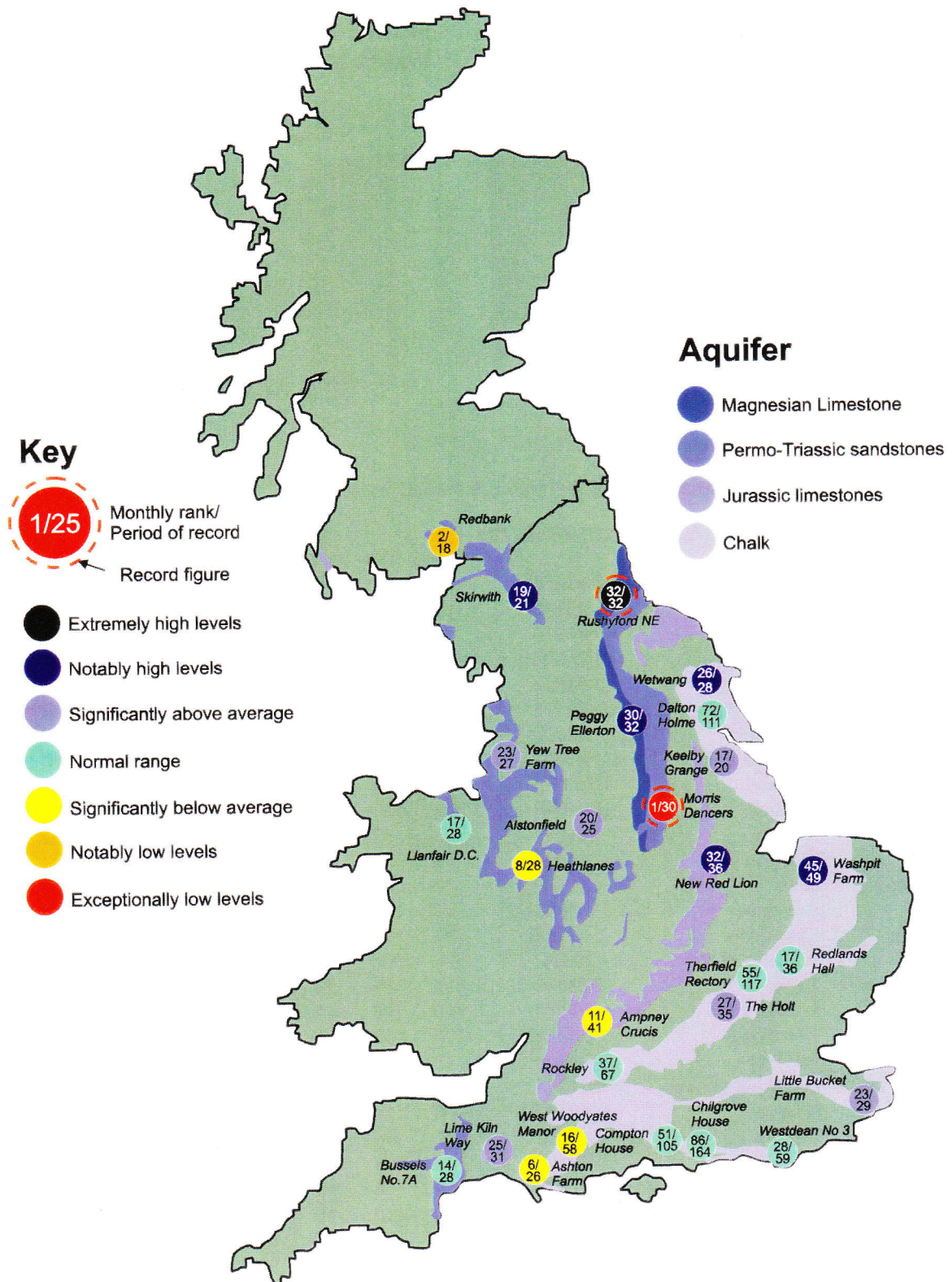
# Groundwater . . . Groundwater



## Groundwater levels March/April 1999

Borehole	Level	Date	Mar av.	Borehole	Level	Date	Mar av.	Borehole	Level	Date	Mar av.
Dalton Holme	21.17	26/03	19.49	Chilgrove	55.28	16/03	55.47	Llanfair DC	80.05	01/04	79.97
Washpit Farm	47.74	06/04	44.83	W Woodyates	87.86	31/03	90.70	Morris Dancers	31.57	24/03	32.49
The Holt	87.77	30/03	88.94	New Red Lion	20.89	30/03	16.50	Heathlanes	61.41	06/03	62.03
Redlands Hall	44.64	24/03	44.04	Ampney Crucis	101.63	30/03	102.03	Bussels	24.30	23/03	24.30
Ashton Farm	68.79	31/03	69.58	Skirwith	131.06	31/03	130.64	Alstonfield	204.47	15/03	195.44
Little Bucket	75.89	06/04	71.52								

# Groundwater . . . Groundwater

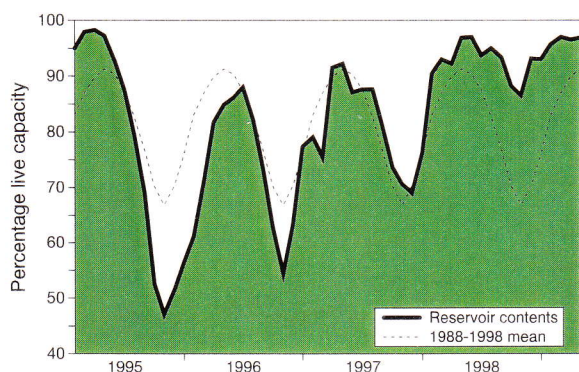


## Groundwater levels - March 1999

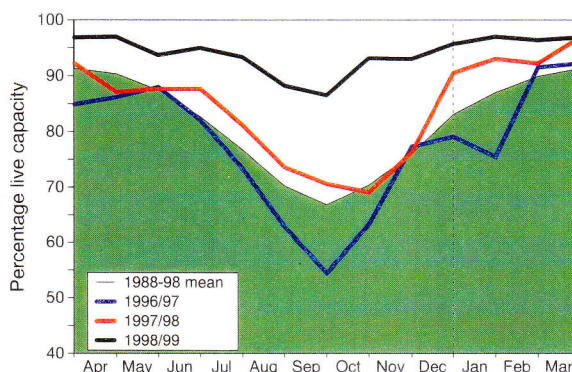
The rankings are based on a comparison of current levels (usually a single reading in a month) with the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record.

# Reservoirs . . . Reservoirs . .

## Guide to the variation in overall reservoir stocks for England and Wales



## Comparison between overall reservoir stocks for England and Wales in recent years



These plots are based on the England and Wales figures listed below.

## Percentage live capacity of selected reservoirs

Area	Reservoir	Capacity (MI)	1998					1999			Min. Apr	Year* of min
			Nov	Dec	Jan	Feb	Mar	Apr	Apr	Apr		
NorthWest	N Command Zone	• 133375	90	93	98	96	93	<b>93</b>	77	1993		
	Vyrnwy	55146	100	93	100	99	100	<b>97</b>	64	1996		
Northumbrian	Teesdale	• 87936	99	98	98	99	97	<b>98</b>	77	1996		
	Kielder	(199175)	(96)	(93)	(94)	(97)	(95)	<b>(95)</b>	(81)	1993		
SevernTrent	Clywedog	44922	100	81	85	91	93	<b>94</b>	86	1996		
	DerwentValley	• 39525	100	99	100	100	100	<b>100</b>	54	1996		
Yorkshire	Washburn	• 22035	96	96	99	99	98	<b>96</b>	70	1996		
	Bradford supply	• 41407	99	99	98	98	96	<b>96</b>	59	1996		
Anglian	Grafham	(55490)	(92)	(87)	(90)	(91)	(93)	<b>(98)</b>	(77)	1997		
	Rutland	(116580)	(87)	(88)	(91)	(95)	(95)	<b>(97)</b>	(74)	1992		
Thames	London	• 206399	83	92	94	94	94	<b>98</b>	88	1990		
	Farmoor	• 13843	96	93	90	85	98	<b>98</b>	84	1992		
Southern	Bewl	28170	77	87	92	99	100	<b>99</b>	58	1989		
	Ardingly	4685	80	100	100	100	100	<b>100</b>	100	<b>1999</b>		
Wessex	Clatworthy	5364	92	100	100	100	97	<b>97</b>	82	1992		
	BristolWV	• (38666)	(84)	(95)	(98)	(97)	(98)	<b>(98)</b>	(71)	1992		
SouthWest	Colliford	28540	82	89	98	100	100	<b>100</b>	58	1997		
	Roadford	34500	100	98	100	98	94	<b>95</b>	37	1996		
	Wimbleball	21320	100	100	100	100	100	<b>99</b>	78	1996		
	Stithians	5205	80	100	100	100	99	<b>99</b>	52	1992		
Welsh	Celyn and Brenig	• 131155	100	96	98	100	100	<b>100</b>	72	1996		
	Brienne	62140	100	94	100	99	99	<b>97</b>	90	1993		
	Big Five	• 69762	92	86	94	99	99	<b>95</b>	78	1993		
	Elan Valley	99106	100	100	100	100	100	<b>97</b>	89	1993		
East of Scotland	Edinburgh/Mid Lothian	• 97639	50	56	60	72	73	<b>76</b>	71	1998		
Scotland	East Lothian	• 10206	100	100	99	100	99	<b>99</b>	95	1990		
West of Scotland	Loch Katrine	• 111363	92	89	90	90	93	<b>95</b>	94	1996		
Scotland	Daer	22412	99	100	100	99	100	<b>100</b>	96	1996		
	LochThom	• 11840	100	100	100	100	100	<b>100</b>	98	1996		

() figures in parentheses relate to gross storage

\* last occurrence

• denotes reservoir groups

Details of the individual reservoirs in each of the groupings listed above are available on request. The featured reservoirs may not be representative of the storage conditions across each area; this can be particularly important during droughts.

The minimum storage figures relate to the 1988-1998 period only. In some gravity-fed reservoirs (eg. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

# Location map . . . Location map



## Where the information comes from

The National Hydrological Monitoring Programme was instigated in 1988 and is undertaken jointly by the Institute of Hydrology (IH) and the British Geological Survey (BGS). Financial support for the production of the monthly Hydrological Summaries is provided by the Department of the Environment, Transport and the Regions, the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA) and the Office of Water Services (OFWAT).

### River flow and groundwater levels

The National River Flow Archive (maintained by IH) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

River flow and groundwater level data are provided by the regional divisions of the EA (England and Wales) and SEPA (Scotland). In all cases the data are subject to revision following validation (flood and drought data in particular may be subject to significant revision).

### Reservoirs

Reservoir level information is provided by the Water Service Companies, the EA and, in Scotland, the West of Scotland and East of Scotland Water Authorities.

### Rainfall

Most rainfall data are provided by the Met Office. To allow better spatial differentiation the rainfall data are presented for the regional divisions of the precursor organisations of the EA and SEPA. The recent rainfall estimates for the Scottish regions are derived by IH in collaboration with the SEPA regions (but the figures for England and Wales are derived independently and may not equate to a combination of the MORECS figures). In England and Wales the recent rainfall figures derive from MORECS. MORECS is the generic name for the Meteorological Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain. The discontinuation of the CARP system used by the Met. Office to provide more definitive regional rainfall assessments means that the recent MORECS figures have not been updated. Negotiations are continuing with the Met. Office to provide more accurate areal figures. Until the negotiations are concluded the regional rainfall figures (and the return periods associated with them) should be regarded as a guide only.

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