Hydrological summary

for Great Britain

December 1998

General

After a cold start, December was generally mild especially in mid-month when spring-like conditions were experienced. However weather systems, carried mainly on a south-westerly airflow, became increasing vigorous with a number of damaging gales afflicting much of western and northern Britain late in the month. Entering 1999, overall reservoir stocks remain close to capacity and groundwater levels are rising briskly - and are appreciably above average in most aquifers units. Most rivers were in spate over the latter half of December but flooding was limited in extent. However, with catchments saturated, many rivers remain vulnerable to further substantial rainfall.

Rainfall

Anticyclonic conditions were dominant initially, producing notably low temperatures and minimal precipitation - little more than a trace of rainfall was recorded in parts of the English lowlands over the first week of December. As the high pressure cell receded eastwards, a succession of frontal systems crossed from the west producing mild and wet conditions (attended by an increased avalanche risk in Scotland) which continued into January. Rainfall was particularly substantial and widespread on Christmas and Boxing Days. Regional rainfall totals for December were mostly in the 70%-120% range with the healthiest rainfall, in percentage terms, in parts of the English lowlands; some Scottish catchments also registered well above average precipitation - approaching twice the average to the east of Loch Lomond. But, especially where rain-shadow effects operated, rainfall totals were relatively modest e.g. around 60% of average in the lower Tweed basin and the upper Lee catchment. A few districts in eastern Scotland registered their seventh successive month with above average rainfall; more significantly from a resources perspective the September-December total is the second highest (after 1993) since 1976 in much of the English lowlands. Accumulated rainfall totals in the 3, 6, 12 and 24-month timeframes are above average in all regions (but not all catchments). 1998 rainfall totals for England and Wales, and for Scotland, were around 15% above average - a notable anomaly given that, on an annual basis, national rainfall totals show only a muted variability; the provisional 1998 total for Great Britain ranks 3rd wettest this century.

River Flows

December began with most rivers in recession and, at the end of the first week, flows were commonly well below average. Runoff rates began a recovery thereafter which gathered momentum with particularly widespread spates in the week following Christmas. The Earn registered its second highest December peak flow since 1966 and modest floodplain inundations affected many Scottish catchments. Significant local flooding occurred in the South-West also but in lowland England river flows rarely exceeded bankfull. The range of flows experienced in December was wide but, generally, monthly runoff totals were close to the long term average - mostly in the 70-150% range but with notably high runoff in parts of eastern England, Lincolnshire and Cambridgshire especially. Sustained high flows in the late autumn are reflected in very healthy October-December runoff totals - many are close to the highest on record. Annual runoff totals for 1998 are also well above average throughout western and northern Britain; new maxima were established on, for example, the Whiteadder and Cree. By contrast, significantly below average runoff characterised a number of, mostly groundwater-fed, rivers in the English Lowlands e.g. the Mimram where flows are recovering after a 38-month sequence of below average runoff totals.

Groundwater

Almost all outstanding soil moisture deficits were eliminated during December; at year-end appreciable deficits were confined to a small area south of the Wash. Elsewhere, recharge was significant in December, and particularly healthy over the three weeks beginning around Christmas Eve.

As a consequence of substantial infiltration over the last three months levels in the deepest eastern Chalk wells (including Therfield Rectory) are now rising; in many recent years recoveries have been delayed until the late winter. At year-end groundwater levels in the great majority of Chalk index wells were above average and most were rising very briskly. Temporary declines in level occurred in some limestone aquifers during early December (e.g. at Alstonfield in the Carboniferous Limestone) but generally levels remain above, to well above, average. Recoveries are still awaited in some very slow responding Permo-Triassic sandstone units (e.g. Morris Dancers) but levels in a number of outcrops are at their highest for three years (e.g. Skirwith). In the southern Chalk, current levels contrast strongly with the depressed water-tables at the beginning of 1998 and the overall groundwater resources outlook is very encouraging.

Institute of Hydrology

British Geological Survey

Rainfall accumulations and return period estimates

Area	Rainfall	Dec 1998	Oct 98-Dec 98	RP	Jul 98-Dec 98	RP	Jan 98-Dec 98	RP	Jan 97-Dec 98	RP
England & Wales	**mm**	**83**	**309**		**503**		**1026**		**1890**	
	%	**88**	**115**	**2-5**	**104**	**2-5**	**115**	**5-10**	**105**	**2-5**
North West	mm	103	437		724		1367		2476	
	%	83	117	2-5	106	2-5	114	5-10	103	2-5
Northumbrian	mm	57	284		534		1088		1920	
	%	70	117	2-5	115	2-5	127	30-50	113	5-15
Severn Trent	mm	69	272		438		894		1632	
	%	90	128	5-10	111	2-5	119	5-15	108	2-5
Yorkshire	mm	60	276		441		950		1722	
	%	73	117	2-5	101	2-5	116	5-10	105	2-5
Anglian	mm	70	219		355		719		1296	
	%	127	133	5-10	112	2-5	121	10-15	109	5-10
Thames	mm	68	258		418		827		1452	
	%	97	131	5-10	115	2-5	120	5-15	105	2-5
Southern	mm	92	305		463		886		1671	
	%	112	123	2-5	110	2-5	114	5-10	107	2-5
Wessex	mm	94	317		500		1008		1888	
	%	101	124	2-5	112	2-5	120	5-15	113	5-10
South West	mm	146	474		723		1392		2589	
	%	105	125	5-10	116	2-5	119	5-15	110	5-10
Welsh	mm	133	502		802		1570		2843	
	%	87	116	2-5	111	2-5	120	10-15	108	2-5
Scotland	**mm**	**165**	**578**		**939**		**1713**		**3136**	
	%	**109**	**126**	**5-15**	**116**	**5-10**	**119**	**20-35**	**109**	**5-10**
Highland	mm	218	676		1045		2046		3747	
	%	111	113	2-5	104	2-5	116	10-15	106	2-5
North East	mm	80	336		632		1160		2195	
	%	86	116	2-5	118	5-10	119	10-20	113	10-20
Tay	mm	151	540		874		1508		2775	
	%	119	143	10-20	132	15-25	123	15-25	113	10-15
Forth	mm	129	510		864		1488		2600	
	%	117	151	35-50	140	50-80	134	150-250	117	30-45
Tweed	mm	82	363		599		1154		2165	
	%	88	129	5-10	113	2-5	119	10-15	112	5-10
Solway	mm	162	622		1043		1749		3152	
	%	109	139	10-20	130	15-25	123	20-35	111	5-10
Clyde	mm	191	694		1122		1958		3550	
	%	107	126	5-10	115	5-10	115	5-15	105	2-5

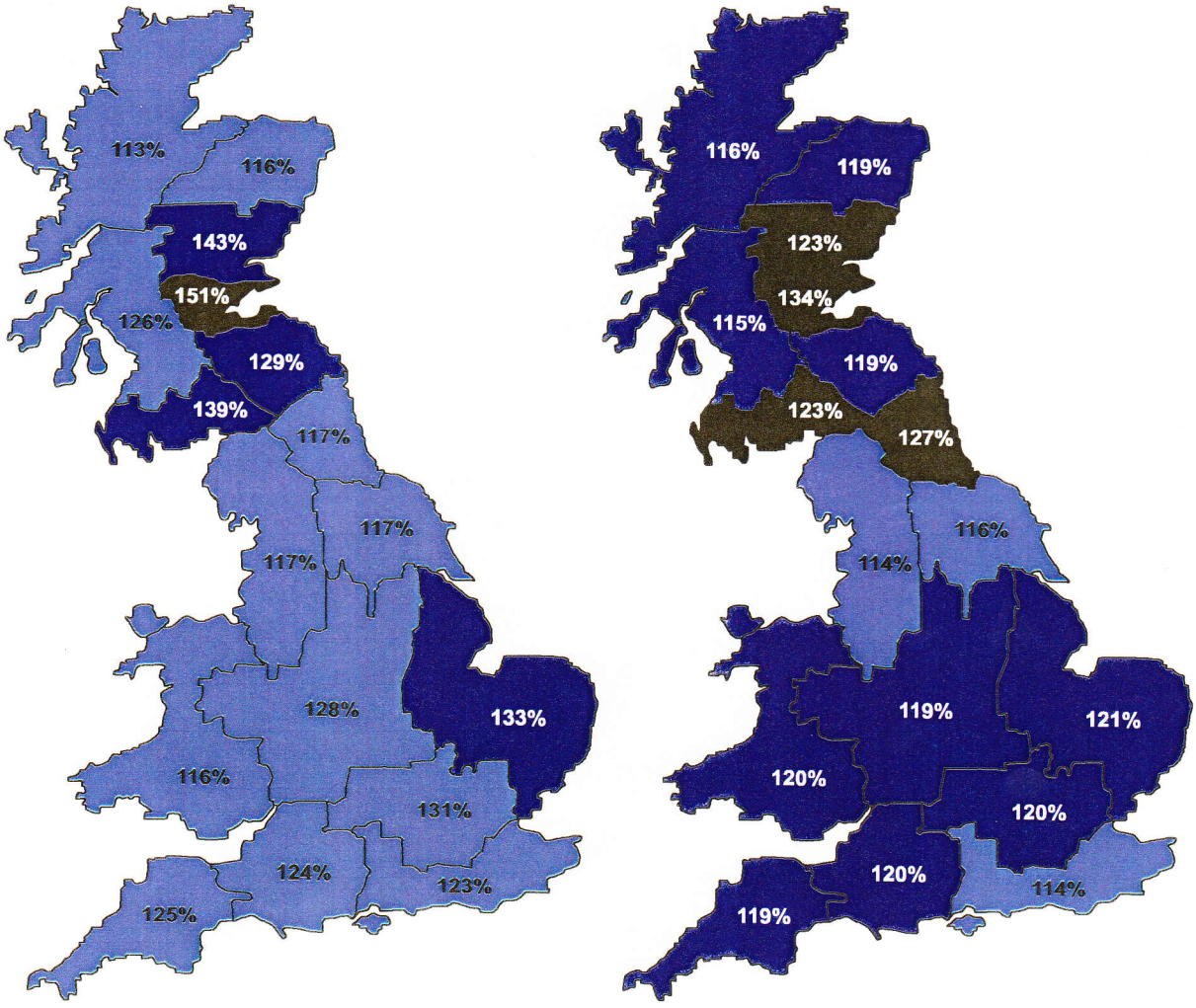
RP = Return period

 Recent monthly rainfall figures for the Scottish regions have ben 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

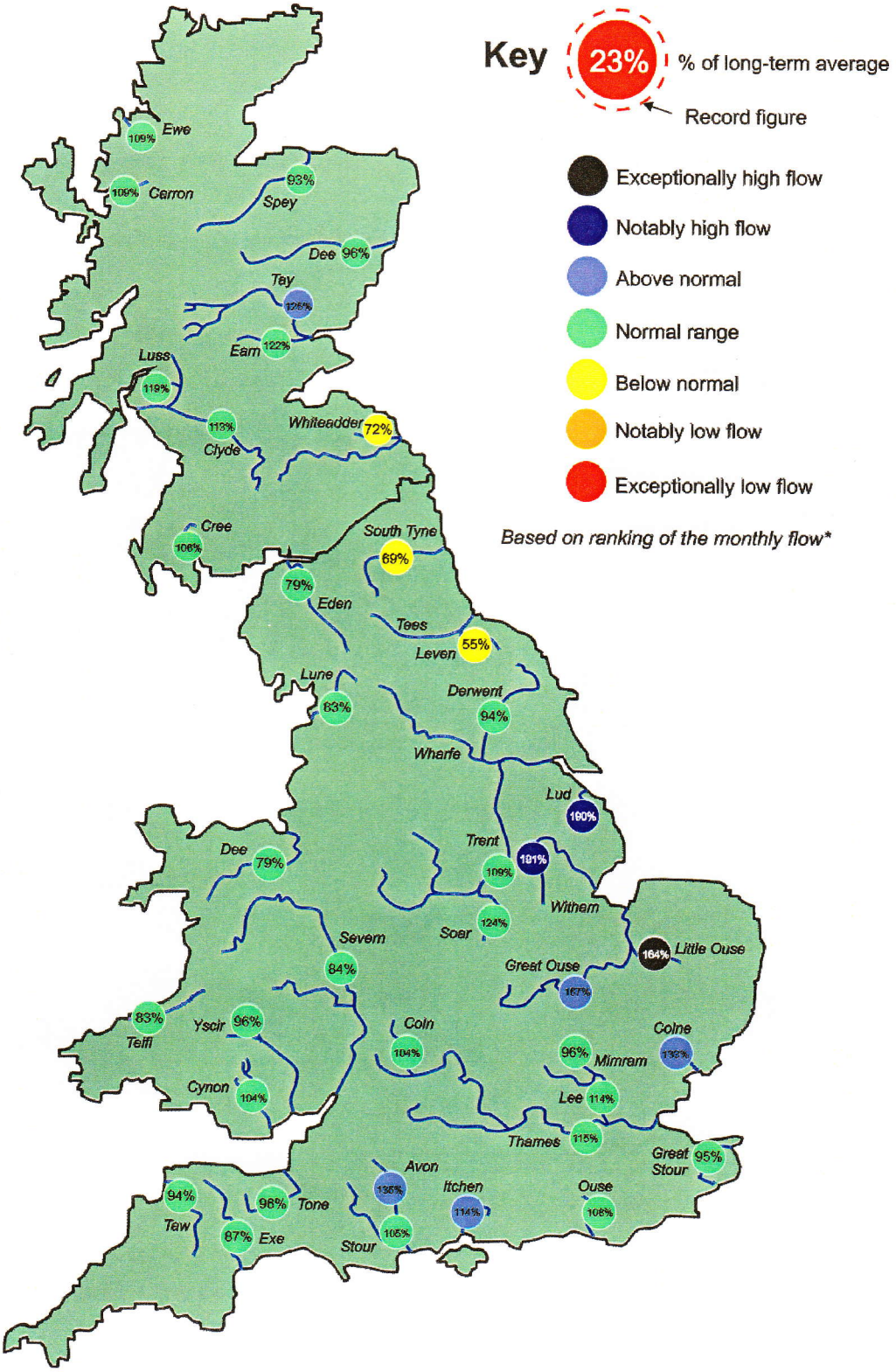


October 1998 - December 1998 **January 1998 - December 1998**

Rainfall accumulation maps

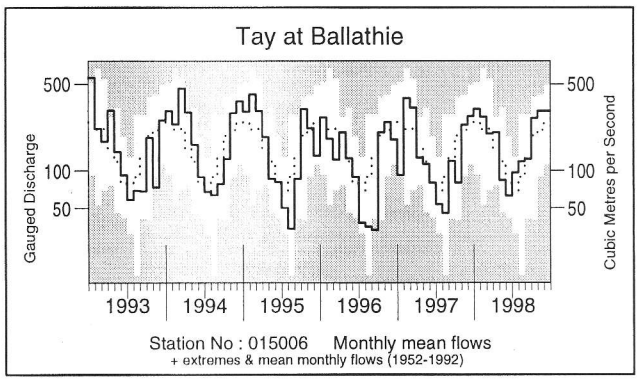
Rainfall over the last three months significantly exceeds the average throughout Britain; parts of eastern Scotland have been exceptionally wet. The 1998 rainfall total for England and Wales is the highest since 1974 whilst Scotland (provisionally) registered its third highest annual total on record, in a series from 1869 - but 1990 and 1992 were both considerably wetter.

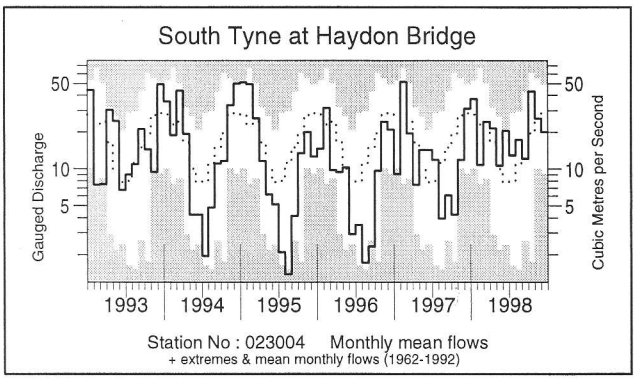
River flow . . . River flow . . .

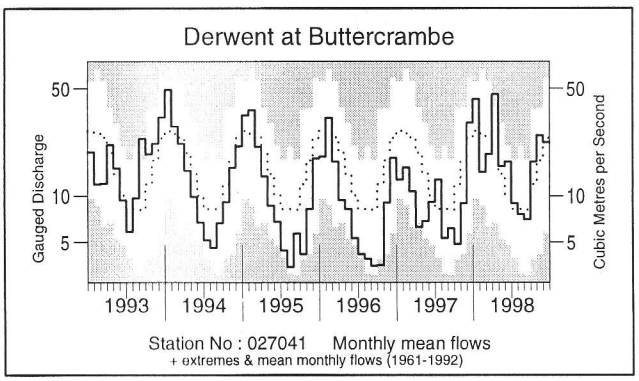


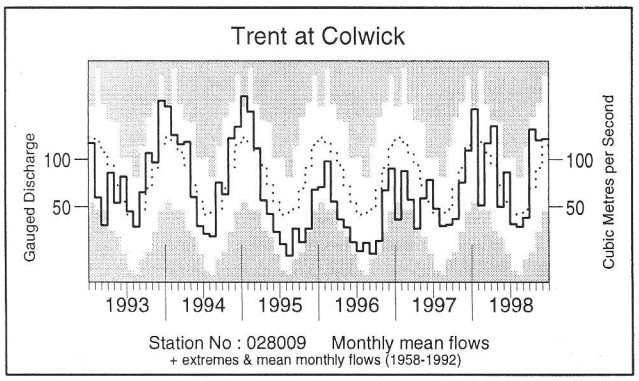
River flows - December 1998

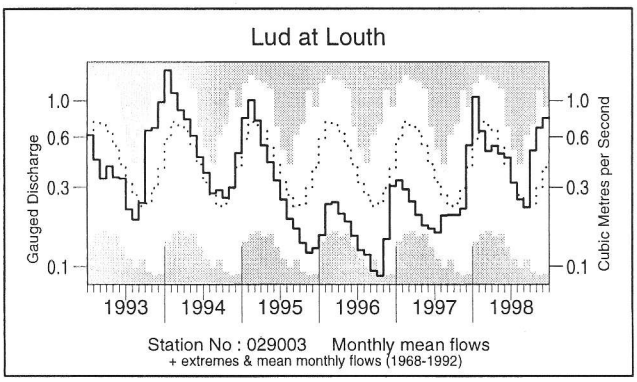
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

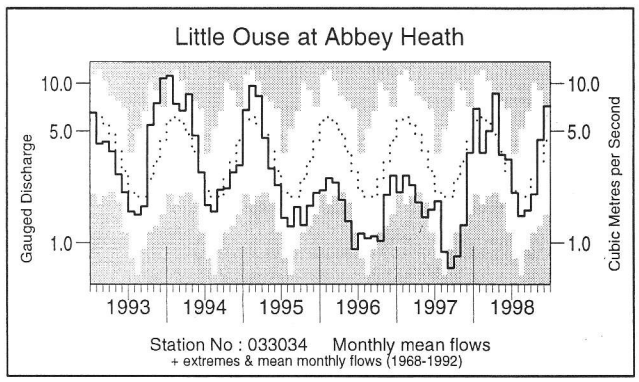


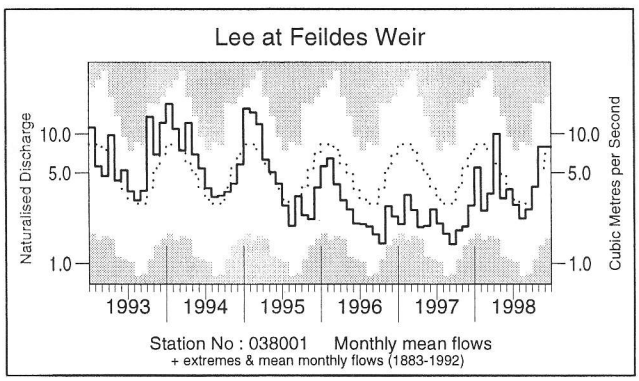


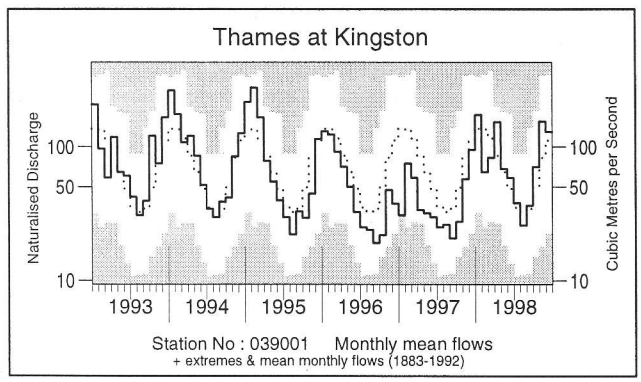








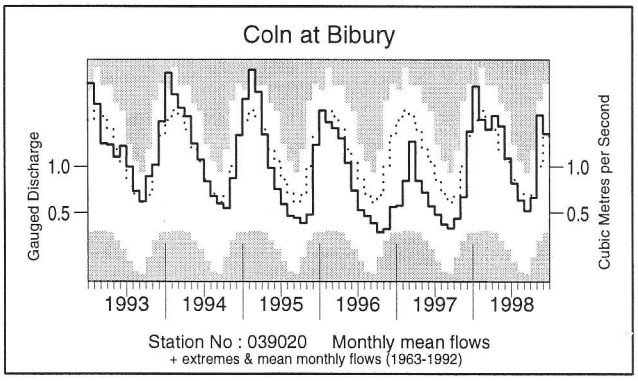


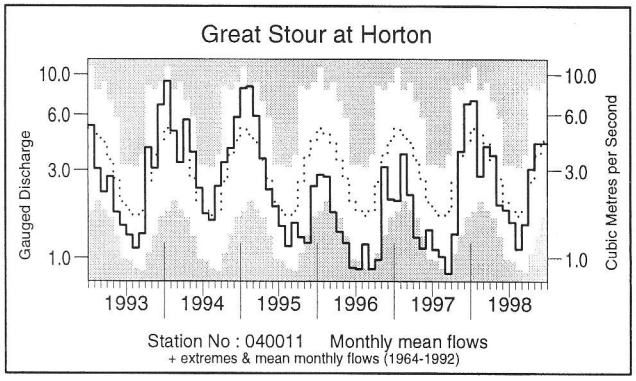


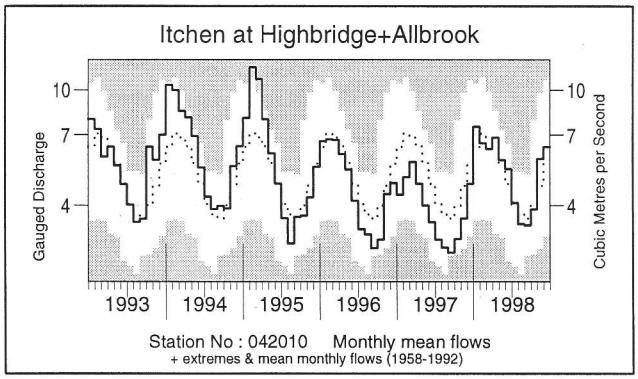
Monthly river flow hydrographs

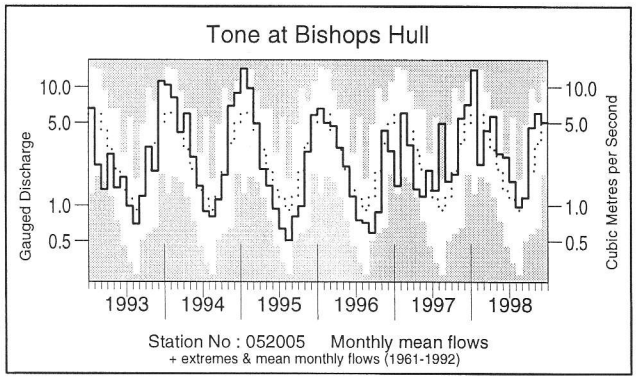
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1992 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

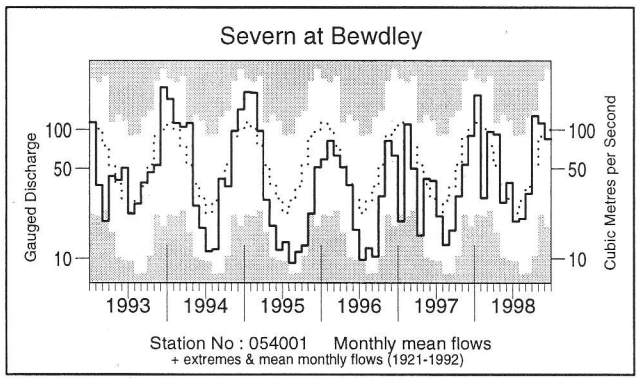
River flow . . . River flow . . .

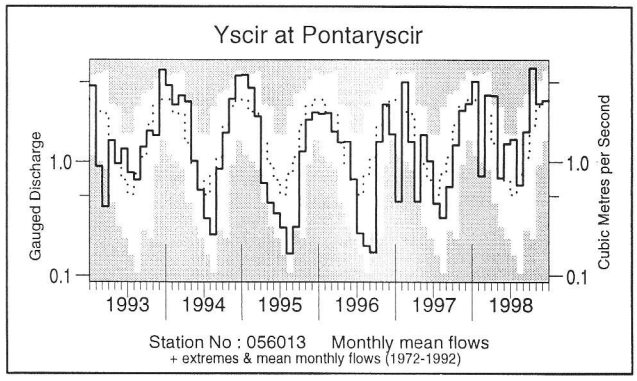


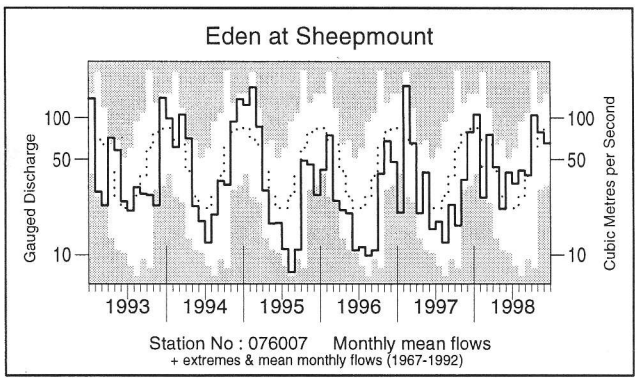


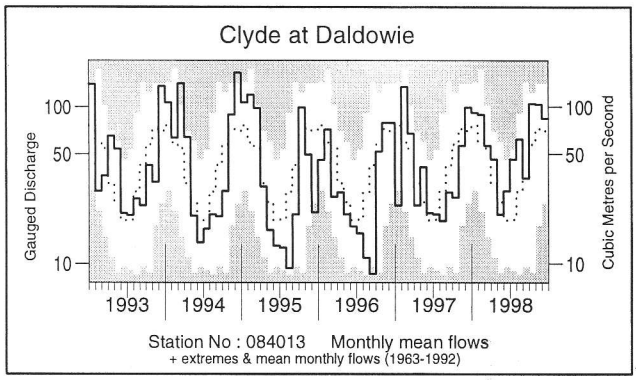










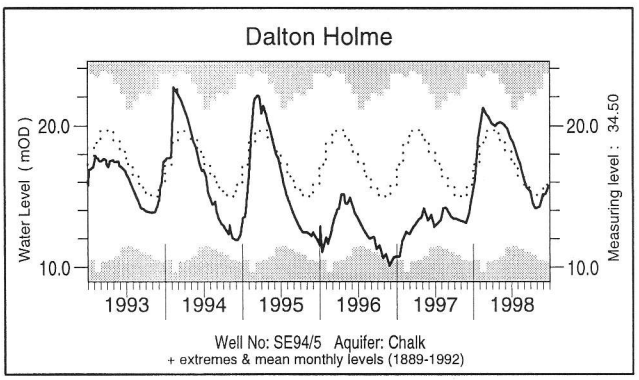


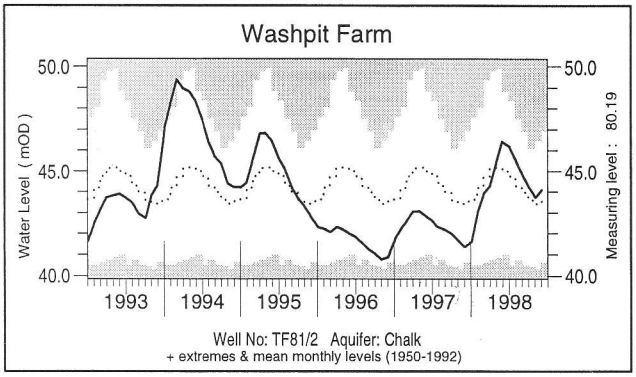
Notable runoff accumulations July 1998 - December 1998 (a); January 1998 - December 1998 (b)

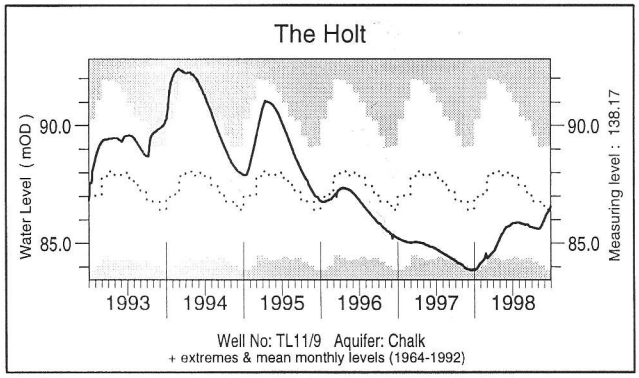
(a) River	%lta	Rank	(b) River	%lta	Rank	River	%lta	Rank
Tay	130	42/46	Dee	117	24/26	Mole	126	22/23
Whiteadder	190	29/29	Tyne	146	33/33	Exe	128	40/42
Dove	134	35/37	Whiteadder	152	29/29	Tone	138	36/37
Lud	134	28/30	Trent	124	38/40	Yscir	143	26/26
Exe	144	41/43	Ouse	158	63/66	Cynon	139	39/39
Yscir	156	26/26	Mimram	62	07/45	Cree	122	35/35

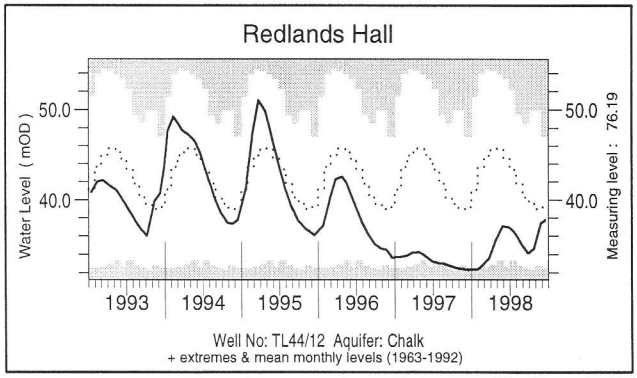
lta = long term average
Rank 1 = lowest on record

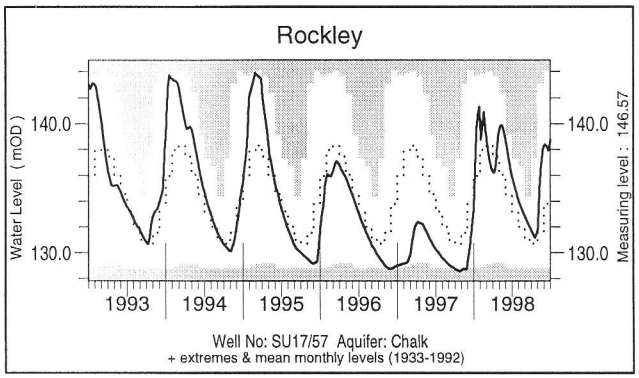
Groundwater . . . Groundwater

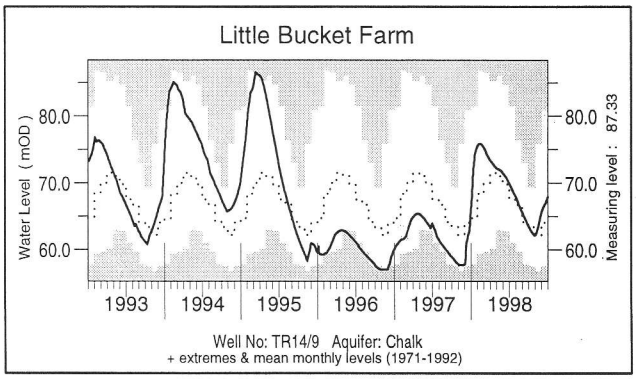


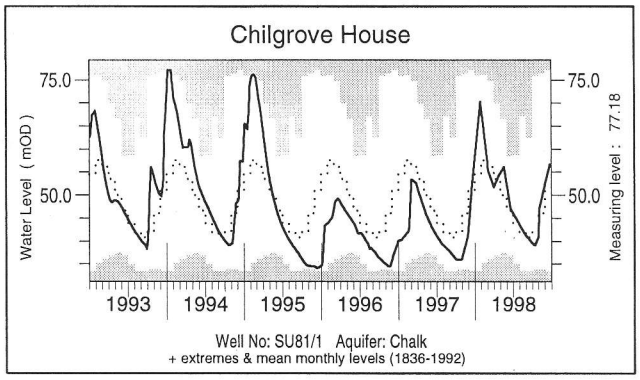


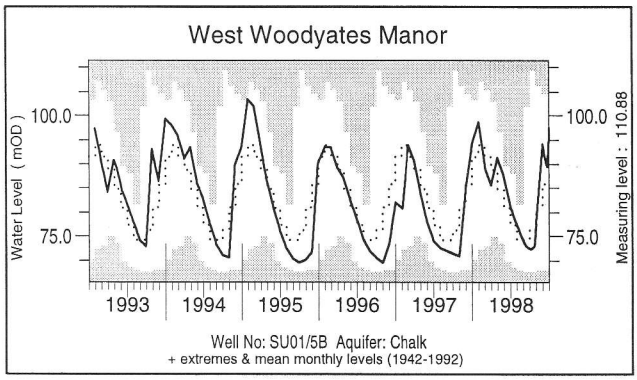








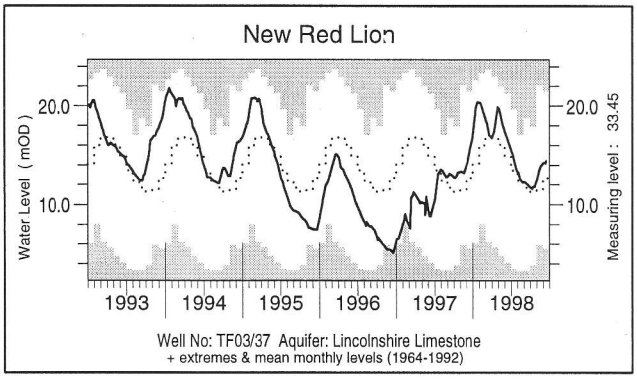


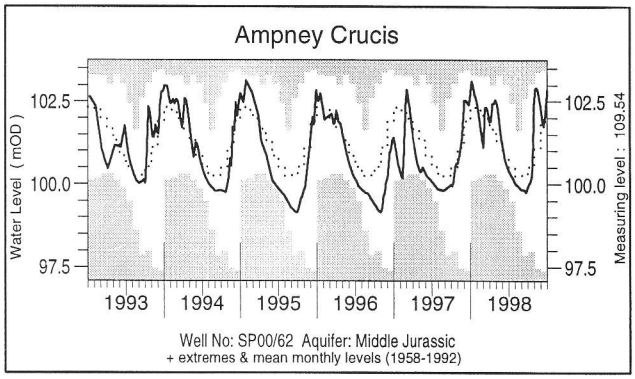


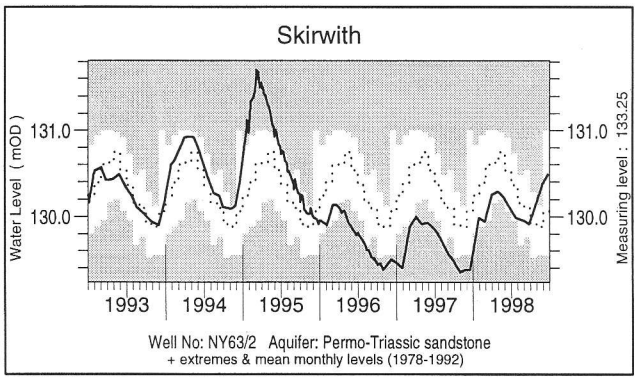
What is groundwater?

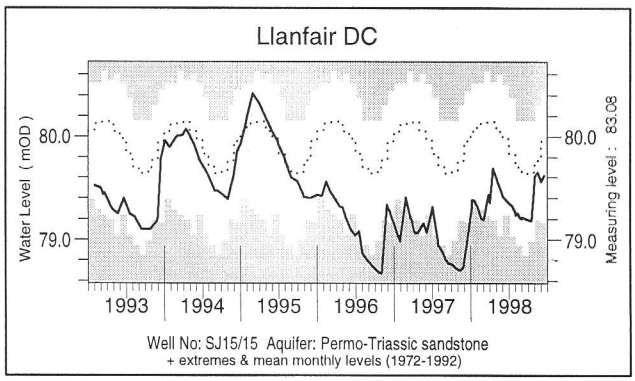
Groundwater is stored in the natural water bearing rock strata (or aquifers) which are found mostly in southern and eastern England (see page 11) where groundwater is the major water supply source. Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment 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.

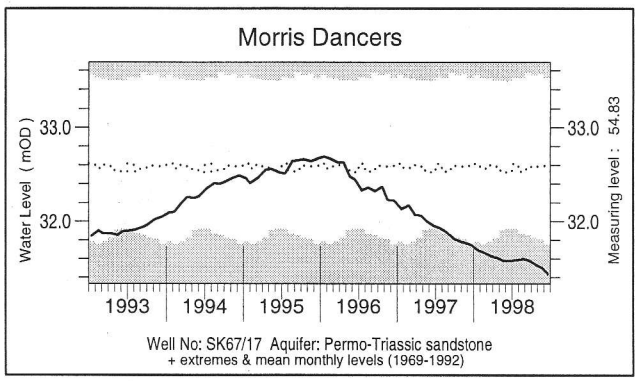
Groundwater . . . Groundwater

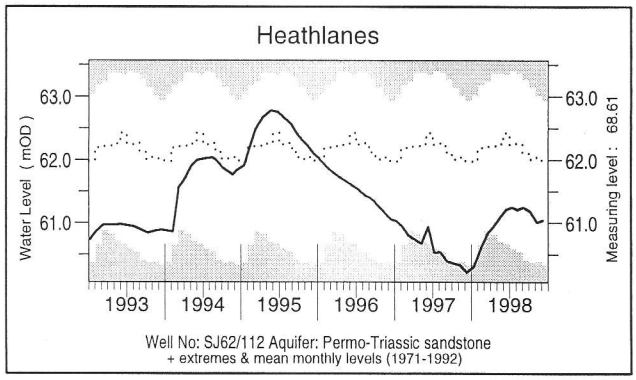


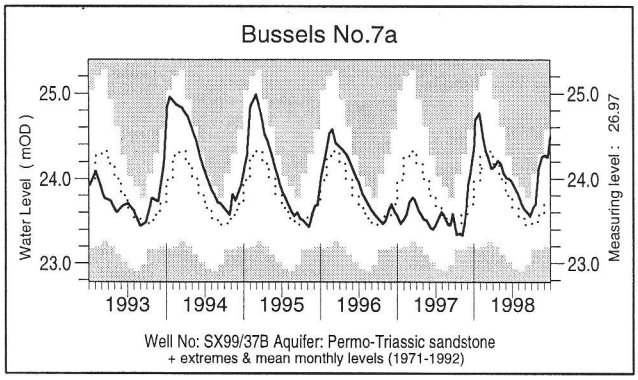


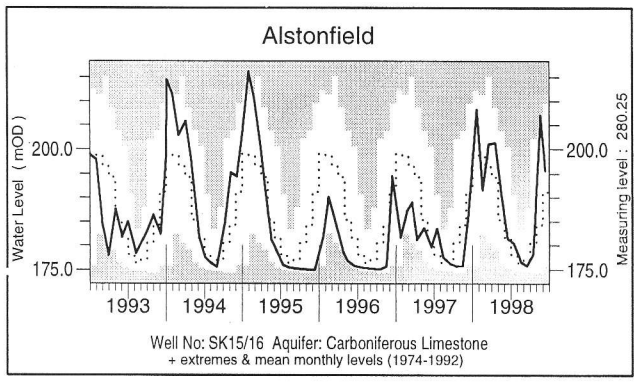












Groundwater levels December/January 1998/9

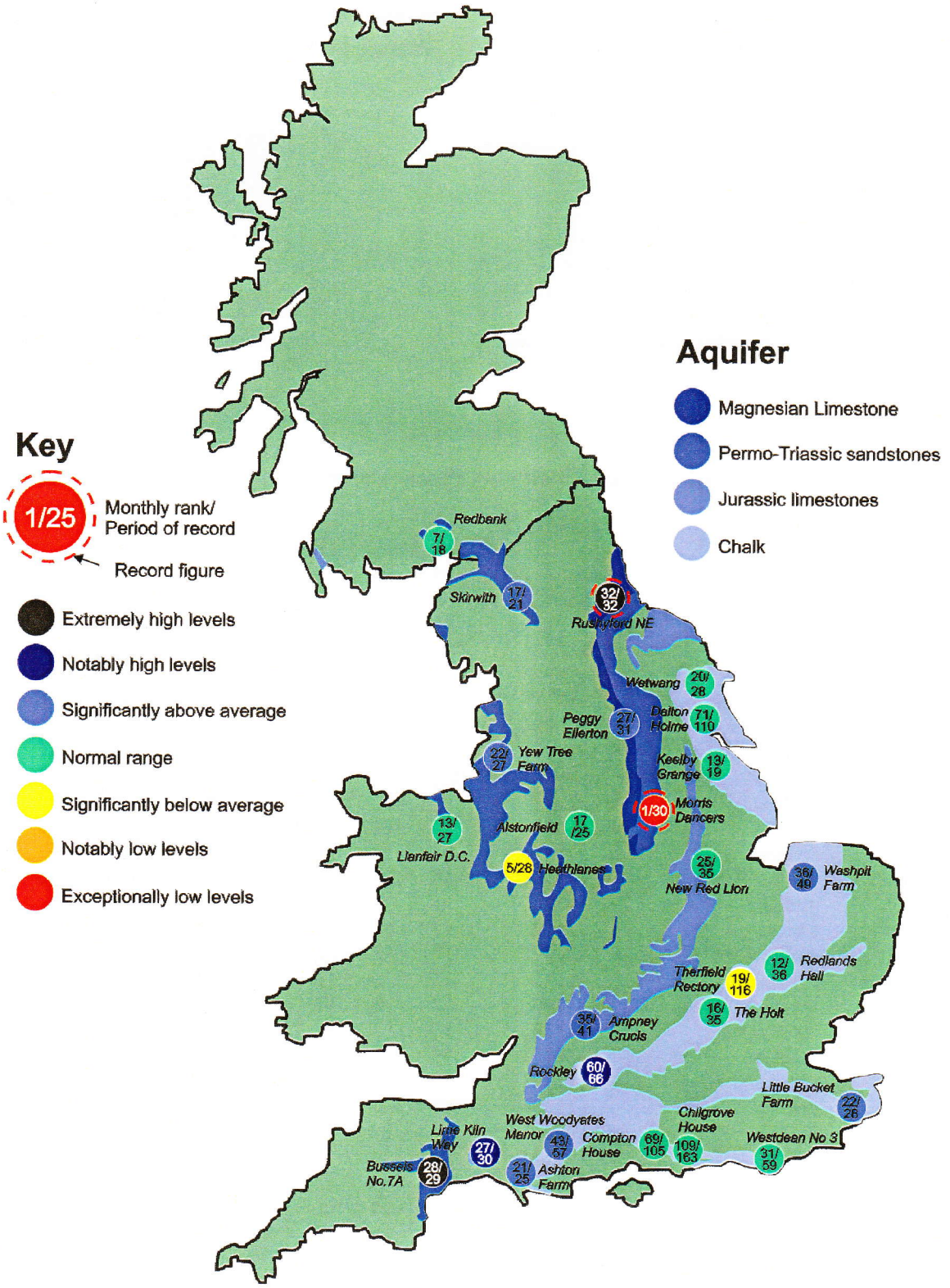
Borehole	Level	Date	Dec av.
Dalton Holme	15.73	24/12	15.54
Washpit Farm	44.10	02/12	43.20
The Holt	86.58	31/12	86.71
Redlands Hall	37.80	16/12	38.43
Ashton Farm	71.27	31/12	67.47
Little Bucket	67.93	29/12	63.66

Borehole	Level	Date	Dec av.
Chilgrove	56.78	23/12	51.74
W Woodyates	97.50	31/12	86.39
New Red Lion	14.46	15/12	12.41
Ampney Crucis	102.85	31/12	101.86
Skirwith	130.49	22/12	130.12

Borehole	Level	Date	Dec av.
Llanfair DC	79.77	01/01	79.77
Morris Dancers	31.44	18/12	32.48
Heathlanes	61.04	05/12	61.80
Bussels	24.49	29/12	23.74
Alstonfield	195.65	11/12	191.19

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater

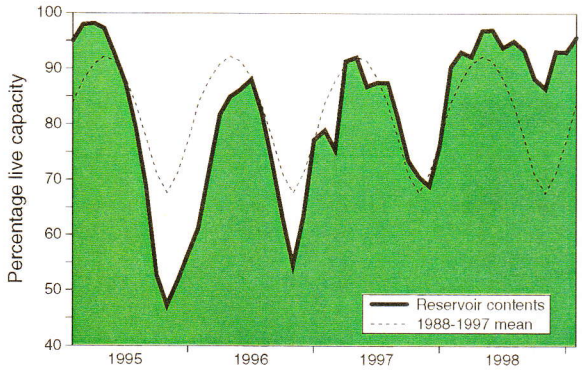


Groundwater levels - December 1998

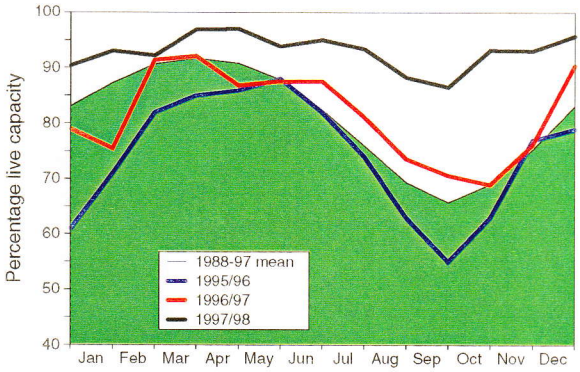
The rankings are based on a comparison of current levels (usually a single reading in a month) with the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods 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 (Ml)	1998 Aug	Sep	Oct	Nov	Dec	1999 Jan	Min. Jan	Year* of min
NorthWest	N Command Zone	• 133375	84	80	75	90	93	98	51	1996
	Vyrnwy	55146	90	81	83	100	93	100	35	1996
Northumbrian	Teesdale	• 87936	90	92	87	99	98	98	41	1996
	Kielder	(199175)	(92)	(94)	(88)	(96)	(93)	(94)	(70)	1990
SevernTrent	Clywedog	44922	97	93	88	100	81	85	54	1996
	DerwentValley	• 39525	93	96	90	100	99	100	10	1996
Yorkshire	Washburn	• 22035	89	85	82	96	96	99	23	1996
	Bradford supply	• 41407	93	92	92	99	99	98	22	1996
Anglian	Grafham	*** (55490)	(95)	(87)	(84)	(92)	(87)	(90)	(57)	1998
	Rutland	***(116580)	(93)	(88)	(86)	(87)	(88)	(91)	(60)	1991
Thames	London	• 206399	96	85	82	83	92	94	60	1991
	Farmoor	• 13843	96	97	98	96	93	90	71	1991
Southern	Bewl	28170	86	76	70	77	87	92	38	1991
	Ardingly	4685	96	74	67	80	100	100	61	1990
Wessex	Clatworthy	5364	87	77	70	92	100	100	59	1989
	BristolWW	• (38666)	(88)	(79)	(72)	(84)	(95)	(98)	(40)	1991
SouthWest	Colliford	28540	78	76	76	82	89	98	46	1996
	Roadford	34500	99	98	96	100	98	100	20	1990
	Wimbleball	21320	99	92	87	100	100	100	46	1996
	Stithians	5205	88	80	71	80	100	100	37	1992
Welsh	Celyn and Brenig	• 131155	100	84	95	100	96	98	54	1996
	Brianne	62140	100	100	97	100	94	100	76	1996
	Big Five	• 69762	97	88	94	92	86	94	67	1996
	Elan Valley	• 99106	98	96	97	100	100	100	56	1996
East of Scotland	Edinburgh/Mid	• 97639	51	45	43	50	56	60**	60	1999
	East Lothian	• 10206	100	99	100	100	100	99	48	1990
West of Scotland	Loch Katrine	• 111363	85	89	85	92	89	90	80	1996
	Daer	22412	98	87	81	99	100	100	83	1996
	LochThom	• 11840	100	98	97	100	100	100	93	1998

() gross storage • reservoir groups * last occurence ** Megget filling, work finished 2/10/98
*** Updated gross capacity

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. 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.

The Meteorological Office
Sutton House
London Road
Bracknell
RG12 2SY.
Tel. 01344 856858; 01344 854024.

The cooperation of all data suppliers is gratefully acknowledged.

Subscription

Subscription to the Hydrological Summaries costs £48 per year. Orders should be addressed to:

Hydrological Summaries
Institute of Hydrology
Wallingford
Oxfordshire
OX10 8BB
Tel.: 01491 838800
Fax: 01491 692424

Selected text and maps are available on the WWW at http://www.nwl.ac.uk/ih

Centre for Ecology & Hydrology
Institute of Freshwater Ecology
Institute of Hydrology
Institute of Terrestrial Ecology
Institute of Virology & Environmental Microbiology
Natural Environment Research Council

12/98