Hydrological summary

for the United Kingdom

September 2000

General

September proved a pivotal month in hydrological terms. It began with very dry soils and modest river flows throughout the lowlands but – from mid-month particularly – sustained frontal rainfall initiated a steep recovery in runoff and (in the west) infiltration rates. Much of the UK reported September rainfall totals more than 50% above average. Reservoir stocks – normally still in decline - increased appreciably over the latter half of the month and, for England and Wales as a whole, now stand at their highest early October level on record. Groundwater levels in most lowland aquifers were still in decline during September but recoveries are expected to begin from around average levels with the encouraging prospect of a lengthy recharge season. The rapid increase in river flows triggered the widespread use of the Environment Agency's new Flood Warning codes (for the first time); with catchments near to saturation in early October, many rivers remain very vulnerable to further significant rainfall.

Rainfall

'Indian Summer' conditions in much of the UK were rapidly succeeded by more autumnal weather patterns as westerly airflows became established in mid-month – heralding an exceptionally unsettled spell of weather which continued into October. Heavy rain on the 10/11th caused significant transport disruption in western Scotland and Northern Ireland. In southern England, a slow-moving frontal system, with embedded thunder cells, produced some remarkable falls on the 14/15th, e.g. Penzance, 62 mm in 11 hours, Portsmouth, 60 mm in around 3 hours, 82 mm in a day at Walderton in West Sussex, and 69.4 mm in 12.5 hours in west London. Large areas of the Midlands and the East reported > 20 mm on the 19th and the 28/29th was also very wet (in NI almost 70 mm was recorded at Helen's Bay, near Bangor). Apart from a few localities (e.g. the eastern tip of Kent) rainfall totals for September exceeded the average throughout E&W and large parts of the North-East reported > 200%. Southern Scotland was wet also but the north was notably dry (in parts of Skye only around 50%). E&W recorded its third successive wet September, the provisional rainfall total is the highest since 1984. Apart from 1999, Northern Ireland had its wettest September since 1985. Notable rainfall deficiencies persist in parts of Scotland (the Western Isles especially) but in E&W the summer deficiencies have largely been made-up and medium term rainfall accumulations are very healthy. The provisional summer half-year (April-September) total for E&W eclipses 1993 as the highest since 1968, and 12-month rainfall totals are above average in almost all regions.

River flows

As in 1999, September began with relatively depressed flows in many catchments (especially in the Midlands and the South) but recoveries began in the west around the 10th and spate conditions were widespread thereafter. The new EA flood warning codes were activated on the 14th (when 'Flood Watches' were issued in S. Wales) and extended to many rivers throughout E&W over the following fortnight. Fortunately the rapid passage of many – but not all – of the more vigorous frontal systems moderated storm rainfall totals, and lessened the risk of exceptional flooding. Local impacts were severe (e.g. in Hampshire) but generally the flooding was notable for the wide distribution of the rivers affected rather than its magnitude. Nonetheless, many rivers reported peaks flows amongst the three or four highest on record for September. In almost all index catchments, September runoff totals exceeded the average – commonly by wide margins. Typically, September mean flows were the highest since 1985 in northern and western rivers, and the first or second highest (after 1999 in most cases) in many lowland rivers. The River Annacloy in NI exceeded the monthly average for only the second time this year but notably low runoff continued in much of northern Scotland and the Western Isles. The April-September runoff totals for the Rivers Ewe and Carron are the lowest for any six-month accumulation in records of 30 and 22 years respectively. Elsewhere, accumulated runoff totals are generally very healthy; a number of new summer half-year runoff maxima have been established (e.g. on the Leven, Witham, Blackwater and Taw).

Groundwater

Soil moisture deficits were above average in most major aquifer outcrop areas until around mid-September. Thereafter they declined briskly and, except in a few pockets (e.g. north Kent), early October smds were appreciably below average, and significant infiltration had begun. Groundwater recessions continued in the Chalk during September (as is usual) when most levels were well within the normal early autumn range. Killyglen in the well-fissured Chalk of Northern Ireland is an exception – a very steep recovery began around mid-month. Recoveries are also under way in most limestone aquifers, where again levels are generally close to, or above, the seasonal average. Throughout most western Permo-Triassic sandstones outcrops (at least where abstractions do not influence natural variability) groundwater levels are well above average; in the east – where recharge is more sporadic – levels remain depressed in a few areas (e.g. in the Sherwood Sandstones). With the expectation of a long winter recharge season – and given rainfall in the normal range – the groundwater resources outlook is good.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Rainfall . . . Rainfall . . . Rainfall.

Rainfall accumulations and return period estimates

Area	Rainfall	Sep 2000	Jul 00-Sep 00	RP	Apr 00-Sep 00	RP	Jan 00-Sep 00	RP	Oct 99-Sep 00	RP
England & Wales	**mm**	**119**	**246**		**499**		**674**		**963**	
	%	**155**	**114**	**2-5**	**124**	**5-15**	**108**	**2-5**	**107**	**2-5**
North West	mm	171	355		638		934		1345	
	%	149	116	2-5	119	5-10	113	2-5	112	5-10
Northumbrian	mm	112	239		503		683		938	
	%	153	109	2-5	127	10-15	112	2-5	110	2-5
Severn Trent	mm	109	222		464		595		839	
	%	170	121	2-5	130	10-20	110	2-5	111	2-5
Yorkshire	mm	132	248		530		664		894	
	%	194	124	5-10	140	30-50	113	2-5	109	2-5
Anglian	mm	82	181		384		475		639	
	%	167	118	2-5	129	10-20	110	2-5	107	2-5
Thames	mm	94	187		431		544		740	
	%	160	113	2-5	132	10-20	111	2-5	107	2-5
Southern	mm	110	204		463		590		834	
	%	159	117	2-5	138	20-30	111	2-5	107	2-5
Wessex	mm	108	222		484		643		929	
	%	150	117	2-5	134	10-20	110	2-5	111	2-5
South West	mm	138	280		552		776		1174	
	%	148	114	2-5	121	5-10	98	2-5	100	<2
Welsh	mm	158	347		658		980		1463	
	%	137	119	2-5	123	5-10	111	2-5	111	2-5
Scotland	**mm**	**145**	**306**		**541**		**1037**		**1598**	
	%	**102**	**87**	**2-5**	**90**	**2-5**	**106**	**2-5**	**111**	**5-10**
Highland	mm	111	262		529		1251		2010	
	%	65	65	15-25	77	10-20	108	2-5	114	5-10
North East	mm	110	246		509		746		1111	
	%	126	100	<2	115	5-10	109	2-5	114	5-10
Tay	mm	162	325		557		962		1437	
	%	142	114	2-5	111	2-5	113	5-10	117	5-15
Forth	mm	155	326		550		902		1324	
	%	141	117	2-5	114	2-5	117	5-10	119	10-20
Tweed	mm	131	313		548		786		1101	
	%	147	125	5-10	124	5-15	114	5-10	113	5-10
Solway	mm	205	417		658		1084		1591	
	%	143	118	2-5	110	2-5	111	2-5	112	5-10
Clyde	mm	222	419		641		1235		1936	
	%	124	99	2-5	93	2-5	108	2-5	114	5-10
Northern Ireland	**mm**	**120**	**258**		**471**		**695**		**1088**	
	%	**122**	**101**	**2-5**	**102**	**2-5**	**94**	**2-5**	**103**	**2-5**

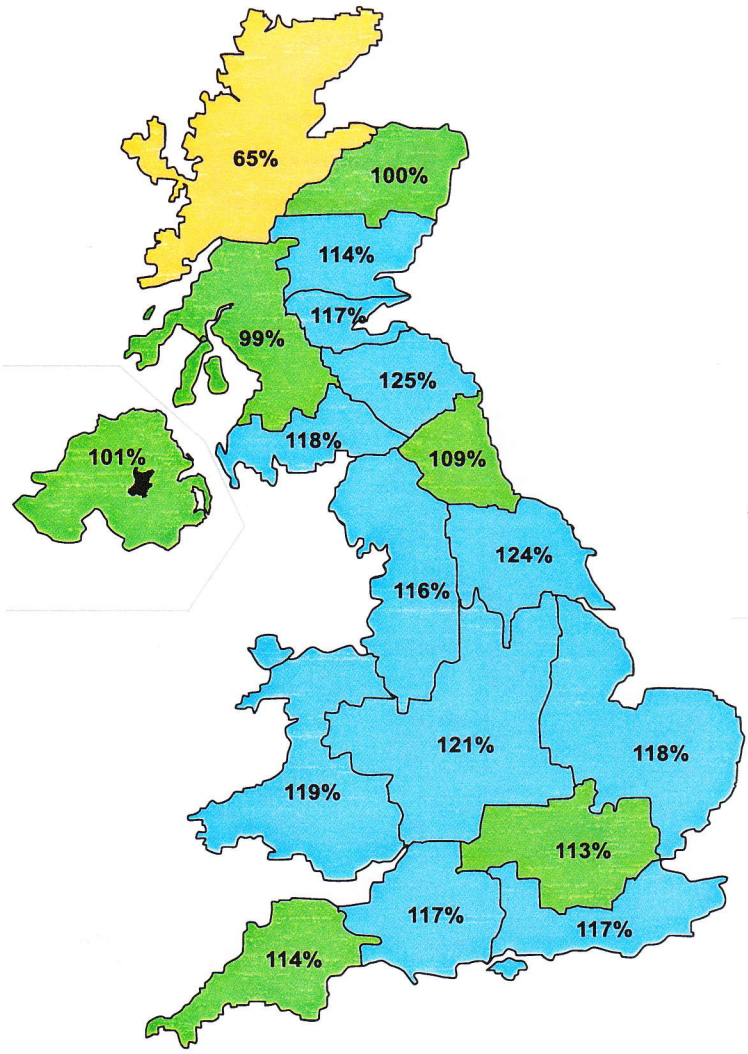
RP = Return period

 All monthly totals since December 1998 are provisional (see page 12). 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); RP estimates for Northern Ireland are based on the tables for north-west England. 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.

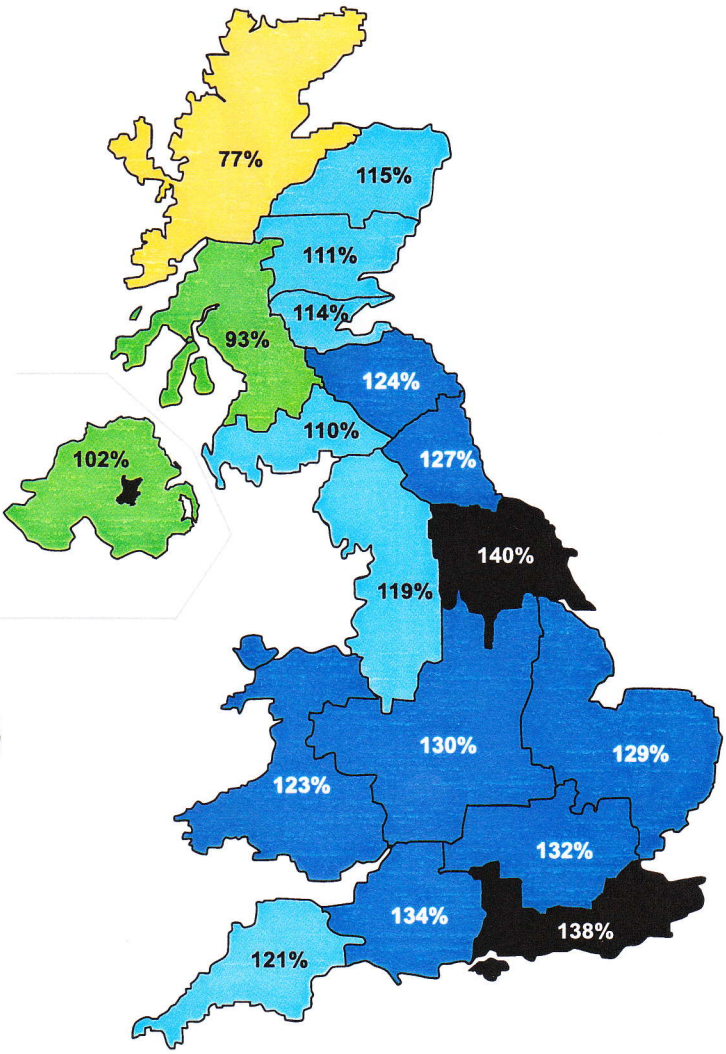
Rainfall . . . Rainfall . . . Rainfall

Key

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



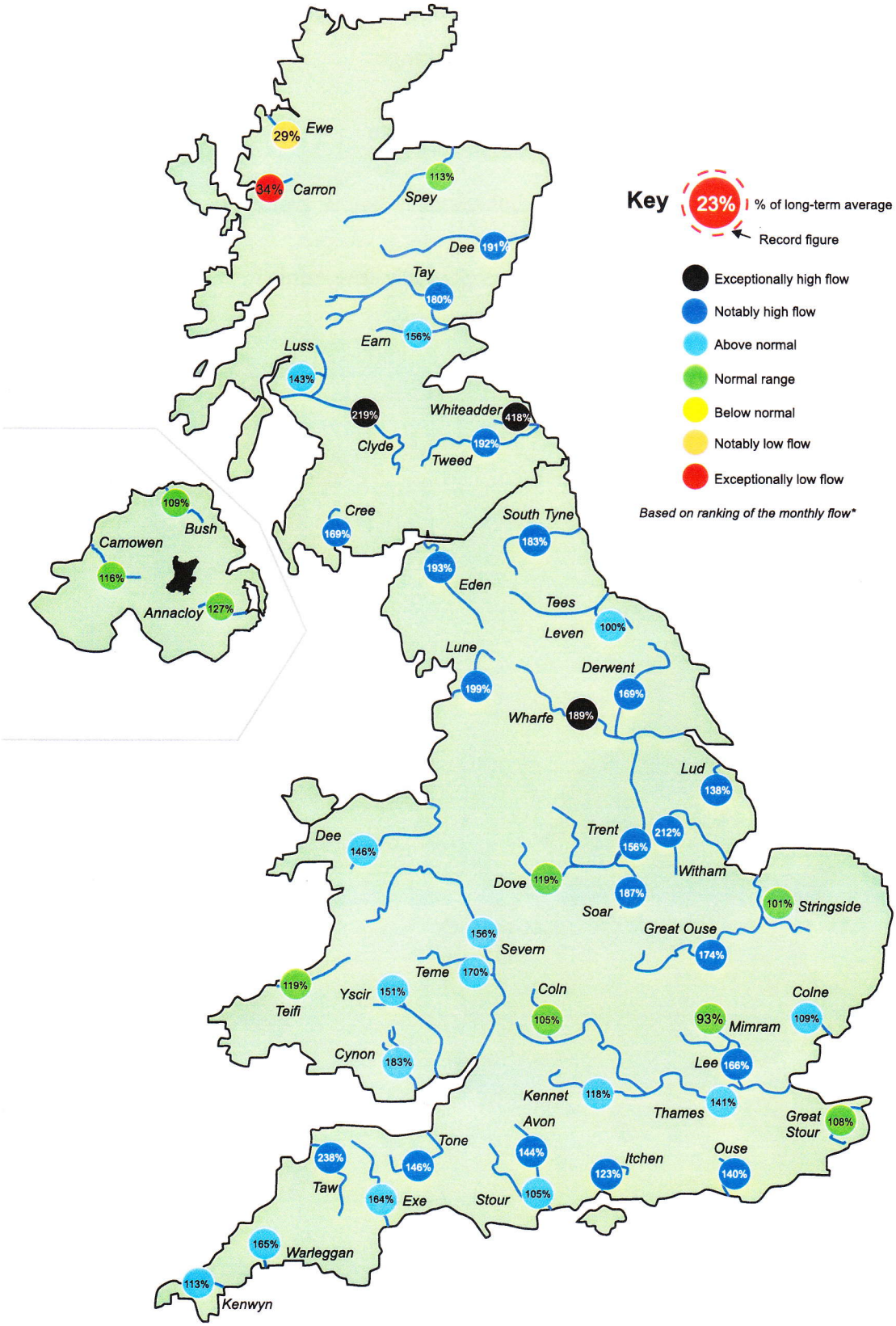
July 2000 - September 2000



April 2000 - September 2000

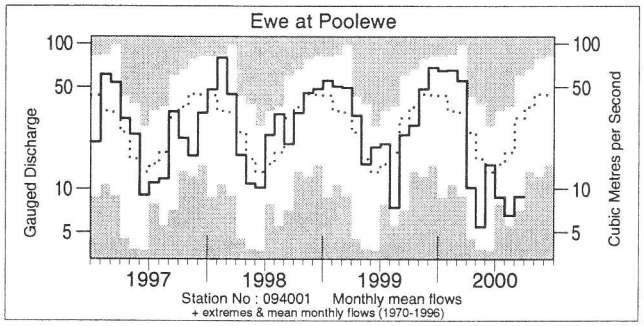
Rainfall accumulation maps

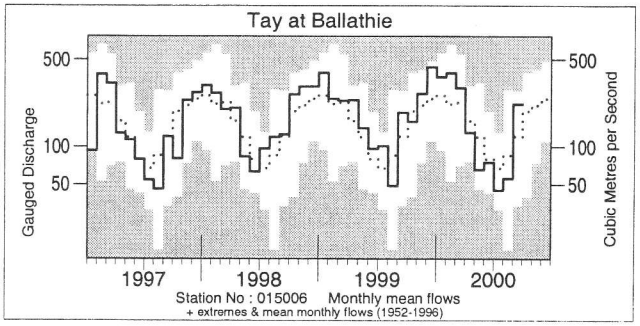
For the UK as a whole, the July-September rainfall was very close to the long-term average. Over the summer half-year however, the rainfall total is well above average albeit lower than in either 1999 or 1998. There are a few notable regional contrasts in northern Britain: while the July-September rainfall for the Highland region is the second lowest since 1976 (and very modest over the 6-month timespan), the summer half-year rainfall for the Yorkshire region is the highest for at least 25 years.

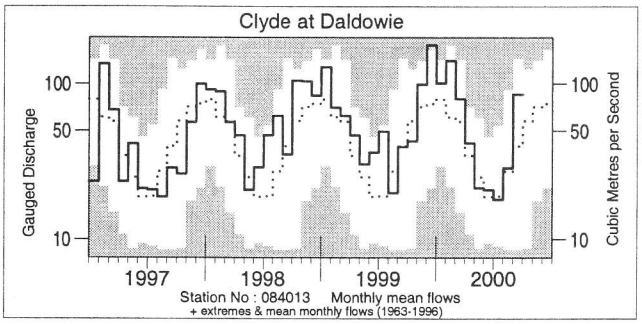


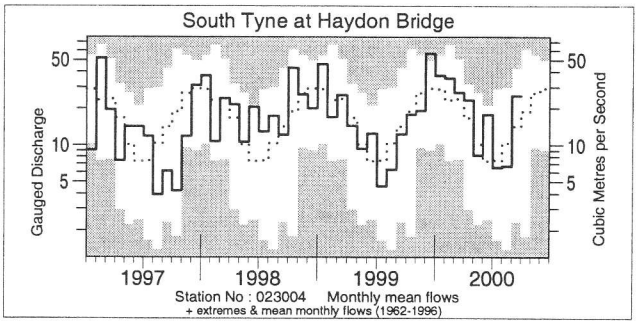
River flows - September 2000

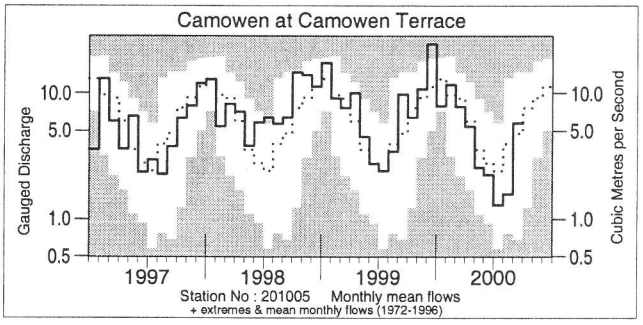
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station.

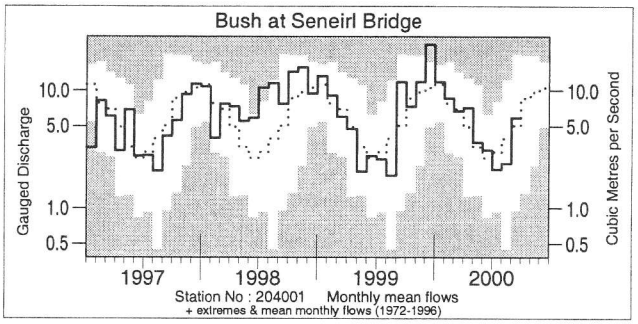


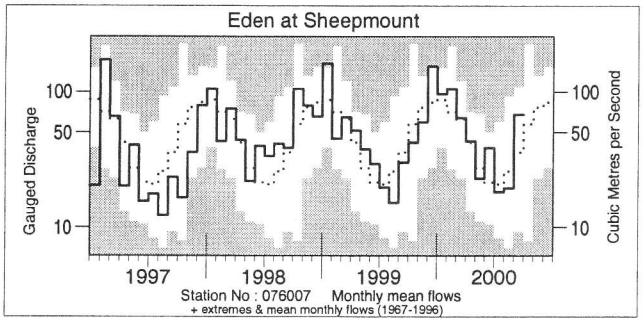


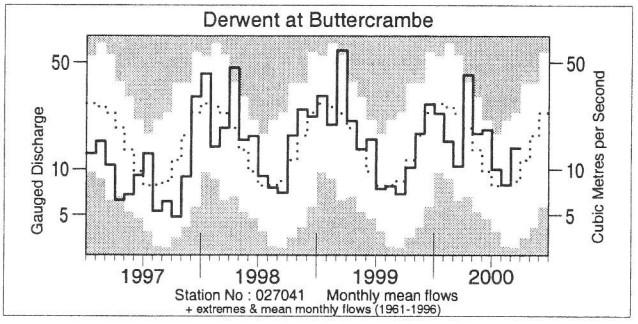


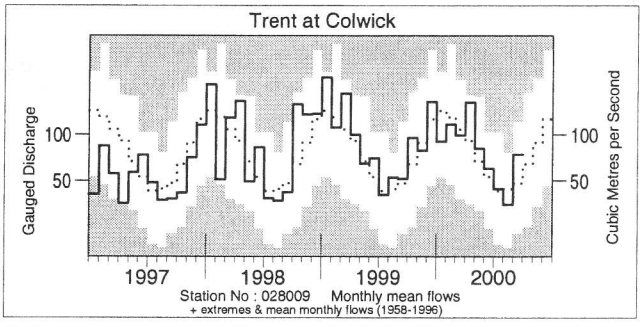


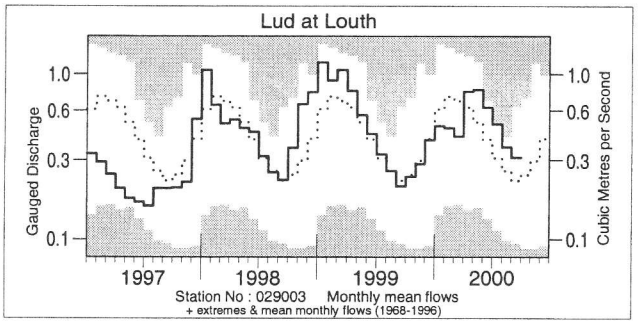








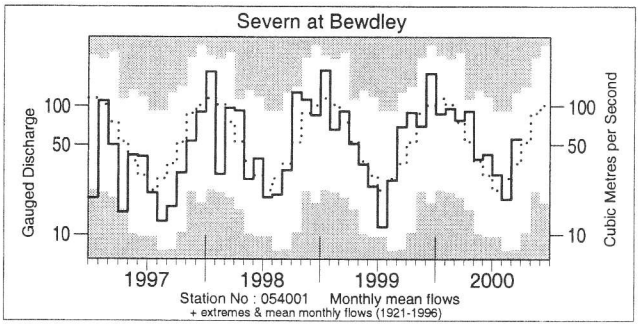


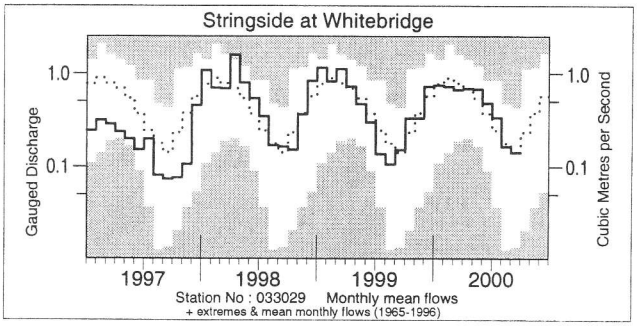


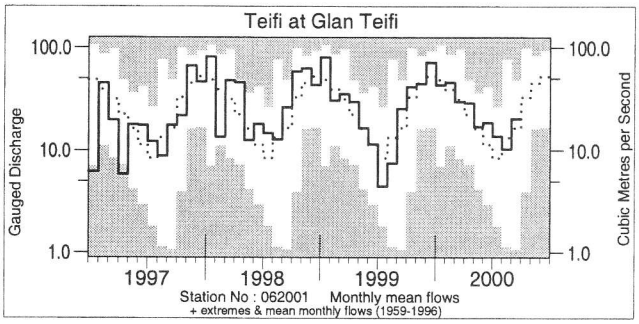
Monthly river flow hydrographs

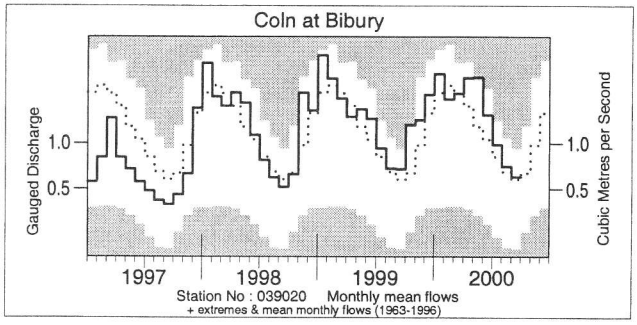
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1997 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

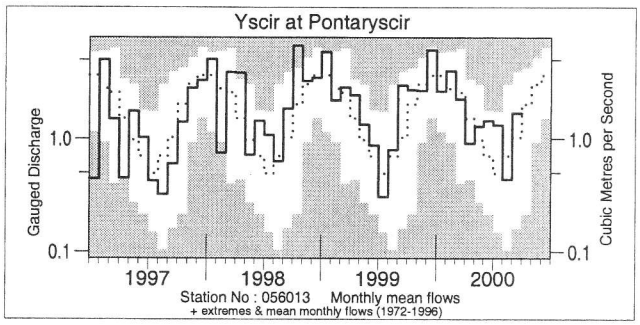
River flow . . . River flow . . .

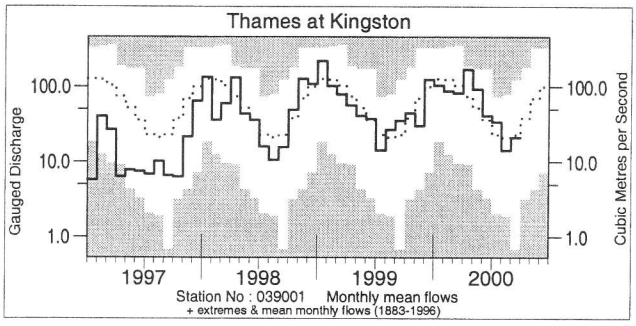


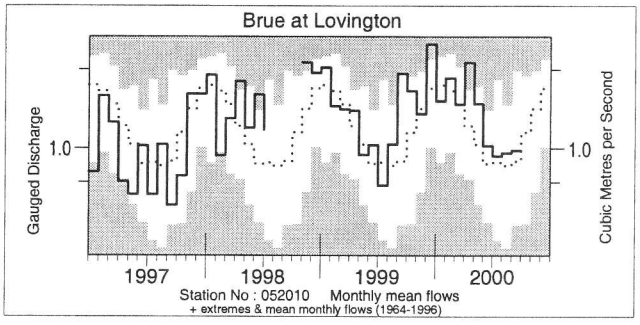


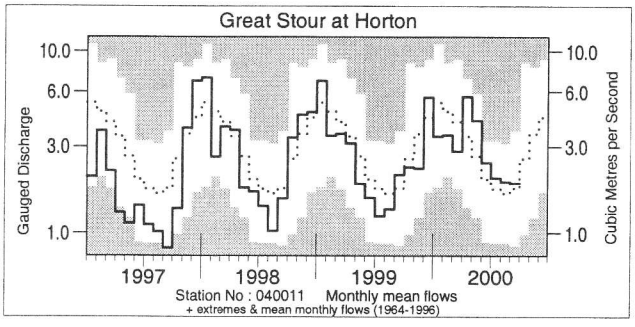


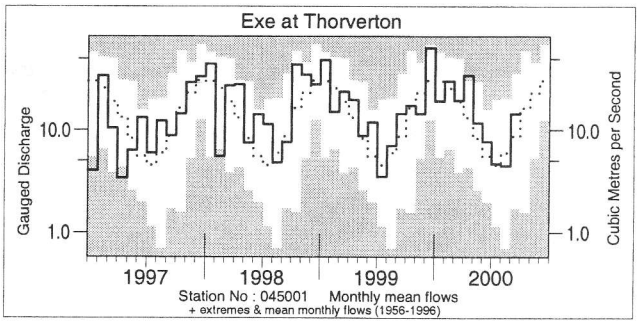


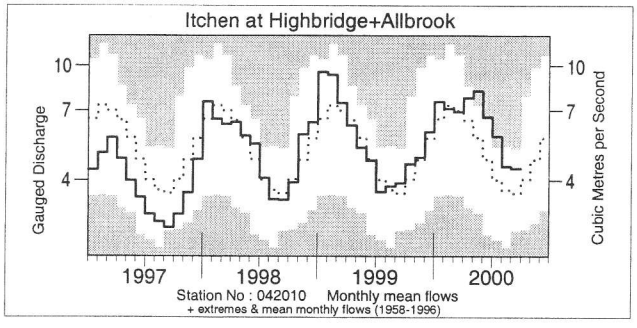










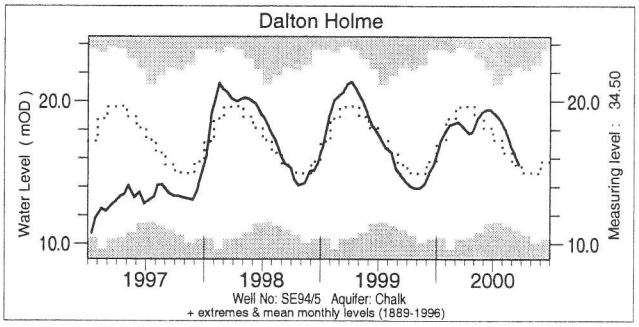


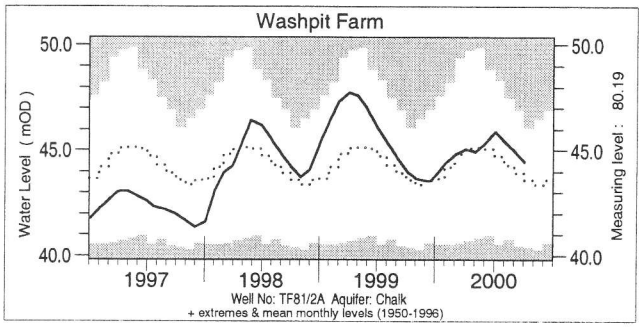
Notable runoff accumulations April - September 2000 (a); October 1999 - September 2000 (b)

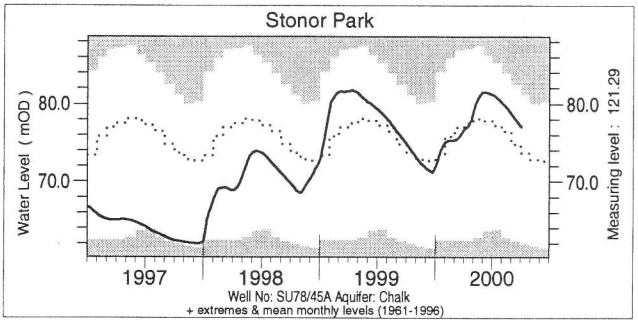
	River	%lta	Rank	River	%lta	Rank	River	%lta	Rank
(a)	Leven	217	40/40	Test	137	42/42	Carron	56	1/22
	Witham	189	41/41	Avon	165	36/36	Ewe	47	1/30
	Kennet	155	39/39	Exe	160	44/44	(b) Brue	159	33/33
	Lymington	194	38/38	Teme	184	31/31	Clyde	147	37/37

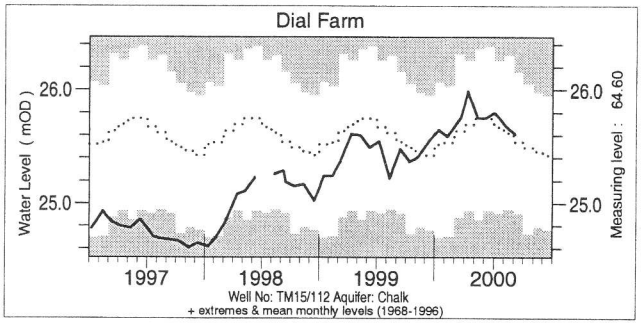
lta = long term average
Rank 1 = lowest on record

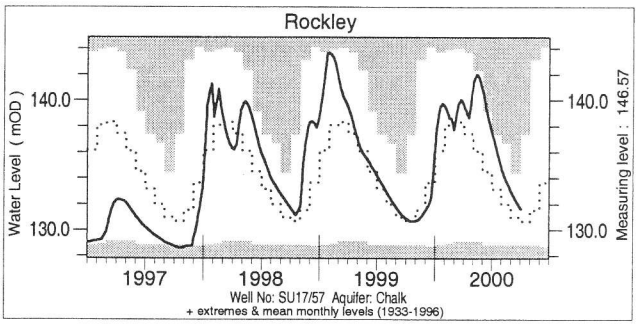
Groundwater . . . Groundwater

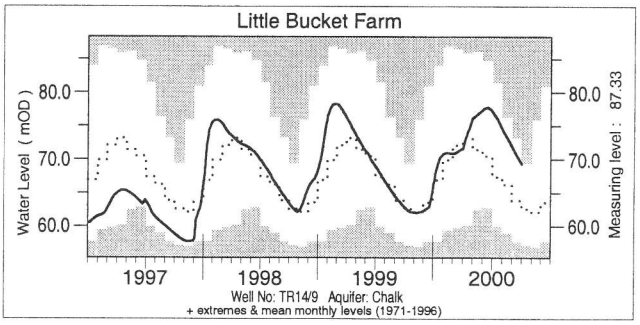


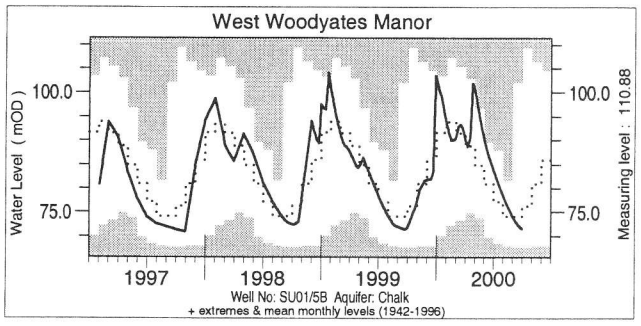


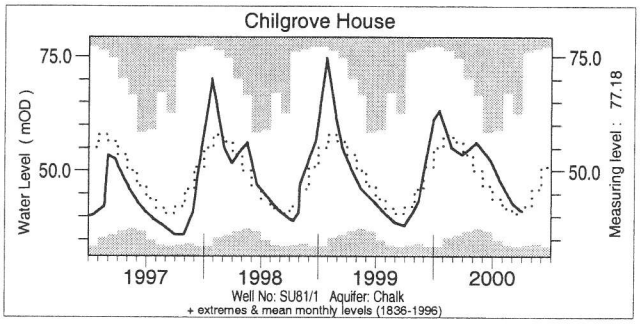


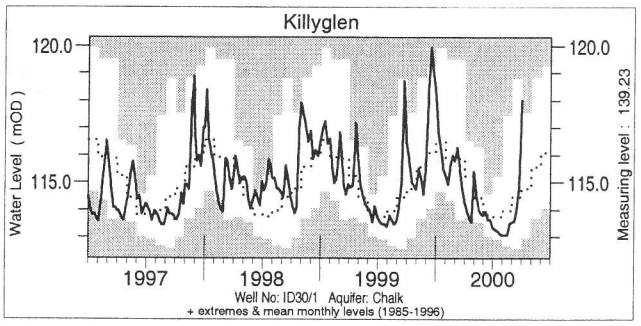


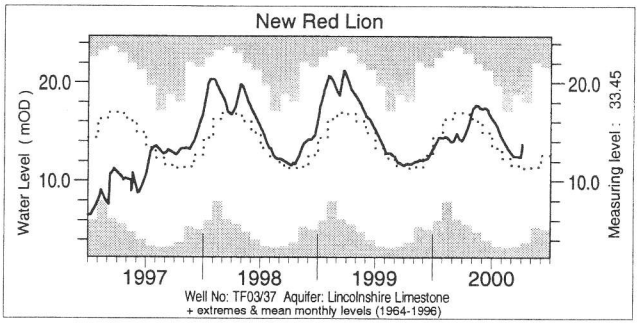








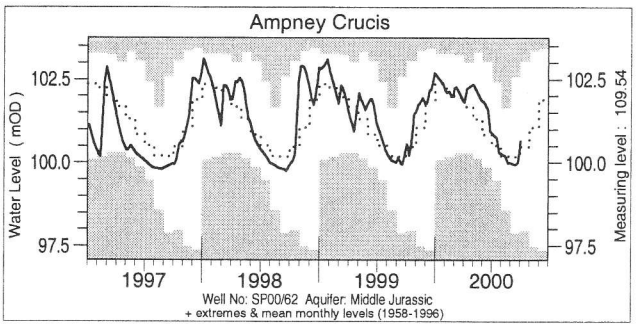


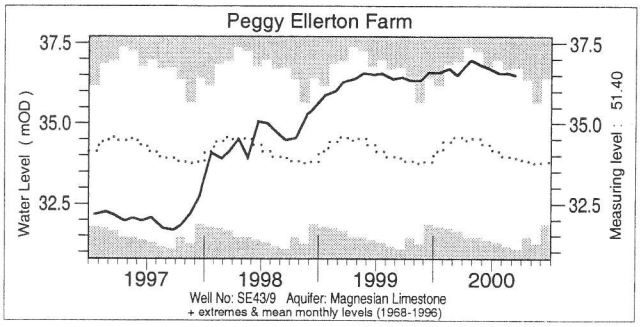


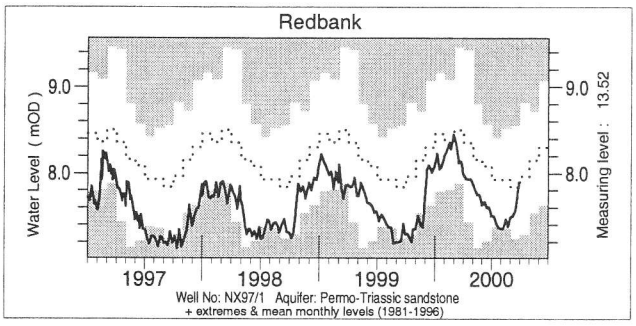
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined 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.

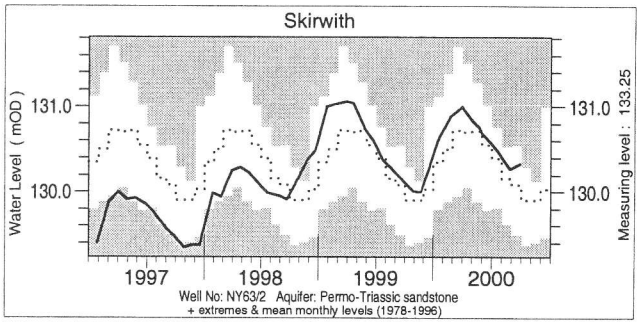
Note. Due to the impact of abstraction on groundwater levels at The Holt borehole, it has been replaced as an index site by the Stonor Park well.

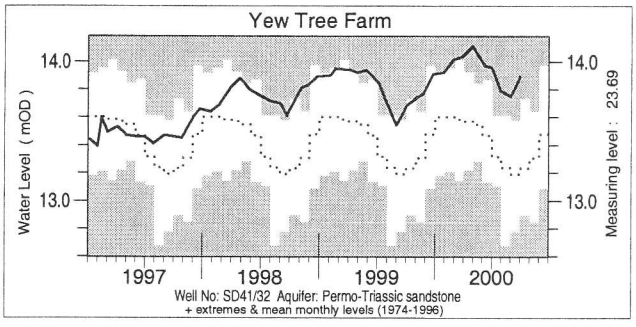
Groundwater . . . Groundwater

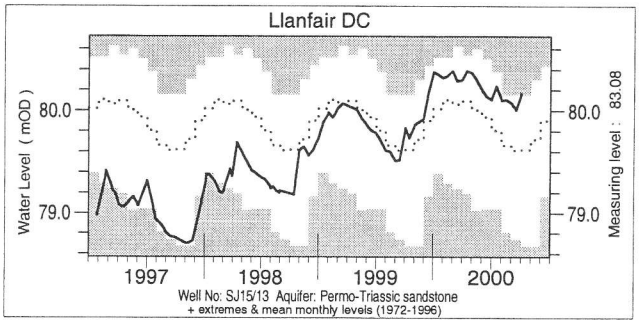


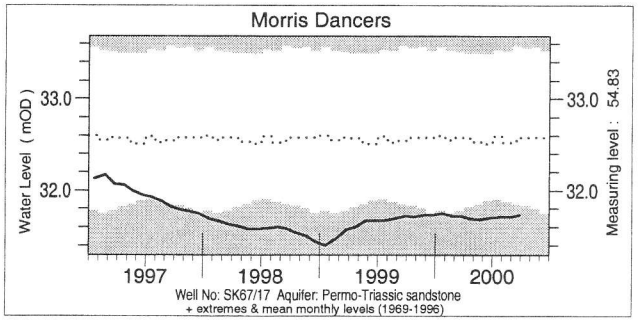


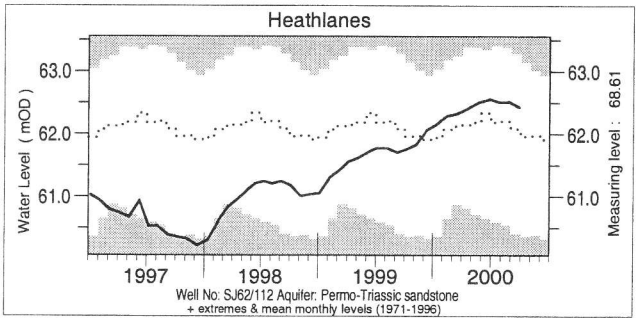


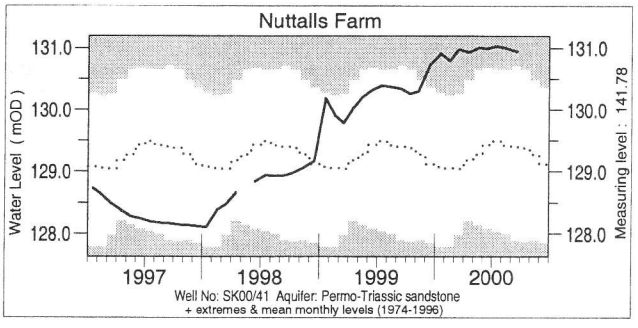


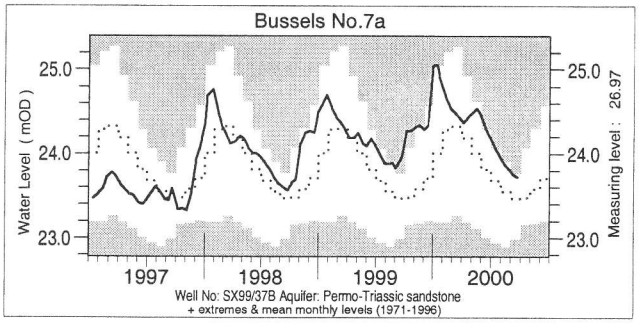












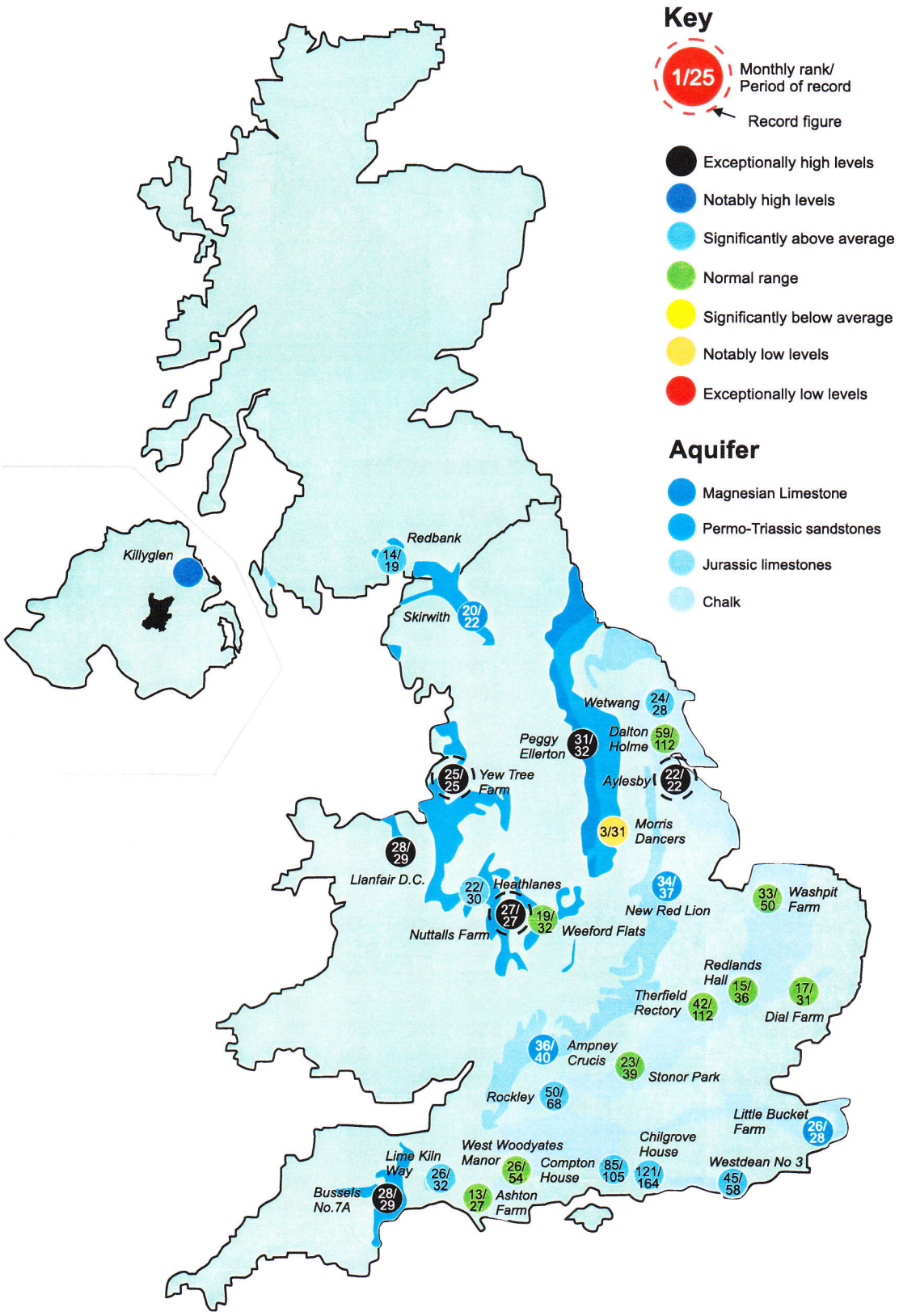
Groundwater levels September/October 2000

Borehole	Level	Date	Sep av.
Dalton Holme	15.56	22/09	15.45
Washpit Farm	44.46	03/10	43.91
Therfield Rectory	77.93	02/10	79.89
Dial Farm	25.61	04/09	25.54
Rockley	131.62	02/10	131.01
Little Bucket	69.35	30/09	64.62
West Woodyates	71.57	30/09	73.06

Borehole	Level	Date	Sep av.
Chilgrove	41.32	26/09	40.80
Killyglen	118.02	30/09	114.54
New Red Lion	13.72	03/10	11.57
Ampney Crucis	100.64	02/10	100.09
Redbank	7.89	27/09	7.77
Skirwith	130.33	27/09	130.08
Yew Tree Farm	13.89	29/09	13.26

Borehole	Level	Date	Sep av.
Llanfair D.C.	80.17	01/10	79.48
Morris Dancers	31.73	26/09	32.38
Heathlanes	62.43	26/09	61.97
Nuttalls Farm	130.94	19/09	129.51
Bussels No. 7A	23.72	20/09	23.51
Peggy Ellerton	36.5	08/09	34.04

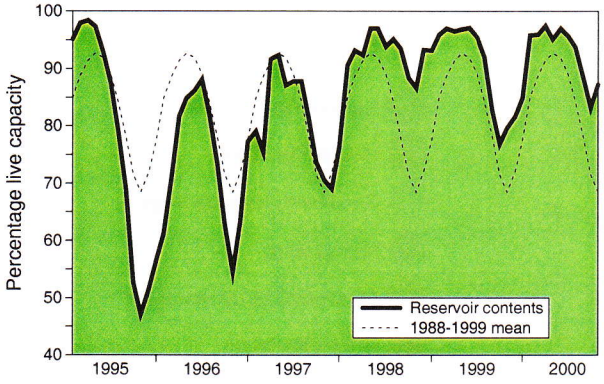
Levels in metres above Ordnance Datum



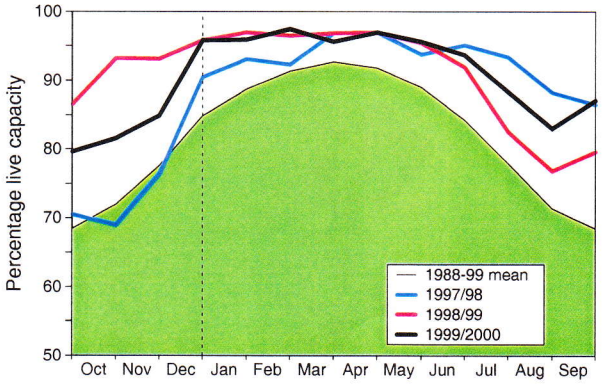
Groundwater levels - September 2000

The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and 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. Rankings may be omitted where they are considered misleading.

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)	2000 May	Jun	Jul	Aug	Sep	Oct	Min. Oct	Year* of min
North West	N Command Zone	• 133375	88	79	77	64	54	62	13	1995
	Vyrnwy	55146	99	95	98	93	89	99	26	1995
Northumbrian	Teesdale	• 87936	100	100	93	87	78	95	31	1995
	Kielder	(199175)	(94)	(95)	(92)	(90)	(91)	(93)	59	1989
Severn Trent	Clywedog	44922	99	99	99	96	88	90	24	1989
	Derwent Valley	• 39525	100	100	92	86	75	87	24	1989
Yorkshire	Washburn	• 22035	100	99	90	83	76	85	24	1995
	Bradford supply	• 41407	99	92	90	76	67	83	15	1995
Anglian	Grafham	** (55490)	(96)	(91)	(92)	(93)	(92)	(94)	46	1997
	Rutland	**(116580)	(97)	(96)	(94)	(90)	(84)	(81)	61	1995
Thames	London	• 206399	97	96	96	88	83	88	53	1997
	Farmoor	• 13843	81	97	95	96	98	95	60	1990
Southern	Bewl	28170	100	100	100	93	85	80	32	1990
	Ardingly	4685	100	100	99	93	78	83	37	1996
Wessex	Clatworthy	5364	100	98	93	80	66	63	30	1995
	Bristol WW	• (38666)	(98)	(99)	(92)	(87)	(77)	(76)	31	1990
South West	Colliford	28540	100	100	98	95	90	92	43	1997
	Roadford	34500	99	97	96	94	92	97	26	1995
	Wimbleball	21320	100	100	96	89	80	83	30	1995
	Stithians	5205	98	92	84	74	58	56	22	1990
Welsh	Celyn and Brenig	• 131155	100	100	100	99	97	98	39	1989
	Brianne	62140	100	100	99	96	92	97	48	1995
	Big Five	• 69762	98	98	96	87	78	83	19	1995
	Elan Valley	• 99106	100	99	97	94	88	96	34	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	100	95	90	84	76	91	43	1998
	East Lothian	• 10206	100	99	96	93	93	100	52	1989
West of Scotland	Loch Katrine	• 111363	84	69	65	53	50	75	43	1995
	Daer	22412	97	90	80	66	68	98	32	1995
	Loch Thom	• 11840	92	79	69	59	60	80	56	1995
Northern Ireland	Silent Valley	• 20634	58	56	57	42	56	45	27	1995

()figures in parentheses relate to gross storage • denotes reservoir groups *last occurrence **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 region; this can be particularly important during droughts. The minimum storage figures relate to the 1988-2000 period only (except for West of Scotland where data commence in 1994). In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

Location map . . . Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme was instigated in 1988 and is undertaken jointly by the Centre for Ecology and Hydrology, Wallingford (formerly 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), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

Data Sources

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

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

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

Rainfall

Most rainfall data are provided by The Met. Office (address opposite). To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA. Following the discontinuation of The Met. Office's CARP system in July 1998, the areal rainfall figures have been derived using several procedures, including initial estimates based on MORECS*. Recent figures have been produced by The Met. Office, National Climate Information Centre (NCIC), using a technique similar to CARP. An initiative is underway with The Met. Office to provide more accurate areal figures and, since October 1999, to include more raingauges in the analysis. A significant number of additional monthly rainfall totals are currently being provided by the Environment Agencies; over the coming months further monthly raingauge totals will be included for selected regions. Until the access to these additional data has stabilised the regional figures (and the return periods associated with them) should be regarded as a guide only.

*MORECS is the generic name for the Meteorological Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.

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The cooperation of all data suppliers is gratefully acknowledged.

Subscription

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

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