Hydrological summary
for the United Kingdom

September 2002

General

September was a very mild, sunny and dry month in most regions. It continued a notably dry spell which, by early October, extended over 10 weeks in many areas. Provisionally, the combined August and September rainfall total for the UK ranks amongst the four driest since 1959. The resulting parched landscape, steep river flow recessions – triggering river flow support measures and irrigation restrictions - provide evidence of the first appreciable widespread drought stress since 1997. Overall reservoir stocks (for England and Wales) registered their largest September decline since 1991 and stocks in some gravity-fed reservoirs in Wales and the South-West are below average. Importantly for the water resources outlook however, overall stocks remain considerably above the early autumn average. Similarly, groundwater levels in most major aquifers are well within the normal early autumn range. Soil moisture deficits increased sharply through September and are now the equivalent of around 10 weeks effective rainfall (rainfall – actual evaporation) in the English Lowlands. The heavy rainfall on the 13th. October will need to herald a wet late autumn to avoid depressed late 2002 river flows and a substantial delay in the seasonal onset of aquifer recharge. Rainfall over the next 8-10 weeks will be very influential in determining the water resources outlook for 2003.

Rainfall

After an unsettled early summer, September began with a relatively rare (during 2002) extension of the Azores high pressure cell across the British Isles. Anticyclonic conditions, bringing warm and dry weather, continued to dominate throughout the month but were interrupted by a notably unsettled interlude on the 7-9th. On the 7/8th, torrential rainfall (>90 mm including 61 mm in 4 hours – estimated return period > 300 years) caused severe flooding in Inverness. The following day produced 24-hour rainfall totals exceeding 20 mm over much of England and Wales – Swanage reported 121.4 mm (including 71 mm in two hours – RP > 250 years). This episode was very atypical of September as a whole; many areas reported 27 or more days without significant rainfall – extending, by early October, to 45 or more since August 10th. Local storm centres apart, September rainfall totals were very modest; Guernsey reported only 2 mm. Localities reporting less than 25% of average were well distributed throughout the country and some areas reported their driest September since 1959 (e.g. Aberdeen). Many upland reservoir gathering grounds in the western hills registered below 40%. Provisionally, Scotland, Northern Ireland and England & Wales registered their driest, 2nd driest and 6th driest September in the last 30 years. More significantly, since the 1959 drought only in 1972 has the combined August/September total been significantly lower than this year. Fortunately from a water resources perspective, regional rainfall totals for the first half of the year were above, to well above, the 1961-90 average.

River Flows

River flows during September were characterised by sustained recessions interrupted briefly by short-lived spates – these were largely restricted to the three days beginning on the 8th – when, for example, the Mimram reported its highest September peak since 1975. Significant flooding did occur but it was generally local and the result of intense storms overwhelming urban drainage capabilities e.g. at Swanage, Inverness, Burntisland (Fife); these storms also caused substantial transport disruption and some landslides. Of more general hydrological significance were the depressed flows registered at end of the month and continuing into October - long term minima were approached in a few areas (e.g. the Tawe in South Wales) and in many rivers across southern Britain flows were at their lowest since 1996 or 1997. Above average September runoff was largely confined to spring-fed eastern and southern rivers (where some residual benefit from the exceptional groundwater recharge of 2000/01 could still be recognised). Mean flows in impermeable western and northern catchments were well below average and new September runoff minima were established for some rivers (e.g. the Cynon, Ewe and Naver). In contrast to the short-term runoff deficiencies, runoff for the year thus far is close to, or above, average (notably so in many western and northern catchments) – emphasising that the depressed flows are not fully representative of the current water resources situation.

Groundwater

In mid summer, soil moisture deficits were generally below average across most aquifer outcrop areas but, contrary to the normal seasonal pattern, they increased through the latter half of September and, by month end, were significantly above average across most of the UK. Continuing dry weather in early October resulted in further increases – in the absence of an extraordinarily wet late autumn, this will delay the seasonal onset of aquifer recharge, and is likely to reduce the length of the 2002/03 recharge season considerably. Current groundwater levels are mostly well below corresponding levels in 2001 (which were remarkably high for the early autumn). In the slower responding Permo-Triassic sandstones levels remain generally well above the early autumn average (and still at record levels for September in a few areas – see Yew Tree Farm) but throughout the Chalk, and most limestone aquifers, levels in index wells and boreholes are still very close to the long term average for September. This is typical of minor aquifers also (e.g. the Suffolk Crag). Recessions are expected to continue for some time and in many Chalk outcrops the 2002 recovery is likely to begin with levels at their lowest since the mid-1990s.

Centre for Ecology & Hydrology
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Sep 2002	Aug 02-Sep 02	RP	Apr 02-Sep 02	RP	Jan 02-Sep 02	RP	Oct 01-Sep 02	RP
England & Wales	**mm**	**41**	**117**		**392**		**644**		**889**	
	%	**53**	**75**	**2-5**	**96**	**2-5**	**101**	**2-5**	**97**	**2-5**
North West	mm	53	155		561		975		1303	
	%	46	70	5-10	105	2-5	118	5-10	108	2-5
Northumbrian	mm	33	119		382		654		883	
	%	46	77	2-5	96	2-5	107	2-5	104	2-5
Severn Trent	mm	30	86		330		537		730	
	%	46	65	5-10	92	2-5	99	2-5	97	2-5
Yorkshire	mm	36	150		397		618		822	
	%	53	105	2-5	105	2-5	106	2-5	100	<2
Anglian	mm	32	88		298		432		589	
	%	64	85	2-5	100	<2	100	<2	99	2-5
Thames	mm	26	68		319		517		702	
	%	43	58	5-10	97	2-5	105	2-5	102	2-5
Southern	mm	43	83		331		555		760	
	%	62	66	5-10	99	2-5	104	2-5	98	2-5
Wessex	mm	38	79		345		601		821	
	%	53	57	5-10	95	2-5	103	2-5	98	2-5
South West	mm	26	76		406		798		1097	
	%	28	43	20-30	89	2-5	100	<2	93	2-5
Welsh	mm	38	119		485		928		1324	
	%	33	55	10-20	91	2-5	105	2-5	101	2-5
Scotland	**mm**	**48**	**135**		**585**		**1151**		**1655**	
	%	**34**	**52**	**30-50**	**97**	**2-5**	**118**	**10-20**	**115**	**10-20**
Highland	mm	48	115		591		1301		1890	
	%	28	39	110-150	86	5-10	112	5-10	107	2-5
North East	mm	38	135		465		751		1059	
	%	44	78	2-5	105	2-5	110	2-5	109	2-5
Tay	mm	32	138		594		1129		1491	
	%	28	66	5-10	118	5-10	133	40-60	121	10-20
Forth	mm	38	142		555		994		1288	
	%	34	70	5-10	115	5-10	129	35-50	116	5-15
Tweed	mm	37	118		452		815		1069	
	%	42	67	5-10	102	2-5	118	5-10	110	2-5
Solway	mm	60	175		691		1235		1624	
	%	42	67	5-10	116	5-10	127	20-35	114	5-10
Clyde	mm	64	163		716		1414		1915	
	%	36	52	20-30	104	2-5	124	20-30	113	5-10
Northern Ireland	**mm**	**41**	**96**		**546**		**898**		**1166**	
	%	**41**	**51**	**10-20**	**118**	**5-10**	**122**	**5-15**	**110**	**2-5**

RP = Return period

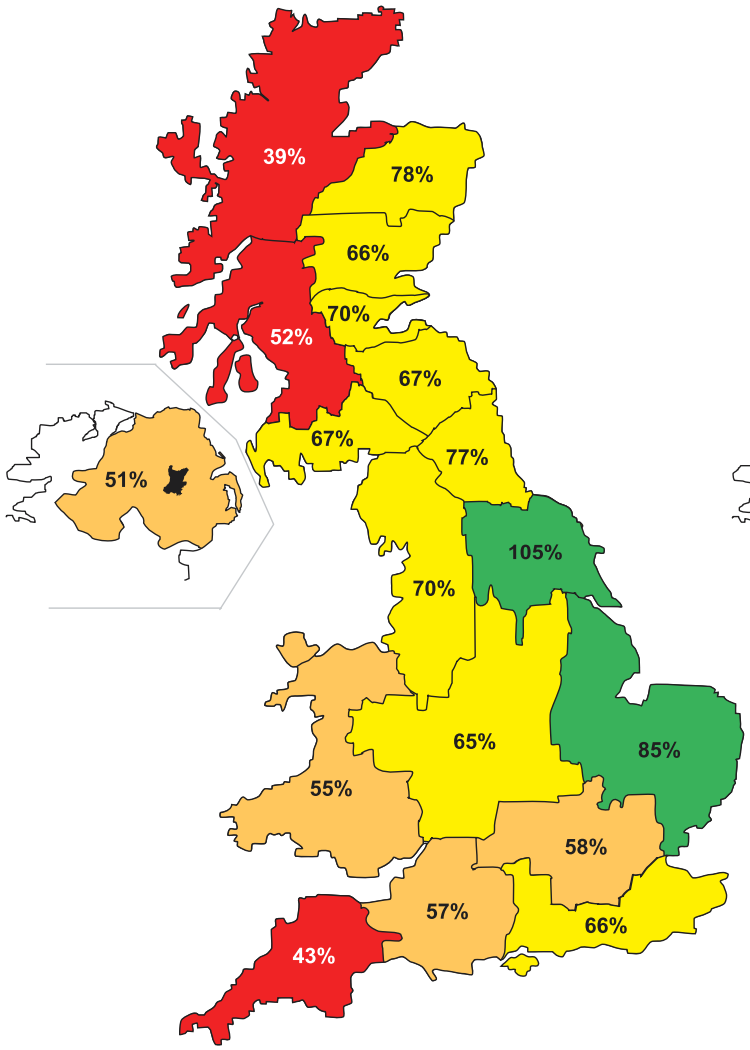
 All monthly totals since December 1998 are provisional (see page 12). The figures for England & Wales are derived by the Hadley Centre and are updates of the homogenised series developed by the Climate Research Unit; the other national figures are derived from different raingauge networks to those used to derive the CRU data series. 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 Scottish rainfall series in particular, can exaggerate the relative wetness of the recent past.

*See page 12.

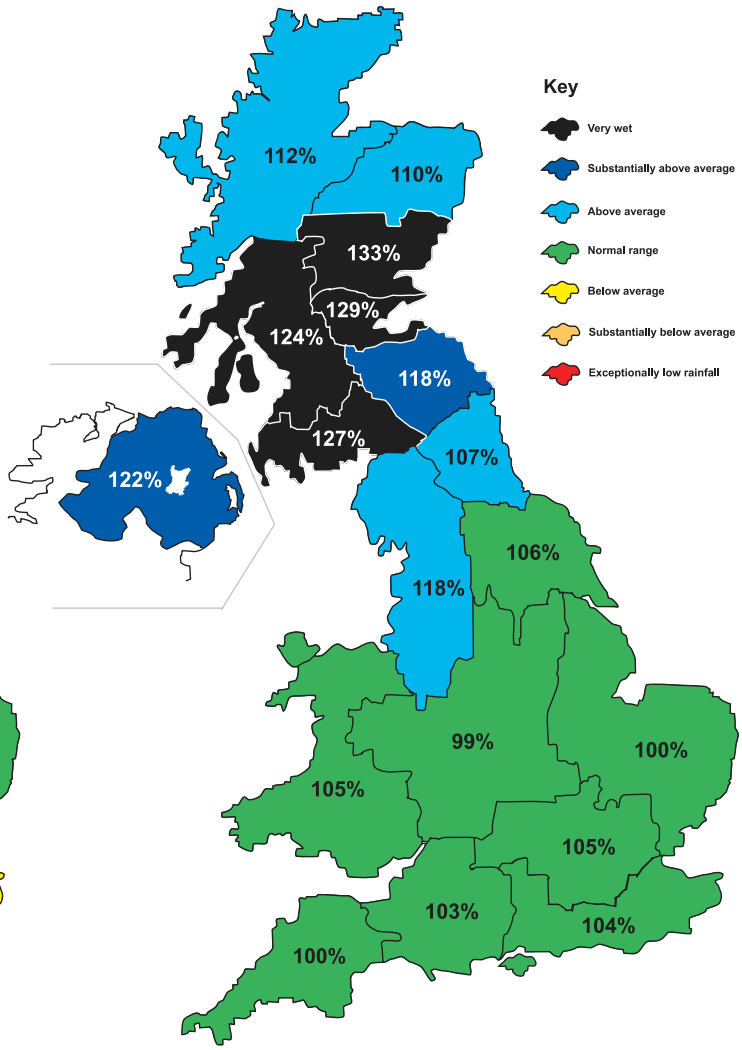
Rainfall . . . Rainfall . .

Key

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



August 2002 - September 2002

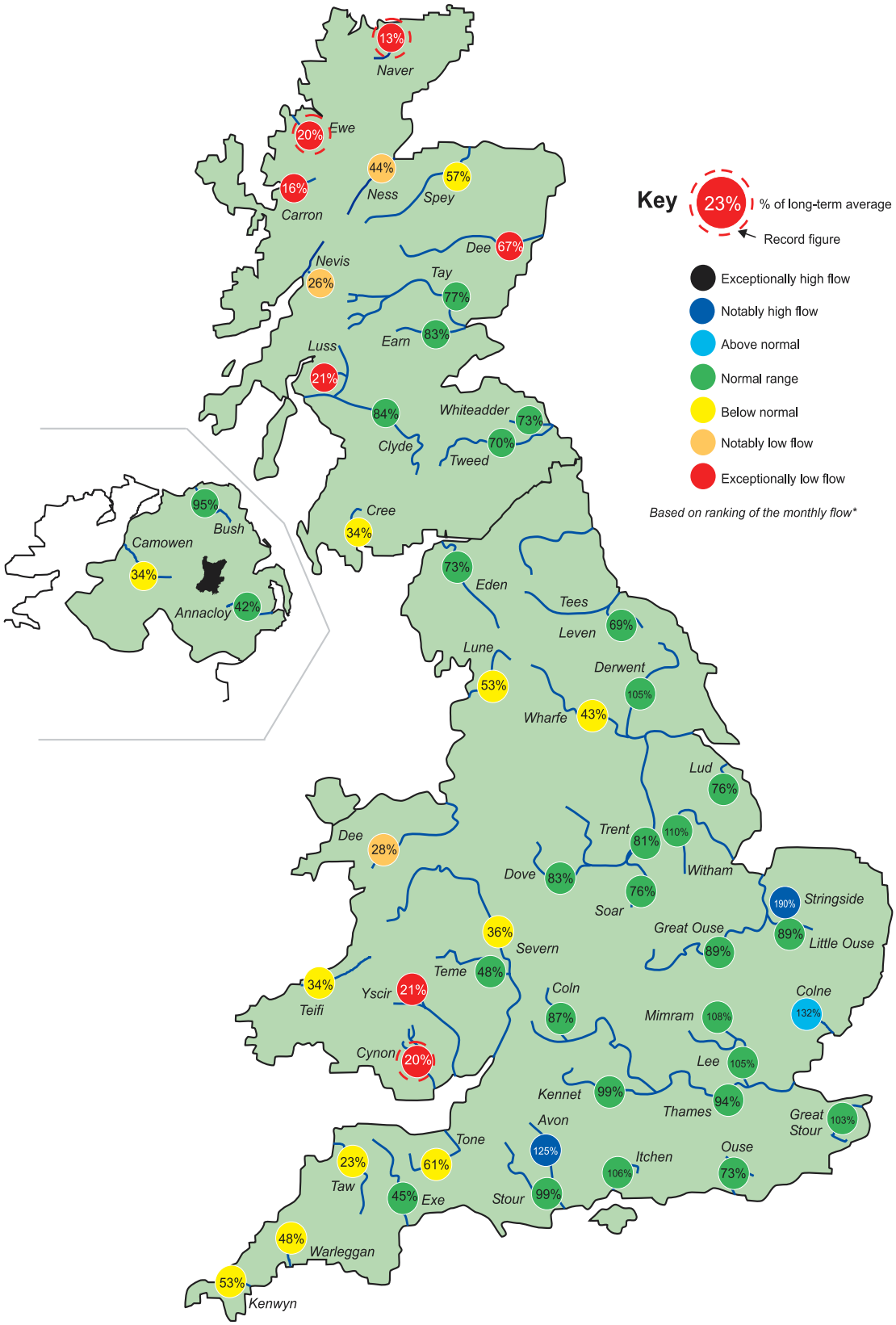


January 2002 - September 2002

Rainfall accumulation maps

Regional rainfall deficiencies generally began to build from the second week of August and deficiencies (in the two-month timeframe) were notable by the end of September; some western parts of Britain recorded their lowest August-September rainfall since 1959. By contrast, regional rainfall totals for the year thus far are at, or above, the long term average - still notably high for much of Scotland.

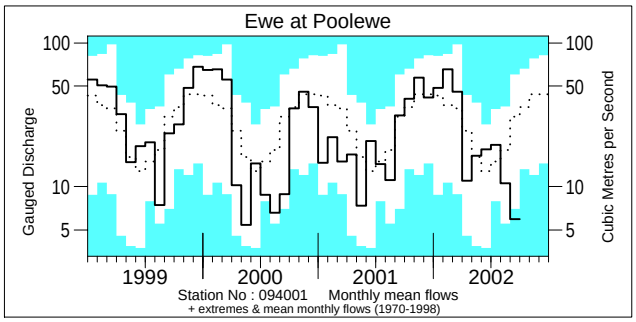
River flow . . . River flow . . .

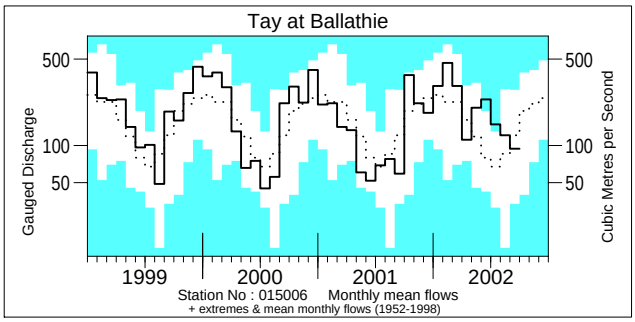


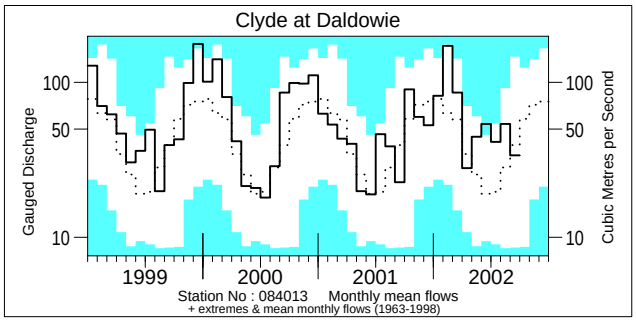
River flows - September 2002

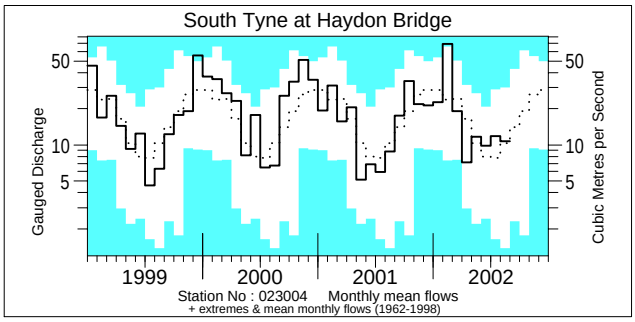
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

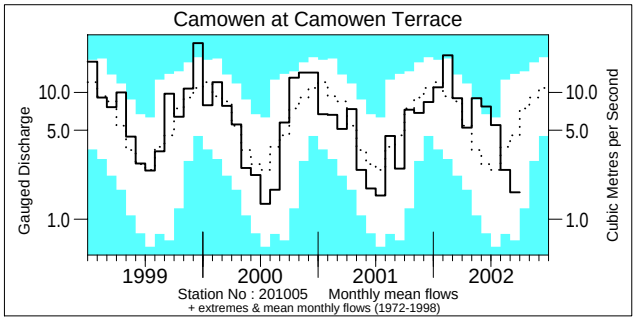
River flow . . . River flow . . .

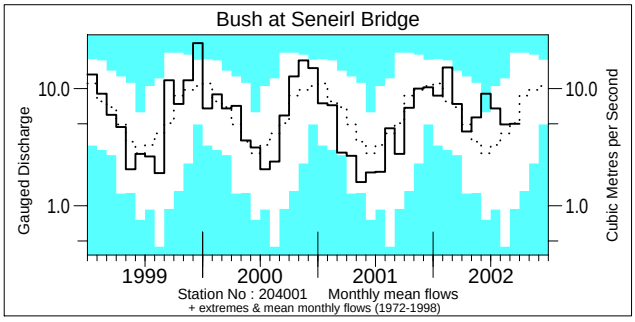


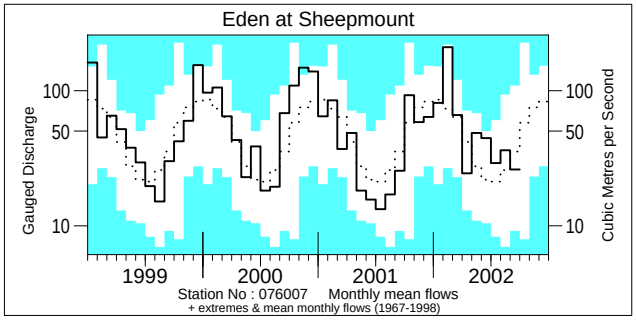


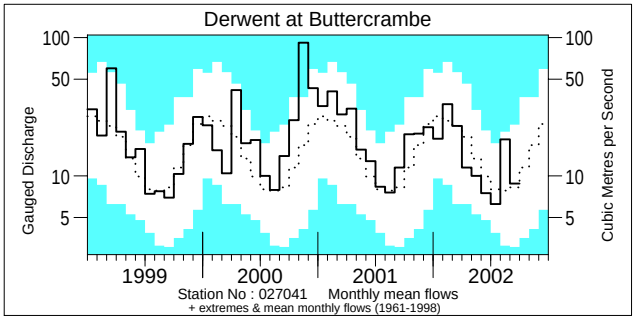


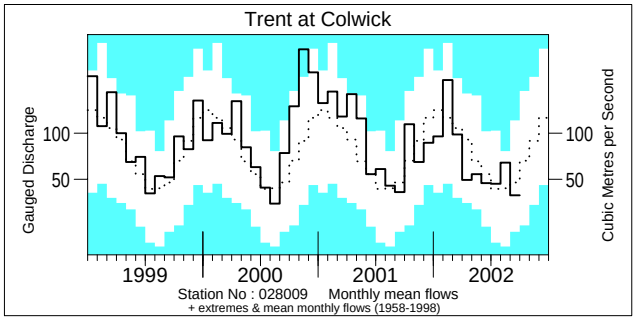


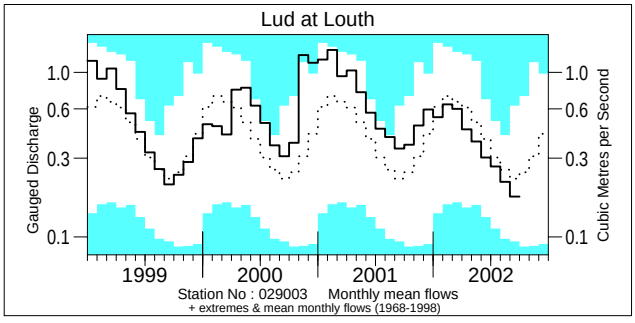








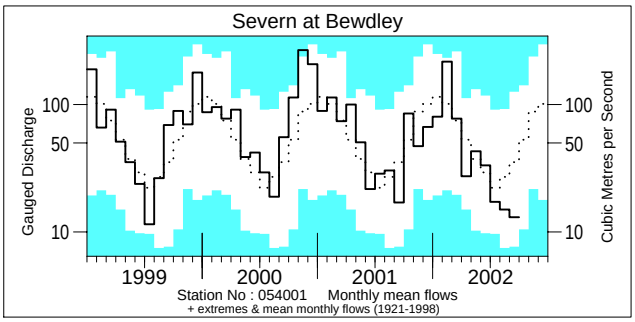


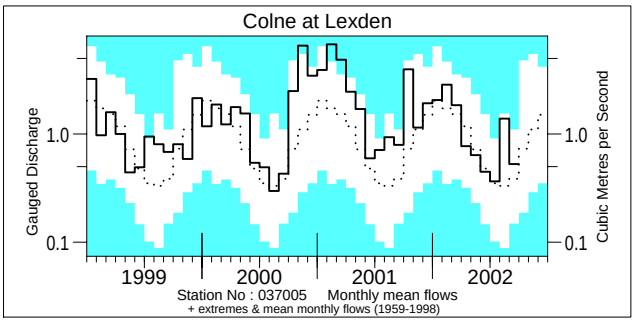


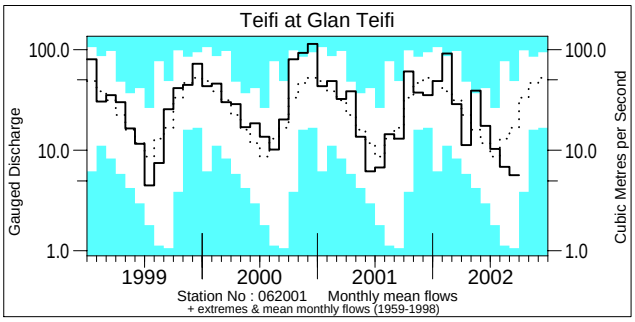
Monthly river flow hydrographs

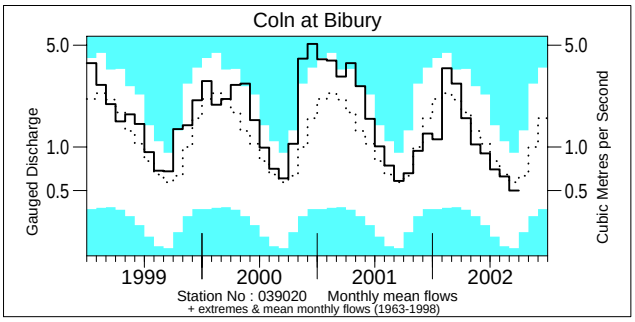
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1999 (shown by the shaded areas). Monthly flows falling outside the maximum/ minimum range are indicated where the bold trace enters the shaded areas.

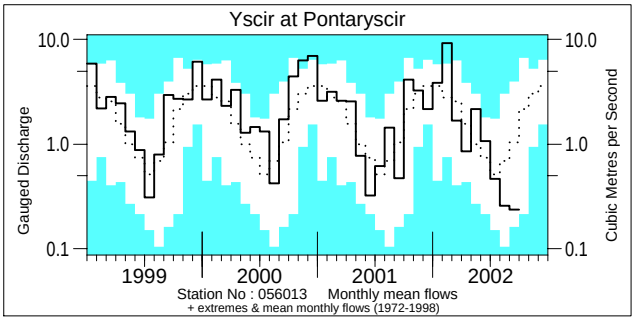
River flow . . . River flow . . .

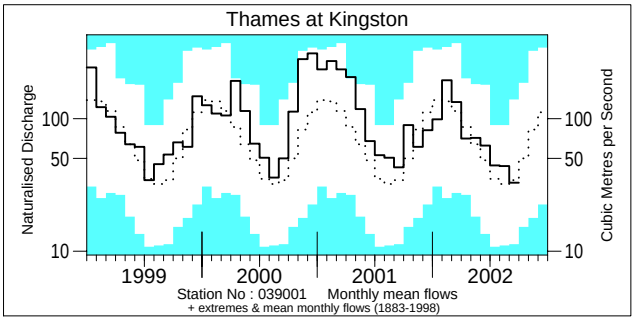


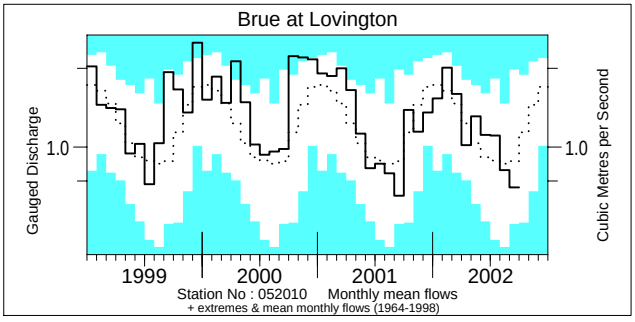


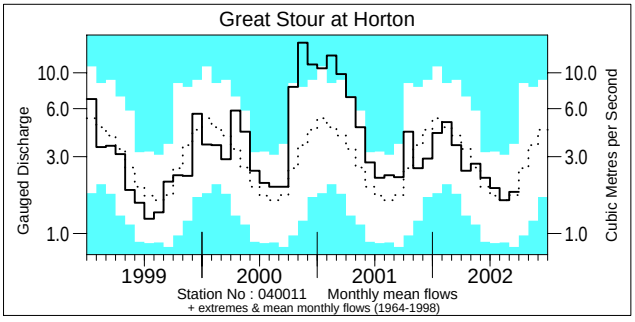


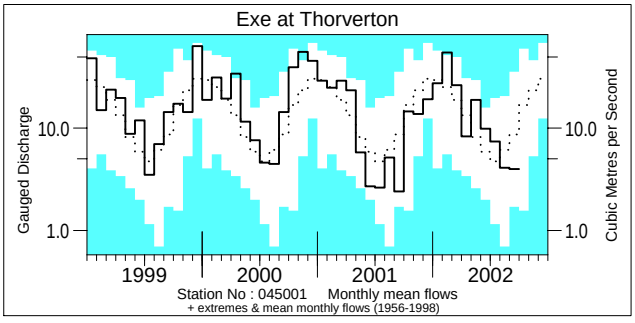


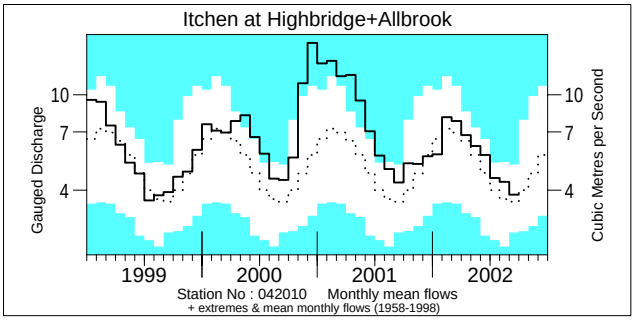












Notable runoff accumulations (a) August 2002 - September 2002, (b) January 2002 - September 2002

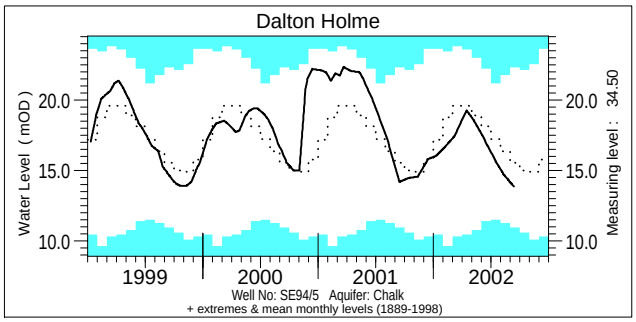
	River	%lta	Rank
a)	Torne	216	31/32
	Colne	247	42/43
	Cynon	27	2/44
	Tawe	20	2/45
	Nevis	37	1/20
	Carron	21	1/24
	Ewe	36	2/32
	Naver	42	2/26

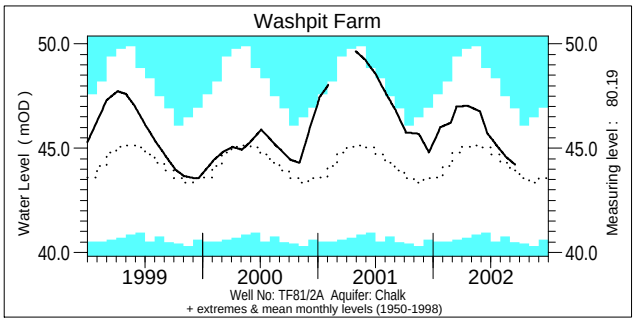
	River	%lta	Rank
b)	Tay	145	49/50
	Earn	155	55/55
	Tweed	131	41/42
	Wharfe	129	45/47
	Mole	137	27/28
	Exe	130	45/46
	Dart	134	42/44

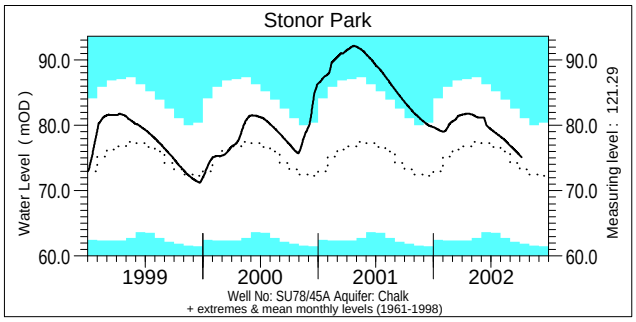
River	%lta	Rank
Lune	138	42/42
Eden	138	35/35
Nith	136	43/45
Clyde	156	39/39
Leven (Glasgow)	148	38/38
Luss	117	22/24
Camowen	134	28/29

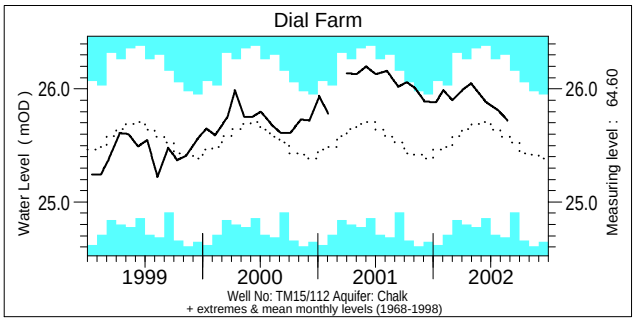
lta = long term average
Rank 1 = lowest on record

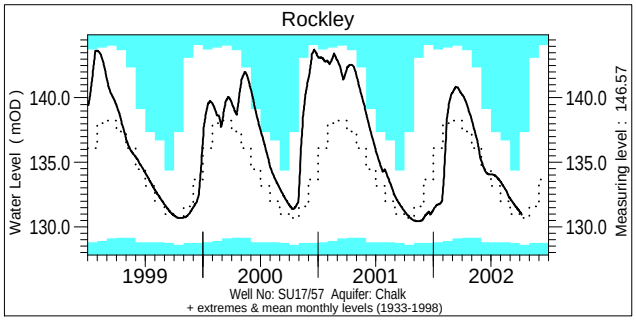
Groundwater . . . Groundwater

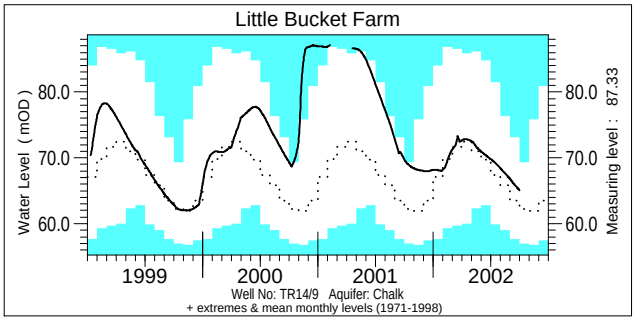


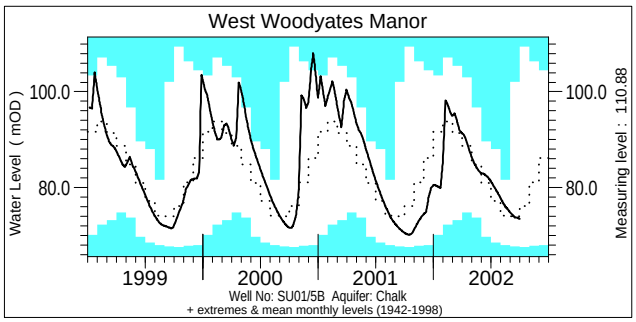


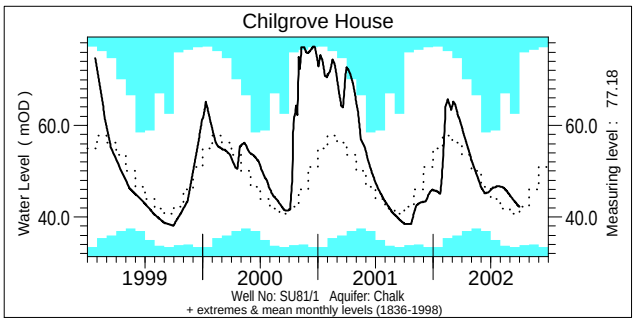


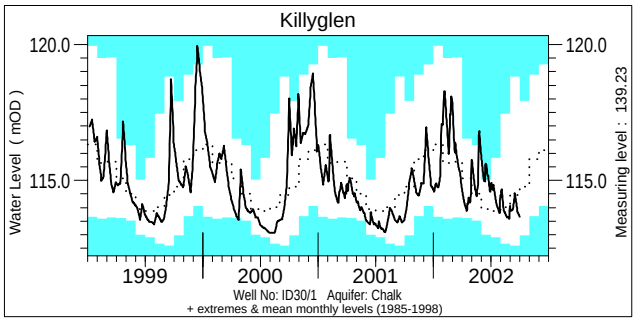


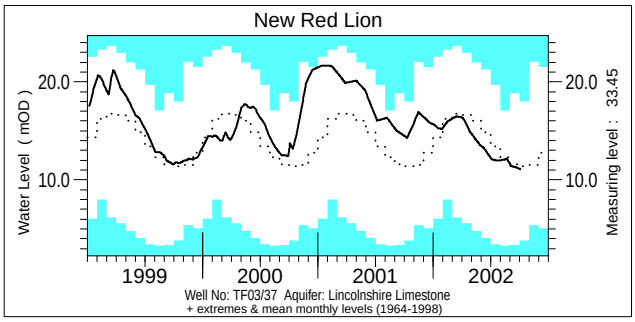






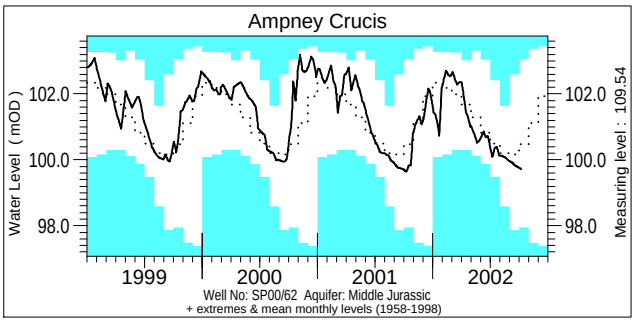


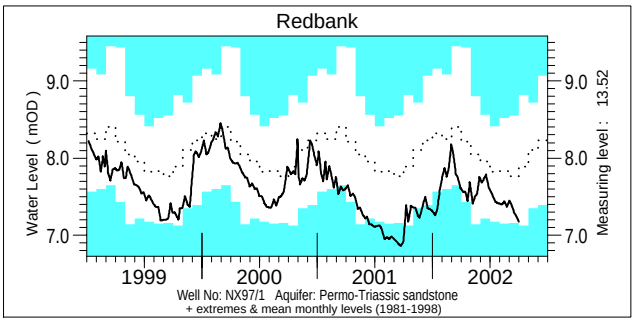


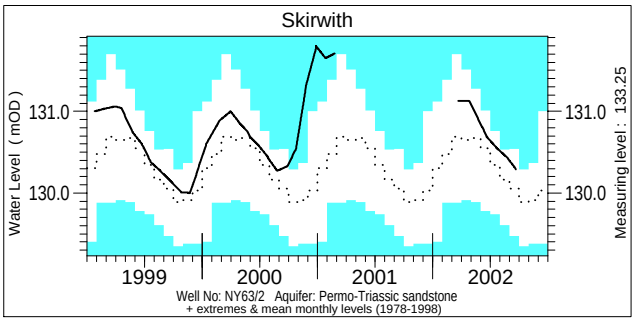


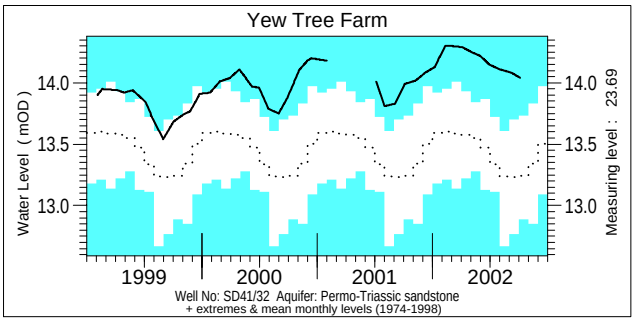
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

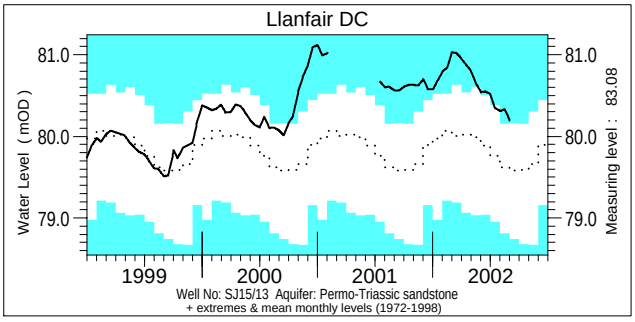
Groundwater . . . Groundwater

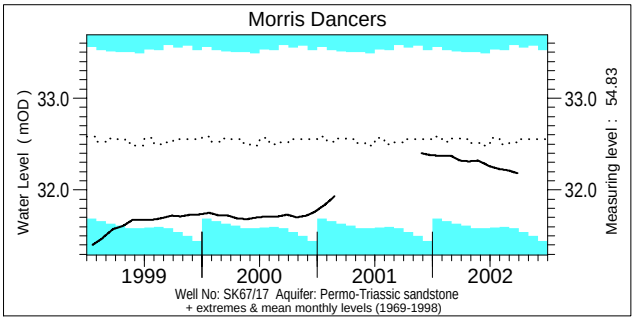


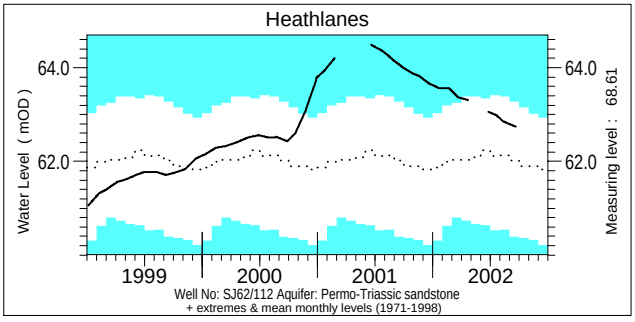


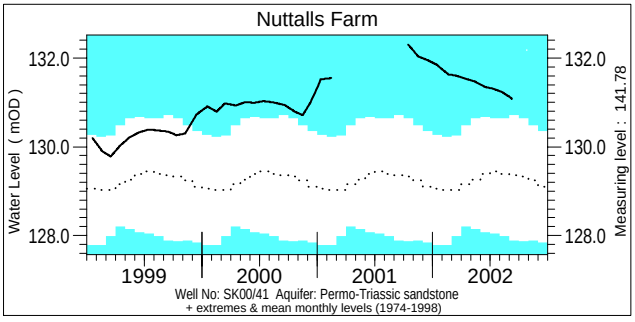


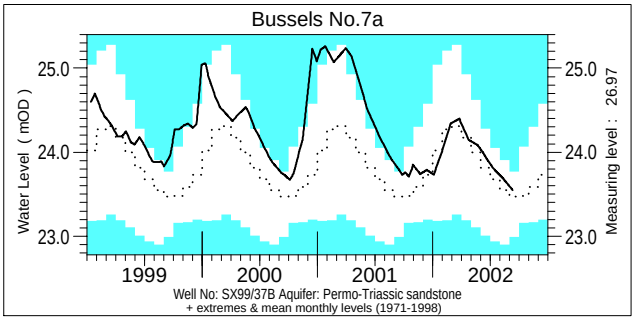


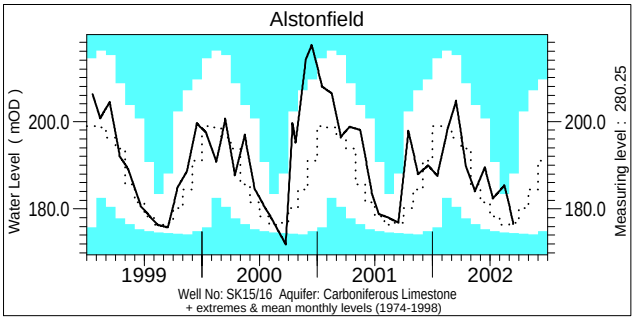










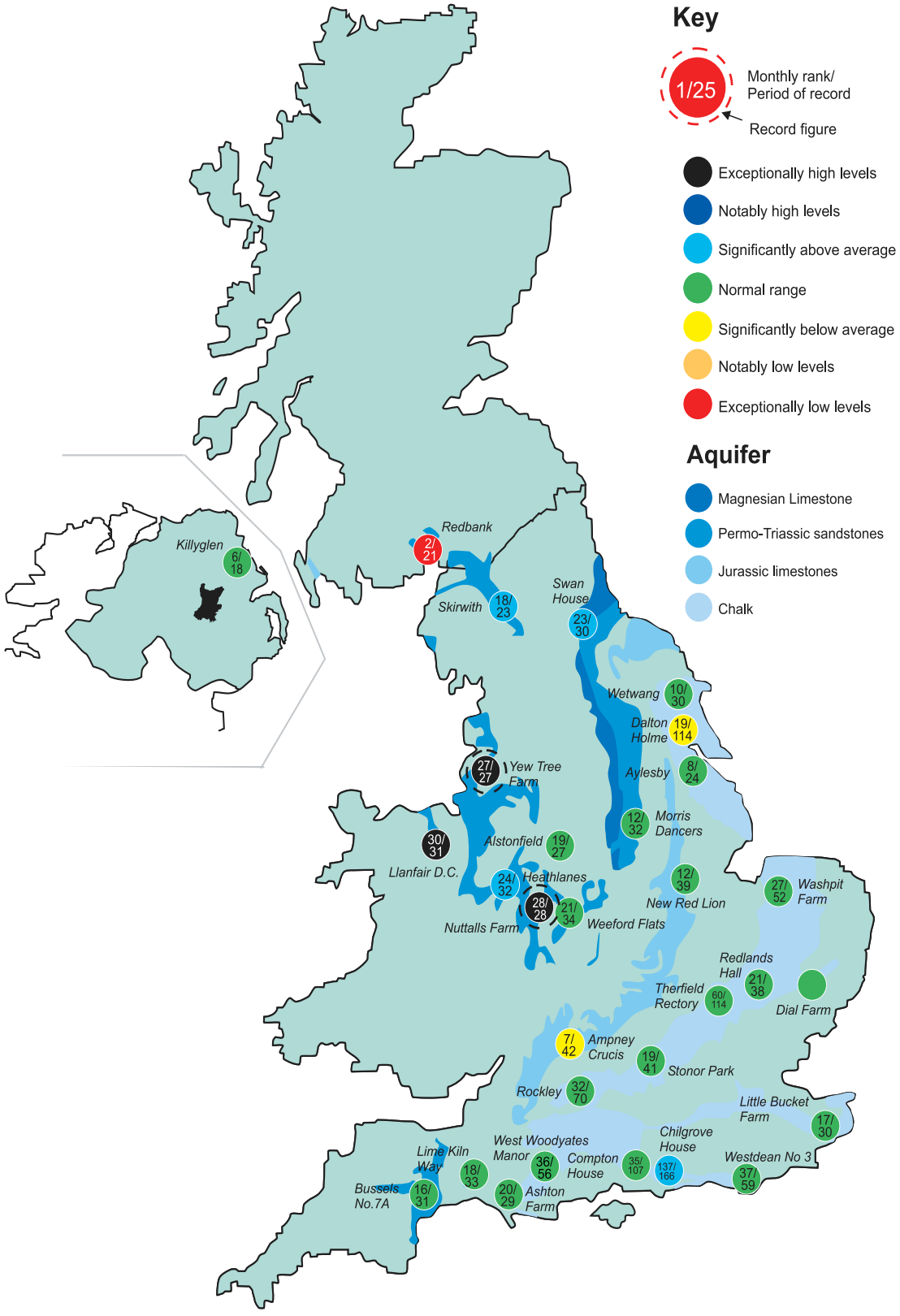


Groundwater levels September 2002 / October 2002

Borehole	Level	Date	Sep. av.	Borehole	Level	Date	Sep. av.	Borehole	Level	Date	Sep. av.
Dalton Holme	13.85	12/09	15.44	Chilgrove House	42.16	30/09	40.79	Llanfair DC	80.19	01/09	79.51
Washpit Farm	44.20	17/09	43.97	Killyglen	113.67	30/09	114.48	Morris Dancers	32.18	26/09	32.38
Stonor Park	75.07	07/10	74.83	New Red Lion	11.08	03/10	11.66	Heathlanes	62.74	20/09	62.03
Dial Farm	25.72	23/08	25.55	Ampney Crucis	99.72	07/10	100.08	Nuttalls Farm	131.08	09/09	129.51
Rockley	130.95	07/10	131.02	Redbank	7.18	30/09	7.73	Bussels No.7a	23.55	10/09	23.52
Little Bucket Farm	65.06	30/09	64.82	Skirwith	130.29	20/09	130.08	Alstonfield	176.61	13/09	176.76
West Woodyates	73.46	30/09	73.03	Yew Tree Farm	14.04	04/10	13.28				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater



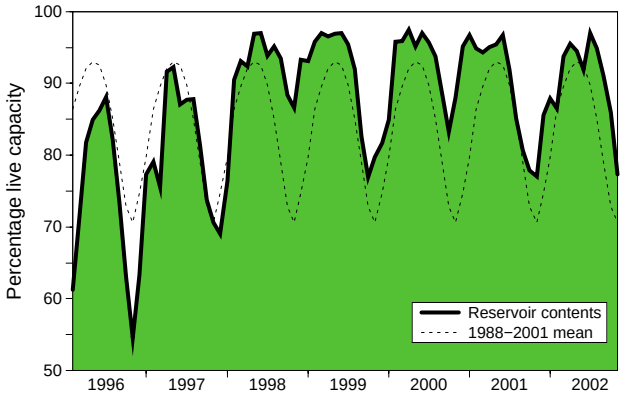
Groundwater levels - September 2002

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.

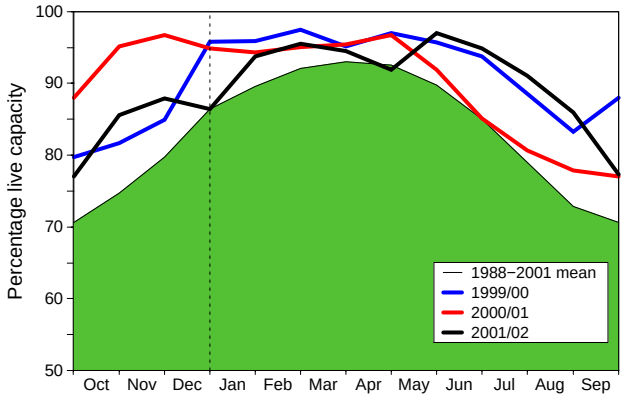
(Note: Redbank is affected by groundwater abstraction.)

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.

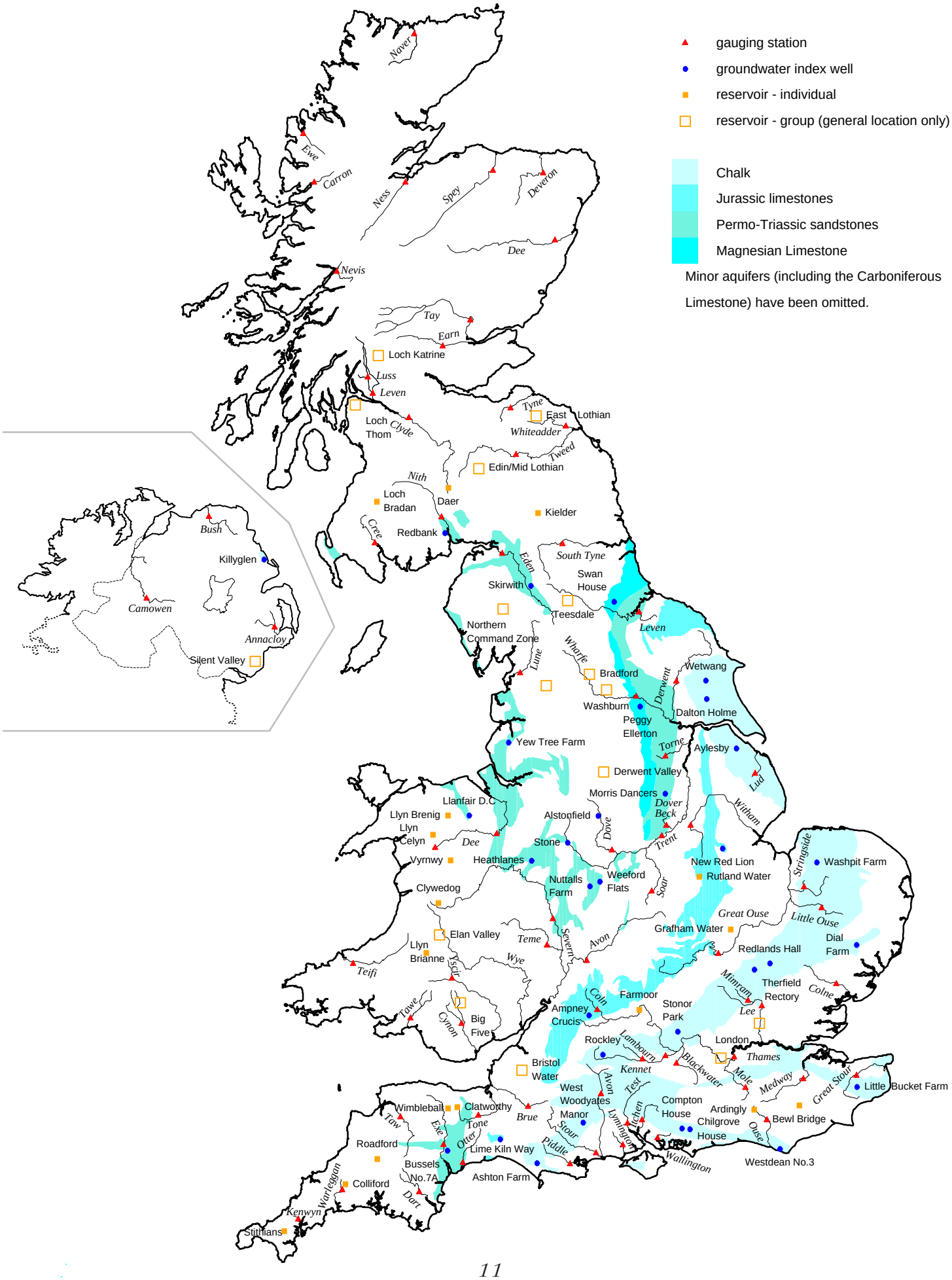
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2002 May	Jun	Jul	Aug	Sep	Oct	Min. Oct	Year* of min
North West	N Command Zone	• 124929	89	100	97	88	78	68	13	1995
	Vyrnwy	55146	94	99	95	90	77	62	26	1995
Northumbrian	Teesdale	• 87936	89	98	95	88	87	77	31	1995
	Kielder	(199175)	(91)	(98)	(94)	(90)	(91)	(86)	(59)	1989
Severn Trent	Clywedog	44922	98	99	98	92	85	71	24	1989
	Derwent Valley	• 39525	88	85	81	80	84	78	24	1989
Yorkshire	Washburn	• 22035	85	91	89	81	84	75	24	1995
	Bradford supply	• 41407	84	95	95	93	92	83	15	1995
Anglian	Grafham	(55490)	(91)	(94)	(96)	(95)	(94)	(89)	(46)	1997
	Rutland	(116580)	(94)	(95)	(92)	(90)	(88)	(85)	(61)	1995
Thames	London	• 202340	93	97	97	94	92	81	53	1997
	Farmoor	• 13830	95	90	96	95	95	91	60	1990
Southern	Bewl	28170	95	95	93	89	85	78	32	1990
	Ardingly	4685	100	100	99	99	98	92	37	1996
Wessex	Clatworthy	5364	89	100	97	91	76	62	30	1995
	Bristol WW	• (38666)	(93)	(95)	(93)	(89)	(78)	(71)	(31)	1990
South West	Colliford	28540	81	84	84	80	74	63	43	1997
	Roadford	34500	91	94	93	97	90	83	26	1995
	Wimbleball	21320	97	100	97	94	86	73	30	1995
	Stithians	5205	85	86	83	76	68	54	22	1990
Welsh	Celyn and Brenig	• 131155	99	100	99	98	93	88	39	1989
	Brianne	62140	89	100	99	96	89	80	48	1995
	Big Five	• 69762	90	98	94	89	69	53	19	1995
	Elan Valley	• 99106	93	100	95	90	75	64	34	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	94	99	100	94	92	88	43	1998
	East Lothian	• 10206	100	96	98	89	96	92	52	1989
West of Scotland	Loch Katrine	• 111363	95	100	99	96	83	74	43	1995
	Daer	22412	99	100	99	99	97	94	32	1995
	Loch Thom	• 11840	95	100	100	95	94	87	56	1995
Northern Ireland	Silent Valley	• 20634	65	81	90	81	79	69	27	1995

() figures in parentheses relate to gross storage • denotes reservoir groups * last occurrence - see footnote

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 1988-2002 period only (except for West of Scotland and Northern Ireland where data commence in 1994 and 1993 respectively). 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 for Environment, Food and Rural Affairs (DEFRA), 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, Scottish Water 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.

The Met Office
Johnson House
London Road
Bracknell
RG12 2SY
Tel.: 01344 856849
Fax: 01344 854906

The National Hydrological Monitoring Programme depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged.

Subscription

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

Hydrological Summaries
National Water Archive
CEH Wallingford
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB
Tel.: 01491 838800
Fax: 01491 692424

Selected text and maps are available on the WWW at
http://www.nerc-wallingford.ac.uk/ih/nrfa/index.htm
Navigate via Water Watch

NATURAL ENVIRONMENT RESEARCH COUNCIL

9/02