Hydrological Summary
for the United Kingdom

November 2006

General

After a mostly cold and dry start, moist westerly airflows ensured that November rainfall totals exceeded the average across most parts of the UK; for the 4th successive month in many of the drought-affected areas. With upland catchments near saturation, most reservoir levels rose significantly – leaving early December stocks for England & Wales around 10% above average. Across southern England most reservoir stocks exceed those reported for early December 2005 (but Stithians and Clatworthy in the South West are important exceptions). Modest early November river flows heralded a steep recovery in runoff rates with floodplain inundations being common in the final week. November runoff totals were exceptionally high in western Scotland and seasonally depressed in only a few spring-fed southern rivers. Some notable groundwater recoveries were reported but a decisive seasonal upturn in groundwater levels is still awaited in many eastern and central aquifer outcrops. The autumn has seen the focus of hydrological concern switch to the risk of flooding, in northern Britain especially. The water resources outlook is much healthier than in the early winter of 2005, residual drought stress being largely restricted to locally depressed groundwater levels in the English Lowlands.

Rainfall

Anticyclonic conditions dominated synoptic patterns during the early part of November producing cool and dry conditions; some parts of the drought-affected region (e.g. south Oxfordshire) registered <5mm of rain in the first fortnight. The high pressure then retreated eastwards allowing a sequence of vigorous frontal systems to bring mild, boisterous and wet conditions across most of the country. Sustained frontal rainfall generated notable storm totals, e.g. Capel Curig: 52mm on the 20th; Feshie (Cairngorms): 58mm on the 30th, and some exceptional November rainfall totals. Provisionally, Scotland recorded its 2nd wettest November in 90 years with the Glasgow Bishopton raingauge reporting around 300mm (the highest for November in a series from 1914). The November rainfall anomalies reflect the prevailing tracks of the low pressure systems; a few sheltered eastern areas (including parts of Kent) reported <60% of average rainfall. Notably in the drought context, the autumn (which was the warmest on record) was the 5th wettest in the last 20 years for E&W and many of the drought-affected areas reported 15-25% above average rainfall. In the four-month timeframe, the Thames basin reported its 3rd highest Aug-Nov rainfall in the last 34 yrs. Correspondingly, long term rainfall deficiencies have declined substantially. For example, the deficiency for Southern Region over the last 25 months has been exceeded in eight protracted drought episodes (starting in any month) over the last 90 years. Although the reduction in the effective rainfall deficiencies has been more modest, the drought is now much diminished, both in intensity and spatial extent.

River Flows

Modest late-autumn flows characterised most rivers during the first week of November (but tidal flooding on the 1st was associated with significant fish mortality in the Norfolk Broads). Thereafter, seasonal recoveries in runoff rates gathered real momentum – with flood events common during the last fortnight, mostly in northern and western Britain (a new Nov. flow maxima was reported for the River Taw) but spate conditions also extended into responsive catchments in the English Lowlands. The Thames reached bankfull during the final week, and the monthly runoff for the Kingston gauging station was more than twice that for November 2005. With few exceptions, November runoff totals were within or above the normal range for the index catchments. A sequence of high spates contributed to new maximum November mean flows in rivers draining the western Highlands of Scotland (from the Nith to the Carron); runoff from Northern Ireland was very healthy also. Notably low flows were generally restricted to very slow responding spring-fed streams in the South East (e.g. the Mimram and Lambourn). Long term runoff accumulations still testify to the drought's hydrological impact, in southern England especially; for the Mimram runoff since July 2005 is the lowest for *any* 18-month total in a 52-yr record. But current flows send a different signal, seasonal recoveries are underway in most Chalk rivers and, elsewhere, the risk of flooding is high as saturated catchments remain very vulnerable to further rainfall.

Groundwater

As commonly happens, residual soil moisture deficits moderated November recharge rates in many eastern and southern outcrop areas but, to the west and north, the sustained frontal rainfall reinforced seasonal recoveries in groundwater resources. Substantial increases in groundwater levels were reported for many responsive wells in the limestone aquifers. The seasonal recovery is also well established in some western Chalk outcrops (e.g. at West Woodyates, Rockley and Ashton Farm where levels are at, or above, the early winter average). Levels also rose through November in a few minor aquifers (e.g. the Suffolk Crag). A steep rise, triggered by exceptional November rainfall, in the Permo-Triassic sandstones at Newbridge contrasts with a number of slow-responding wells and boreholes in the Midlands where, in some areas (see Heathlanes), a near-linear recession from early 2004 has yet to be arrested. In parts of the eastern Chalk November levels were similarly depressed, e.g. at Well House Inn and Redlands – where only in 1997 have lower late autumn levels been recorded (in a series from 1963). However, with soil moisture deficits effectively eliminated in almost all outcrop areas, and a valuable pulse of recent recharge descending through the unsaturated zone, it is likely that this winter will be a lengthier and more productive recharge season than 2004/05 or 2005/06.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

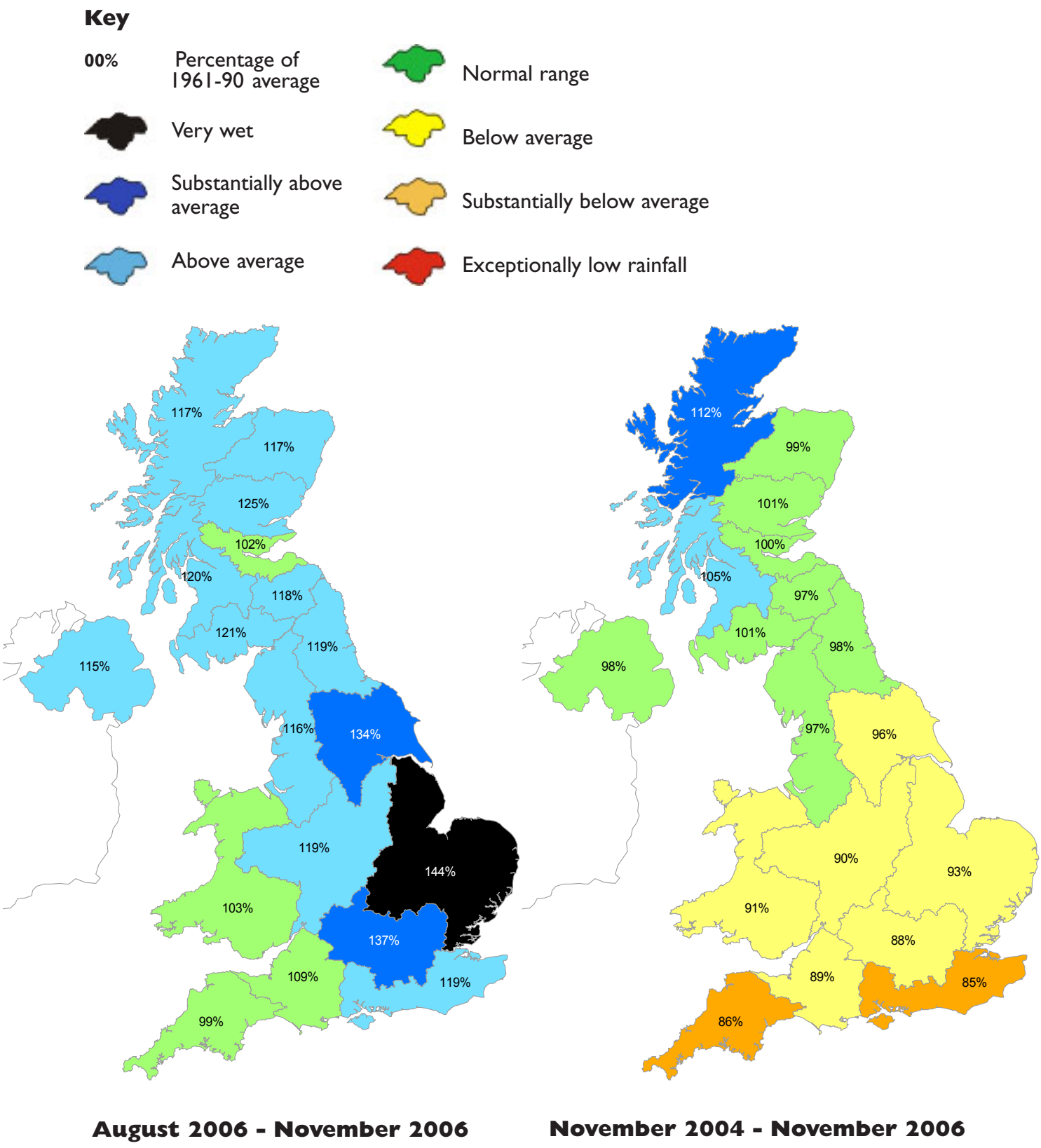
Area	Rainfall	Nov 2006	Aug 06-Nov 06	RP	Jun 06-Nov 06	RP	Dec 05-Nov 06	RP	Nov 04-Nov 06	RP
England & Wales	**mm**	**111**	**392**		**457**		**866**		**1742**	
	%	**121**	**118**	**2-5**	**100**	**<2**	**96**	**2-5**	**92**	**5-10**
North West	mm	**154**	555		649		1223		2483	
	%	**123**	116	2-5	100	<2	100	<2	97	2-5
Northumbrian	mm	**90**	381		433		816		1778	
	%	**103**	119	2-5	97	2-5	94	2-5	98	2-5
Severn Trent	mm	**79**	322		378		720		1452	
	%	**110**	119	2-5	98	2-5	94	2-5	90	5-10
Yorkshire	mm	**85**	405		455		859		1673	
	%	**104**	134	5-15	107	2-5	103	2-5	96	2-5
Anglian	mm	**64**	310		360		605		1180	
	%	**111**	144	20-30	113	2-5	100	<2	93	2-5
Thames	mm	**101**	340		405		708		1288	
	%	**153**	137	5-15	114	2-5	101	2-5	88	5-10
Southern	mm	**102**	348		398		750		1399	
	%	**119**	119	2-5	100	<2	96	2-5	85	10-20
Wessex	mm	**123**	334		424		809		1592	
	%	**145**	109	2-5	102	2-5	95	2-5	89	5-10
South West	mm	**150**	422		506		1025		2160	
	%	**117**	99	2-5	89	2-5	86	5-10	86	5-15
Welsh	mm	**183**	521		595		1232		2591	
	%	**127**	103	2-5	89	2-5	92	2-5	91	5-10
Scotland	**mm**	**241**	**677**		**824**		**1478**		**3276**	
	%	**153**	**117**	**5-10**	**109**	**2-5**	**101**	**2-5**	**106**	**2-5**
Highland	mm	**294**	805		978		1772		4112	
	%	**149**	117	5-10	110	2-5	102	2-5	112	10-20
North East	mm	**114**	457		557		980		2151	
	%	**110**	117	5-10	104	2-5	95	2-5	99	2-5
Tay	mm	**212**	604		730		1276		2745	
	%	**166**	125	5-10	114	2-5	99	2-5	101	2-5
Forth	mm	**139**	456		555		1057		2399	
	%	**119**	102	2-5	93	2-5	92	2-5	100	<2
Tweed	mm	**131**	445		526		941		2039	
	%	**136**	118	2-5	101	2-5	94	2-5	97	2-5
Solway	mm	**265**	691		836		1485		3042	
	%	**181**	121	5-10	112	2-5	103	2-5	101	2-5
Clyde	mm	**336**	851		1038		1825		3880	
	%	**182**	120	5-10	113	2-5	104	2-5	105	2-5
Northern Ireland	**mm**	**132**	**482**		**587**		**1126**		**2253**	
	%	**123**	**115**	**2-5**	**105**	**2-5**	**102**	**2-5**	**98**	**2-5**

% = percentage of 1961-90 average

RP = Return period

Important note: Figures in the above table may be quoted provided that their source is acknowledged. See page 12. Where appropriate, specific reference must be made to the uncertainties associated with the return period estimates. Generally, the return period estimates are based on tables provided by the Met Office but those for Northern Ireland are based on the estimates for north-west England. The estimates relate to the specified region and span of months only (RPs may be an order of magnitude less if n-month periods beginning in any month are considered), they reflect rainfall variability over the period 1911-70 only, and assume a stable climate. (For further details see Tabony, R. C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37). The timespans featured do not purport to represent the critical periods for any particular water resource management zone and, normally, for hydrological or water resources assessments of drought severity, river flows and groundwater levels provide a better guide than return periods based on rainfall totals. All monthly rainfall totals since June 2006 are provisional.

Rainfall . . . Rainfall . . .

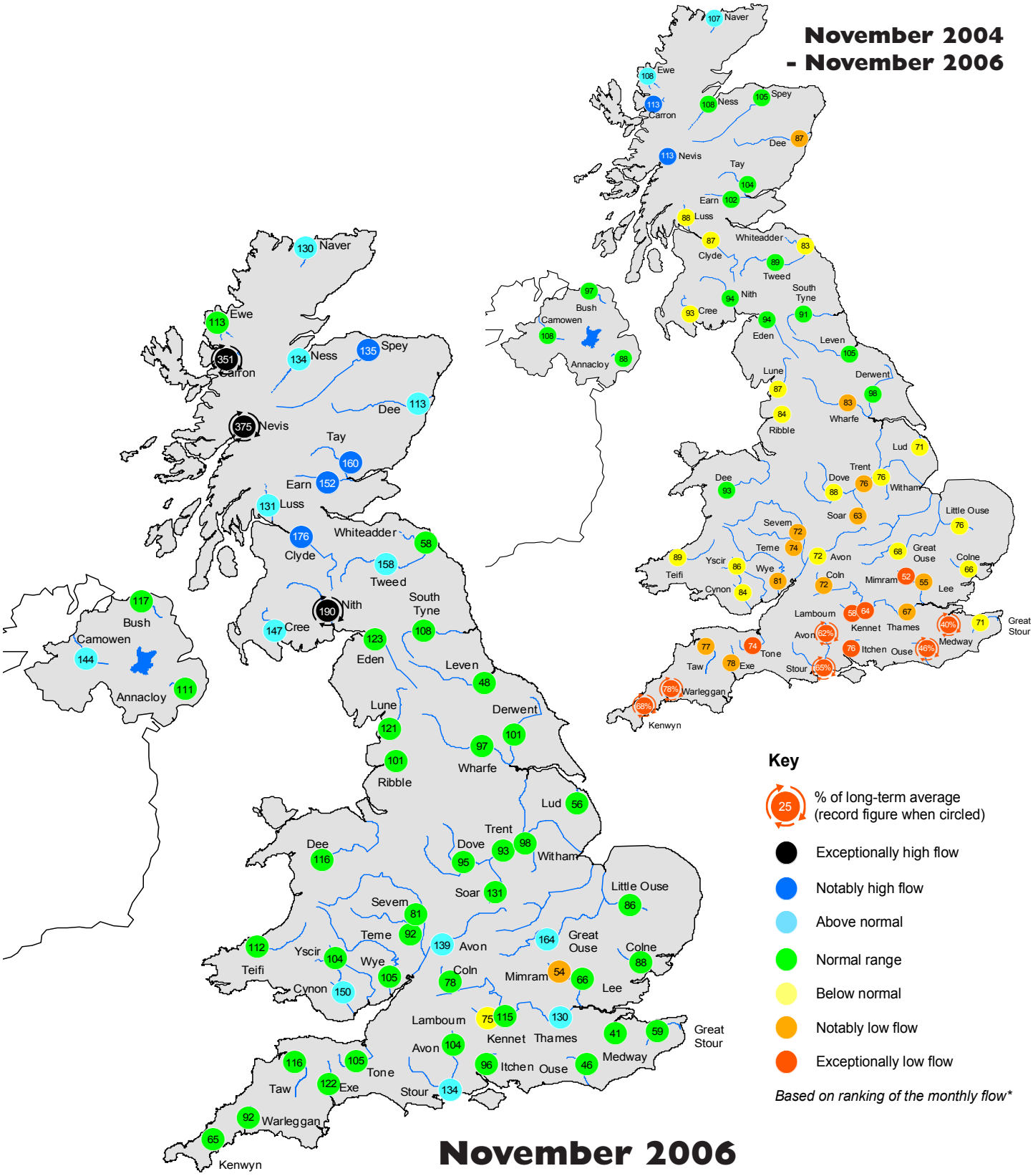


August 2006 - November 2006 **November 2004 - November 2006**

Rainfall accumulation maps

Rainfall over the Aug-Nov period was above average in all regions of the UK with the marginal exception of the South West. Near-average totals typify regional accumulations over 12 months and regional rainfall deficiencies since the start of the drought (Nov 2004) are generally below 15%.

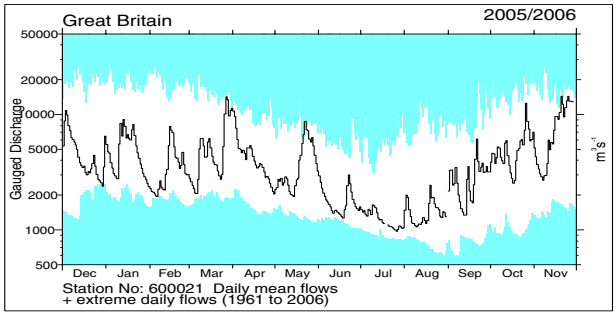
River flow . . . River flow . . .

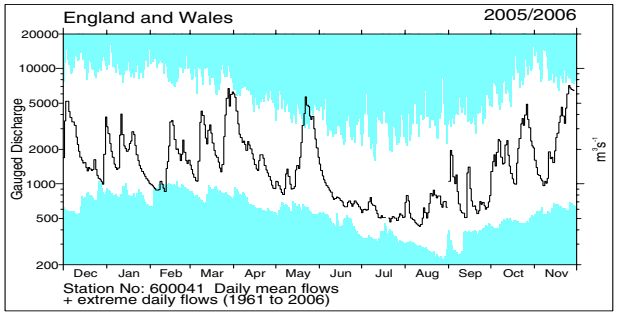


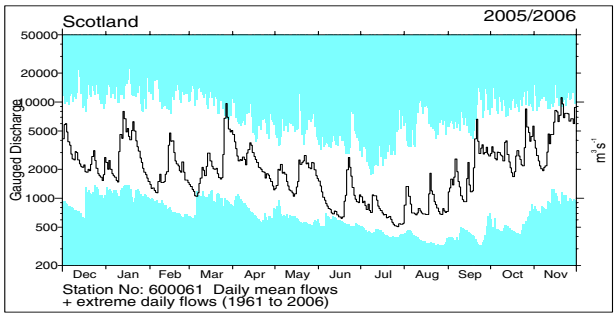
River flows

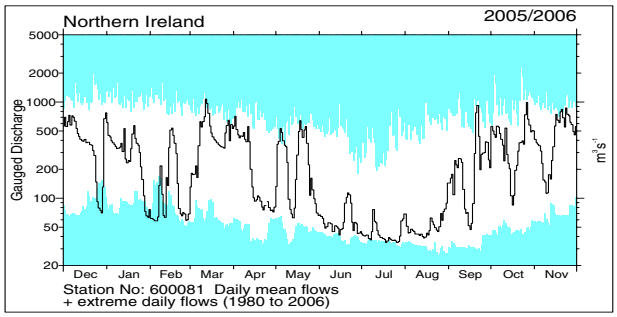
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

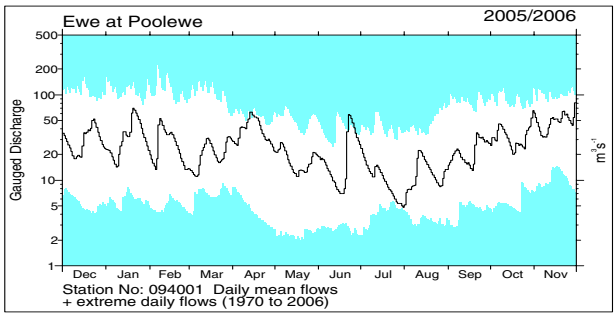
River flow . . . River flow . . .

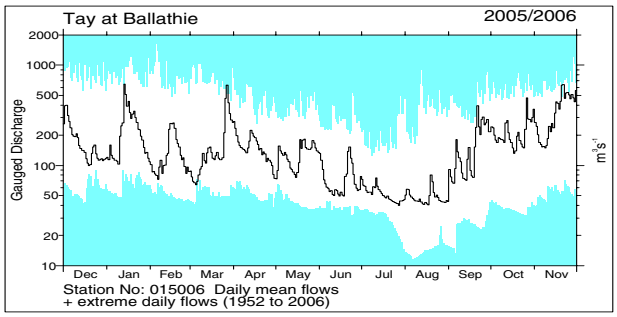


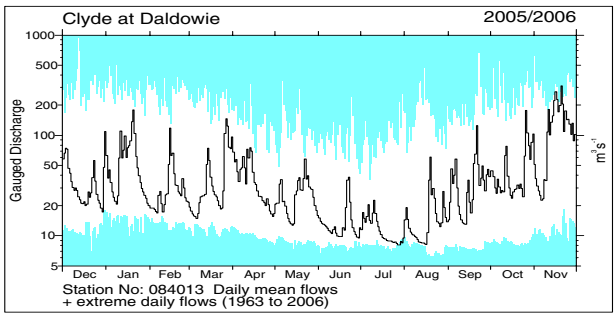


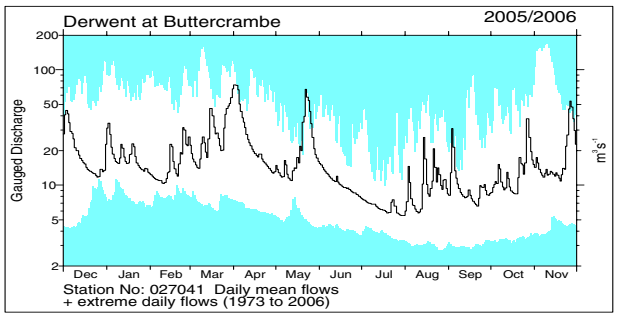


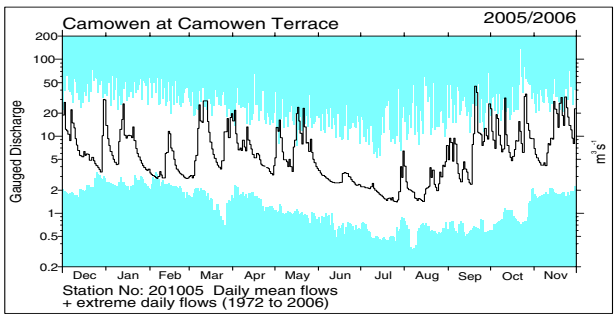


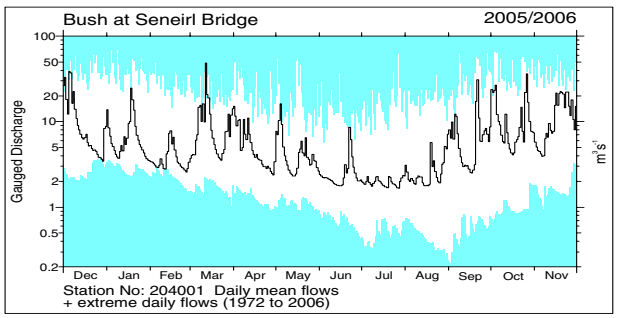








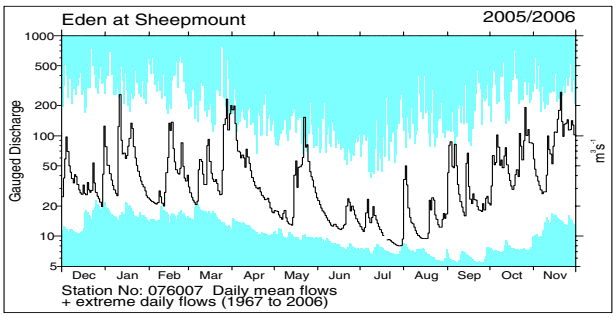


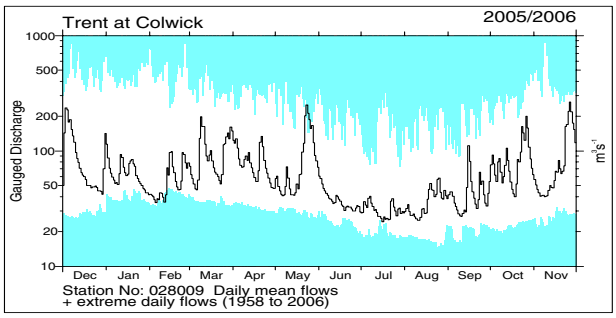


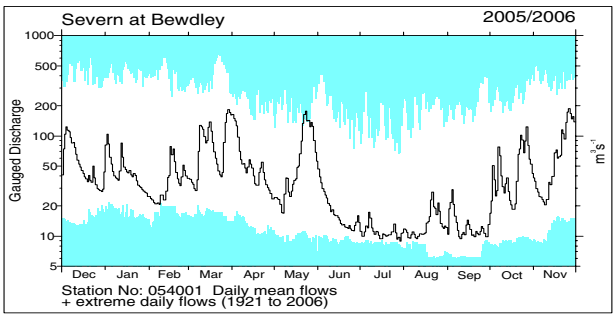
River flow hydrographs

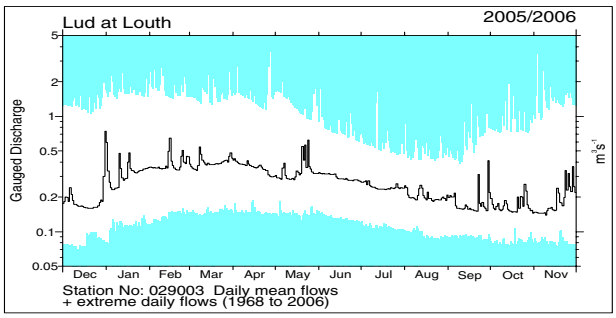
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to December 2005 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

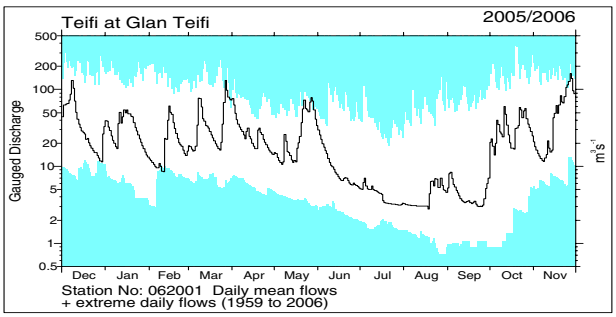
River flow . . . River flow . . .

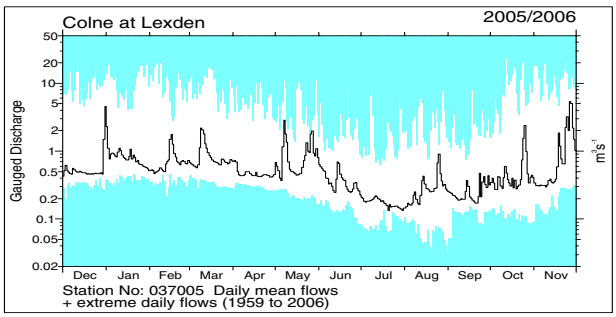


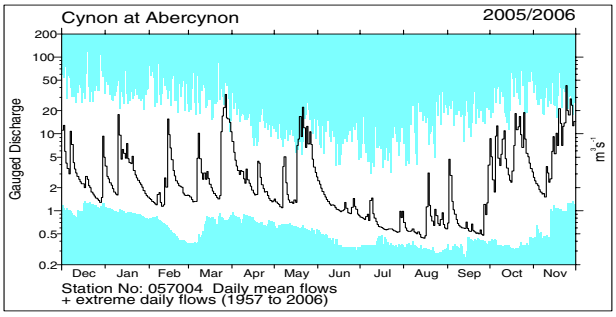


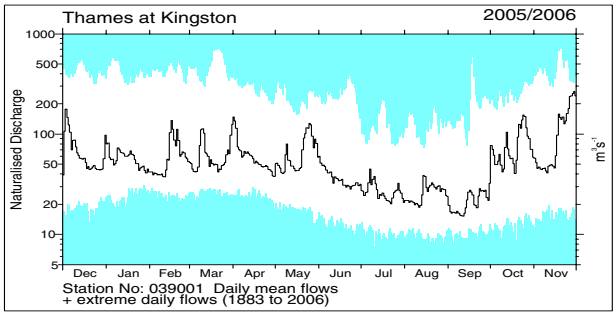


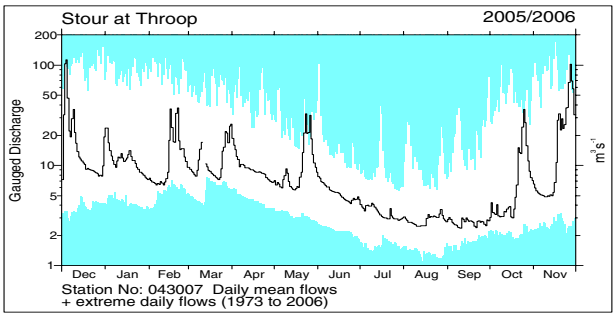


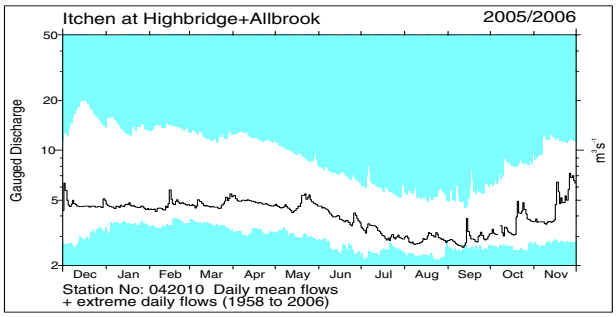












Notable runoff accumulations (a) August - November 2006, (b) November 2004 - November 2006

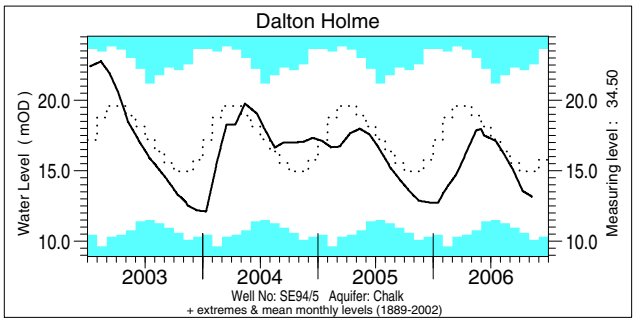
	River	%lta	Rank
a)	Mimram	50	3/54
	Test	70	4/49
	Nevis	175	24/24
	Carron	162	28/28
	Naver	153	28/30
	Camowen	148	32/35

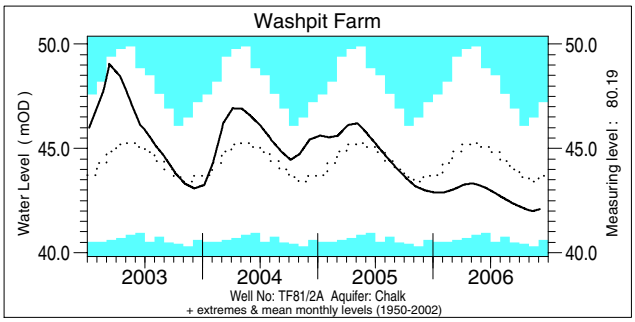
	River	%lta	Rank
b)	Mimram	52	2/50
	Kennet	64	2/44
	Mole	71	1/29
	Medway	40	1/40
	Ouse (Gold Bridge)	46	1/37
	Avon (Amesbury)	62	1/40
	Stour (Throop)	65	1/32

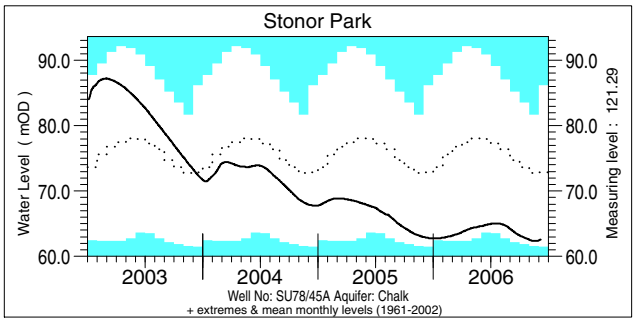
River	%lta	Rank
Piddle	65	1/40
Warleggan	78	1/36
Kenwyn	68	1/37
Tone	74	2/44
Nevis	113	22/23
Carron	113	25/26
Faughan	75	2/29

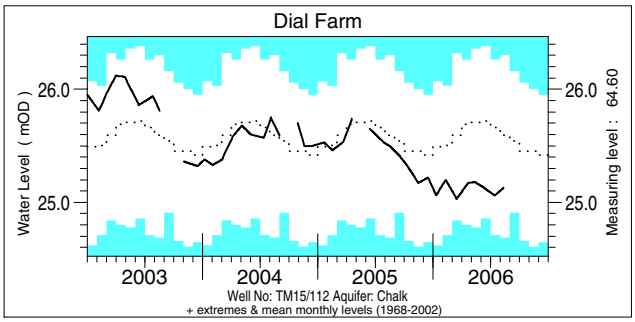
lta = long term average
Rank 1 = lowest on record

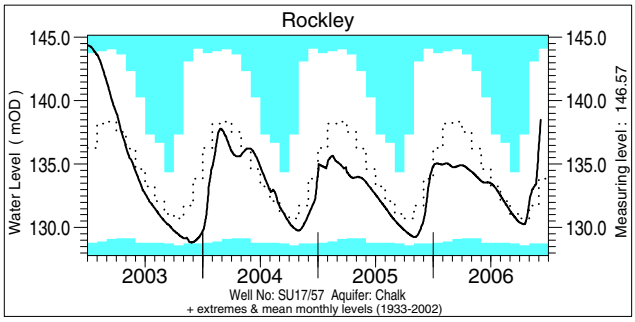
Groundwater . . . Groundwater

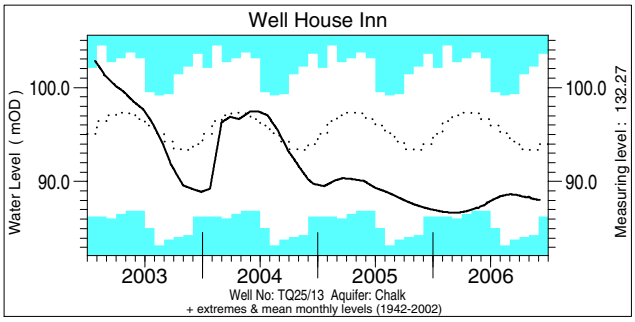


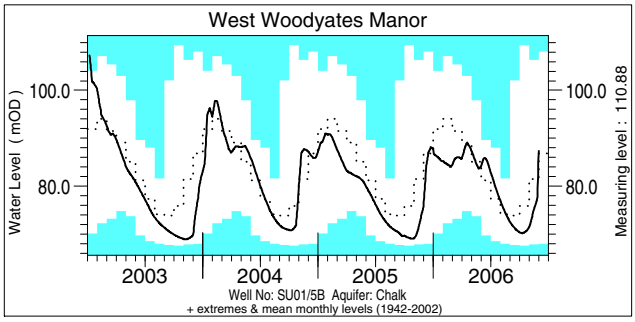


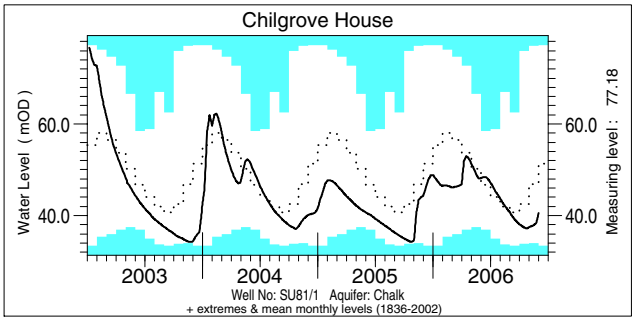


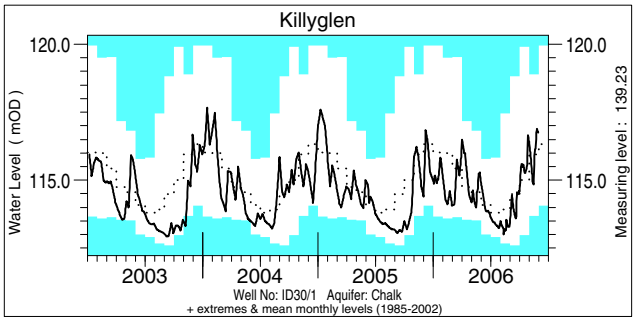


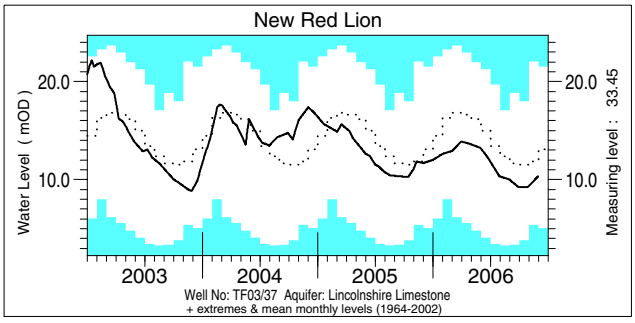






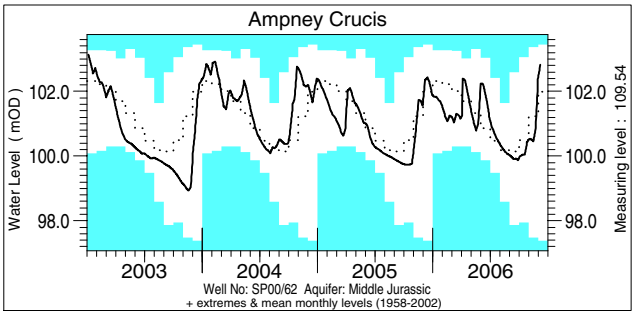


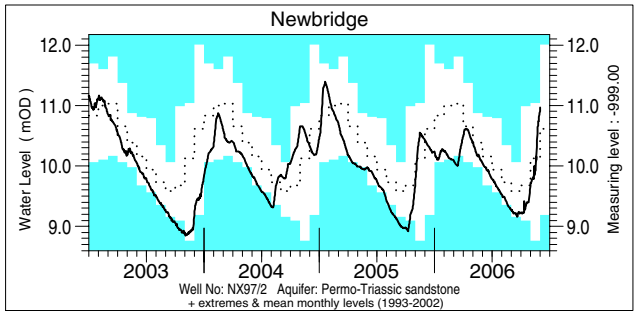


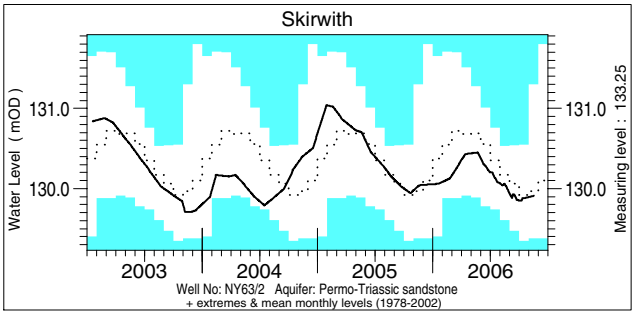


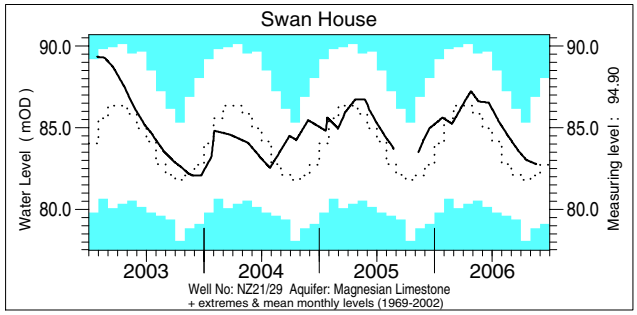
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly mean and the highest and lowest levels recorded for each month 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.

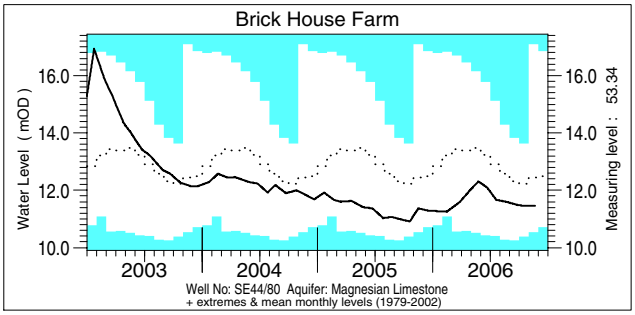
Groundwater . . . Groundwater

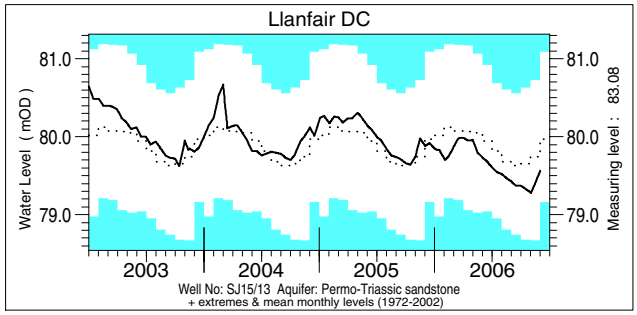


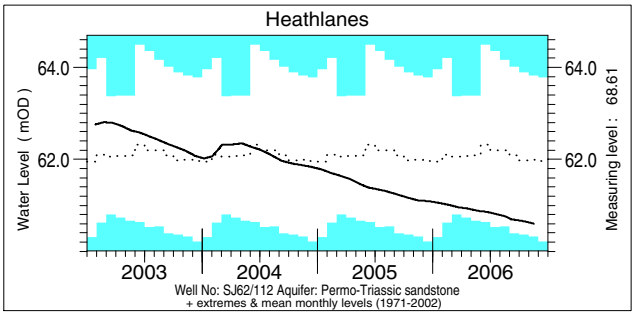


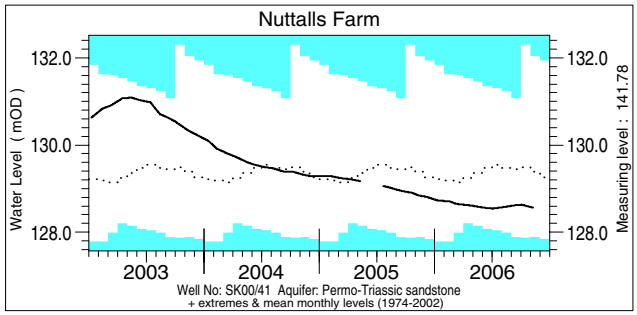


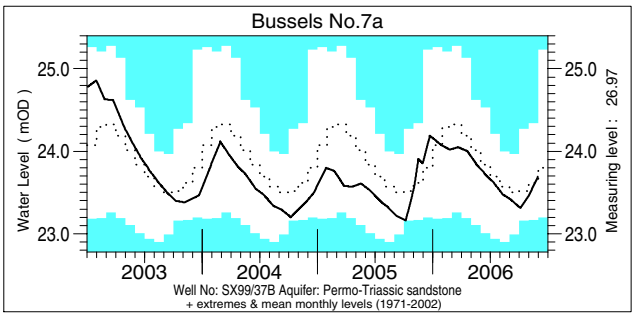


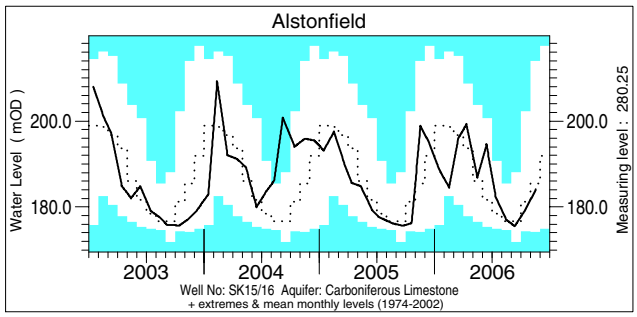










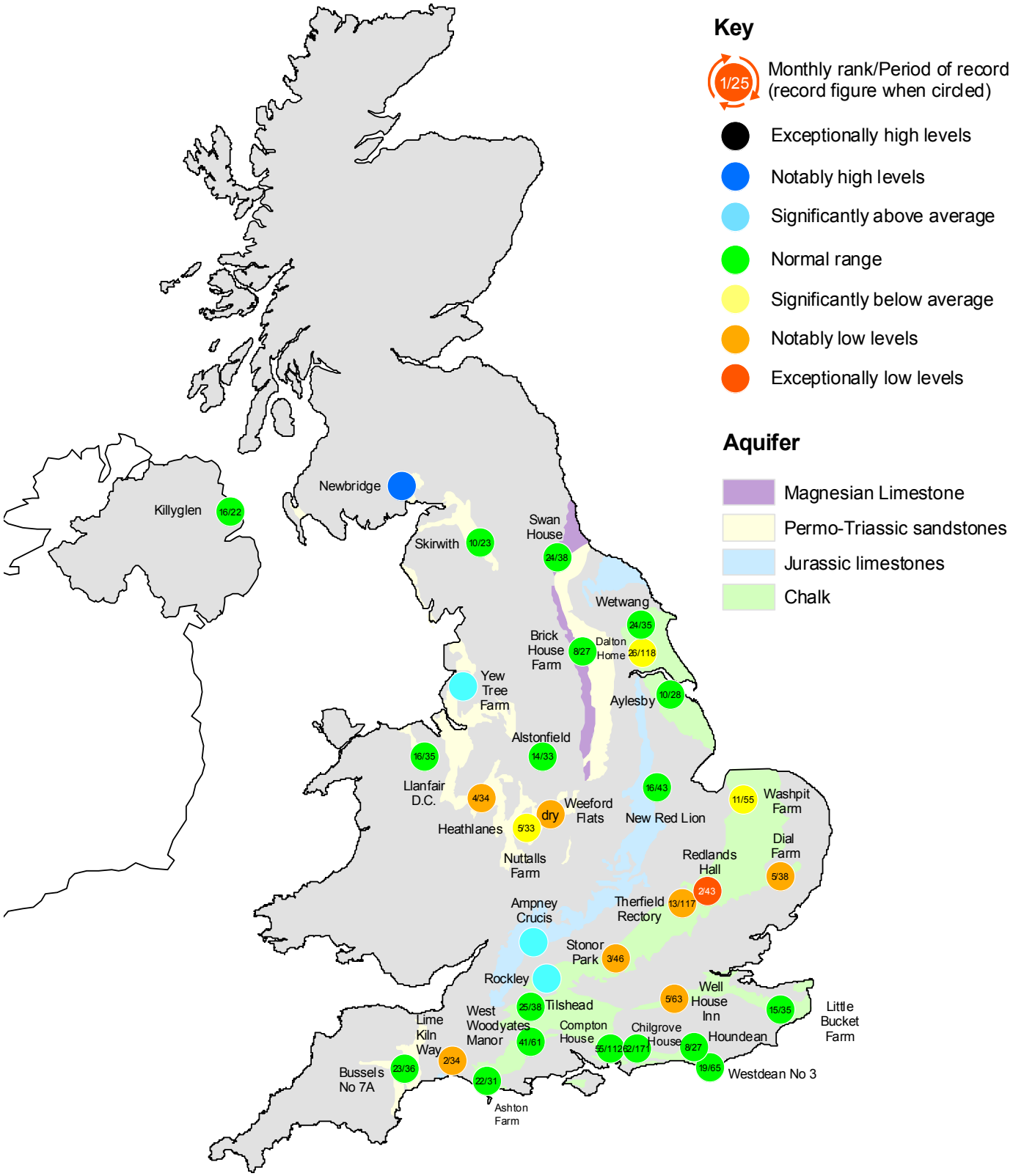


Groundwater levels November / December 2006

Borehole	Level	Date	Nov. av.	Borehole	Level	Date	Nov. av.	Borehole	Level	Date	Nov. av.
Dalton Holme	13.16	08/11	14.79	Chilgrove House	40.49	30/11	46.57	Brick House Farm	11.45	21/11	12.30
Washpit Farm	42.09	05/12	43.30	Killyglen	116.78	29/11	115.94	Llanfair DC	79.57	01/12	79.68
Stonor Park	62.62	06/12	72.39	New Red Lion	10.37	29/11	12.25	Heathlanes	60.60	17/11	61.93
Dial Farm	25.05	17/11	25.44	Ampney Crucis	102.83	06/12	101.20	Nuttalls Farm	128.56	08/11	129.55
Rockley	138.51	06/12	131.58	Newbridge	10.97	01/12	10.09	Bussels No.7a	23.69	29/11	23.63
Well House Inn	88.04	04/12	93.14	Skirwith	129.91	16/11	129.99	Alstonfield	184.14	16/11	186.87
West Woodyates	87.32	3 0/11	80.87	Swan House	82.75	17/11	82.38				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



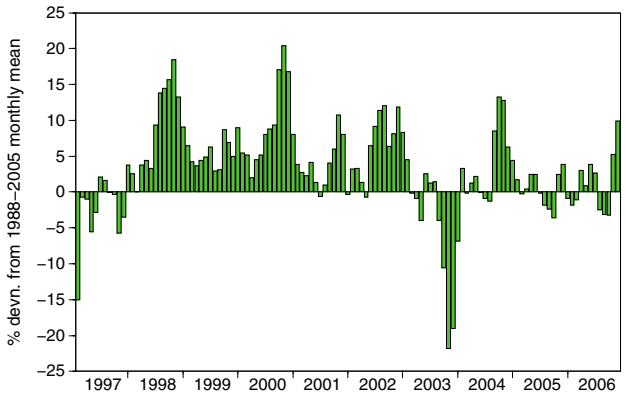
Groundwater levels - November 2006

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.

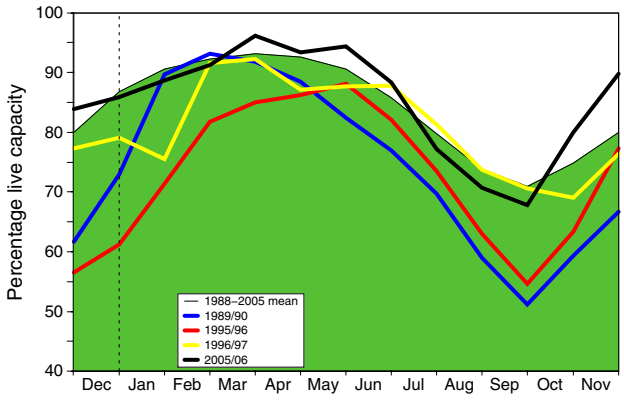
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.
iii. Data for Morris Dancers are currently under review.

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.

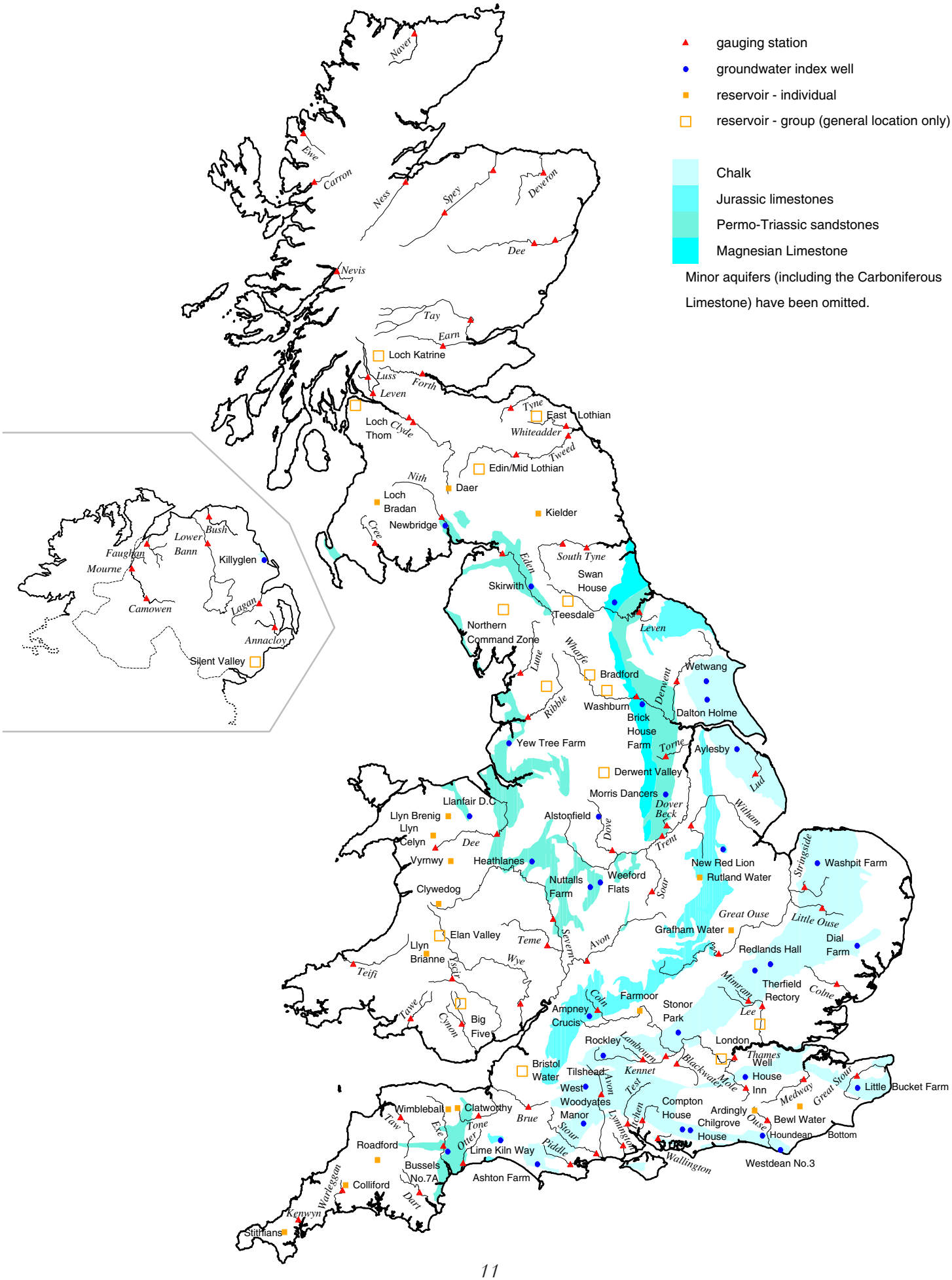
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2006 Oct	Nov	Dec	Dec Anom.	Min. Dec	Year* of min.	2005 **Dec**	Diff **06-05**
North West	N Command Zone	• 124929	58	77	**97**	23	44	1993	90	7
	Vyrnwy	55146	59	77	**95**	16	33	1995	88	7
Northumbrian	Teesdale	• 87936	62	82	**100**	24	39	1995	91	9
	Kielder	(199175)	(83)	(89)	**(94)**	9	(64)	2003	(91)	3
Severn Trent	Clywedog	44922	51	69	**82**	3	43	1995	82	0
	Derwent Valley	• 39525	70	90	**91**	15	9	1995	86	5
Yorkshire	Washburn	• 22035	77	89	**94**	25	16	1995	79	15
	Bradford supply	• 41407	65	78	**97**	19	20	1995	80	17
Anglian	Grafham	(55490)	(80)	(85)	**(88)**	7	(47)	1997	(81)	7
	Rutland	(116580)	(71)	(71)	**(75)**	-4	(57)	1995	(73)	2
Thames	London	• 202406	75	92	**95**	16	52	1990	80	15
	Farmoor	• 13822	98	91	**84**	-6	52	1990	99	-15
Southern	Bewl	28170	61	61	**62**	-2	34	1990	36	26
	Ardingly	4685	66	73	**88**	15	23	2003	50	38
Wessex	Clatworthy	5364	49	51	**70**	-7	16	2003	92	-22
	Bristol WW	• (38666)	(69)	(66)	**(69)**	4	(27)	1990	(59)	10
South West	Colliford	28540	38	38	**46**	-25	42	1995	51	-5
	Roadford	34500	47	48	**61**	-11	19	1995	63	-2
	Wimbleball	21320	60	59	**73**	1	34	1995	73	0
	Stithians	5205	36	33	**43**	-21	29	2001	64	-21
Welsh	Celyn and Brenig	• 131155	76	85	**96**	11	50	1995	95	1
	Brianne	62140	77	95	**100**	5	72	1995	92	8
	Big Five	• 69762	44	72	**89**	10	49	1990	87	2
	Elan Valley	• 99106	58	80	**100**	8	47	1995	98	2
Scotland(E)	Edinburgh/Mid Lothian	• 97639	79	82	**93**	10	45	2003	94	-1
	East Lothian	• 10206	66	66	**78**	-8	38	2003	93	-15
Scotland(W)	Loch Katrine	• 111363	77	94	**100**	10	66	2003	88	12
	Daer	22412	86	99	**100**	4	73	2003	98	2
	Loch Thom	• 11840	94	95	**97**	4	72	2003	100	-3
Northern Ireland	Total+	• 67270	76	85	**90**	8	59	2003	85	5
	Silent Valley	• 20634	72	84	**93**	19	43	2001	92	1

() figures in parentheses relate to gross storage • denotes reservoir groups +excludes Lough Neagh *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 storage figures relate to the 1988-2006 period only (except for West of Scotland and Northern Ireland where data commence in the mid-1990's). 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 (NHMP) 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 Environment Agency, the Environment Agency Wales, the Scottish Environment Protection Agency and, for Northern Ireland, 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 (see 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. A significant number of additional monthly raingauge totals are provided by the EA and SEPA to help derive the contemporary regional rainfalls. Revised monthly national and regional rainfall totals for the post-1960 period (together with revised 1961-90 averages) were made available by the Met Office in 2004; these have been adopted by the NHMP. As with all regional figures based on limited raingauge networks the monthly tables and accumulations (and the return periods associated with them) should be regarded as a guide only.

NATURAL ENVIRONMENT RESEARCH COUNCIL

The monthly rainfall figures are provided by the Met Office (National Climate Information Centre) and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

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

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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:

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

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12/06