# Hydrological summary

## *for the United Kingdom*

*April 2000*

## General

Following a very mild beginning to the new millennium, April brought a belated touch of winter with snowfalls extending to southern England. In contrast to March, it was a notably wet month, matching 1998 as the wettest April in the UK rainfall series (from 1900); many April rainfall records were rewritten. Frosts and saturated soils made it a difficult month for farmers but it was very productive in water resources terms. Overall reservoir stocks are similar to the record early May totals registered last year and most reservoirs remain close to capacity. A late surge of aquifer replenishment was especially welcome in eastern areas and the general resources outlook is very healthy. Many rivers remained in spate for protracted periods but, in southern Britain, the relatively even rainfall distribution through the month moderated the flood risk. Eastern Scotland was less fortunate, experiencing severe flooding late in the month.

## Rainfall

Synoptic conditions in April were very variable but most rain-bearing systems followed a southerly track over the initial three weeks, thereafter a north-easterly airflow was particularly influential in eastern Scotland. Throughout large parts of southern Britain April rainfall totals exceeded 250% of average. Bristol, Birmingham and Southampton (in a record from 1856) each recorded new April maxima, and the Oxford total is unprecedented in a series from 1767. As notably, the Thames catchment registered its highest April rainfall in a series from 1883. In Grampian Region a few localities (e.g. Torwinny) exceeded four times the April average and the final week was very wet in much of eastern Scotland. Edinburgh registered its second wettest April since 1785; 112mm fell in 48 hours on the 24$^{th}$-26$^{th}$ (return period around 100 years). Such exceptional totals contributed to a marked reversal in the normal rainfall gradient across Scotland - a few localities in the western Highlands reported less than 50% of average. Northern Ireland was wet but rainfall for Silent Valley (where reservoir stocks are low) again failed to reach the monthly mean. Apart from the Clyde, all regions exceeded the April mean, most by a very wide margin. For England and Wales the provisional April rainfall total ranks as the wettest since 1818 (1998 was only a little drier). Accumulated regional rainfall totals mostly exceed the average; for Scotland the November - April total is the highest in a series from 1869.

## River flows

Generally runoff rates recovered very briskly after the depressed flows of late March and spate conditions were widespread, especially in responsive rivers in southern Britain. With catchments saturated, the flood risk remained high throughout the month – flood warnings were common - but the persistence of near bankfull flows was more notable than the magnitude of most peak flows. Many Scottish rivers had modest flows in mid-month but, thereafter, runoff rates increased steeply in the east, culminating in severe flooding around the 27$^{th}$; adding to a very notable cluster of Scottish floods over the last 15 years. The Lothians were worst affected but flooding was reported in many areas (e.g.Inverness, Elgin and Ayr); transport disruption was severe - exacerbated by landslips (e.g. at Culloden Viaduct). Previous flow maxima were exceeded on the Water of Leith and Gogar Burn (Edinburgh), and on the Don and Ugie in the north-east; April maximum flows were widely eclipsed in many rivers. Rivers establishing new maximum April runoff totals showed a very wide distribution (including the Deveron, Leven, Blackwater, Exe and Teme – all with records of >30 years); the Thames registered its highest April flow since 1951. In contrast, runoff totals in a few western Scottish catchment fell below 50% of average. Below average April flows also characterised some slow-responding Chalk streams in eastern England. English lowland rivers aside, runoff accumulations over the last six months are mostly well above average – outstandingly so in parts of Scotland (e.g. the Spey and Clyde basins).

## Groundwater

Dry late-March soils in eastern England appeared to signal the end of the 1999/2000 recharge season. However the sustained April rainfall - mostly with intensities of less than 3 mm an hour - provided ideal conditions for substantial further infiltration. In some eastern outcrops the April recharge was more than three times the monthly average. Due to the normal lagged water-table response this surge is yet to be fully reflected in most groundwater hydrographs. In many wells and boreholes the seasonal recession was reversed, markedly so in some outcrops (e.g at West Woodyates). Early May levels throughout most of the Chalk outcrop are rising and currently stand above average – this will help to sustain spring-fed streams through the summer. The late spring recovery has also left limestone levels above average – in the Magnesian Limestone especially. Levels in most Permo-Triassic sandstones outcrops are within the normal range, but regional and local variability is considerable – reflecting the very differing response time to surface infiltration. Overall groundwater stocks are healthy.

Centre for Ecology & Hydrology
CEH Wallingford (formerly the Institute of Hydrology)

British Geological Survey

# Rainfall . . . Rainfall . . . Rainfall.

## Rainfall accumulations and return period estimates

| Area | Rainfall | Apr 2000 | Feb 00-Apr 00 | RP | Nov 99-Apr 00 | RP | Aug 99-Apr 00 | RP | May 99-Apr 00 | RP |
|---|---|---|---|---|---|---|---|---|---|---|
| **England & Wales** | mm | **127** | **253** | | **511** | | **811** | | **971** | |
| | % | **212** | **130** | **5-10** | **109** | **2-5** | **115** | **5-10** | **108** | **2-5** |
| North West | mm | 112 | 295 | | 717 | | 1052 | | 1274 | |
| | % | 158 | 121 | 2-5 | 117 | 5-10 | 109 | 5-10 | 106 | 2-5 |
| Northumbrian | mm | 133 | 241 | | 514 | | 741 | | 939 | |
| | % | 238 | 130 | 5-10 | 118 | 5-10 | 111 | 2-5 | 110 | 2-5 |
| Severn Trent | mm | 130 | 231 | | 428 | | 712 | | 860 | |
| | % | 236 | 136 | 5-15 | 110 | 2-5 | 122 | 5-15 | 114 | 5-10 |
| Yorkshire | mm | 152 | 233 | | 447 | | 680 | | 849 | |
| | % | 258 | 126 | 5-10 | 105 | 2-5 | 106 | 2-5 | 103 | 2-5 |
| Anglian | mm | 97 | 169 | | 293 | | 520 | | 657 | |
| | % | 210 | 130 | 5-10 | 100 | <2 | 116 | 5-10 | 110 | 2-5 |
| Thames | mm | 131 | 222 | | 382 | | 646 | | 789 | |
| | % | 262 | 147 | 10-20 | 109 | 2-5 | 122 | 5-15 | 114 | 5-10 |
| Southern | mm | 138 | 237 | | 441 | | 725 | | 840 | |
| | % | 260 | 139 | 5-15 | 106 | 2-5 | 116 | 5-10 | 108 | 2-5 |
| Wessex | mm | 153 | 282 | | 526 | | 832 | | 967 | |
| | % | 289 | 150 | 10-20 | 117 | 2-5 | 125 | 5-15 | 115 | 5-10 |
| South West | mm | 141 | 315 | | 692 | | 1005 | | 1167 | |
| | % | 204 | 117 | 2-5 | 103 | 2-5 | 104 | 2-5 | 99 | 2-5 |
| Welsh | mm | 147 | 378 | | 821 | | 1281 | | 1472 | |
| | % | 184 | 133 | 5-15 | 114 | 2-5 | 119 | 5-10 | 112 | 5-10 |
| **Scotland** | mm | **101** | **406** | | **1048** | | **1397** | | **1707** | |
| | % | **133** | **134** | **10-20** | **139** | **110-150** | **119** | **10-20** | **119** | **20-30** |
| Highland | mm | 112 | 555 | | 1432 | | 1835 | | 2193 | |
| | % | 123 | 146 | 30-45 | 148 | >200 | 125 | 30-40 | 125 | 40-60 |
| North East | mm | 148 | 282 | | 666 | | 909 | | 1122 | |
| | % | 247 | 139 | 10-20 | 135 | 30-45 | 119 | 5-15 | 115 | 5-15 |
| Tay | mm | 106 | 338 | | 887 | | 1210 | | 1482 | |
| | % | 171 | 127 | 5-10 | 135 | 20-35 | 121 | 10-15 | 121 | 10-20 |
| Forth | mm | 105 | 331 | | 805 | | 1042 | | 1321 | |
| | % | 178 | 142 | 20-30 | 141 | 50-80 | 117 | 5-10 | 119 | 10-20 |
| Tweed | mm | 122 | 270 | | 618 | | 836 | | 1067 | |
| | % | 214 | 133 | 5-15 | 126 | 10-20 | 110 | 2-5 | 110 | 2-5 |
| Solway | mm | 91 | 363 | | 941 | | 1262 | | 1592 | |
| | % | 118 | 123 | 5-10 | 127 | 10-20 | 109 | 2-5 | 112 | 5-10 |
| Clyde | mm | 79 | 451 | | 1248 | | 1626 | | 1974 | |
| | % | 94 | 129 | 5-15 | 139 | 50-80 | 116 | 5-10 | 116 | 5-15 |
| **Northern Ireland** | mm | **99** | **263** | | **661** | | **987** | | **1168** | |
| | % | **154** | **115** | **2-5** | **121** | **5-10** | **116** | **5-10** | **110** | **2-5** |

*RP = Return period*

 **All monthly totals since July 1998 are provisional (see page 12).** Recent monthly rainfall figures for the Scottish regions have been compiled using data provided by the Scottish Environment Protection Agency. The return period estimates are based on tables provided by the Meteorological Office (see Tabony, R.C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered); 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

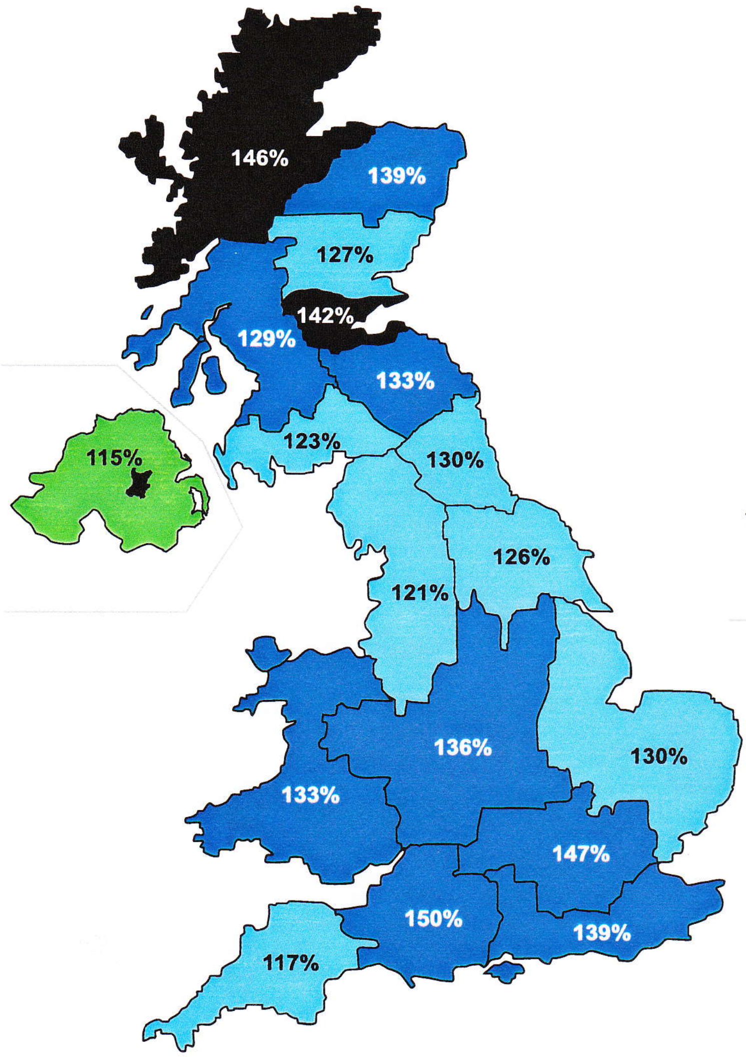
Above average

Normal range

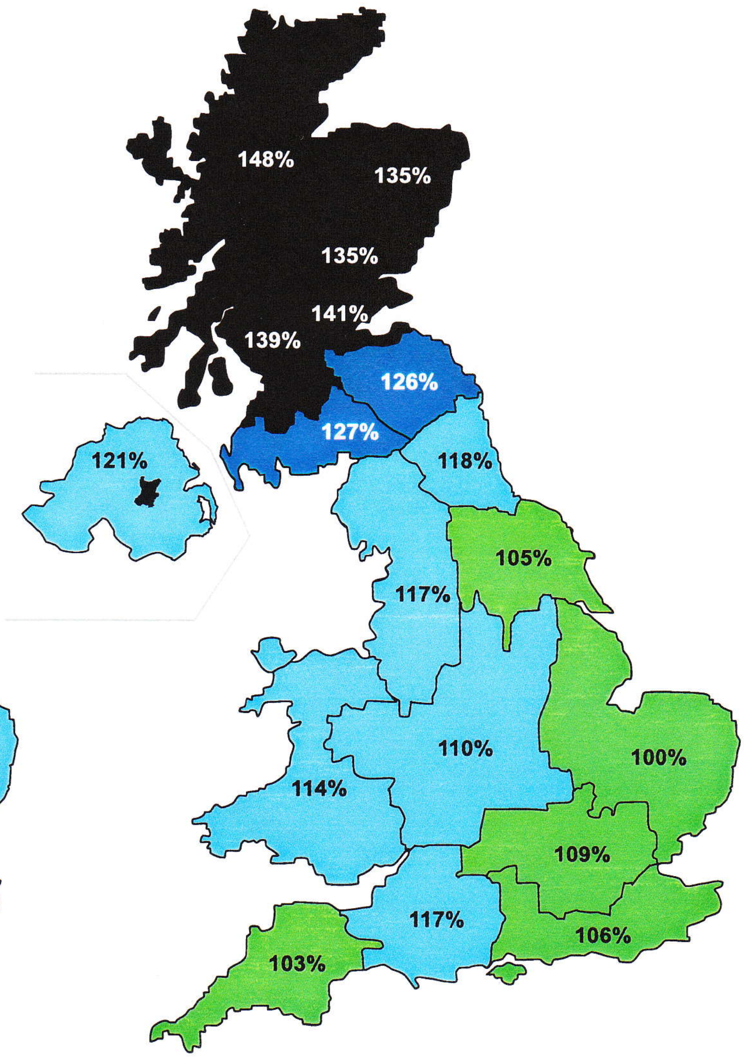
Below average

Substantially below average

Exceptionally low rainfall



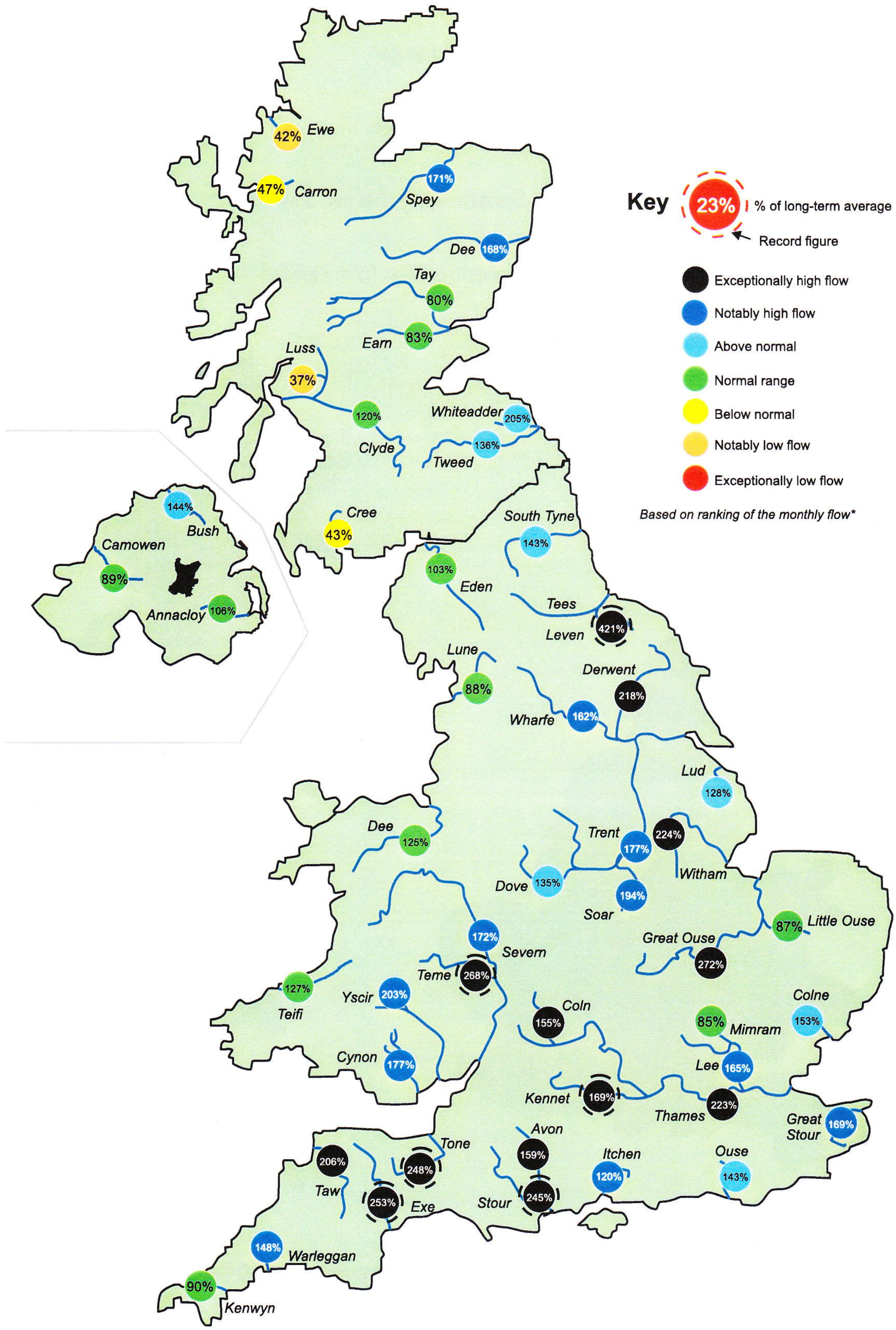

**February 2000 - April 2000**




**November 1999 - April 2000**

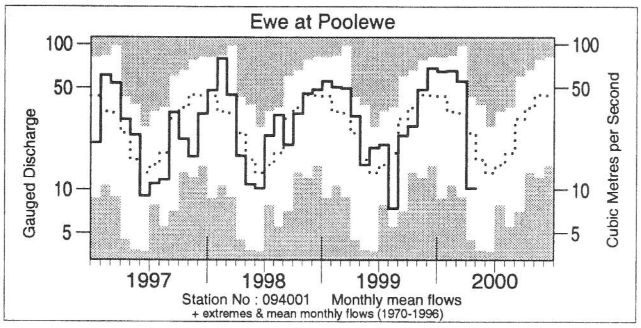
## Rainfall accumulation maps

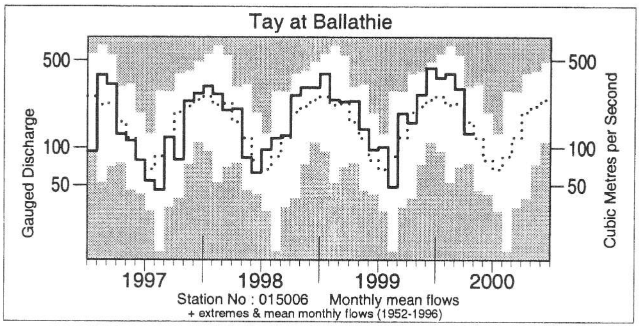
Most regional rainfall totals exceed the average over timespans of 3, 6, 9 and 12 months. Much of Scotland has been very wet since August 1999. In the English lowlands, rainfall over the last three months is well above the long term mean and in the November-April timeframe, the most important period for groundwater replenishment, rainfall has exceeded the average in each of the last three years.

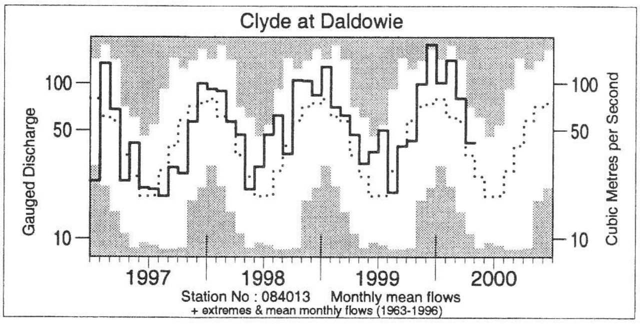


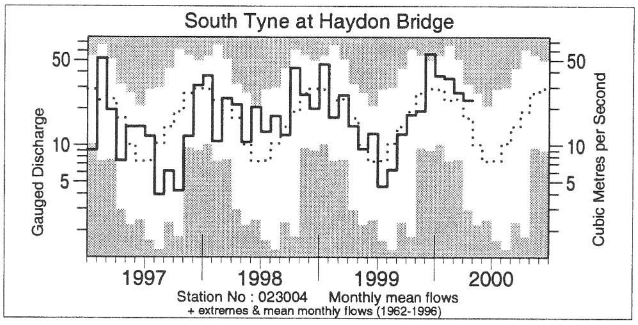

## River flows - April 2000

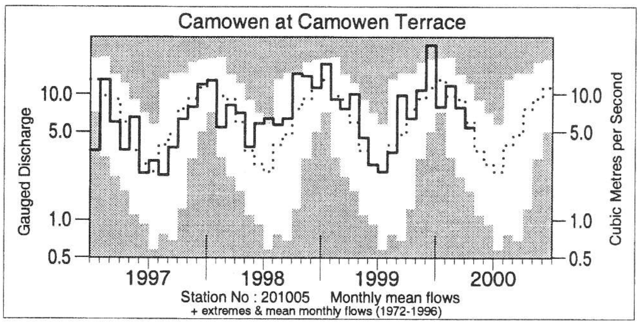
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

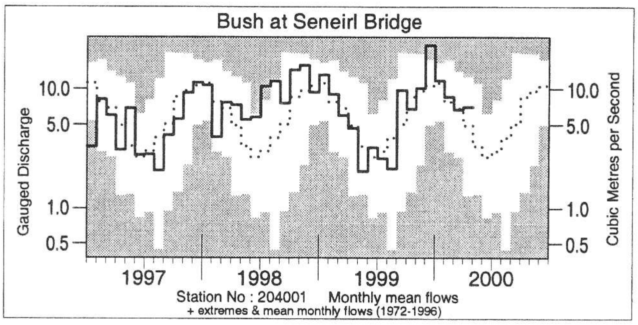


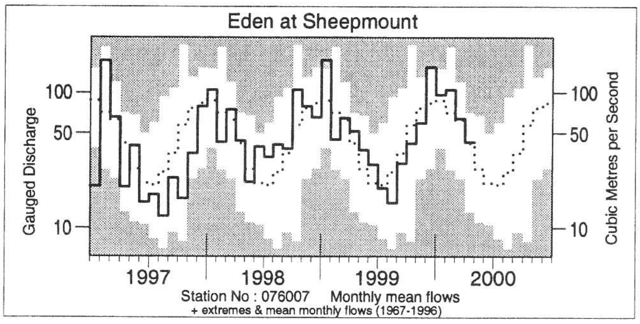



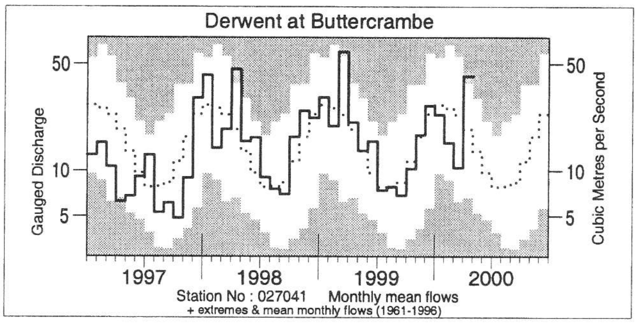



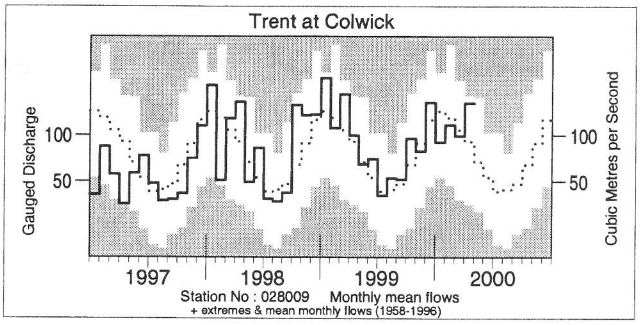



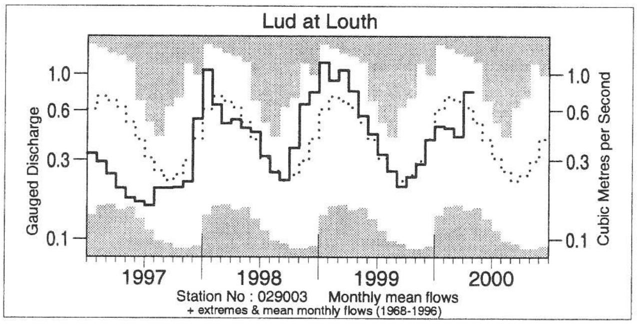



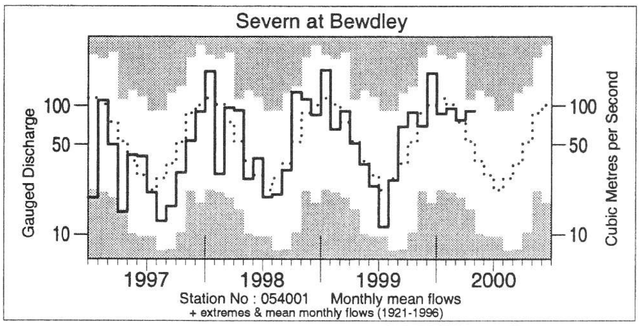



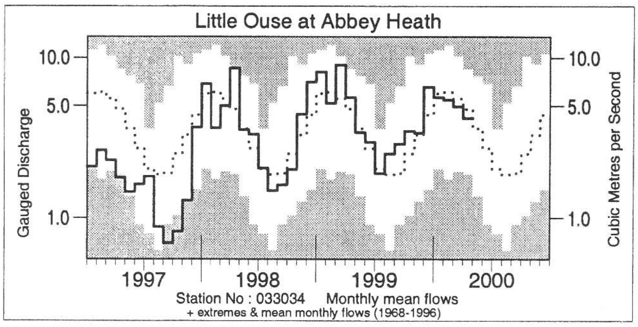



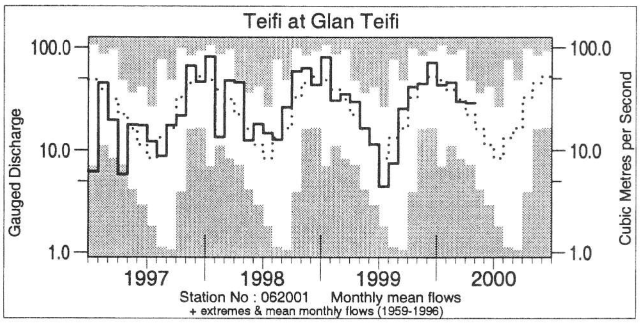

## Monthly river flow hydrographs

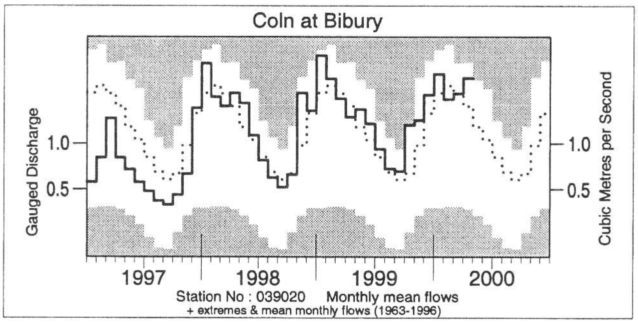
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1997 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded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

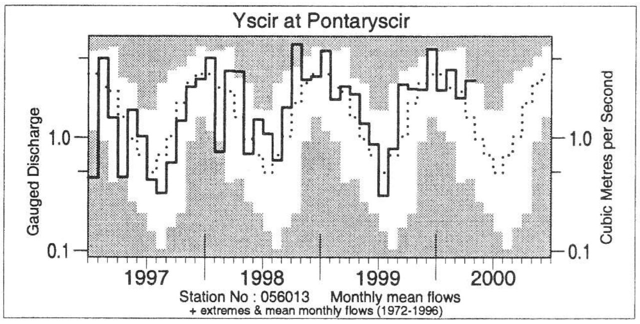
# River flow . . . River flow . . .

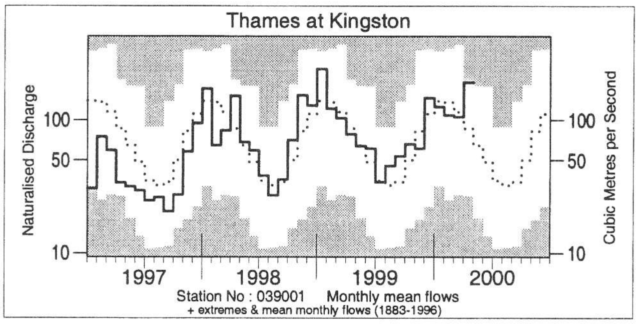


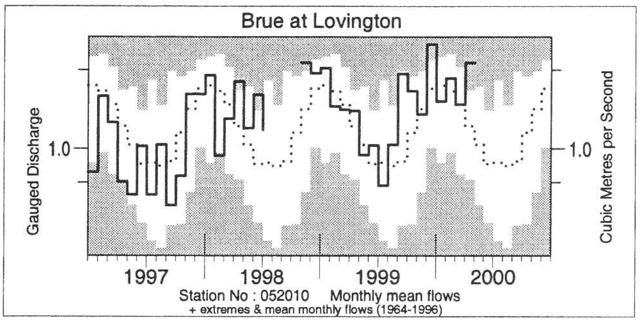



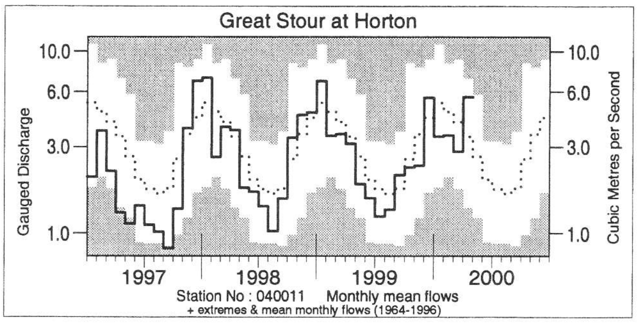



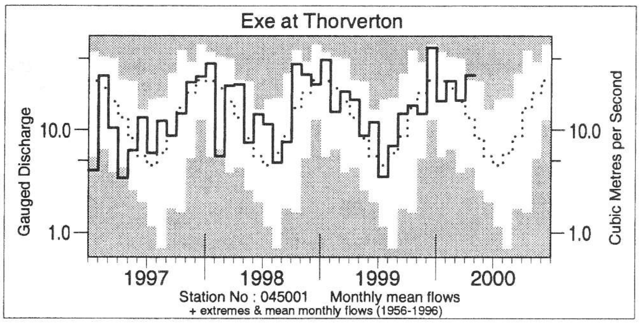



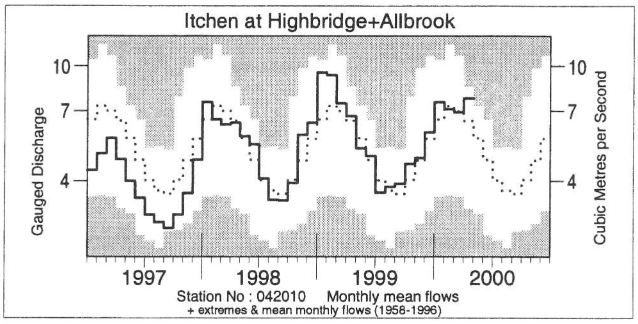



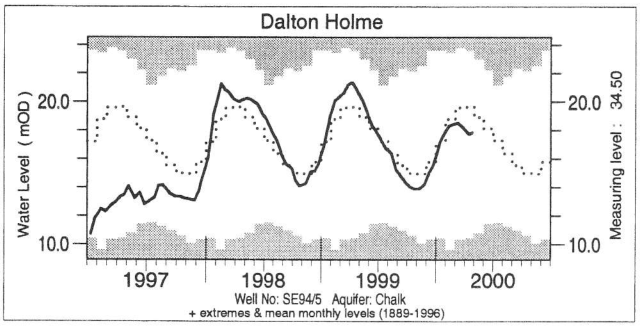



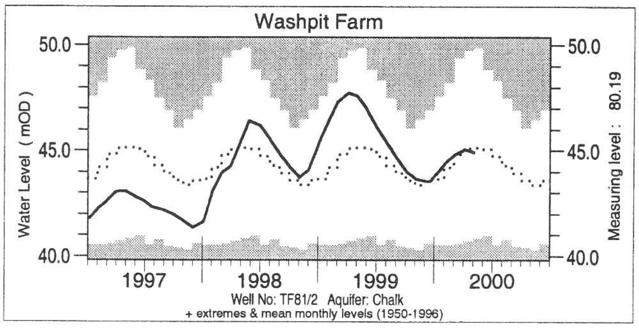

**Notable runoff accumulations February - April 2000 (a); November 1999 - April 2000 (b)**

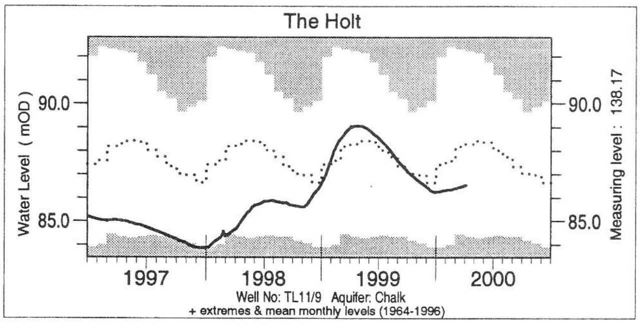
| (a) River | %lta | Rank | (b) River | %lta | Rank | River | %lta | Rank |
|---|---|---|---|---|---|---|---|---|
| Blackwater | 152 | 46/48 | Brue | 152 | 36/36 | Spey | 152 | 48/48 |
| Lymington | 151 | 39/40 | Clyde | 164 | 37/37 | Ewe | 136 | 30/30 |
| Exe | 145 | 43/44 | Tweed | 134 | 38/39 | Naver | 142 | 23/23 |
| Brue | 172 | 36/36 | Tay | 141 | 47/48 | Bush | 132 | 26/26 |

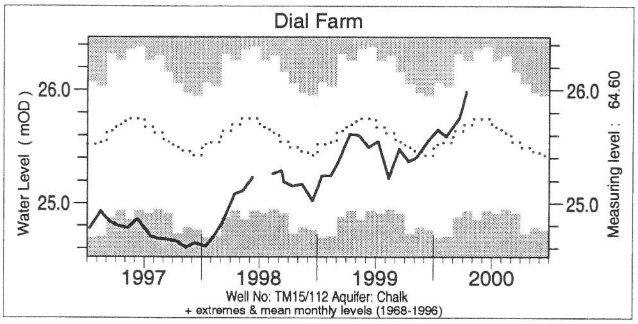
*lta = long term average*
*Rank 1 = lowest on record*

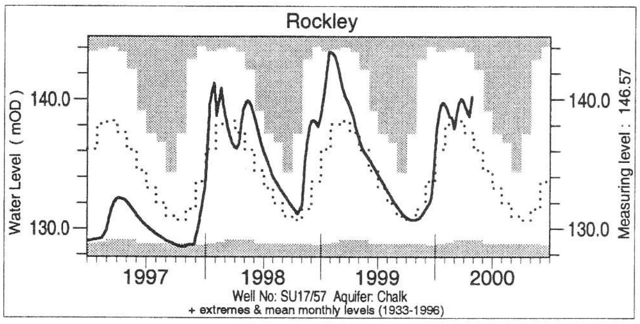
# Groundwater . . . Groundwater

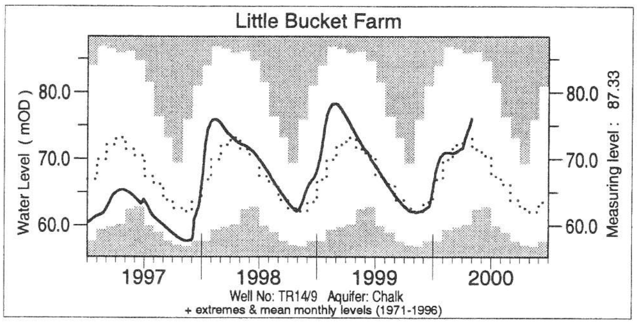


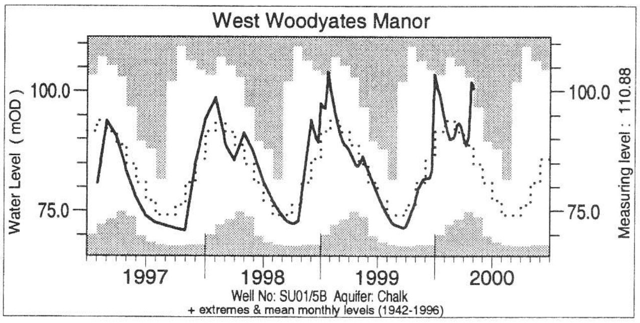



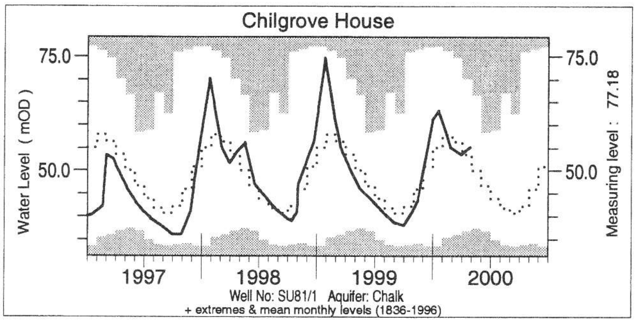



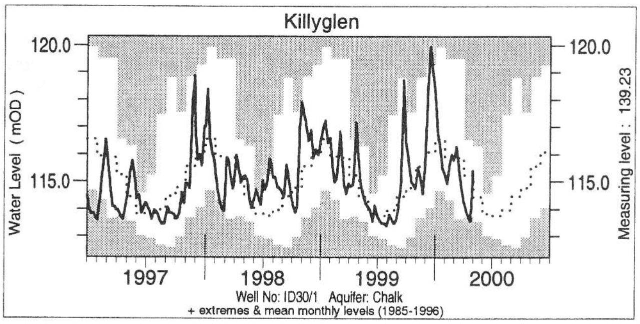



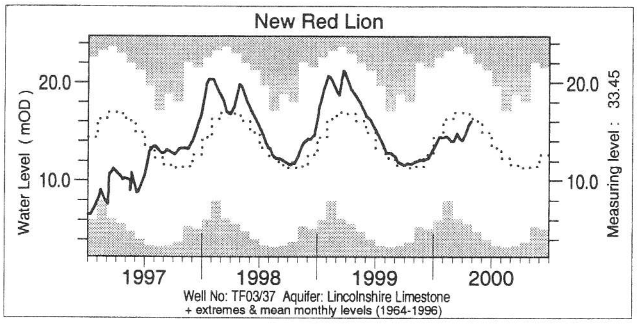



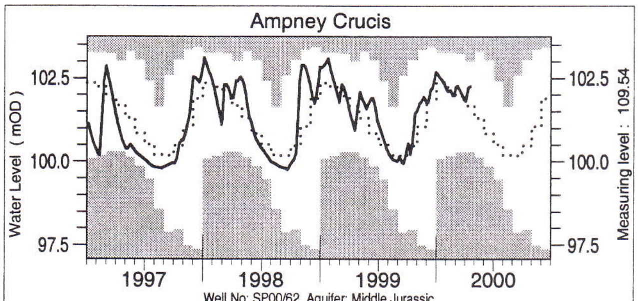



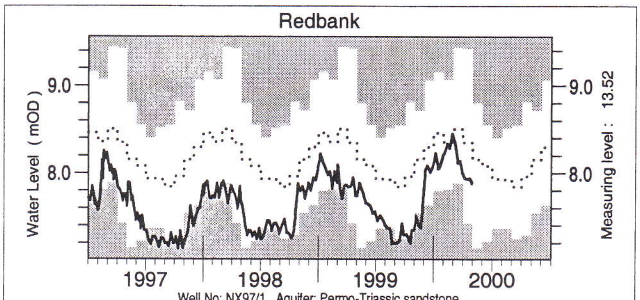

## What is groundwater?

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.

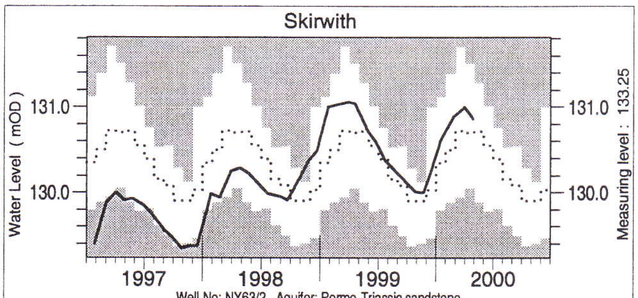
# Groundwater . . . Groundwater



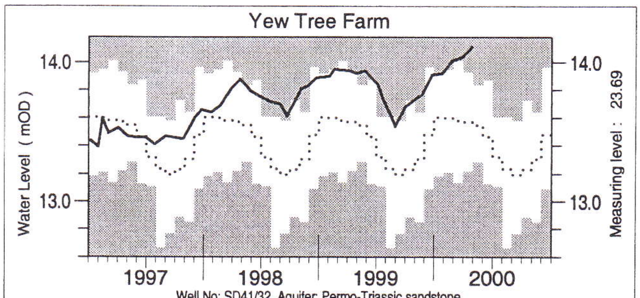
Well No: SP00/62 Aquifer: Middle Jurassic
+ extremes & mean monthly levels (1958-1996)



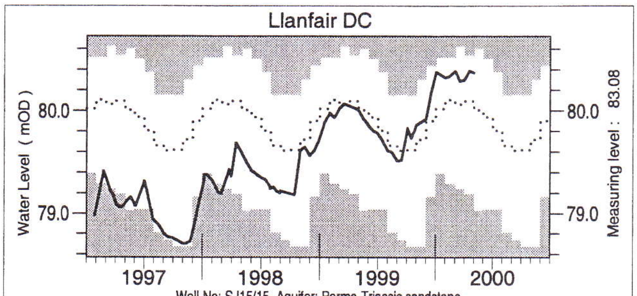
Well No: NX97/1 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1981-1996)



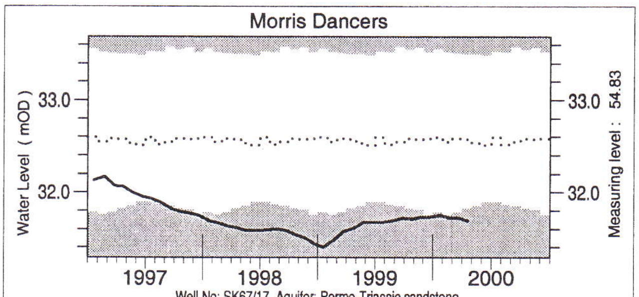
Well No: NY63/2 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1978-1996)



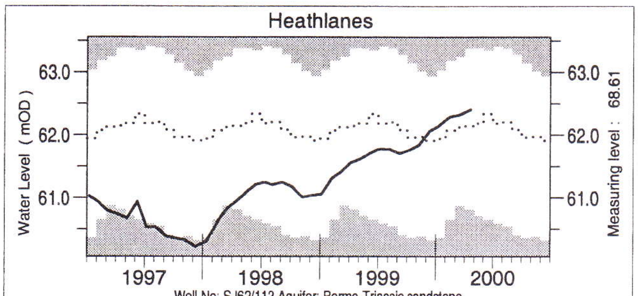
Well No: SD41/32 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1974-1996)



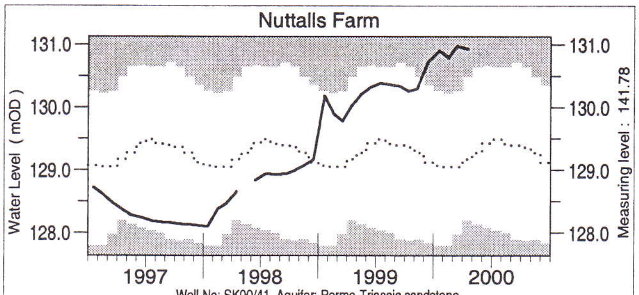
Well No: SJ15/15 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1972-1996)



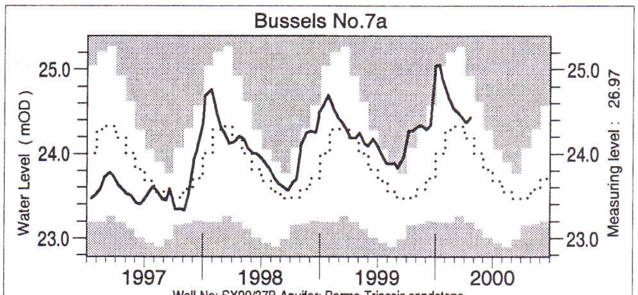
Well No: SK67/17 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1969-1996)



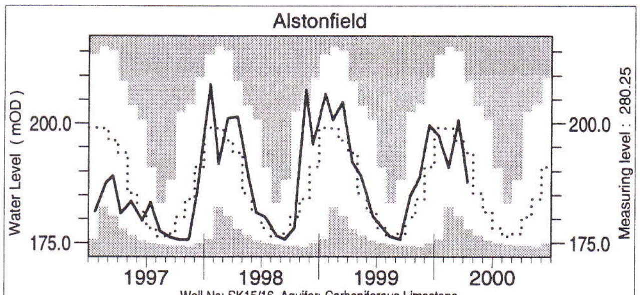
Well No: SJ62/112 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1971-1996)



Well No: SK00/41 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1974-1996)



Well No: SX99/37B Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1971-1996)



Well No: SK15/16 Aquifer: Carboniferous Limestone
+ extremes & mean monthly levels (1974-1996)

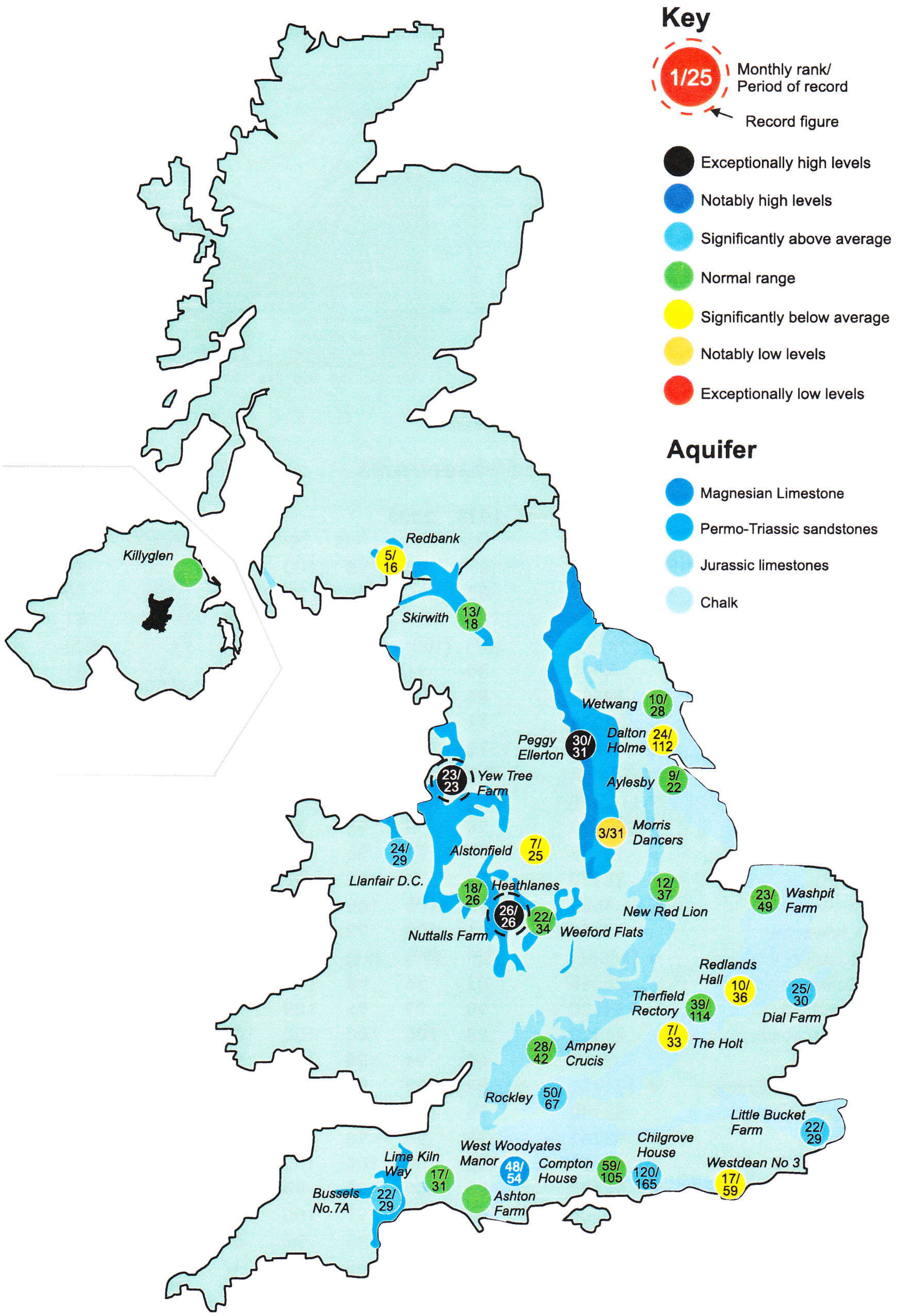
## Groundwater levels April/May 2000

| Borehole | Level | Date | Apr av. |
|---|---|---|---|
| Dalton Holme | 17.86 | 26/04 | 19.50 |
| Washpit Farm | 44.93 | 04/05 | 45.15 |
| The Holt | 86.55 | 06/04 | 88.06 |
| Dial Farm | 25.99 | 12/04 | 25.64 |
| Rockley | 140.20 | 25/03 | 137.45 |
| Little Bucket | 76.06 | 30/04 | 71.72 |
| West Woodyates | 100.15 | 30/04 | 88.28 |

| Borehole | Level | Date | Apr av. |
|---|---|---|---|
| Chilgrove | 55.28 | 27/04 | 52.22 |
| Killyglen | 115.41 | 30/04 | 115.12 |
| New Red Lion | 16.10 | 27/04 | 16.49 |
| Ampney Crucis | 102.26 | 17/04 | 101.72 |
| Redbank | 7.88 | 30/04 | 8.30 |
| Skirwith | 130.86 | 27/04 | 130.58 |
| Yew Tree Farm | 14.11 | 28/04 | 13.58 |

| Borehole | Level | Date | Apr av. |
|---|---|---|---|
| Llanfair D.C. | 80.37 | 01/05 | 79.95 |
| Morris Dancers | 31.69 | 20/04 | 32.45 |
| Heathlanes | 62.41 | 20/04 | 62.04 |
| Nuttalls Farm | 130.93 | 17/04 | 129.27 |
| Bussels No. 7A | 24.43 | 19/04 | 24.15 |
| Alstonfield | 187.62 | 14/04 | 193.81 |

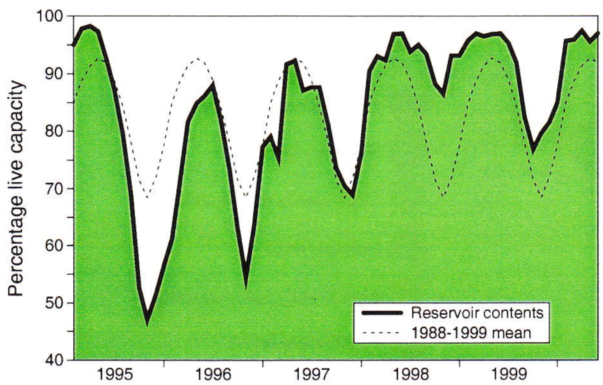
*Levels in metres above Ordnance Datum*



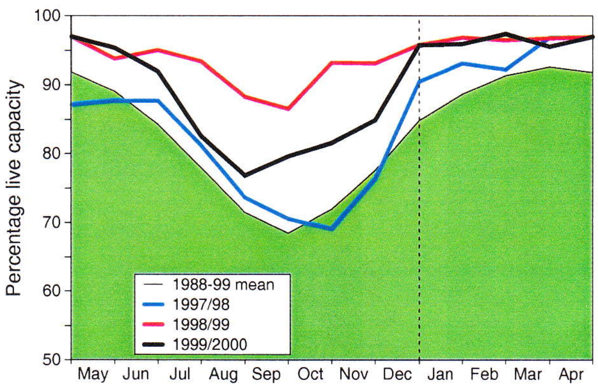

## Groundwater levels - April 2000

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) | 1999 Dec | 2000 Jan | Feb | Mar | Apr | May | Min. May | Year* of min |
|---|---|---|---|---|---|---|---|---|---|---|
| North West | N Command Zone | • 133375 | 67 | 93 | 98 | 100 | 92 | 88 | 80 | 1996 |
| | Vyrnwy | 55146 | 82 | 99 | 96 | 96 | 95 | 99 | 70 | 1996 |
| Northumbrian | Teesdale | • 87936 | 69 | 99 | 97 | 100 | 94 | 100 | 81 | 1996 |
| | Kielder | (199175) | (87) | (100) | (93) | (97) | (90) | (94) | (85) | 1990 |
| Severn Trent | Clywedog | 44922 | 84 | 91 | 88 | 94 | 92 | 99 | 85 | 1988 |
| | Derwent Valley | • 39525 | 84 | 100 | 100 | 100 | 100 | 100 | 54 | 1996 |
| Yorkshire | Washburn | • 22035 | 71 | 99 | 98 | 100 | 94 | 100 | 76 | 1996 |
| | Bradford supply | • 41407 | 78 | 99 | 99 | 99 | 93 | 99 | 60 | 1996 |
| Anglian | Grafham | ** (55490) | (96) | (95) | (94) | (90) | (94) | (96) | (73) | 1997 |
| | Rutland | **(116580) | (83) | (88) | (91) | (94) | (95) | (97) | (72) | 1997 |
| Thames | London | • 206399 | 90 | 94 | 95 | 95 | 98 | 97 | 86 | 1990 |
| | Farmoor | • 13843 | 98 | 77 | 95 | 93 | 100 | 81 | 81 | 2000 |
| Southern | Bewl | 28170 | 54 | 74 | 95 | 98 | 98 | 100 | 63 | 1990 |
| | Ardingly | 4685 | 65 | 100 | 100 | 100 | 100 | 100 | 100 | |
| Wessex | Clatworthy | 5364 | 91 | 100 | 98 | 100 | 98 | 100 | 81 | 1990 |
| | Bristol WW | • (38666) | (89) | (93) | (94) | (96) | (95) | (98) | (85) | 1990 |
| South West | Colliford | 28540 | 82 | 96 | 98 | 100 | 100 | 100 | 56 | 1997 |
| | Roadford | 34500 | 90 | 99 | 95 | 100 | 97 | 99 | 41 | 1996 |
| | Wimbleball | 21320 | 88 | 100 | 100 | 100 | 100 | 100 | 79 | 1992 |
| | Stithians | 5205 | 60 | 94 | 98 | 100 | 98 | 98 | 65 | 1992 |
| Welsh | Celyn and Brenig | • 131155 | 89 | 99 | 99 | 100 | 100 | 100 | 75 | 1996 |
| | Brianne | 62140 | 96 | 100 | 98 | 100 | 97 | 100 | 86 | 1997 |
| | Big Five | • 69762 | 92 | 94 | 98 | 97 | 96 | 98 | 85 | 1997 |
| | Elan Valley | • 99106 | 100 | 100 | 100 | 100 | 100 | 100 | 91 | 1997 |
| East of Scotland | Edinburgh/Mid Lothian | • 97639 | 80 | 100 | 98 | 99 | 99 | 100 | 62 | 1998 |
| | East Lothian | • 10206 | 98 | 99 | 97 | 100 | 97 | 100 | 89 | 1992 |
| West of Scotland | Loch Katrine | • 111363 | 95 | 88 | 85 | 95 | 88 | 84 | 84 | 2000 |
| | Daer | 22412 | 100 | 100 | 100 | 100 | 97 | 97 | 91 | 1995 |
| | Loch Thom | • 11840 | 84 | 100 | 100 | 100 | 97 | 92 | 92 | 2000 |
| Northern Ireland | Silent Valley | • 20634 | 58 | 61 | 62 | 63 | 57 | 58 | 58 | 2000 |

()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. Since the discontinuation of The Met. Office's CARP system in July 1998, rainfall figures have been provided by differing methods. Initial rainfall estimates for Scotland and the Scottish regions were derived by IH in collaboration with SEPA. In England and Wales, between July 1998 and May 1999, provisional rainfall figures derive from MORECS*. Beginning with the June 1999 report, provisional rainfall figures for England and Wales, the EA regions and Northern Ireland (from September 1999) 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 SEPA; over the coming months further monthly raingauge totals will be included for selected EA 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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