# Hydrological Summary for Great Britain

## *DECEMBER 1993*

### Rainfall

December was a relatively mild but exceptionally unsettled month with an unremitting succession of Atlantic frontal systems producing notable monthly precipitation totals in all regions. The breakdown of persistent anticyclonic conditions in late November heralded a very wet six weeks, in southern Britain particularly. Many districts registered only three or four dry days in the 40-day sequence from December 3rd. Individual daily totals were mostly unremarkable however - an important factor in limiting the extent of the December flooding. Some western and southern areas recorded more than twice the average December rainfall and Eskdalemuir (Dumfries and Galloway) registered its highest December total in a record from 1911. For England and Wales, December was the wettest month since February 1990 and continued a notably wet sequence of months in the English lowlands. The September-December rainfall total for a few catchments is the second highest, after 1960, since the 1930s. A particularly wet phase can be traced back to last April and regional 1993 rainfall totals are appreciably above average throughout southern and eastern Britain. In the 18-month timeframe, the accumulated rainfall total for the Anglian region provides a stark contrast with the preceding drought years and, generally, long term regional rainfall deficiencies have been reduced to very modest magnitudes. Very unsettled conditions continued into the New Year; rainfall in some areas in the South-East had exceeded the January average by around the 10th.

### River Flow

Six weeks of dry weather, which began in mid-October, substantially reduced flood vulnerability in most regions by early December - when flows were below average in most catchments. Subsequently, runoff rates increased rapidly and flooding, initially restricted to south-western Britain, became increasingly prevalent towards month-end especially in the English lowlands where very high baseflows contributed to lengthy periods of bankfull flows (or above). Numerous flood warnings were issued during the month. Before Christmas significant flooding occurred in the Severn Valley; levels at Shrewsbury were the highest in 25 years. After a short respite, the focus of attention switched to southern England where overbank flows produced substantial flooding e.g. at Polperro, (Cornwall) Uckfield (Sussex) and, most notably, Chichester where runoff in the spring-fed Lavant reached several times the previous maximum producing a major, and very protracted, flood event. New maximum December runoff totals were established for an appreciable number of rivers throughout Britain. Generally however runoff totals in much of eastern and southern England, though greatly above average, were similar to those of December 1992 and substantially lower than the December 1960 runoff. Until the New Year the natural drainage systems coped well, the flooding which did occur tended to be in the relatively densely populated lowlands, thus its impact was often greater than hydrological data alone might imply. Subsequently, with catchments saturated and rivers already flowing at capacity, early January rainfall produced widespread and very persistent floodplain inundation.

### Groundwater

Abundant infiltration characterised most of December and replenishment to the Chalk aquifer since the early autumn already exceeds the full winter average over wide areas. The full impact of the recent rainfall has yet to appear on the hydrograph traces for some deeper wells. Nonetheless, some notably sharp recoveries were registered in December. For example, the 11 metre rise at Little Bucket in Kent (over the 17 days beginning on the 22nd Dec.) is without recorded precedent. In southern England, the South Downs especially, many high level springs were flowing strongly and a number of boreholes overflowing. Levels at Washpit Farm, which remained appreciably below pre-drought minima throughout 1992, are now close to the seasonal maxima and a new December peak level was established at the Holt. Dramatic recoveries also typified most other aquifers: levels at Alstonfield (Carb. Limestone) rose 30 metres to exceed the previous December maximum and end-of-year levels throughout the Permo-Triassic aquifers were generally greatly above average and commonly at their highest for at least five years. With further water-table rises expected in January, it is anticipated that late-winter levels will approach or exceed seasonal maxima throughout much of England and Wales.

### General

Steep increases in previously somewhat depleted reservoir stocks in north-western Britain occurred during December. Elsewhere, continuing downstream spates provided little scope for drawdown to increase flood alleviation margins. Entering 1994, the water resources outlook is extremely healthy but many catchments are very vulnerable to further significant flooding.

Institute of Hydrology



British Geological Survey

Data for this report have been provided principally by the regional divisions of the National Rivers Authority* in England and Wales, the River Purification Boards in Scotland and by the Meteorological Office. Reservoir contents information has been supplied by the Water Services Companies, the NRA or, in Scotland, the Lothians Regional Council. The most recent areal rainfall figures are derived from a restricted network of raingauges (particularly in Scotland) and a proportion of the river flow data is of a provisional nature.

A map (Figure 3) is provided to assist in the location of the principal monitoring sites.

Financial support towards the production of the Hydrological Summaries is given by the Department of the Environment and the National Rivers Authority.

The Hydrological Summaries are available on annual subscription at a current cost of £48 per year - enquiries should be directed to the National Water Archive Office at the address below. No charge is made to those organisations providing data for the Summaries.

* For reasons of consistency and to provide greater spatial discrimination, the original ten regional divisions of the NRA have been retained for use in the Hydrological Summaries.

MORECS

The recent monthly regional rainfall data featured in the Hydrological Summaries are MORECS assessments. MORECS is the generic name for The Meteorological Office services involving the calculation of evaporation and soil moisture routinely for Great Britain. Products include a weekly issue of maps and tables of potential and actual evaporation, soil moisture deficits, effective rainfall and the hydrometeorological variables used to calculate them. The data are used to provide values for 40 km squares - or larger areas - and various sets of maps and tables are available according to user requirements. Options include a day-by-day retrospective calculation of soil moisture at any of 4000 rain-gauge sites.

Further information about MORECS services may be obtained from: The Meteorological Office, Sutton House, London Road, Bracknell, RG12 2SY

Tel: 0344 856858 Fax: 0344 854024

Institute of Hydrology/British Geological Survey
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

 12 January 1994

# TABLE 1 1992/93 RAINFALL AS A PERCENTAGE OF THE 1961-90 AVERAGE



| | | Dec 1992 | Jan 1993 | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| England and Wales | mm | 83 | 113 | 16 | 26 | 94 | 89 | 68 | 80 | 54 | 110 | 90 | 80 | 152 |
| | % | 88 | 128 | 25 | 36 | 157 | 139 | 105 | 129 | 71 | 143 | 106 | 88 | 162 |
| NRA REGIONS | | | | | | | | | | | | | | |
| North West | mm | 118 | 162 | 18 | 38 | 123 | 128 | 69 | 99 | 75 | 86 | 51 | 66 | 241 |
| | % | 95 | 134 | 23 | 40 | 173 | 171 | 85 | 116 | 70 | 75 | 40 | 54 | 195 |
| Northumbria | mm | 71 | 107 | 16 | 25 | 123 | 119 | 38 | 57 | 76 | 108 | 90 | 69 | 145 |
| | % | 88 | 127 | 27 | 36 | 220 | 192 | 63 | 88 | 94 | 148 | 118 | 80 | 179 |
| Severn-Trent | mm | 61 | 82 | 9 | 16 | 79 | 80 | 75 | 77 | 44 | 96 | 73 | 63 | 123 |
| | % | 79 | 117 | 17 | 26 | 144 | 136 | 127 | 145 | 66 | 150 | 114 | 88 | 160 |
| Yorkshire | mm | 71 | 91 | 19 | 15 | 102 | 83 | 49 | 67 | 78 | 133 | 62 | 65 | 138 |
| | % | 86 | 115 | 33 | 22 | 173 | 138 | 82 | 114 | 105 | 196 | 85 | 82 | 166 |
| Anglian | mm | 41 | 57 | 17 | 17 | 71 | 52 | 49 | 69 | 46 | 105 | 90 | 65 | 83 |
| | % | 75 | 114 | 46 | 36 | 154 | 108 | 96 | 141 | 84 | 214 | 176 | 112 | 151 |
| Thames | mm | 58 | 86 | 7 | 25 | 83 | 61 | 57 | 56 | 33 | 102 | 111 | 45 | 101 |
| | % | 83 | 134 | 16 | 45 | 166 | 109 | 104 | 114 | 57 | 173 | 179 | 70 | 144 |
| Southern | mm | 76 | 95 | 9 | 31 | 91 | 58 | 53 | 62 | 37 | 123 | 134 | 56 | 139 |
| | % | 93 | 119 | 17 | 49 | 172 | 107 | 98 | 129 | 65 | 178 | 168 | 66 | 169 |
| Wessex | mm | 86 | 119 | 9 | 40 | 83 | 62 | 69 | 67 | 37 | 119 | 126 | 63 | 158 |
| | % | 92 | 137 | 14 | 57 | 157 | 102 | 121 | 129 | 56 | 165 | 159 | 76 | 170 |
| South West | mm | 122 | 172 | 23 | 33 | 99 | 131 | 109 | 128 | 39 | 168 | 119 | 109 | 236 |
| | % | 88 | 125 | 23 | 33 | 143 | 182 | 158 | 186 | 46 | 181 | 103 | 87 | 170 |
| Welsh | mm | 145 | 193 | 24 | 35 | 112 | 134 | 97 | 101 | 74 | 118 | 80 | 103 | 262 |
| | % | 95 | 135 | 25 | 33 | 140 | 163 | 123 | 131 | 73 | 103 | 58 | 73 | 171 |
| Scotland | mm | 159 | 306 | 67 | 120 | 116 | 111 | 75 | 112 | 74 | 76 | 117 | 96 | 212 |
| | % | 105 | 203 | 66 | 96 | 153 | 129 | 87 | 119 | 63 | 54 | 75 | 63 | 140 |
| RIVER PURIFICATION BOARDS | | | | | | | | | | | | | | |
| Highland | mm | 239 | 397 | 120 | 156 | 85 | 93 | 85 | 141 | 86 | 53 | 137 | 69 | 250 |
| | % | 121 | 211 | 94 | 96 | 93 | 101 | 87 | 133 | 68 | 31 | 69 | 34 | 127 |
| North-East | mm | 78 | 159 | 33 | 55 | 69 | 108 | 59 | 80 | 72 | 87 | 165 | 46 | 125 |
| | % | 84 | 161 | 51 | 71 | 115 | 157 | 89 | 110 | 83 | 100 | 170 | 46 | 134 |
| Tay | mm | 113 | 343 | 25 | 114 | 134 | 128 | 59 | 87 | 60 | 102 | 132 | 80 | 171 |
| | % | 89 | 238 | 26 | 105 | 216 | 154 | 81 | 113 | 64 | 89 | 102 | 66 | 135 |
| Forth | mm | 84 | 261 | 20 | 90 | 109 | 120 | 73 | 74 | 50 | 79 | 107 | 83 | 179 |
| | % | 76 | 221 | 25 | 96 | 185 | 162 | 106 | 99 | 53 | 72 | 93 | 74 | 163 |
| Tweed | mm | 82 | 161 | 16 | 43 | 124 | 131 | 62 | 54 | 52 | 90 | 135 | 65 | 163 |
| | % | 88 | 161 | 24 | 54 | 218 | 185 | 95 | 74 | 59 | 101 | 142 | 70 | 175 |
| Solway | mm | 133 | 216 | 29 | 101 | 165 | 146 | 70 | 101 | 67 | 101 | 52 | 92 | 246 |
| | % | 90 | 138 | 29 | 86 | 214 | 172 | 83 | 112 | 56 | 71 | 33 | 64 | 166 |
| Clyde | mm | 165 | 350 | 69 | 158 | 159 | 117 | 77 | 135 | 84 | 75 | 66 | 122 | 281 |
| | % | 92 | 185 | 58 | 107 | 189 | 129 | 83 | 124 | 63 | 42 | 34 | 68 | 157 |

Note: The monthly rainfall figures for November and December correspond to the MORECS areal assessments derived by The Meteorological Office. In northern Britain these initial assessments may have a wide error band associated with them. The provisional figures for England and Wales and for Scotland are derived using a different raingauge network. Regional areal rainfall figures are regularly updated (normally one or two months in arrears) using figures derived from a far denser raingauge network.

## TABLE 2 RAINFALL RETURN PERIOD ESTIMATES

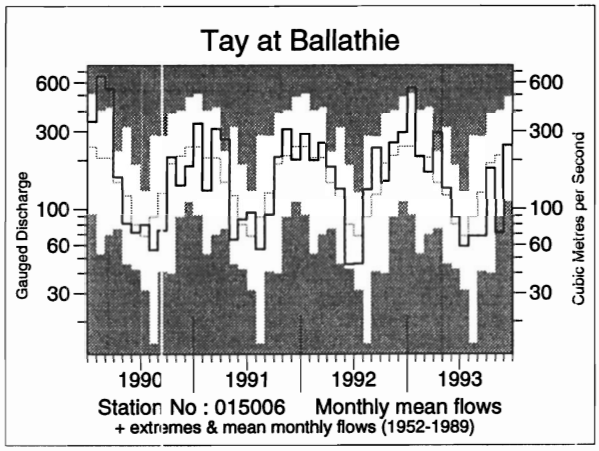
| | | Sept-Dec93 | | Jan-Dec93 | | Jul92-Dec93 | | Mar90-Dec93 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Est Return Period, years | | Est Return Period, years | | Est Return Period, years | | Est Return Period, years |
| England and Wales | mm | 432 | | 972 | | 1581 | | 3274 | |
| | % LTA | 125 | 5-10 | 108 | 2-5 | 115 | 5-15 | 95 | 2-5 |
| NRA REGIONS | | | | | | | | | |
| North West | mm | 445 | | 1157 | | 1908 | | 4372 | |
| | % LTA | 91 | 2-5 | 96 | 2-5 | 101 | 2-5 | 95 | 2-5 |
| Northumbria | mm | 412 | | 973 | | 1482 | | 3244 | |
| | % LTA | 130 | 5-15 | 114 | 5-10 | 113 | 5-10 | 99 | 2-5 |
| Severn-Trent | mm | 354 | | 816 | | 1343 | | 2781 | |
| | % LTA | 128 | 5-10 | 108 | 2-5 | 117 | 10-20 | 96 | 2-5 |
| Yorkshire | mm | 398 | | 902 | | 1427 | | 2960 | |
| | % LTA | 131 | 5-15 | 110 | 2-5 | 113 | 5-10 | 94 | 2-5 |
| Anglian | mm | 343 | | 721 | | 1176 | | 2241 | |
| | % LTA | 161 | 80-120 | 121 | 10-20 | 129 | 80-120 | 98 | 2-5 |
| Thames | mm | 359 | | 767 | | 1293 | | 2511 | |
| | % LTA | 140 | 10-20 | 111 | 2-5 | 123 | 20-35 | 95 | 2-5 |
| Southern | mm | 451 | | 887 | | 1439 | | 2833 | |
| | % LTA | 143 | 15-25 | 114 | 5-10 | 120 | 10-25 | 95 | 2-5 |
| Wessex | mm | 466 | | 952 | | 1520 | | 3027 | |
| | % LTA | 142 | 10-25 | 114 | 5-10 | 118 | 10-20 | 95 | 2-5 |
| South West | mm | 632 | | 1366 | | 2150 | | 4326 | |
| | % LTA | 134 | 10-20 | 116 | 5-10 | 119 | 10-25 | 97 | 2-5 |
| Welsh | mm | 563 | | 1333 | | 2223 | | 4788 | |
| | % LTA | 103 | 2-5 | 102 | 2-5 | 109 | 2-5 | 96 | 2-5 |
| Scotland | mm | 501 | | 1482 | | 2465 | | 6060 | |
| | % LTA | 84 | 5-10 | 103 | 2-5 | 110 | 5-10 | 110 | 20-40 |
| RIVER PURIFICATION BOARDS | | | | | | | | | |
| Highland | mm | 508 | | 1671 | | 2909 | | 7461 | |
| | % LTA | 66 | 20-40 | 95 | 2-5 | 105 | 2-5 | 111 | 20-40 |
| North-East | mm | 423 | | 1058 | | 1625 | | 3768 | |
| | % LTA | 112 | 2-5 | 109 | 2-5 | 108 | 2-5 | 101 | 2-5 |
| Tay | mm | 485 | | 1435 | | 2219 | | 5063 | |
| | % LTA | 99 | 2-5 | 117 | 5-10 | 117 | 10-25 | 108 | 5-15 |
| Forth | mm | 448 | | 1245 | | 1971 | | 4578 | |
| | % LTA | 100 | 2-5 | 112 | 5-10 | 114 | 10-20 | 108 | 5-15 |
| Tweed | mm | 452 | | 1095 | | 1725 | | 3918 | |
| | % LTA | 122 | 5-10 | 113 | 5-10 | 115 | 10-20 | 106 | 2-5 |
| Solway | mm | 492 | | 1387 | | 2310 | | 5561 | |
| | % LTA | 83 | 2-5 | 98 | 2-5 | 104 | 2-5 | 103 | 2-5 |
| Clyde | mm | 544 | | 1693 | | 2852 | | 7261 | |
| | % LTA | 74 | 5-15 | 100 | 2-5 | 107 | 2-5 | 112 | 30-60 |

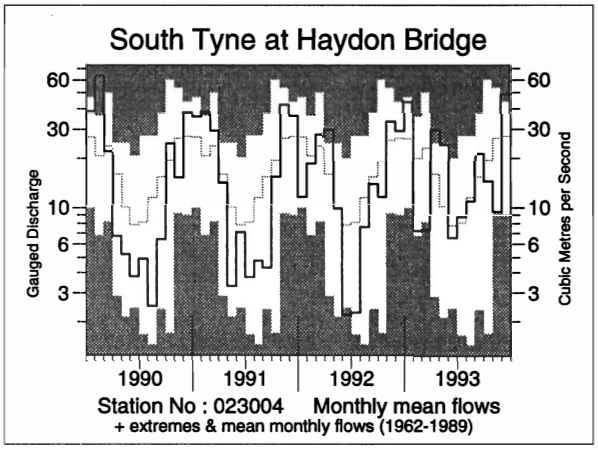
LTA refers to the period 1961-90.

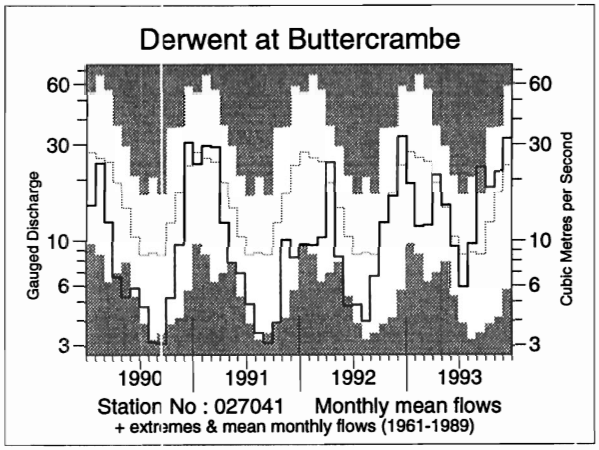
Return period assessments are based on tables provided by the Meteorological Office*. The tables reflect rainfall totals over the period 1911-70 only and the estimate assumes a sensibly stable climate. They assume a start in a specified month; return periods for a start in any month may be expected to be an order of magnitude less - for the longest durations the return period estimates converge. "Wet" return periods underlined.

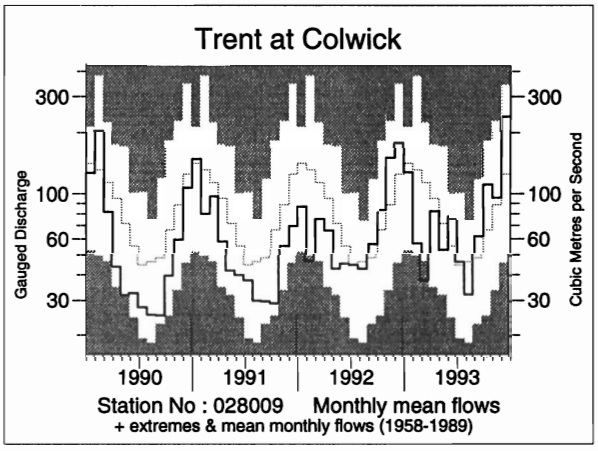
* Tabony, R.C., 1977, The Variability of long duration rainfall over Great Britain, Scientific Paper No. 37, Meteorological Office.

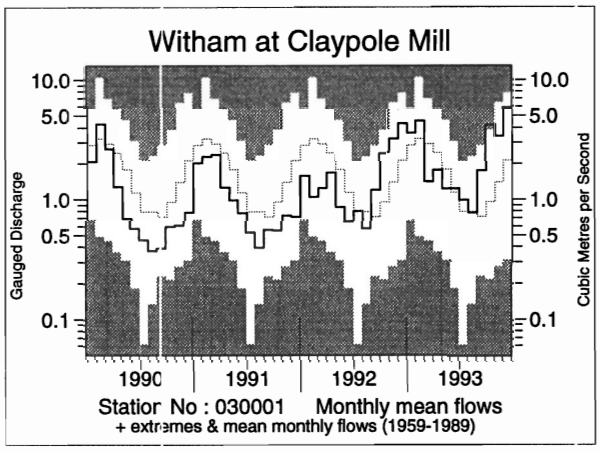
# FIGURE 1 MONTHLY RIVER FLOW HYDROGRAPHS

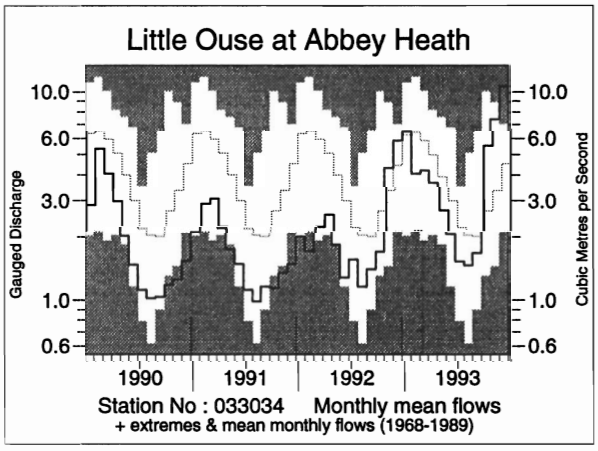


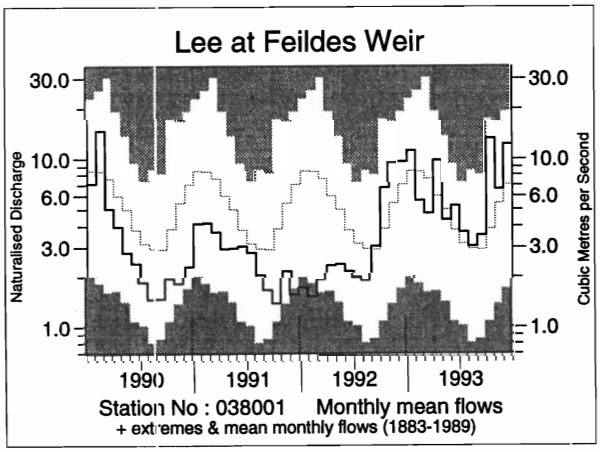



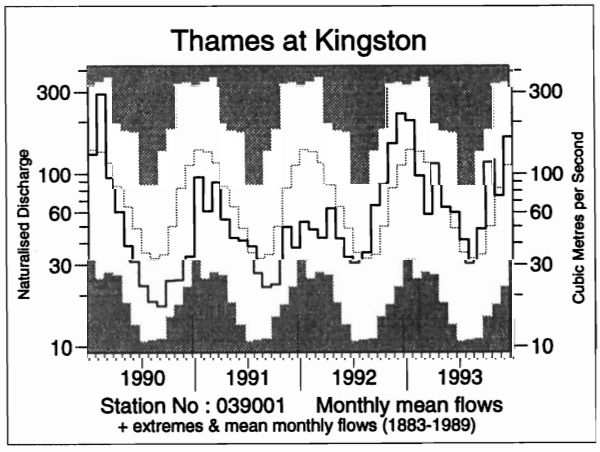



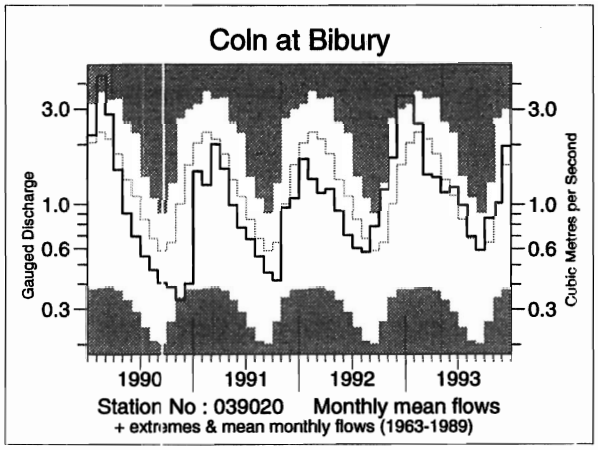



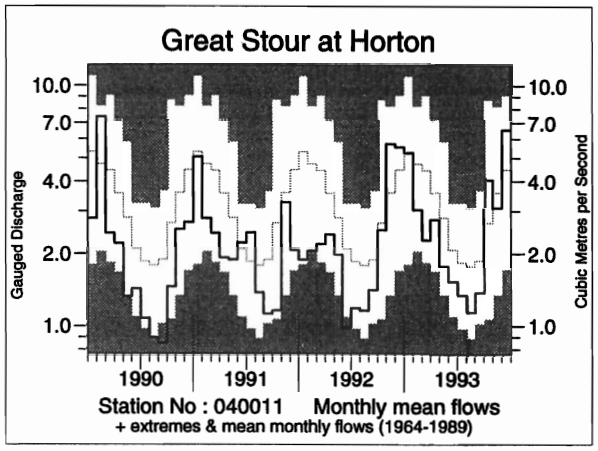



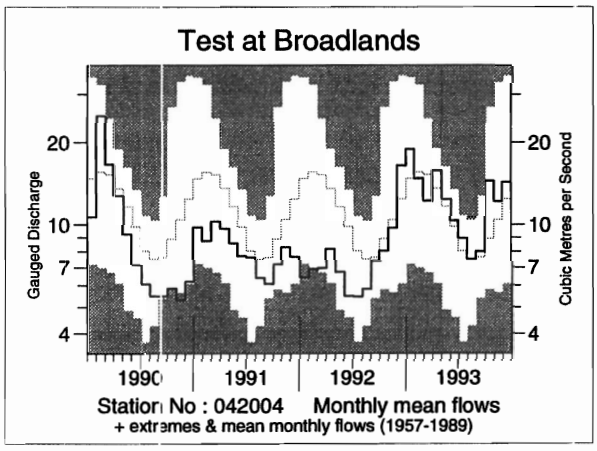



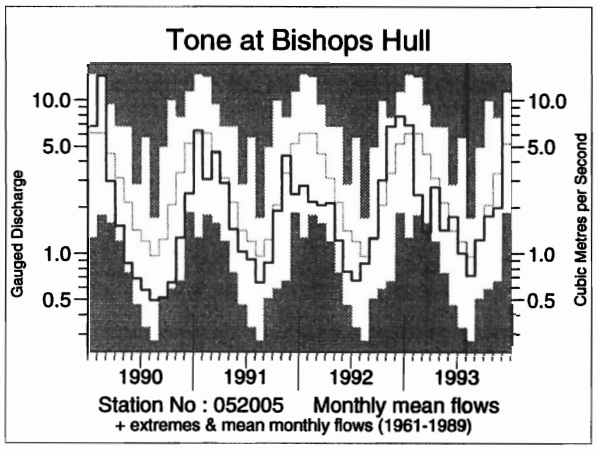



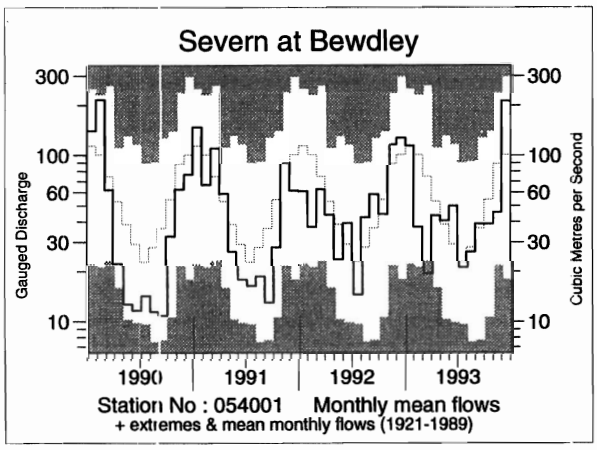



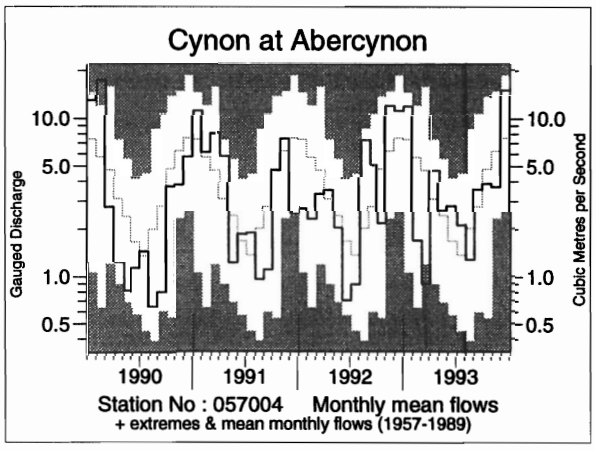

Coln at Bibury
Gauged Discharge
Cubic Metres per Second
3.0
1.0
0.6
0.3
1990
1991
1992
1993
Station No : 039020 Monthly mean flows
+ extremes & mean monthly flows (1963-1989)

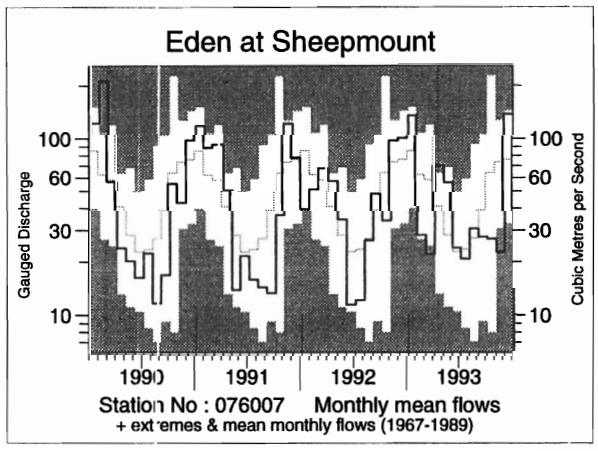

Great Stour at Horton
Gauged Discharge
Cubic Metres per Second
10.0
7.0
4.0
2.0
1.0
1990
1991
1992
1993
Station No : 040011 Monthly mean flows
+ extremes & mean monthly flows (1964-1989)

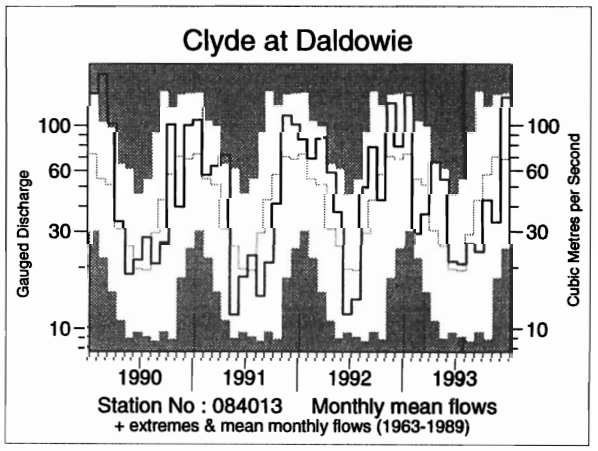

Test at Broadlands
Gauged Discharge
Cubic Metres per Second
20
10
7
4
1990
1991
1992
1993
Station No : 042004 Monthly mean flows
+ extremes & mean monthly flows (1957-1989)


Tone at Bishops Hull
Gauged Discharge
Cubic Metres per Second
10.0
5.0
1.0
0.5
1990
1991
1992
1993
Station No : 052005 Monthly mean flows
+ extremes & mean monthly flows (1961-1989)


Severn at Bewdley
Gauged Discharge
Cubic Metres per Second
300
100
60
30
10
1990
1991
1992
1993
Station No : 054001 Monthly mean flows
+ extremes & mean monthly flows (1921-1989)


Cynon at Abercynon
Gauged Discharge
Cubic Metres per Second
10.0
5.0
1.0
0.5
1990
1991
1992
1993
Station No : 057004 Monthly mean flows
+ extremes & mean monthly flows (1957-1989)


Eden at Sheepmount
Gauged Discharge
Cubic Metres per Second
100
60
30
10
1990
1991
1992
1993
Station No : 076007 Monthly mean flows
+ extremes & mean monthly flows (1967-1989)


Clyde at Daldowie
Gauged Discharge
Cubic Metres per Second
100
60
30
10
1990
1991
1992
1993
Station No : 084013 Monthly mean flows
+ extremes & mean monthly flows (1963-1989)

# TABLE 3 RUNOFF AS MM. AND AS A PERCENTAGE OF THE PERIOD OF RECORD AVERAGE WITH SELECTED PERIODS RANKED IN THE RECORD

| River/ Station name | Aug 1993 | Sep | Oct | Nov | Dec 1993 | | 9/93 to 12/93 | | 1/93 to 12/93 | | 5/90 to 12/93 | | 11/88 to 12/93 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm %LT | mm %LT | mm %LT | mm %LT | mm %LT | rank /yrs | mm %LT | rank /yrs | mm %LT | rank /yrs | mm %LT | rank /yrs | mm %LT | rank /yrs |
| Dee at Park | 24 75 | 50 122 | 172 218 | 33 43 | 80 93 | 12 /22 | 335 116 | 18 /21 | 894 114 | 19 /21 | 2677 94 | 7 /18 | 3712 89 | 3 /17 |
| Tay at Ballathie | 40 77 | 38 53 | 104 93 | 40 33 | 144 102 | 24 /42 | 326 73 | 5 /41 | 1233 109 | 28 /41 | 4272 106 | 27 /38 | 6678 113 | 31 /37 |
| Tweed at Boleside | 26 67 | 31 61 | 100 139 | 30 34 | 168 176 | 32 /33 | 329 108 | 18 /32 | 847 112 | 24 /32 | 3026 112 | 28 /29 | 4318 110 | 27 /28 |
| Whiteadder Water at Hutton Castle | 8 53 | 13 83 | 73 267 | 21 56 | 98 217 | 24 /25 | 205 159 | 24 /25 | 446 113 | 15 /24 | 1380 99 | 10 /21 | 1725 83 | 6 /20 |
| South Tyne at Haydon Bridge | 39 101 | 73 145 | 51 75 | 33 36 | 176 177 | 32 /32 | 333 105 | 15 /30 | 828 110 | 22 /30 | 2707 98 | 11 /24 | 3818 94 | 6 /22 |
| Wharfe at Flint Mill Weir | 42 106 | 79 180 | 46 73 | 25 31 | 166 171 | 36 /39 | 316 110 | 25 /38 | 712 99 | 20 /38 | 2317 90 | 9 /35 | 3351 88 | 3 /34 |
| Derwent at Buttercrambe | 16 115 | 38 285 | 32 159 | 36 130 | 54 135 | 26 /33 | 160 156 | 30 /32 | 333 103 | 20 /32 | 923 80 | 5 /29 | 1227 71 | 1 /28 |
| Trent at Colwick | 12 73 | 21 126 | 40 172 | 33 108 | 86 194 | 35 /36 | 180 155 | 32 /35 | 360 102 | 19 /35 | 1063 85 | 8 /32 | 1558 84 | 3 /31 |
| Lud at Louth | 9 69 | 11 102 | 32 276 | 32 230 | 48 251 | 26 /26 | 123 211 | 25 /26 | 260 104 | 13 /25 | 536 62 | 3 /22 | 771 59 | 1 /21 |
| Witham at Claypole Mill | 7 103 | 15 239 | 38 432 | 29 238 | 52 276 | 33 /35 | 135 277 | 34 /35 | 270 145 | 31 /34 | 600 95 | 16 /32 | 828 87 | 10 /30 |
| Little Ouse at Abbey Heath | 6 81 | 6 84 | 21 218 | 28 232 | 41 246 | 26 /26 | 96 203 | 24 /26 | 196 117 | 19 /25 | 420 72 | 3 /23 | 632 73 | 1 /21 |
| Colne at Lexden | 3 75 | 5 117 | 19 223 | 17 136 | 41 247 | 33 /35 | 82 187 | 30 /34 | 155 114 | 24 /34 | 370 80 | 6 /31 | 567 81 | 3 /30 |
| Lee at Feildes Weir (natr.) | 8 106 | 9 125 | 34 342 | 17 125 | 32 177 | 98 /109 | 91 186 | 100 /108 | 212 130 | 91 /107 | 450 79 | 23 /102 | 682 81 | 17 /99 |
| Thames at Kingston (natr.) | 8 91 | 13 145 | 32 239 | 19 88 | 44 146 | 91 /111 | 109 146 | 90 /111 | 287 117 | 81 /111 | 730 85 | 26 /108 | 1094 85 | 22 /106 |
| Coln at Bibury | 17 102 | 14 99 | 22 135 | 25 102 | 49 123 | 23 /31 | 110 117 | 20 /30 | 426 109 | 19 /30 | 1209 88 | 9 /27 | 1780 88 | 5 /26 |
| Great Stour at Horton | 9 68 | 10 74 | 32 159 | 23 85 | 51 151 | 27 /29 | 116 121 | 21 /29 | 261 90 | 11 /27 | 786 77 | 3 /22 | 1096 73 | 1 /18 |
| Test at Broadlands | 19 100 | 20 107 | 57 164 | 30 117 | 37 118 | 28 /37 | 124 125 | 31 /36 | 379 112 | 28 /35 | 993 84 | 3 /29 | 1441 83 | 2 /27 |
| Piddle at Baggs Mill | 15 97 | 19 126 | 48 237 | 41 143 | 72 172 | 26 /31 | 179 167 | 29 /30 | 478 119 | 25 /29 | 1251 89 | 7 /24 | 1816 86 | 3 /21 |
| Exe at Thorverton | 22 78 | 40 104 | 87 118 | 47 48 | 270 205 | 36 /38 | 445 129 | 32 /38 | 812 98 | 17 /37 | 2632 90 | 10 /35 | 3816 88 | 2 /33 |
| Taw at Umberleigh | 19 102 | 39 163 | 103 168 | 44 47 | 230 198 | 35 /36 | 415 138 | 32 /35 | 775 113 | 24 /35 | 2279 94 | 11 /32 | 3346 92 | 6 /31 |
| Tone at Bishops Hull | 9 74 | 16 106 | 23 86 | 25 58 | 150 225 | 33 /33 | 214 139 | 27 /33 | 448 95 | 13 /32 | 1340 82 | 2 /30 | 2087 83 | 1 /28 |
| Severn at Bewdley | 16 93 | 23 106 | 24 72 | 27 50 | 132 212 | 71 /73 | 206 121 | 52 /73 | 421 93 | 30 /72 | 1372 86 | 12 /70 | 2070 87 | 6 /68 |
| Teme at Knightsford Bridge | 8 89 | 9 105 | 29 152 | 33 99 | 103 191 | 24 /24 | 174 149 | 21 /24 | 342 95 | 10 /23 | 1011 81 | 2 /21 | 1571 82 | 1 /19 |
| Cynon at Abercynon | 32 61 | 88 130 | 98 82 | 91 58 | 375 199 | 34 /36 | 653 120 | 26 /34 | 1347 107 | 22 /34 | 4422 99 | 15 /28 | 6622 101 | 14 /27 |
| Dee at Manley Hall | 48 106 | 57 96 | 45 52 | 57 48 | 275 201 | 56 /57 | 434 107 | 35 /56 | 922 96 | 22 /56 | 3179 92 | 12 /53 | 4736 93 | 10 /52 |
| Dee at New Inn | 105 113 | 83 63 | 55 28 | 69 28 | 514 210 | 25 /25 | 720 88 | 10 /25 | 1603 89 | 8 /24 | 5762 88 | 2 /21 | 8529 89 | 1 /20 |
| Eden at Sheepmount | 36 120 | 31 73 | 31 43 | 25 29 | 160 175 | 22 /24 | 248 88 | 7 /23 | 693 101 | 12 /23 | 2456 101 | 8 /17 | 3636 102 | 7 /14 |
| Clyde at Daldowie | 37 91 | 32 55 | 60 74 | 45 46 | 192 193 | 30 /31 | 330 98 | 12 /30 | 875 113 | 23 /30 | 3268 117 | 25 /27 | 4734 117 | 25 /26 |
| Carron at New Kelso | 131 76 | 36 13 | 128 49 | 64 21 | 317 92 | 6 /15 | 545 48 | 1 /15 | 2147 84 | 3 /15 | 9374 100 | 8 /12 | 14545 108 | 9 /10 |
| Ewe at Poolewe | 164 145 | 41 21 | 87 39 | 71 26 | 264 95 | 11 /24 | 463 49 | 2 /23 | 2005 94 | 10 /23 | 8326 107 | 15 /20 | 12649 112 | 18 /19 |

Notes:
(i) Values based on gauged flow data unless flagged (natr.), when naturalised data have been used.
(ii) Values are ranked so that lowest runoff as rank 1.
(iii) %LT means percentage of long term average from the start of the record to 1992. For the long periods (at the right of this table), the end date for the long term is 1993.

## TABLE 4 START-MONTH RESERVOIR STORAGES UP TO JANUARY 1994

| Area | Reservoir (R)/ Group (G) | | Capacity● (Ml) | 1993 Aug | Sep | Oct | Nov | Dec | 1994 Jan | 1993 Jan |
|---|---|---|---|---|---|---|---|---|---|---|
| North West | Northern Command Zone[1] | (G) | 133375 | 66 | 58 | 51 | 42 | 44 | 80 | 88 |
| | Vyrnwy | (R) | 55146 | 81 | 79 | 73 | 60 | 64 | 100 | 89 |
| Northumbria | Teesdale[2] | (G) | 87936 | 72 | 66 | 73 | 71 | 69 | 100 | 90 |
| | Kielder | (R) | 199175* | 90* | 87* | 84* | 87* | 80* | 99* | 74* |
| Severn-Trent | Clywedog | (R) | 44922 | 94 | 92 | 87 | 82 | 83 | 100 | 84 |
| | Derwent Valley[3] | (G) | 39525 | 77 | 76 | 84 | 83 | 79 | 100 | 88 |
| Yorkshire | Washburn[4] | (G) | 22035 | 72 | 63 | 67 | 68 | 59 | 92 | 95 |
| | Bradford supply[5] | (G) | 41407 | 74 | 74 | 90 | 86 | 76 | 97 | 94 |
| Anglian | Grafham | (R) | 58707 | 96 | 95 | 95 | 96 | 93 | 89 | 94 |
| | Rutland | (R) | 130061 | 93 | 90 | 86 | 88 | 88 | 95 | 95 |
| Thames | London[6] | (G) | 206232 | 96 | 87 | 86 | 92 | 88 | 87 | 96 |
| | Farmoor [7] | (G) | 13843 | 98 | 98 | 93 | 98 | 99 | 98 | 96 |
| Southern | Bewl | (R) | 28170 | 85 | 78 | 74 | 81 | 82 | 97 | 82 |
| | Ardingly | (R) | 4685 | 90 | 80 | 77 | 100 | 100 | 100 | 100 |
| Wessex | Clatworthy | (R) | 5364* | 82 | 72 | 61 | 76 | 68 | 100 | 100 |
| | Bristol W [8] | (G) | 38666* | 67* | 60* | 48* | 59* | 60* | 88* | 94* |
| South West | Colliford | (R) | 28540 | 86 | 81 | 84 | 86 | 88 | 98 | 82 |
| | Roadford | (R) | 34500 | 81 | 74 | 76 | 81 | 78 | 92 | 90 |
| | Wimbleball[9] | (R) | 21320 | 83 | 76 | 74 | 80 | 82 | 100 | 90 |
| | Stithians | (R) | 5205 | 91 | 85 | 93 | 99 | 100 | 100 | 100 |
| Welsh | Celyn + Brenig | (G) | 131155 | 98 | 94 | 92 | 92 | 84 | 100 | 96 |
| | Brianne | (R) | 62140 | 97 | 92 | 91 | 91 | 95 | 100 | 99 |
| | Big Five[10] | (G) | 69762 | 86 | 78 | 80 | 80 | 84 | 98 | 94 |
| | Elan Valley[11] | (G) | 99106 | 96 | 97 | 97 | 95 | 99 | 100 | 98 |
| Lothian | Edinburgh/Mid Lothian | (G) | 97639 | 89 | 83 | 81 | 82 | 78+ | 92 | 98 |
| | West Lothian | (G) | 5613 | 89 | 81 | 87 | 98 | 100 | 100 | 98 |
| | East Lothian | (G) | 10206 | 92 | 81 | 85 | 98 | 87 | 98 | 100 |

● Live or usable capacity (unless indicated otherwise)

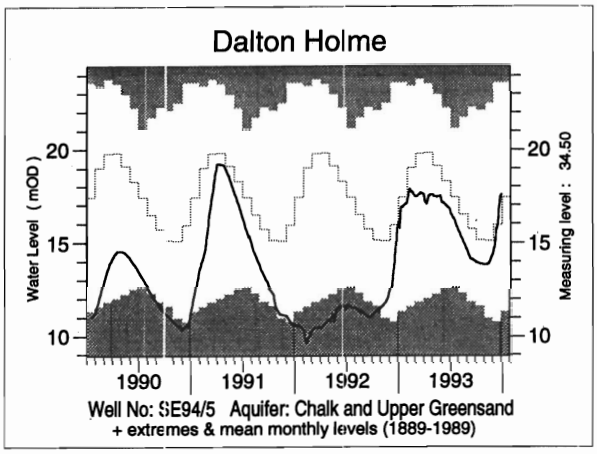
* Gross storage/percentage of gross storage

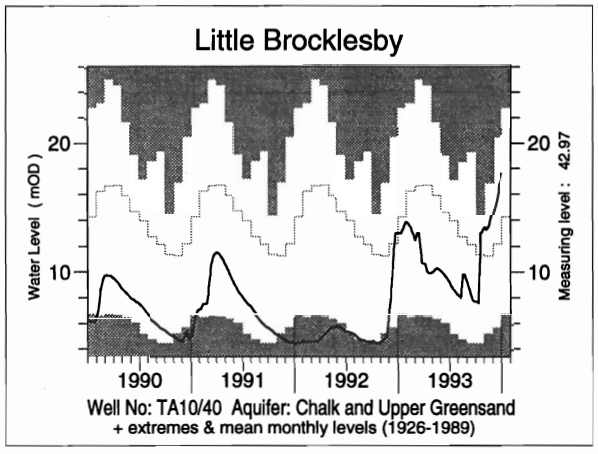
\+ Megget reservoir held at 75% capacity for repairs

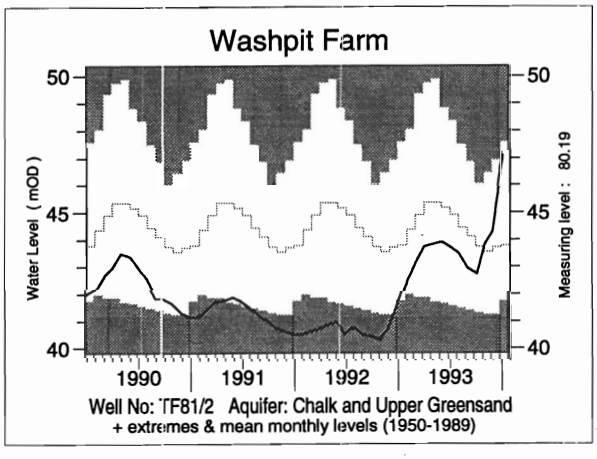
1. Includes Haweswater, Thirlmere, Stocks and Barnacre.
2. Cow Green, Selset, Grassholme, Balderhead, Blackton and Hury.
3. Howden, Derwent and Ladybower.
4. Swinsty, Fewston, Thruscross and Eccup.
5. The Nidd/Barden group (Scar House, Angram, Upper Barden, Lower Barden and Chelker) plus Grimwith.
6. Lower Thames (includes Queen Mother, Wraysbury, Queen Mary, King George VI and Queen Elizabeth II) and Lee Valley (includes King George and William Girling) groups - pumped storages.
7. Farmoor 1 and 2 - pumped storages.
8. Blagdon, Chew Valley and others.
9. Shared between South West (river regulation for abstraction) and Wessex (direct supply).
10. Usk, Talybont, Llandegfedd (pumped storage), Taf Fechan, Taf Fawr.
11. Claerwen, Caban Coch, Pen y Garreg and Craig Goch.

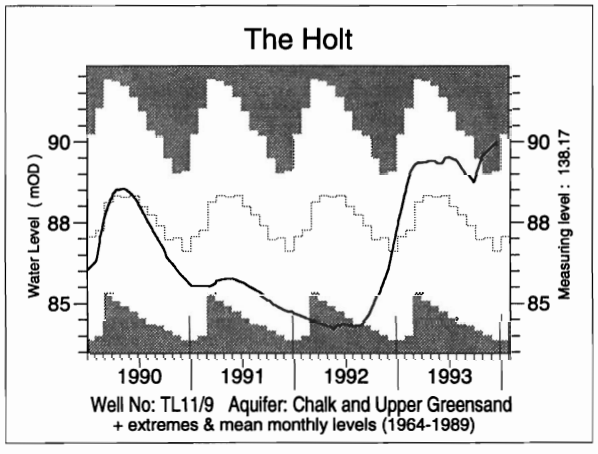
Note: Variations in storage depend on the balance between inputs (from catchment rainfall and any pumping) and outputs (to supply, compensation flow, HEP, amenity). There will be additional losses due to evaporation, especially in the summer months. Operational strategies for making the most efficient use of water stocks will further affect reservoir storages. Table 4 provides a link between the hydrological conditions described elsewhere in the report and the water resources situation.

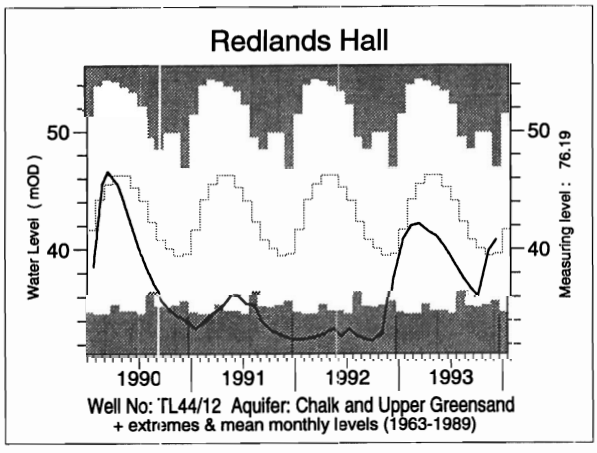
# FIGURE 2 GROUNDWATER LEVEL HYDROGRAPHS

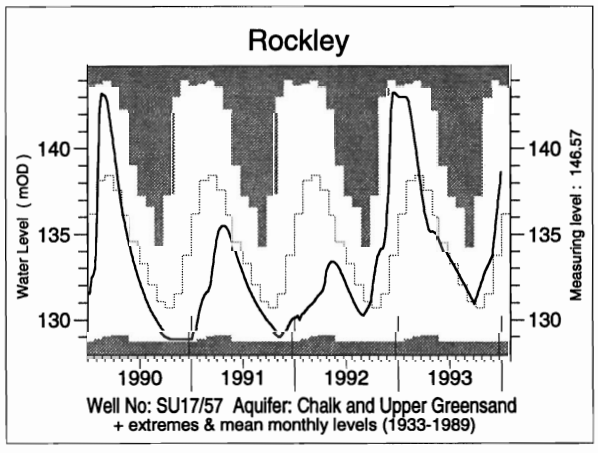


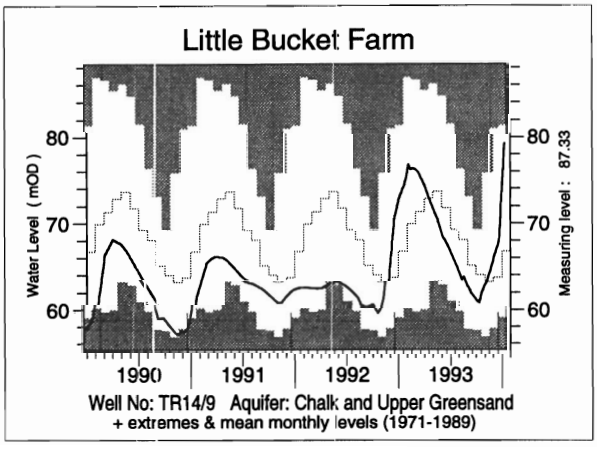



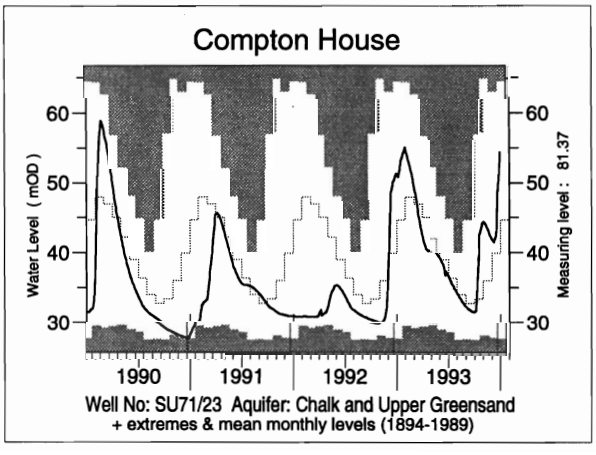



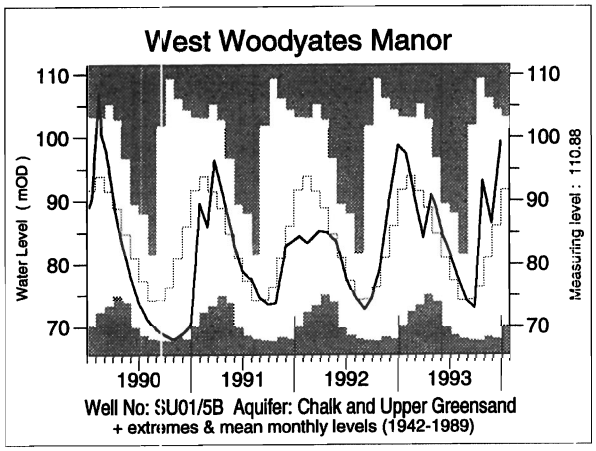



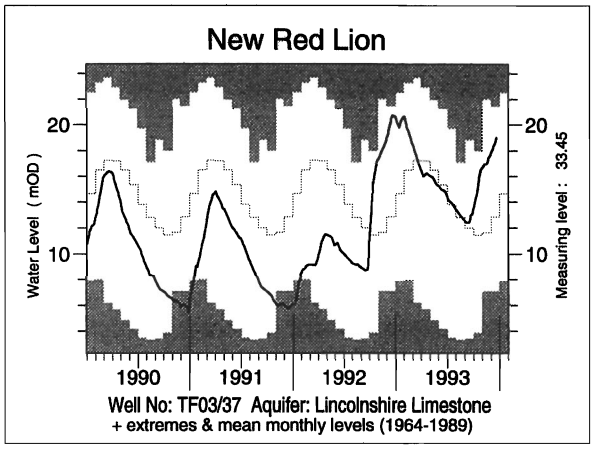



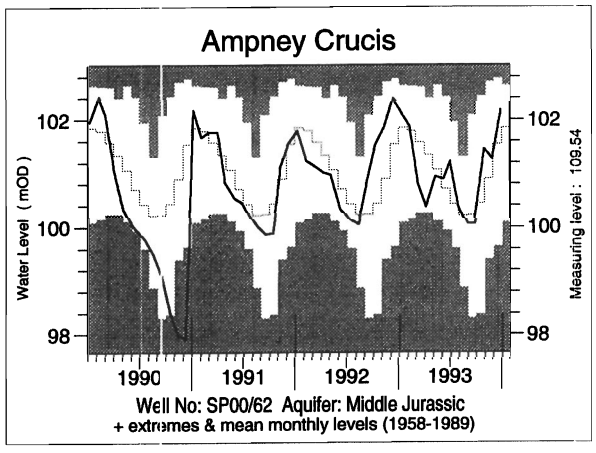



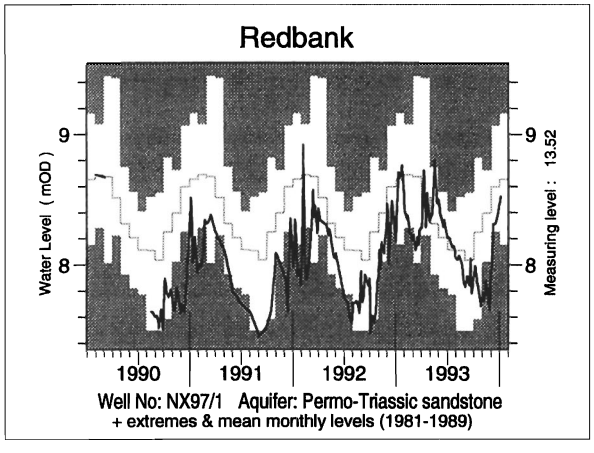



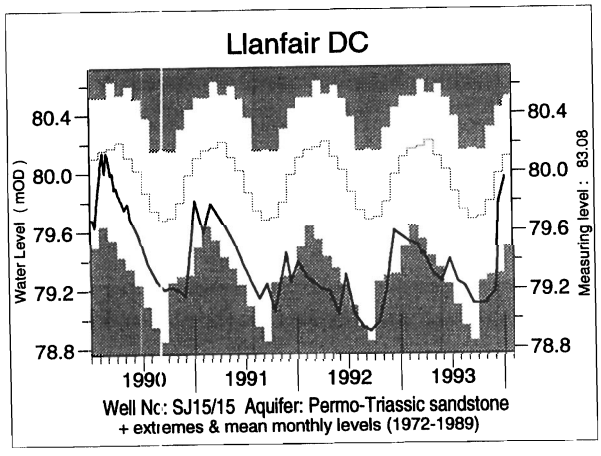



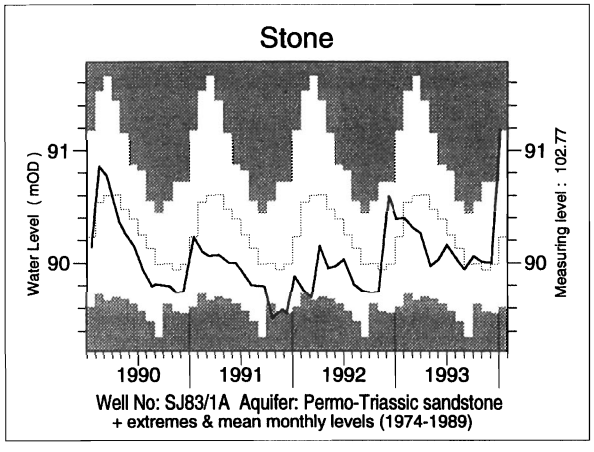

West Woodyates Manor
Water Level ( mOD )
110
100
90
80
70
1990
1991
1992
1993
Measuring level : 110.88
Well No: SU01/5B Aquifer: Chalk and Upper Greensand
+ extremes & mean monthly levels (1942-1989)

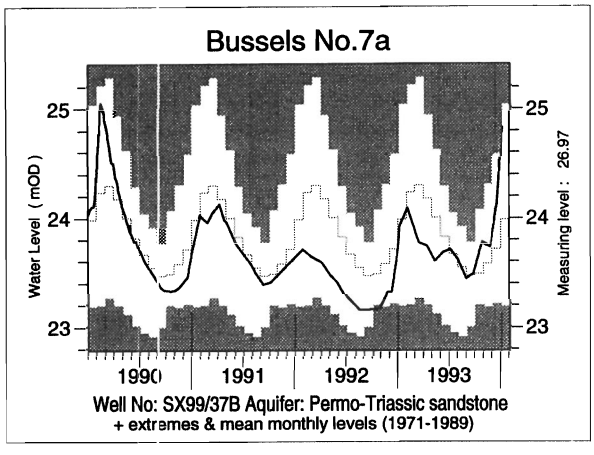

New Red Lion
Water Level ( mOD )
20
10
1990
1991
1992
1993
Measuring level : 33.45
Well No: TF03/37 Aquifer: Lincolnshire Limestone
+ extremes & mean monthly levels (1964-1989)

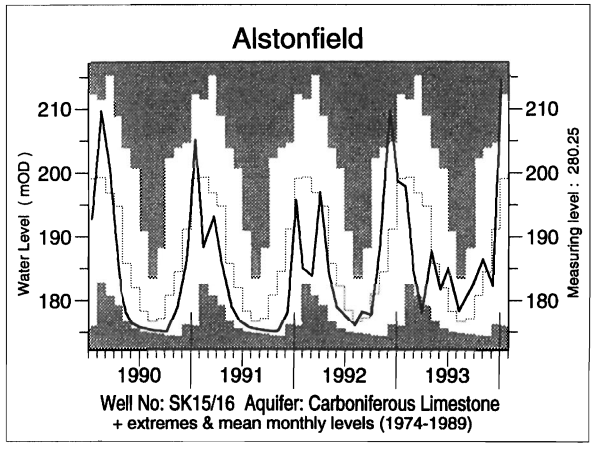

Ampney Crucis
Water Level ( mOD )
102
100
98
1990
1991
1992
1993
Measuring level : 109.54
Well No: SP00/62 Aquifer: Middle Jurassic
+ extremes & mean monthly levels (1958-1989)


Redbank
Water Level ( mOD )
9
8
1990
1991
1992
1993
Measuring level : 13.52
Well No: NX97/1 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1981-1989)


Llanfair DC
Water Level ( mOD )
80.4
80.0
79.6
79.2
78.8
1990
1991
1992
1993
Measuring level : 83.08
Well No: SJ15/15 Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1972-1989)


Stone
Water Level ( mOD )
91
90
1990
1991
1992
1993
Measuring level : 102.77
Well No: SJ83/1A Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1974-1989)


Bussels No.7a
Water Level ( mOD )
25
24
23
1990
1991
1992
1993
Measuring level : 26.97
Well No: SX99/37B Aquifer: Permo-Triassic sandstone
+ extremes & mean monthly levels (1971-1989)


Alstonfield
Water Level ( mOD )
210
200
190
180
1990
1991
1992
1993
Measuring level : 280.25
Well No: SK15/16 Aquifer: Carboniferous Limestone
+ extremes & mean monthly levels (1974-1989)

## TABLE 5 A COMPARISON OF DECEMBER GROUNDWATER LEVELS: 1992 AND 1993

| Site | Aquifer | Records commence | Average December level | December 1992 | | Dec/Jan 1993/4 | | No of years Dec level <1993 | Least pre-1993 level |
|---|---|---|---|---|---|---|---|---|---|
| | | | | day | level | day | level | | any month |
| Dalton Holme | C & UGS | 1889 | 15.79 | 31/12 | 16.11 | 31/12 | 17.51 | >10 | 9.64 |
| Little Brocklesby | C & UGS | 1926 | 11.69 | 22/12 | 12.97 | 29/12 | 17.64 | >10 | 4.53 |
| Washpit Farm | C & UGS | 1950 | 43.54 | 01/12 | 40.70 | 04/01 | 47.11 | >10 | 40.30 |
| The Holt | C & UGS | 1964 | 86.79 | 02/12 | 86.13 | 20/12 | 90.01 | >10 | 83.90 |
| Therfield Rectory | C & UGS | 1883 | 77.84 | 01/12 | 72.23 | 29/12 | 78.69 | >10 | dry <71.6 |
| Redlands Hall | C & UGS | 1964 | 39.12 | 11/12 | 37.46 | 10/12 | 40.82 | >10 | 32.29 |
| Rockley | C & UGS | 1933 | 133.82 | 27/12 | 143.15 | 29/12 | 138.63 | >10 | dry <128.9 |
| Little Bucket Farm | C & UGS | 1971 | 63.88 | 31/12 | 72.71 | 10/01 | 79.21 | >10 | 56.77 |
| Compton House | C & UGS | 1894 | 39.64 | 30/12 | 51.29 | 30/12 | 54.31 | >10 | 27.64 |
| Chilgrove House | C & UGS | 1836 | 50.01 | 30/12 | 64.78 | 30/12 | 69.80 | >10 | 33.46 |
| West Dean No.3 | C & UGS | 1940 | 1.96 | 23/12 | 2.48 | 30/12 | 2.97 | >10 | 1.01 |
| Lime Kiln Way | C & UGS | 1969 | 124.84 | 30/12 | 124.07 | 29/12 | 124.75 | 10 | 123.70 |
| Ashton Farm | C & UGS | 1974 | 67.12 | 31/12 | 71.29 | 31/12 | 71.48 | >10 | 63.10 |
| West Woodyates Manor | C & UGS | 1942 | 85.95 | 31/12 | 98.72 | 31/12 | 99.34 | >10 | 67.62 |
| New Red Lion | LLst | 1964 | 12.49 | 31/12 | 20.60 | 21/12 | 19.02 | >10 | 3.29 |
| Ampney Crucis | Mid Jur | 1958 | 101.97 | 09/12 | 102.99 | 29/12 | 102.73 | >10 | 97.38 |
| Yew Tree Farm | PTS | 1973 | 13.61 | 30/12 | 13.69 | 11/01 | 14.19 | >10 | 8.43 |
| Llanfair D.C | PTS | 1972 | 79.92 | 07/12 | 79.60 | 05/01 | 79.96 | >10 | 78.85 |
| Morris Dancers | PTS | 1969 | 32.53 | 14/12 | 31.88 | 14/12 | 32.05 | 3 | 30.87 |
| Stone | PTS | 1974 | 90.10 | 07/12 | 90.59 | 05/01 | 91.19 | >10 | 89.34 |
| Skirwith | PTS | 1978 | 130.01 | 30/12 | 130.21 | 30/12 | 130.21 | 7 | 129.44 |
| Redbank | PTS | 1981 | 8.40 | 31/12 | 8.18 | 04/01 | 8.52 | 8 | 7.45 |
| Bussels No.7A | PTS | 1972 | 23.72 | 30/12 | 23.70 | 05/01 | 24.83 | >10 | 22.90 |
| Rushyford NE | MgLst | 1967 | 71.58 | 31/12 | 74.91 | 22/12 | 76.45 | >10 | 64.77 |
| Peggy Ellerton | MgLst | 1968 | 34.14 | 07/12 | 32.29 | 08/12 | 32.58 | 3 | 31.10 |
| Alstonfield | CLst | 1974 | 192.33 | 07/12 | 209.62 | 05/01 | 214.39 | >10 | 174.22 |

groundwater levels are in metres above Ordnance Datum

| | | | |
|---|---|---|---|
| C & UGS | Chalk and Upper Greensand | Mid Jur | Middle Jurassic limestones |
| LLst | Lincolnshire Limestone | MgLst | Magnesian Limestone |
| PTS | Permo-Triassic sandstones | CLst | Carboniferous Limestone |

Note: Beginning with January 1994, the format of this table will be revised to reflect the improvement in the groundwater situation; the emphasis over most of the last five years has been on drought conditions.

**FIGURE 3 LOCATION MAP OF GAUGING STATIONS AND GROUNDWATER INDEX WELLS**