HYDROLOGICAL SUMMARY FOR ENGLAND AND WALES
MARCH 1989

Data for this March review, which also includes a preliminary hydrological assessment of the 1988/89 winter, have been provided, principally, by the Water Authorities and the Meteorological Office. These data have been used in conjunction with historical data held on the Surface Water Archive (IH) and the Groundwater Archive (BGS) to chart the 1988/89 drought's progress and assess its intensity.

A substantial proportion of the recent data featured in this note is of a provisional nature and subject to later revision.

'AT A GLANCE'

The complexion of the 1988/89 drought, which had achieved a notable magnitude by mid-February, has changed considerably as a result of sustained rainfall over the subsequent 6-8 weeks. In relation to water resources this rainfall came at a crucial time; with soil moisture deficits (SMDs) of very modest proportions in most areas, the precipitation has been particularly hydrologically effective. Consequently the end-of-March outlook is very much more reassuring than seemed likely in early February. However the situation remains fragile in some areas and this month's rainfall will be an important determining factor regarding the drought's impact on river flows and water supplies through the summer months.

The drought may be considered to be a long-term shortfall, beginning in many areas as early as February 1988, which intensified significantly over the winter period - see the monthly rainfall histograms presented in Figure 1. Accumulated rainfall deficits remain considerable away from the western hills and the Pennines but parallels with the 1976 situation - which were certainly compelling in early February - are now appropriate for a few localities only. Generally, river flows have increased briskly and - except for the very slow responding catchments - monthly mean flows are within the normal range over wide areas. Reservoirs have benefited from substantial inflows and many strategically important impoundments - chiefly in the West and North - may be expected to remain close to capacity later into the year than would normally be the case. In those areas of central and southern England which have been the focus of most concern, further sustained rainfall in April will be required for the summer to be faced with confidence but the recent, healthy, increase in groundwater levels is encouraging.

There is now no realistic prospect of many springs and bournes flowing again until the autumn. The associated loss of amenity and aquatic habitats throughout the early months of 1989, in particular, has been serious but is not unprecedented; similar conditions obtained in 1964/65, 1972/73 and 1975/76.

Groundwater recharge, to most aquifers, has been plentiful since mid-February. Currently groundwater levels are rising at a time when, normally, a decline from the early spring peak may be anticipated as natural drainage (and abstractions) exceed aquifer replenishment. In the Chalk of Yorkshire and the Lincolnshire Limestone groundwater recoveries have, as yet, been very modest but in the South many observation boreholes are approaching average levels (a few are above) and in some areas groundwater storage is greater than at the same time last year.

RAINFALL

The sequence of Atlantic frontal systems which crossed England and Wales in late February continued throughout much of March bringing rainfall at fairly regular intervals to all areas. The synoptic situation entered a changeable phase from the 25th; the re-establishment of anticyclonic conditions over north-west Europe brought easterly and, then, southerly airstreams across the British Isles but precipitation amounts continued to be significant.

Table 1 gives the monthly rainfall totals for 1988/89 commencing in October. March rainfall for England and Wales was well above average (142 per cent of the 1941-70 mean) but significant regional variations also occurred. Precipitation in some western districts was almost twice the average whereas only a little over half the normal rainfall was recorded in a few north-eastern coastal localities. Also tabulated are the provisional winter (October-March) rainfall totals for each Water Authority together with the corresponding estimated return period. In most western regions winter rainfall may be seen to be within the normal range, albeit still significantly below average, following abundant precipitation in recent weeks. Southern and eastern regions had a considerably drier winter with accumulated rainfall deficits of an appreciable magnitude; the Southern Water shortfall, for instance, represents almost three times the average April rainfall. A measure of the impact of the recent rainfall may be obtained by comparing the estimated return period for the winter rainfall with that for the November-January period (see Table 1). Generally speaking a regional drought of notable severity has given way to significant rainfall deficits, mostly in eastern areas. The final two weeks of February and the first three weeks of March proved pivotal to the drought's development. Over this five week period rainfall in the regions upon which most concern was then focused (the Thames, Southern and Wessex Water Authority areas) was close to 200 per cent of the long term average. This was insufficient to make good the large winter shortfalls but, with evaporation losses still modest, it contributed significantly to river runoff and aquifer recharge.

The Water Authority figures presented in Table 1 mask some important local differences in precipitation amounts. For some eastern districts, particularly north of the Wash, late-winter and early-spring rainfall has barely exceeded the average and only a modest diminution in the drought's intensity could be detected by the end of March.

Sustained rainfall, with some snow, has been a feature of the first ten days of April - a number of districts have already reached their average April rainfall total - and a more meaningful picture of the drought's hydrological status will emerge when the effect of this rainfall, in terms of runoff and recharge, has been determined.

SOIL MOISTURE DEFICITS

Soil moisture deficits for most of March were, generally, modest throughout most of lowland England and soils remained at field capacity in the west and north (apart from some eastern coastal districts). Over much of Lincolnshire, the Lower Trent Valley and adjacent to the Thames estuary, MORECS data confirm that there has been no return to field capacity throughout the entire winter. To the north of Nottingham deficits at the end of March still approached 60 mm, the greatest March deficits in a record extending back to 1961; corresponding deficits in 1965 and 1976 were, however, only marginally smaller.

After fluctuating in March, SMDs - in those areas below field capacity - generally decreased somewhat in early April and were eliminated in the lower Thames Valley. Prospects for further significant recharge in April are good.

RUNOFF

Since the drought of 1975/76 winter runoff has, generally, exceeded the long term average, notably so in some years. By contrast 1988/89 has been a very dry winter in runoff terms. Regional runoff variations have also been considerable. In a few western catchments October-March runoff totals have been very high; the River Lune, for instance, recorded a winter runoff total which ranks second only to that of 1967/68 - see Table 2. By contrast, winter runoff for some southern rivers was the lowest on record - in isolated cases falling well below the corresponding total for 1975/76. Table 2 gives the monthly catchment runoff totals for October to March together with the accumulated total and its rank (for comparison, the corresponding figure for 1975/76 is given) for a set of catchments in England and Wales. Reference to the Sussex Ouse and the Hampshire Itchen provides an insight into the magnitude of the 1988/89 hydrological drought; in both cases the winter runoff is unprecedented. This, together with the acceleration in evaporation rates through April as the days lengthen and crops utilise more water, suggests a worrying water resources outlook over the summer and autumn periods. However, the runoff distribution through the winter provides grounds for some optimism. River flows, including those in areas where the drought has been severe, increased significantly through February and substantially in March. This much-delayed upturn in runoff rates has increased monthly mean flows to, typically, 2-8 times those experienced towards the end of the winter. In early April river flows, with a few important exceptions, were generally above average in western regions and well within the normal spring range elsewhere.

For a selection of rivers, Figure 2 shows the 1987-89 monthly mean flows together with the associated maximum, mean and minimum flows for the preceding record. The lack of any real seasonal upturn in 1988 and the recent sharp increase in runoff is well illustrated by the River Thames hydrograph. Similar, but less dramatic, contrasts are evident on the other hydrographs; the Yorkshire Derwent is an exception - the March mean flow is considerably below average. The Thames flows serve as a useful indicator of the very unusual runoff distribution in 1988/89. Over the six month winter period almost half the total runoff occurred in the final six weeks, a characteristic shared with a number of rivers including the Dorset Stour. In mid-February the Thames flows, measured at Kingston, were typical of late summer and accumulated winter runoff was extremely low. The mean for March, however, had improved to a healthy 116 per cent of the average and the total winter runoff ranks as only the 23rd driest in a 106 year record. Too much can be made of historical comparisons; land use change and the possibility of climatic perturbations imply that such comparisons should be used with caution. Nonetheless, in many parts of England and Wales where a very severe drought was in prospect, the recent heavy runoff - with localised washland flooding in some areas - has transformed the character of the drought.

Many reservoirs are close to capacity, especially the strategically important sites in the Lake District, Wales and the Pennines. Recent replenishment has also been plentiful in the South-East where most major reservoirs (apart for those drawn down in 1988 for maintenance purposes) are more than 85 per cent full and some are at capacity.

Figure 3 is provided as a location map for the rivers featured in this note.

GROUNDWATER

Up to the end of February little or no groundwater recharge had taken place in the principle aquifers of England and Wales. In most areas groundwater levels began to rise (where they had not already done so) during early March. Figure 4 confirms this upturn but assessing the improvement in groundwater resources is complicated by the different lag times between rainfall and water table response in the various observation boreholes. Also, many monitoring boreholes are visited only once a month and the latest available level reading may be somewhat unrepresentative of the situation at the end of March. In the southern Chalk outcrop, the well hydrograph for Compton showed a rise of about 14 metres (by the 4th of April), and approached the seasonal average level. Data for the Chalk aquifer in Dorset and the Berkshire Downs also point to a brisk response to recent recharge. Similarly, at Ampney Crucis in the Great Oolite, the groundwater level rose by some 2.8 metres in March and now exceeds the seasonal mean. By contrast, at the New Red Lion site in the Lincolnshire Limestone, the rise has been very much smaller and groundwater levels remain well below the seasonal average. At the Dalton Holme site in the Yorkshire Chalk, the groundwater levels have remained the lowest on record with only a very small seasonal rise. The broken trace in Figure 4 confirms that levels remain below those recorded in 1976 (when some winter recharge did take place; the drought was less severe than further south). Elsewhere, the well hydrographs clearly suggest that a repetition of the very depressed groundwater levels experienced in the summer of 1976 is exceedingly unlikely.

Using the seasonal fluctuations from the well hydrographs, it is possible to estimate the percentage of the mean annual replenishment that had been received to the end of March 1989 - see Figure 5. In Yorkshire and in the northern part of East Anglia, less than 10 per cent had been received, while from the Northumbrian coast to Kent and East Sussex the recharge was less than 50 per cent (Figure 5). Elsewhere, the recharge generally exceeded 50 per cent, and probably exceeded 100 per cent in the north-west of England. A separate assessment by Thames Water suggests that most of their aquifer units received between half and two-thirds of normal recharge over the winter period. This represents a very considerable increase in storage compared with mid-February and in some parts of the English lowlands exceeds that available in early April last year. Recharge during 1986/87, and in other recent years, has continued into May. Should this occur again in 1989, the effects of the winter drought will be small. Additional recharge will be particularly welcome in the Yorkshire Chalk and the Lincolnshire Limestone where currently the outlook is less encouraging.

IH/BGS

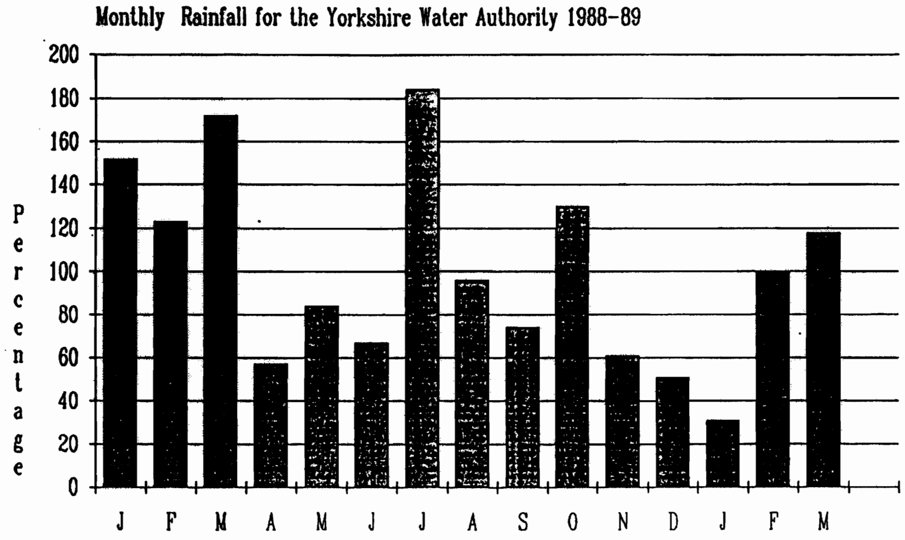
11/4/89

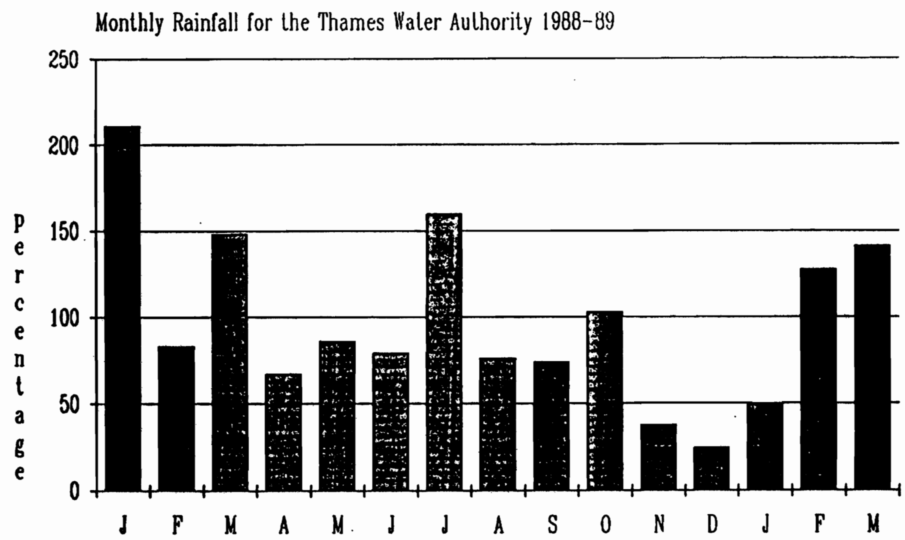
TABLE 1 1988/9 RAINFALL IN MM AND AS A PERCENTAGE OF THE 1941-70 AVERAGE

		Oct	Nov	Dec	Jan	Feb	Mar	Oct-Mar	Shortfall Oct-Mar (mm)	Approx Return* Period for Oct-Mar Rainfall (Yrs)	Approx Return* Period for Nov-Jan Rainfall (Yrs)
		1988/89									
England and Wales	mm	89	48	41	44	78	84	384	96	5-10	50
	%	107	49	46	51	121	142	80			
WATER AUTHORITIES											
North West	mm	120	67	86	68	123	113	577	47	<5	10-20
	%	102	55	72	61	151	157	92			
Northumbria	mm	101	73	38	32	70	55	368	75	5	20
	%	135	78	51	40	106	105	83			
Severn Trent	mm	62	38	34	35	65	69	303	86	5-10	25-50
	%	95	48	49	51	122	132	78			
Yorkshire	mm	90	54	38	24	64	63	333	94	5-10	50
	%	130	61	51	31	100	118	78			
Anglia	mm	52	36	22	31	34	48	223	78	10	20-30
	%	100	58	42	59	81	121	74			
Thames	mm	66	28	16	31	60	65	267	92	5-10	75-100
	%	103	38	24	50	129	141	74			
Southern	mm	84	32	20	29	62	75	302	137	10-20	>100
	%	108	34	25	38	109	144	69			
Wessex	mm	101	34	22	44	89	87	377	94	5	75-100
	%	123	35	24	52	151	149	80			
South West	mm	144	55	56	65	135	115	570	116	<5	50
	%	127	41	41	50	151	137	83			
Welsh	mm	125	67	65	80	140	151	628	109	<5	25-50
	%	97	47	45	59	146	174	85			

Note: December, January, February and March rainfalls are based upon MORECS figures supplied by the Meterological Office.
*The return periods have been estimated from data provided by the Meteorological Office.

FIGURE 1 MONTHLY RAINFALLS AS A PERCENTAGE OF THE LONG TERM AVERAGE - JANUARY 1988 TO MARCH 1989





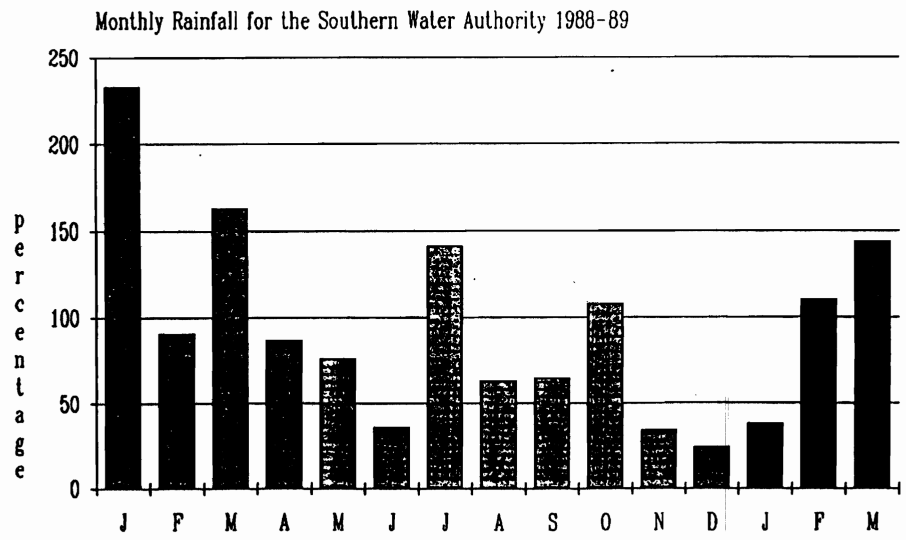
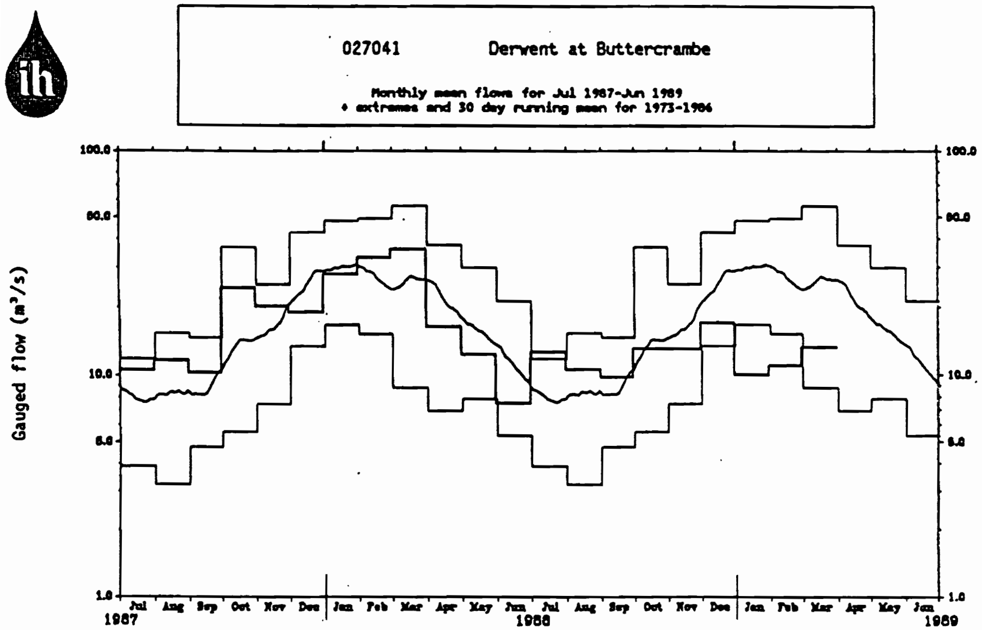
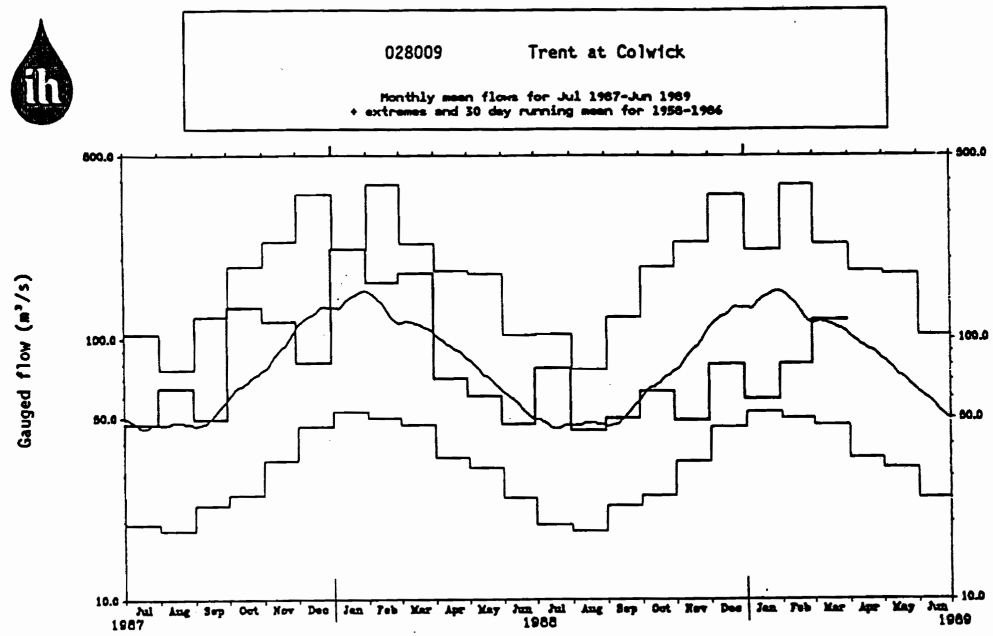


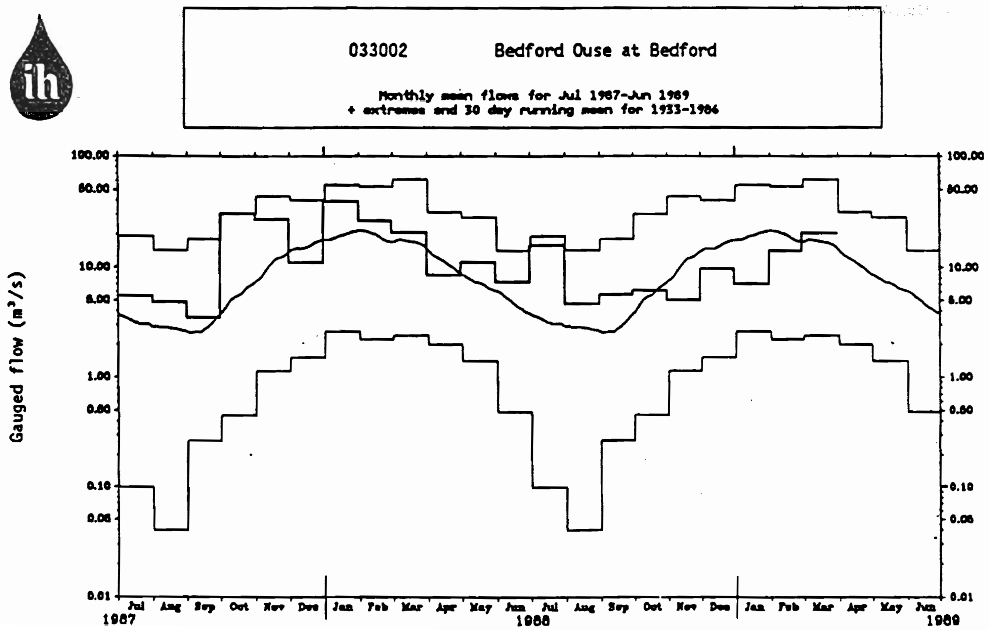
TABLE 2 CATCHMENT RUNOFF IN MM AND AS A PERCENTAGE OF LTA

River/Station Name		Oct 1988	Nov 1988	Dec 1988	Jan 1989	Feb 1989	Mar 1989	Oct 1988-Mar 1989	Rank/No. of Years	Oct 1975-Mar 1976
Wharfe at Flint Ml	mm	80	65	81	42	64	95	427	11/34	310
	%	125	80	84	43	84	127	87		63
Derwent at B'crambe	mm	22	21	29	17	17	22	128	2/16	27
	%	92	81	67	33	39	49	56		17
Trent at Colwick	mm	23	17	29	21	26	42	158	2/31	84
	%	96	55	64	41	59	105	68		23
Lud at Louth	mm	14	13	17	15	12	16	87	3/21	41
	%	117	87	85	48	33	42	56		26
Witham at Claypole	mm	5	5	9	8	8	12	47	3/30	28
	%	56	42	47	31	28	46	39		23
Ouse at Bedford	mm	11	9	18	13	23	37	111	14/56	27
	%	110	45	64	36	85	119	70		17
Colne at Lexden	mm	9	8	11	13	14	23	114	24/30	33
	%	100	62	65	59	74	128	114		33
Thames at Kingston	mm	14	12	15	13	19	36	109	23/106	60
(nat)	%	108	57	50	35	59	116	66		36
Coln at Bibury	mm	15	15	18	15	19	48	130	3/26	55
	%	88	60	44	30	56	91	55		23
Kennet at Theale	mm	18	14	16	16	19	31	114	3/28	71
	%	113	70	59	46	32	82	67		42
Ouse at Gold Bridge	mm	13	10	11	8	12	44	98	1/28	119
	%	43	20	20	13	25	98	35		42
Test at Broadlands	mm	20	20	20	20	20	31	131	3/31	109
	%	87	80	67	51	40	79	70		58
Itchen at Highbrdge	mm	27	27	27	26	25	41	174	1/31	181
	%	87	77	63	53	46	79	68		70
Stour at Throop	mm	25	13	20	19	28	57	162	2/16	85
	%	109	38	59	31	49	110	56		29
Tone at Bishops H	mm	42	20	26	25	54	80	249	5/28	119
	%	156	45	38	31	72	138	72		34
Severn at Bewdley	mm	41	22	36	27	45	77	249	13/68	146
	%	121	41	57	38	64	167	77		45
Yscir at Pont'yscir	mm	91	39	66	92	130	182	600	2/16	416
	%	98	28	43	64	123	160	81		55
Dee at Manley Hall	mm	107	60	94	75	88	183	607	16/51	412
	%	120	115	69	56	84	194	90		61
Lune at Caton	mm	129	68	168	256	167	191	979	23/24	569
	%	71	42	86	174	192	193	133		77

FIGURE 2 MONTHLY HYDROGRAPHS







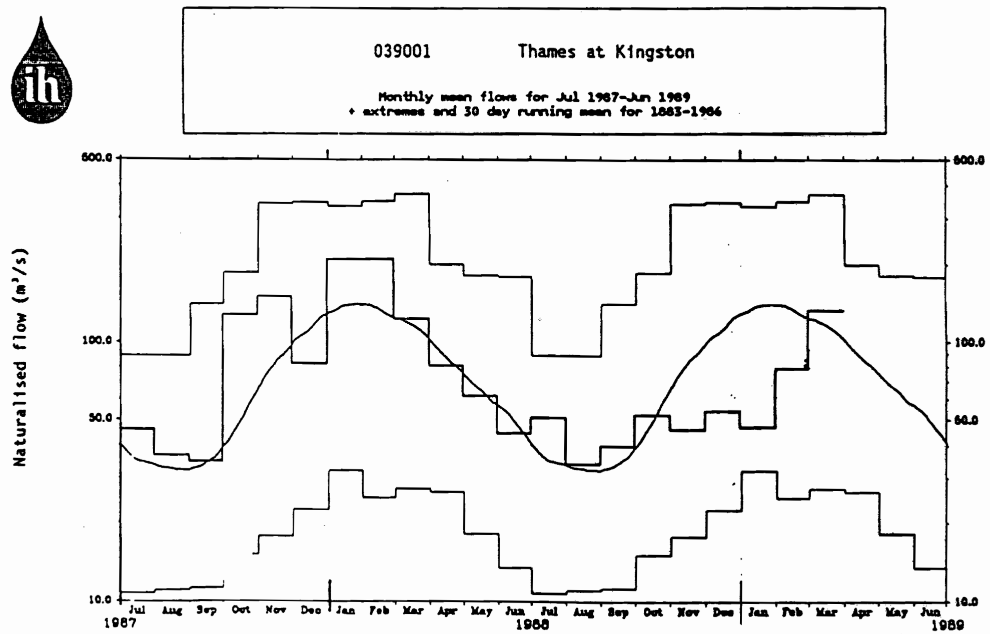
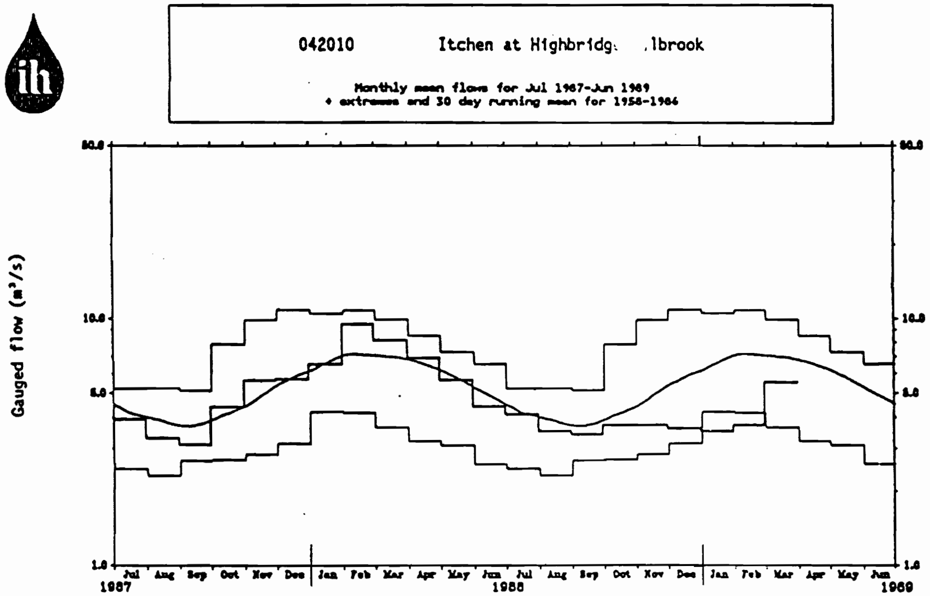


FIGURE 2 CONTD



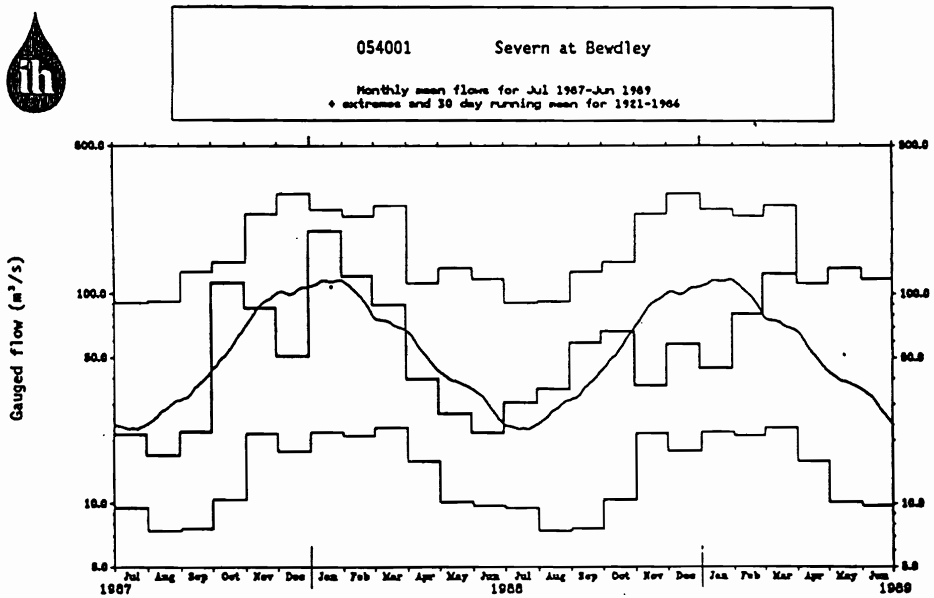


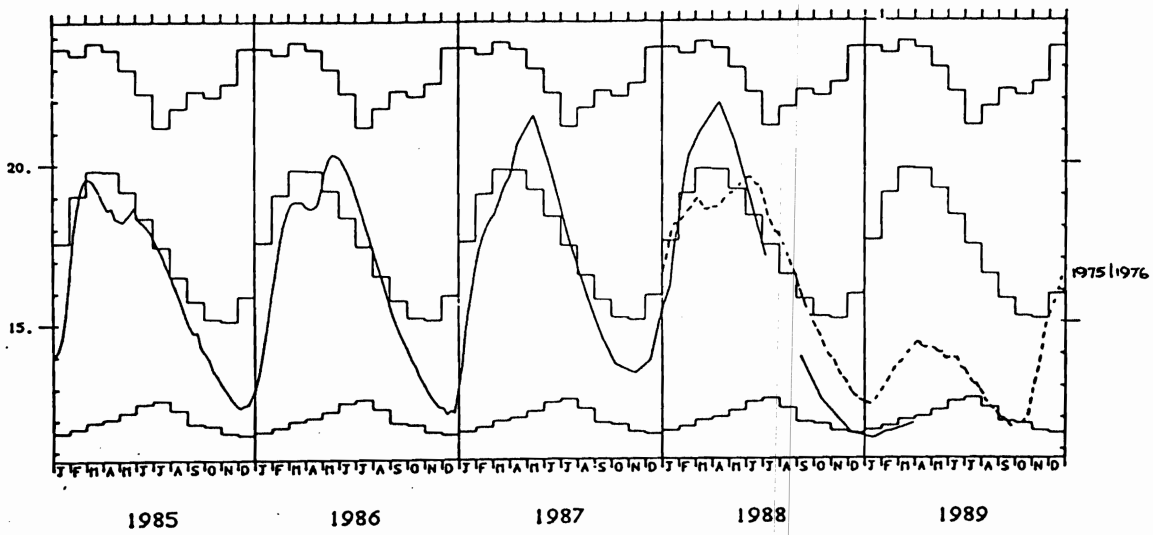
FIGURE 3 GAUGING STATION LOCATION MAP

FIGURE 4 GROUNDWATER OBSERVATION WELL HYDROGRAPHS

Site name: DALTON HOLME

National grid reference: SE 9651 4530 | Well number: SE94/5

Aquifer: CHALK AND UPPER GREENSAND | Measuring level: 33.50



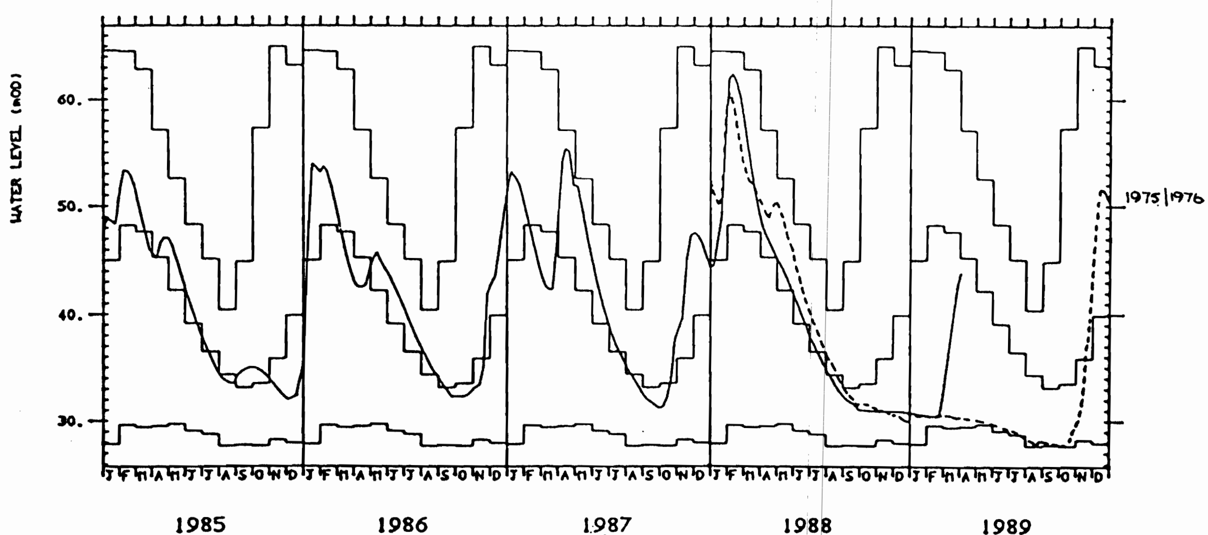
Max, Min and Mean values calculated from years 1889 TO 1988

A break in the data line indicates a recording interval of greater than 8 weeks

Site name: COMPTON HOUSE

National grid reference: SU 7755 1490 | Well number: SU71/23

Aquifer: CHALK AND UPPER GREENSAND | Measuring level: 81.37



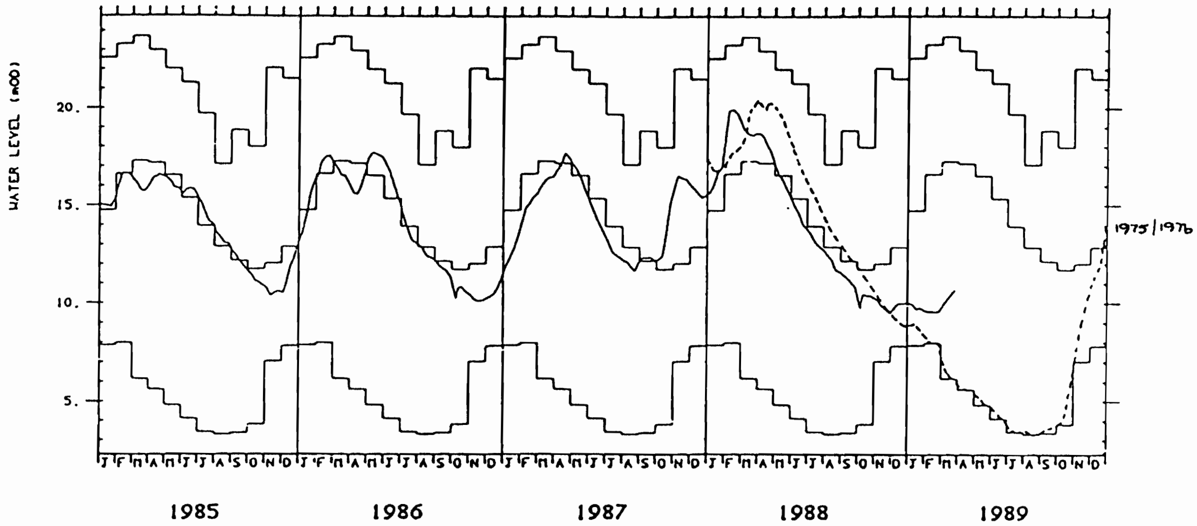
Max, Min and Mean values calculated from years 1893 TO 1988

FIGURE 4 CONTD

Site name: NEW RED LION

National grid reference: TF 0885 3034 Well number: TF03/37

Aquifer: LINCOLNSHIRE LIMESTONE Measuring level: 33.82



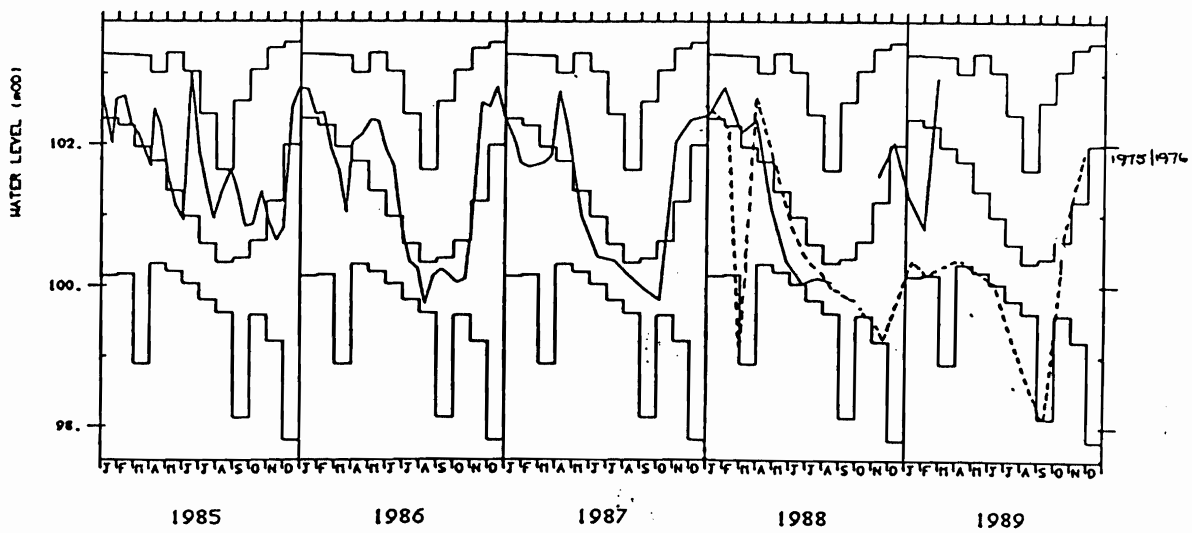
Max, Min and Mean values calculated from years 1964 TO 1988

A break in the data line indicates a recording interval of greater than 8 weeks

Site name: AMPNEY CRUCIS

National grid reference: SP 0595 0190 Well number: SP00/62

Aquifer: MIDDLE JURASSIC Measuring level: 109.70



Max, Min and Mean values calculated from years 1958 TO 1988

A break in the data line indicates a recording interval of greater than 8 weeks

FIGURE 5 AREAL DISTRIBUTION OF THE PERCENTAGE OF THE MEAN ANNUAL RECHARGE RECEIVED BY AQUIFERS UP TO THE END OF MARCH (APPROXIMATELY) 1989. BASED ON GROUNDWATER LEVEL OBSERVATION WELL HYDROGRAPHS.