

1989/049



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Low Flow Study - 1989 Drought

Interim Report June/July 1989

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INTRODUCTION

This report is the second in a series whose purpose is to provide monthly low flow estimates throughout the summer of 1989 to Department of the Environment. The estimates are based on two data sets: May daily flows to estimate June minimum flows, and June monthly flows to estimate July minimum flows.

2. CATCHMENTS STUDIED

The analysis and flow estimates centre on the same four surface water catchments as were used in the last report:

Thames at Kingston/Teddington (39001):	1881-1988 gauged flows
	1881-1987 naturalised flows
Medway at Teston (40003):	1956-1987 gauged flows
Sussex Ouse at Gold Bridge (41005):	1960-1987 gauged flows
Itchen at Highbridge (42010):	1958-1987 gauged flows

3. MONTHLY MINIMUM ANALYSIS

Revised tables showing monthly seven day minimum flows for the months April to October, for 10, 20 and 50 year return periods are given in Table 1.

Table 1. 7 DAY MINIMA (cumecs) (percentage of monthly average flow in italics)

39001 THAMES at Kingston (gauged flows) Month	Monthly average flow m^3s^{-1}	Mean		Return Period (years)					
		7 day min		10		20		50	
		m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%
March	104.9	69.1	65.9	29.4	28	22.0	21	13.6	13
April	75.5	52.7	69.8	24.9	33	20.4	27	15.1	20
May	54.0	37.1	68.7	15.7	29	11.9	22	8.1	15
June	37.5	24.3	64.7	10.1	27	7.9	21	5.6	15
July	23.7	17.2	75.2	7.3	31	5.5	23	3.1	13
August	22.1	15.5	70.2	6.6	30	4.6	21	2.4	11
September	23.6	15.7	66.5	7.1	30	5.2	22	3.1	13
October	39.0	21.6	55.4	8.2	21	6.2	16	4.3	11
November	73.3	39.3	53.6	15.4	21	12.5	17	8.1	11

39001 THAMES at Kingston (naturalised flows) Month	Monthly average flow m^3s^{-1}	Mean		Return Period (years)					
		7 day min		10		20		50	
		m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%
March	115.9	80.3	69.3	40.6	35	34.8	30	26.7	23
April	86.5	64.1	74.1	36.3	42	31.1	36	25.1	29
May	65.3	48.6	74.5	26.1	40	22.9	35	18.3	28
June	49.0	36.0	55.5	21.6	44	18.6	32	15.7	32
July	35.2	28.7	81.7	15.1	43	13.4	38	12.0	34
August	32.7	26.0	79.5	14.1	43	11.8	36	10.5	32
September	34.4	26.3	76.4	14.8	43	12.7	37	11.4	33
October	50.1	32.5	64.9	17.5	35	15.5	31	14.0	28
November	84.1	50.6	60.1	22.7	27	20.2	24	18.5	22

42010 ITCHEN at Highbridge (gauged flows) Month	Monthly average flow m^3s^{-1}	Mean		Return Period (years)					
		7 day min		10		20		50	
		m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%
March	7.0	6.5	93.0	4.6	65	3.9	55	3.2	46
April	6.5	6.1	93.9	4.6	71	4.1	63	3.4	52
May	5.8	5.4	92.8	4.1	70	3.6	62	3.1	54
June	4.9	4.6	93.2	3.4	70	3.0	61	2.6	54
July	4.2	3.9	92.9	3.2	77	3.1	73	2.9	68
August	3.9	3.6	92.6	3.0	78	2.9	74	2.7	70
September	3.7	3.4	92.6	2.8	77	2.7	73	2.5	67
October	4.2	3.8	90.9	2.9	70	2.7	66	2.5	61
November	4.9	4.4	89.0	3.0	62	2.8	57	2.5	51

Comment: Very stable flow - even a 1 in 50 year drought only causes flow in any month to be approximately halved.

Table 1. (Contd.)

41005 SUSSEX OUSE at Gold Bridge (gauged flows) Month	Monthly average flow m^3s^{-1}	Mean		Return Period (years)					
		7 day min m^3s^{-1}	%	10		20		50	
				m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%
March	3.09	1.68	54.5	.87	28	.68	22	.49	16
April	2.36	1.43	60.5	.80	34	.66	28	.52	22
May	1.71	1.05	61.6	.55	32	.41	24	.29	17
June	1.09	0.61	55.6	.29	27	.25	23	.20	18
July	0.67	0.44	65.5	.25	37	.21	32	.18	27
August	0.76	0.43	56.9	.22	29	.17	23	.14	18
September	1.06	0.47	44.0	.21	20	.18	17	.13	12
October	2.09	0.82	39.1	.25	12	.19	9	.17	8
November	3.42	1.29	37.6	.38	11	.31	9	.24	7

40003 MEDWAY at Teston (gauged flows) Month	Monthly average flow m^3s^{-1}	Mean		Return Period (years)					
		7 day min m^3s^{-1}	%	10		20		50	
				m^3s^{-1}	%	m^3s^{-1}	%	m^3s^{-1}	%
March	14.9	7.0	46.9	3.7	25	3.3	22	2.5	17
April	10.9	5.9	53.8	3.2	29	2.7	25	2.3	21
May	6.9	4.0	58.6	2.4	35	2.1	31	1.7	25
June	5.3	3.0	56.5	1.5	28	1.2	22	0.7	14
July	3.0	2.1	69.7	1.4	47	1.2	41	1.1	37
August	3.4	2.0	58.8	1.2	35	1.0	30	0.9	25
September	5.0	2.0	44.4	1.2	24	1.0	20	0.9	17
October	9.1	3.2	35.7	1.4	15	1.2	13	1.1	12
November	15.7	5.6	35.6	1.9	12	1.7	11	1.6	10

4. PREDICTING FUTURE MINIMUM FLOWS FROM REGRESSION

Regressions developed in the last report, were used to predict June seven day minima from May seven day minima. The results, with corresponding return periods, are given in Table 2.

Table 2. Predicted June 1989 seven day minimum flows
 (% - percentage of June mean flow
 T - return period in years)

Station	June mean flow	Recorded June 1989 mean flow		Predicted June 1989 7-day minimum flow			Actual June 1989 7-day minimum		
	m ³ s ⁻¹	m ³ s ⁻¹	%	m ³ s ⁻¹	%	T	m ³ s ⁻¹	%	T
39001(g)	37.5	14.5	38.7	16.5	43.9	< 5	-	-	
39001(n)	48.9	33.4	68.2	32.0	65.3	< 5	24.4	49.9	
40003	5.23	2.6	49.7	2.14	40.9	5			
41005	1.10	0.39	35.8	0.43	39.0	< 5			
42010	4.88	3.26	66.8	3.64	74.7	5-10			

It can be seen that in three of the five cases the recorded average June 1989 flow is less than the predicted seven day minimum.

Regressions were also developed to estimate July and August 7-day minimum flows from June average flows. These regressions are given in Table 3, and the results from implementing them on June 1989 mean flows are given in Table 4.

Table 3. Regressions to derive July and August 7-day minima from June mean flow

Station	Regression		
39001(g)	[JULY7DY] = 8.57 + 0.23 [JUNE30DY]	[JUNE30DY]	R ² = 0.405
	[AUG7DY] = 7.43 + 0.22 [JUNE30DY]	[JUNE30DY]	R ² = 0.370
39001(n)	[JULY7DY] = 15.64 + 0.27 [JUNE30DY]	[JUNE30DY]	R ² = 0.493
	[AUG7DY] = 13.69 + 0.25 [JUNE30DY]	[JUNE30DY]	R ² = 0.467
40003	[JULY7DY] = 1.88 + 0.05 [JUNE30DY]	[JUNE30DY]	R ² = 0.094
	[AUG7DY] = 1.87 + 0.04 [JUNE30DY]	[JUNE30DY]	R ² = 0.021
41005	[JULY7DY] = 0.35 + 0.09 [JUNE30DY]	[JUNE30DY]	R ² = 0.231
	[AUG7DY] = 0.37 + 0.07 [JUNE30DY]	[JUNE30DY]	R ² = 0.053
42010	[JULY7DY] = 1.25 + 0.54 [JUNE30DY]	[JUNE30DY]	R ² = 0.786
	[AUG7DY] = 1.36 + 0.45 [JUNE30DY]	[JUNE30DY]	R ² = 0.528

It is worth noting that confidence in a relationship between June 30-day flow and July and August 7-day minimum flows would only be justified for Station 42010 (Itchen at Highbridge), and possibly the Thames naturalised data (39001 (n)).

Table 4. Predicted July and August 7-day minimum flows (from June 1989 mean flow)

Station	Predicted July 7-day minimum			Predicted August 7-day minimum		
	m^3s^{-1}	% July mean	T(yrs)	m^3s^{-1}	% August mean	T(yrs)
39001(g)	11.91	50.3	< 5	10.62	48.1	< 5
39001(n)	24.66	70.1	< 5	22.04	67.4	< 5
40003	2.01	67.0	< 5	1.97	57.9	< 5
41005	0.385	57.5	< 5	0.398	52.4	< 5
42010	3.22	76.7	10	3.00	76.9	10-25

The revised estimate of July 7-day minimum for the naturalised Thames data, using recorded June 7-day minimum flow and the regression supplied on page 6 of the first report, is $21.8 m^3s^{-1}$, or 62.0% of mean July flow. This would have a return period of less than 5 years.

A comparison between predicted May 7-day minimum flows from April mean and April 7-day minimum flows, and recorded May 7-day minimum flows is given in Table 5.

Table 5. Comparison of predicted and recorded May 7-day minimum flows.
 (% - percentage of May mean flow
 T - return period in years)

Station	Recorded			Predicted from April mean			Predicted from April 7-day		
	m^3s^{-1}	%	T	m^3s^{-1}	%	T	m^3s^{-1}	%	T
39001(g)	21.9	40.6	5	57.8	107.0	< 5	47.3	87.5	< 5
39001(n)	41.3	63.3	< 5	53.8	82.4	< 5	57.0	87.3	< 5
40003	2.07	30.0	25	6.70	97.1	< 5	4.27	61.9	< 5
41005	0.63	37.0	5-10	1.08	63.2	< 5	1.16	67.8	< 5
42010	4.27	73.5	5-10	4.70	81.0	5	4.80	82.8	5

MINIMUM FLOW FROM DRY WEATHER FLOW RECESSIONS

Using the recession constants derived in the first report, and end-of-month daily flows, an end-of-following-month daily flow can be derived. This was done using 30 April recorded flow to predict 30 May flow, and 31 May recorded flow to predict 30 June flow. Predicted and recorded flows from 30 May are shown in Table 6 for comparison. 30 July and 31 August flows assume continuous recession throughout the whole of June and July, and June, July and August respectively. Return periods quoted assume that the flows quoted are the monthly minimum.

Table 6. Predicted end-of-month daily flows assuming constant recession

Station	30 May 1989 flow		30 June 1989 flow		30 July 1989 flow		31 August 1989 flow			
	Recorded m^3s^{-1}	T	Predicted m^3s^{-1}	T	Predicted m^3s^{-1}	T	Predicted m^3s^{-1}	T		
39001(g)	11.0	10	11.53	10	2.62	50	0.62	50-100	0.13	100
39001(n)	35.50	< 5	26.40	5	14.60	35	5.69	< 200	2.09	> 500
40003	1.993	5-10	2.110	5-10	0.639	25-50	0.16	> 500	0.04	> 500
41005	0.603	5	0.697	< 5	0.208	10-25	0.12	50	0.07	100
42010	4.147	5-10	3.997	5-10	3.196	10	2.37	200	1.76	> 500

unending recession
- 2 May
- says it's affected?

It can be seen that 30 May 1989 flow was generally quite well predicted. On closer inspection of the May flow record, however, this is coincidental as no station experienced a continuous recession through the month. The recorded Thames naturalised flow for the 30 June was $31.60 m^3s^{-1}$. A return period cannot be assigned to it as it is not the monthly minimum. The revised estimates for 30 July and 31 August flows for the Thames (naturalised), based on recorded 30 June flows are: $12.32 m^3s^{-1}$ (T = 5 years), and $4.51 m^3s^{-1}$ (T = > 200 years) respectively.

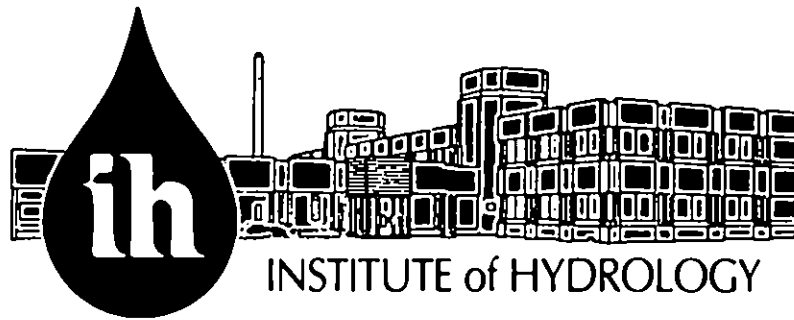
← low during
but 24.4 m³/s lowest
7 days

6. CONTINUING DROUGHT FLOW TABLE

Predicted 7-day minimum monthly flows based on the return period of May 1989 7-day minimum flow, and assuming constant severity (or return period) throughout the rest of the year are given in Table 7.

Table 7. Predicted 7-day monthly minima assuming constant return period.

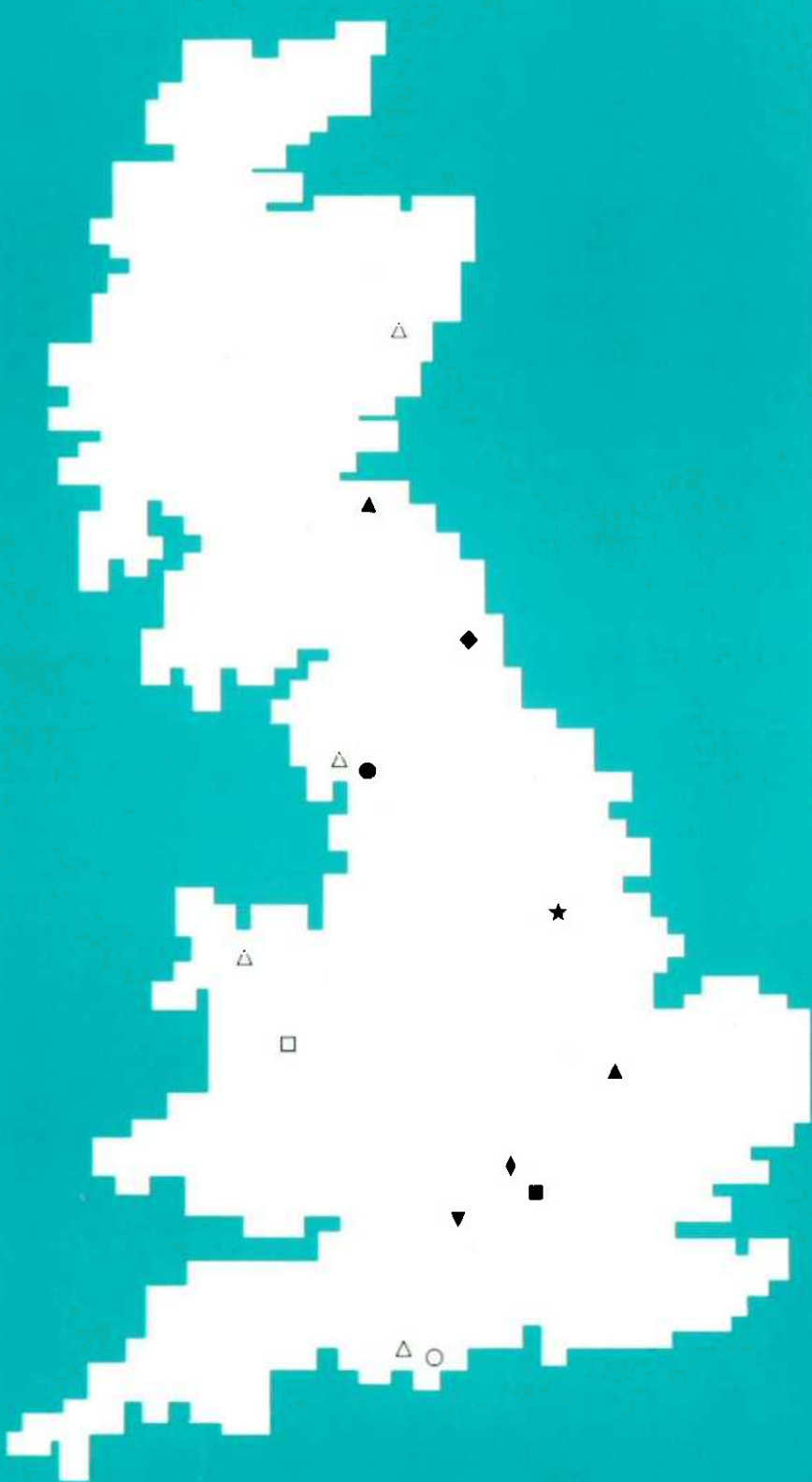
Station	7-day monthly minima (m^3s^{-1})					
	May 1989	T (years)	June 1989	July 1989	August 1989	September 1989
39001(g)	21.90	5	13.89	10.19	9.28	10.62
39001(n)	41.33	< 5	27.93	24.64	21.26	20.64
40003	2.069	25	1.060	1.230	0.900	1.000
41005	0.632	5-10	0.338	0.268	0.236	0.244
42010	4.265	5-10	3.626	3.360	3.081	2.886



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