Annex to Draft Final Report   R & D Project 128

Groundwater Storage in British Aquifers: Chalk

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APPENDIX A
VOLUME OF WATER STORED IN A MULTILAYERED AQUIFER:
Definition and mathematical formulae.

A.1 Introduction

The volume of water in an aquifer can be roughly estimated as the product of the saturated volume and an average storage coefficient. To improve such an estimate the heterogeneity of the rock and the accompanying variations in storage coefficient need to be taken into account. Another complication is that of the elastic storage. The amount of water that a given volume of rock can give up from elastic storage, unlike drainable porosity, is not an intrinsic function of the rock but depends on the initial and final pressures that pertain in the rock. Elastic storage is important under confined conditions but becomes relatively unimportant if conditions change from confined to unconfined.

Because of such complexities a well-founded theory of storage that can be interpreted in a consistent manner for computational purposes must be established, and that is the aim of this appendix. The starting point must be a clear definition of the amount of water stored in a saturated volume of rock.

A.2 Definition of Stored Volume

The following, somewhat restrictive, definition of storage has been adopted:

> *The amount of water stored in an aquifer is the volume of water that would have to be removed in order to reduce the pressure to atmospheric pressure throughout.*

For an unconfined aquifer, the definition corresponds to the water table being lowered to the base of the aquifer. For confined aquifers, however, the removal of water can in reality reduce the pressure below atmospheric pressure, and the definition is *restrictive* in the sense that such a condition is not permitted; a more general definition does not seem possible because of the complexities of the drainage process.

Implicit in the definition is the assumption that the aquifer can drain - otherwise hydrostatic pressures would not allow a uniform atmospheric pressure. For an initially confined aquifer, air must be able to enter at atmospheric pressure once the potentiometric surface drops to the upper surface of the aquifer.

If the base of the aquifer is permeable and the underlying rock has some storage capacity then the definition is incorrect in the sense that elastic storage from that underlying layer will be included. Therefore the definition must assume an impermeable base to the aquifer or, equivalently, that the aquifer must be taken to extend to such a base.

In the same way both elastic storage and drainable porosity (specific yield) of any overlying rock will contribute if the potentiometric surface is initially in that rock. However, the definition implies that regions above the potentiometric surface cannot contribute extractable water. Because of delayed drainage, it must therefore be envisaged that the lowering of the potentiometric surface - implied in the definition - occurs very slowly.

The storage between any two levels (for example, maximum and minimum water levels) is, on the basis of the above definition, simply the difference in total aquifer storage between the two cases with the potentiometric surface at those levels.

Since water is compressible, the volume removed will depend on the pressure at which the volume is measured. It is natural to take that pressure to be atmospheric pressure.

A.3 <u>Formulae for the Stored Volume</u>

Consider a system with N horizontal layers with different storage parameters for each layer (Figure A1). The total volume of water stored when the potentiometric surface is at elevation z is given by

$$V = A \sum_{i=1}^{N} (\lambda_i S_{yi} + \alpha_i S_{si}) \tag{1}$$

where

V = volume of water stored [L^3],

A = area of the system [L^2],

S_{yi} = specific yield of layer i [-],

S_{si} = specific storage of layer i [L^{-1}],

λ_i = length coefficient [L],

and

α_i = area coefficient [L^2].

The two coefficients, λ_i and α_i, are functions of the layer elevations, z_1 to z_N, and the elevation of the potentiometric surface, z:

$$\lambda_i = P(z - z_i) - P(z - z_{i+1}) \tag{2}$$

$$\alpha_i = \frac{1}{2}[P^2(z - z_i) - P^2(z - z_{i+1})] \tag{3}$$

where $P(x) = (|x| + x)/2$ is the 'positive-value' function. It is assumed in (2) and (3) that $z_i \leq z_{i+1}$ and $z_1 \leq z < z_{N+1}$: the potentiometric surface is no higher than the upper layer.

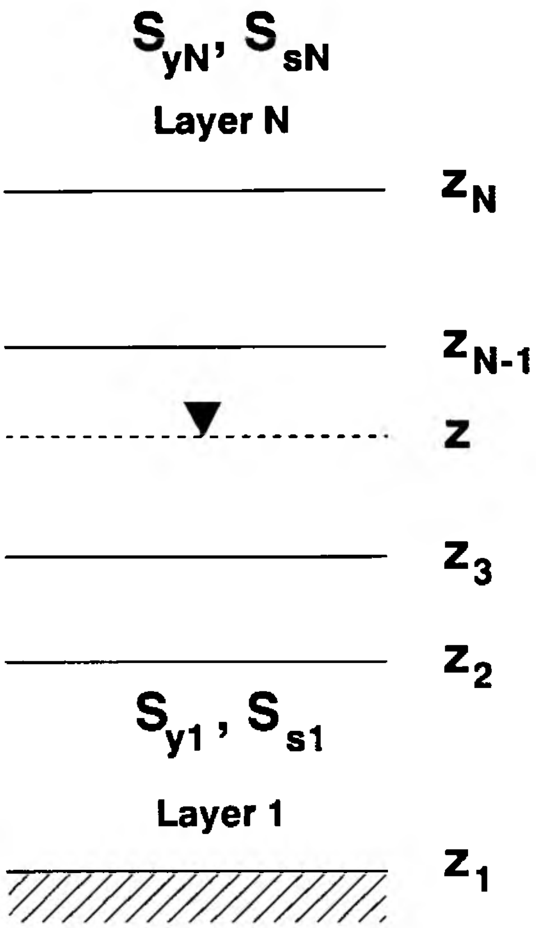

Figure A1. **Notation for the calculation of storage in a multilayered system.**

A.4 Mathematical Derivation

Given here is an outline derivation of the above formulae.

We start by considering the more general case where the storage properties vary continuously with elevation, ζ. When the potentiometric surface is at elevation ζ the storage coefficient, including both drainable and elastic storage, is given by

$$S(\zeta) = S_y(\zeta) + \int_{z_1}^{\zeta} S_s(u)\,du \qquad (4)$$

where the integral is taken from the base of the aquifer. It is implicit in this equation that there is no contribution of water from above the potentiometric surface.

That means that if the potentiometric surface were to drop from $\zeta + \Delta\zeta$ (where $\Delta\zeta$ is small) to ζ , the volume, ΔV, released over area A would be $AS(\zeta)\Delta\zeta$. Therefore, according to the operational definition given earlier, the total volume stored between elevations z_1 and z must be given by

$$V(z) = A\int_{z_1}^{z} S(\zeta)\,d\zeta \tag{5}$$

For the multilayered system depicted in Figure A1, the continuous storage parameters can be expressed in terms of piecewise constant functions:

$$S_y(\zeta) = \sum_{i=1}^{N} H(z_i, z_{i+1}, \zeta) S_{yi} \tag{6}$$

$$S_s(\zeta) = \sum_{i=1}^{N} H(z_i, z_{i+1}, \zeta) S_{si} \tag{7}$$

where $H(a, b, x)$is the 'top-hat' function which has value unity for $a < x < b$ and value zero otherwise. Inserting these expressions into (4) and performing the integral gives

$$S(\zeta) = \sum_{i=1}^{N} \{H(z_i, z_{i+1}, \zeta) S_{yi} + [P(z - z_i) - P(z - z_{i+1})] S_{si}\} \tag{8}$$

where $P(x)$ is the positive-value function (defined earlier).

Inserting this storage coefficient into (5) and performing the integral gives the required result of (1) with the coefficients given by (2) and (3).

A.5 Notes

a. Generally, the layer elevations and the water table will vary across a region; then, in order to find the total stored volume, V^{tot}, Equation (1) needs to be integrated across the region. Normally that will involve sub-dividing the region into, M, small regions (probably on a grid) within each of which the elevations are assumed constant. Then the stored volume is the sum of volumes of the individual sub-regions:

$$V^{tot} = A^{tot} \sum_{i=1}^{N} (\lambda_i^{tot} S_{yi} + \alpha_i^{tot} S_{si}) \tag{9}$$

where

$$\lambda_i^{tot} = \sum_{j=1}^{M} \frac{A_j \lambda_{ij}}{A^{tot}} \tag{10}$$

$$\alpha_i^{tot} = \sum_{j=1}^{M} \frac{A_j \alpha_{ij}}{A_{tot}} \tag{11}$$

b. In the actual Chalk computations, the results recorded were the total coefficients in (9) applying to each storage coefficient:

$$A^{tot}\lambda_i^{tot} = A \sum_{j=1}^{M} \lambda_{ij} \qquad [L^3] \tag{12}$$

and

$$A^{tot}\alpha_i^{tot} = A \sum_{j=1}^{M} \alpha_{ij} \qquad [L^4] \tag{13}$$

where the areas of the grid squares, $A = A_j$, were identical.

c. Artesian conditions with the potentiometric surface above ground level could be included in the above analysis by assigning z_N to the ground surface and zero storage parameters to the upper layer.

d. A non-draining confining layer can be included by setting the specific storage to zero but equating the specific yield to the product of the layer thickness and the (actual) specific storage. However, note the previously mentioned assumption of free air entry, implicit in (4) and (8), which stops any water being obtained from a given layer once the water table (or potentiometric surface) has dropped into the layer below.

e. Specific yields are often derived from pumping tests. Rarely in the analysis of such tests is an attempt made to separate elastic storage from drainable porosity, so the derived *specific yield* will include the specific storage, and therefore represents the storage coefficient - as expressed in (4).

APPENDIX B
CONDITIONS AND CONSTRAINTS ON VOLUME CALCULATIONS

Details of surfaces used in volume calculations appear in Section 4. In this appendix conditions and constraints on these and other surfaces that are written into the volume calculation code are listed. These are not always realistic but were included to ensure that no errors in interpolation had occurred. Checks are given in the order they appear in the code.

A		B
Base of Middle Chalk	$<$	Top of Chalk
Base of Lower Chalk	$<$	Top of Chalk
Base of Middle Chalk	$>$	Base of Lower Chalk
Top of Chalk - 10 metres	$>$	Base of Lower Chalk
Top of Chalk - 30 metres	$>$	Base of Lower Chalk
Base of Middle Chalk + 40 metres	$<$	Top of Chalk
Maximum groundwater level	$<$	Top of Chalk#
Minimum groundwater level	$<$	Top of Chalk#
Lower constraining plane*	$<$	Top of Chalk
Maximum groundwater level	$>$	Base of Lower Chalk
Minimum groundwater level	$>$	Base of Lower Chalk
Lower constraining plane*	$>$	Base of Lower Chalk
Maximum groundwater level	$>$	Lower constraining plane*
Minimum groundwater level	$>$	Lower constraining plane*

* Refers to the gauging station level for the Itchen and Kennet catchments and to Ordnance Datum when that is a constraint in volume calculations for the whole of the Chalk.

\# Applies in unconfined Chalk.

Where any of the above conditions or constraints are broken the value on the grid node of the surface in Column A will be set to that of the surface in Column **B**.

APPENDIX C
COMPUTING PROBLEMS

C.1 Introduction

This Appendix discusses problems specific to the computing requirements of the project. The majority of complications resulted from the very large data sets required to produce the interpolated Chalk and groundwater surfaces for the volume calculations.

C.2 Production of Top of Chalk contours

The top of Chalk surface at outcrop was created using digitised Ordnance Survey topographic contours. The pseudo-scattered data was input along with the borehole data for the covered Chalk into the interpolation package. The size of the files containing the topographic data were initially too large for the software to handle. One possible approach to avoid the problem was to divide the Chalk into sub-areas that could be processed individually; however this would result in mismatching at the boundaries between the sub-areas. Therefore it was decided to invest a substantial amount of time in reducing the data files to a manageable size.

C.3 Transfer of files and execution of code

The contouring packages used (SURFER and ISM) did not have the capability to produce the volumes of saturated chalk required, as to identify the storage values used in the calculations on each node conditional statements were needed. The only practical way of including these conditions was the use of a FORTRAN code. The code required, as input, grid files in ASCII rather than the compact binary format used by the packages.

For such a large grid with its relatively small spacing the size of each ASCII file for the whole of the Chalk was over 3.5 megabytes. The smaller files for the Itchen and Kennet catchments were over 1 megabyte in size; the files totalling over 60 in number. The transfer of these files between a PC and remote mainframe computer was a time-consuming exercise, but was necessary as the catchment interpolation work was carried out on PCs which did not have sufficient memory to run the volume calculation code. Therefore the code had to be run on the IBM mainframe at Wallingford.

After the code was debugged, compiled and running there was reticence, due to its complexity, to repeat the exercise on the mainframe VAX at Keyworth where the work on the whole Chalk had been carried out. Therefore the grid files for the whole of the Chalk had to be transferred down to Wallingford.

C.4 Output data management and error checks

The output from the IBM was large due to the range of storage values and the number of catchments involved. Management of the resulting calculations and the error checks produced was also a time and space-consuming process.

APPENDIX D
TABLES OF GROUNDWATER VOLUMES

D.1 Introduction

The tables presented in this appendix contain the volumes of water calculated from the rock volumes between various levels and the values of specific yield and specific storage given in Table 6.3 of the main report. Each table presents volumes of water stored between the base of chalk and two water levels and between the base of chalk and a datum or gauge level; also presented are the differences between these three storages.

A summary of the most important results is given in Table 8.2 of the main report.

D.2 Explanation of the Tables

1. Volumes are given to only two significant figures.

2. 'Catchment numbers' were used during computation and are of no general interest.

3. Kennet 1989 results are not presented because of a particular data processing problem yet to be dealt with.

4. NRA regions were defined for current purposes of consisting of the following catchment numbers:-

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Yorks    = 26 + 27
Anglian  = 29 + 30 + 33 + 34 + 35 + 36 + 37
Thames   = 38 + 39
Southern = 40 + 41 +42
Wessex   = 43 + 44 + 53
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5. There is some repetition and redundancy in the tables, reflecting the order and groupings of computations.

D.3 Index to Tables

The groundwater volume tables are presented in a somewhat arbitrary order, therefore the following four tables of table numbers are provided as an aid to finding any particular set of results quickly.

TABLE 0.1 Table numbers: UK Hydrometric Areas

Hydrometric Area	1975max-1976min	1976min-1976min-10m.	1988max-1990min	1990min-1990min-10m
Total	1	24	47	70
26	2	25	48	71
27	3	26	49	72
29	4	27	50	73
30	5	28	51	74
33	6	29	52	75
34	7	30	53	76
35	8	31	54	77
36	9	32	55	78
37	10	33	56	89
38	11	34	57	80
39	12	35	58	81
40	13	36	59	82
41	14	37	60	83
42	15	38	61	84
43	16	39	62	85
44	17	40	63	86
53	18	41	64	87

TABLE 0.2 Table numbers: NRA Regions

NRA Region	1975max-1976min	1976min-1976min-10m.	1988max-1990min	1990min-1990min-10m
Yorks	19	42	65	88
Anglian	20	43	66	89
Thames	21	44	67	90
Southern	22	45	68	91
Wessex	23	46	69	92

TABLE 0.3 Table numbers: Itchen (Gauging stations)

Sub-Catchment	1975	1976.	1988	1989
Candover	93	97	101	105
Alre	94	98	102	106
Cheriton	95	99	103	107
Highbridge	96	100	104	108

TABLE 0.4 Table numbers: Kennet (Gauging stations)

Sub-Catchment	1975	1976.	1988	1989
Lambourn	109	113	116	-
Dun	110	114	118	-
Knighton	111	115	119	-
Theale	112	116	120	-

TABLE 1. VOLUMES OF GROUNDWATER
Years: 1975-76. UK Total

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
31000	100000	24000	33000	7600	69000	Start WL	-	Base of Chalk
30000	99000	23000	32000	7300	67000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
31000	100000	24000	33000	7600	69000	Start WL	-	Datum
30000	99000	23000	32000	7300	67000	End WL	-	Datum
890	3500	620	1100	270	2400	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 46% (min.) and 58% (max.).

TABLE 2. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 26

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 1

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3700	1800	2200	250	1400	Start WL	-	Base of Chalk
2000	3600	1700	2200	240	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2000	3700	1800	2200	250	1400	Start WL	-	Datum
2000	3600	1700	2200	240	1400	End WL	-	Datum
30	91	20	38	9.6	53	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 25% (max.).

TABLE 3. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 27

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
25	32	25	32	0	0	Start WL	-	Base of Chalk
24	31	24	31	0	0	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
25	32	25	32	0	0	Start WL	-	Datum
24	31	24	31	0	0	End WL	-	Datum
.70	.88	.70	.88	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 75% (min.) and 63% (max.).

TABLE 4. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 29

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
370	1200	220	410	150	800	Start WL	-	Base of Chalk
340	1100	220	390	130	700	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
370	1200	220	410	150	800	Start WL	-	Datum
340	1100	220	390	130	700	End WL	-	Datum
26	120	8.7	19	17	99	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 21% (min.) and 23% (max.).

TABLE 5. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 30

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
.59	4.0	.36	.58	.23	3.4	Start WL	-	Base of Chalk
.12	2.1	.01	.01	.11	2.1	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
.59	4.0	.36	.58	.23	3.4	Start WL	-	Datum
.12	2.1	.01	.01	.11	2.1	End WL	-	Datum
.48	1.9	.36	.57	.12	1.3	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 3% (min.) and 46% (max.).

TABLE 6. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 33

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 5

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
1200	2300	1200	2000	65	340	Start WL	-	Base of Chalk
1100	2100	1100	1800	53	270	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1200	2300	1200	2000	65	340	Start WL	-	Datum
1100	2100	1100	1800	53	270	End WL	-	Datum
95	230	83	170	12	61	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 22% (min.) and 19% (max.).

TABLE 7. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 34

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 6

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
4700	9500	4000	5300	650	4300	Start WL	-	Base of Chalk
4600	9200	4000	5200	610	3900	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
4700	9500	4000	5300	650	4300	Start WL	-	Datum
4600	9200	4000	5200	610	3900	End WL	-	Datum
91	380	47	75	44	310	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 26% (min.) and 31% (max.).

TABLE 8. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 35

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 7

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
1500	3100	1300	1700	220	1400	Start WL	-	Base of Chalk
1500	3000	1300	1700	210	1300	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1500	3100	1300	1700	220	1400	Start WL	-	Datum
1500	3000	1300	1700	210	1300	End WL	-	Datum
22	75	14	23	8.1	52	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 24% (min.) and 24% (max.).

TABLE 9. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 36

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 8

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
910	2000	770	1100	140	830	Start WL	-	Base of Chalk
880	1800	760	1100	120	720	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
910	2000	770	1100	140	830	Start WL	-	Datum
880	1800	760	1100	120	720	End WL	-	Datum
33	130	16	24	17	110	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 22% (min.) and 25% (max.).

TABLE 10. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 37

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 9

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2300	8100	1700	2400	630	5700	Start WL	-	Base of Chalk
2200	7700	1700	2400	600	5400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2300	8100	1700	2400	630	5700	Start WL	-	Datum
2200	7700	1700	2400	600	5400	End WL	-	Datum
52	370	14	16	37	350	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 89% (min.) and 93% (max.).

TABLE 11. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 38

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 10

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
870	2800	760	1300	110	1500	Start WL	-	Base of Chalk
810	2500	720	1200	95	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
870	2800	760	1300	110	1500	Start WL	-	Datum
810	2500	720	1200	95	1400	End WL	-	Datum
57	280	46	94	11	190	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 24% (min.) and 65% (max.).

TABLE 12. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 39

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 11

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
4300	16000	3200	4800	1100	11000	Start WL	-	Base of Chalk
4100	15000	3100	4500	1000	10000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
4300	16000	3200	4800	1100	11000	Start WL	-	Datum
4100	15000	3100	4500	1000	10000	End WL	-	Datum
280	1300	180	310	97	970	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 62% (min.) and 78% (max.).

TABLE 13. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 40

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 12

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
950	2000	810	1200	130	800	Start WL	-	Base of Chalk
910	2000	790	1200	130	770	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
950	2000	810	1200	130	800	Start WL	-	Datum
910	2000	790	1200	130	770	End WL	-	Datum
33	82	27	45	6.0	38	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 43% (min.) and 44% (max.).

TABLE 14. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 41

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 13

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
920	1400	900	1200	18	180	Start WL	-	Base of Chalk
880	1300	860	1200	16	160	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
920	1400	900	1200	18	180	Start WL	-	Datum
880	1300	860	1200	16	160	End WL	-	Datum
37	70	35	53	1.7	17	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 57% (min.) and 51% (max.).

TABLE 15. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 42

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 14

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
7300	37000	4100	5100	3200	32000	Start WL	-	Base of Chalk
7200	37000	3900	4900	3200	32000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
7300	37000	4100	5100	3200	32000	Start WL	-	Datum
7200	37000	3900	4900	3200	32000	End WL	-	Datum
110	290	100	190	10	100	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 53% (min.) and 51% (max.).

TABLE 16. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 43

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 15

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2800	9600	2100	2700	690	6900	Start WL	-	Base of Chalk
2800	9600	2100	2700	690	6900	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2800	9600	2100	2700	690	6900	Start WL	-	Datum
2800	9600	2100	2700	690	6900	End WL	-	Datum
23	39	23	47	-.80	-8.0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 32% (min.) and 1% (max.).

TABLE 17. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 44

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 16

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
1000	3000	850	1100	190	1900	Start WL	-	Base of Chalk
1000	3000	850	1100	190	1900	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1000	3000	850	1100	190	1900	Start WL	-	Datum
1000	3000	850	1100	190	1900	End WL	-	Datum
.82	8.9	-.05	.17	.87	8.7	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 5% (min.) and 85% (max.).

TABLE 18. VOLUMES OF GROUNDWATER
Years: 1975-76. Hydrometric Area: 53

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 19

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2.4	2.4	2.4	2.4	0	0	Start WL	-	Base of Chalk
2.0	2.1	2.0	2.1	0	0	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2.4	2.4	2.4	2.4	0	0	Start WL	-	Datum
2.0	2.1	2.0	2.1	0	0	End WL	-	Datum
.38	.39	.38	.39	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 5% (min.) and 6% (max.).

TABLE 19. VOLUMES OF GROUNDWATER
Years: 1975-76. NRA Region: Yorks

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 20

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3700	1800	2300	250	1400	Start WL	-	Base of Chalk
2000	3600	1800	2200	240	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2000	3700	1800	2300	250	1400	Start WL	-	Datum
2000	3600	1800	2200	240	1400	End WL	-	Datum
30	92	21	39	9.6	53	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 25% (max.).

TABLE 20. VOLUMES OF GROUNDWATER
Years: 1975-76. NRA Region: Anglia

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 21

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
11000	26000	9200	13000	1900	13000	Start WL	-	Base of Chalk
11000	25000	9000	13000	1700	12000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
11000	26000	9200	13000	1900	13000	Start WL	-	Datum
11000	25000	9000	13000	1700	12000	End WL	-	Datum
320	1300	180	330	130	980	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 34% (min.) and 45% (max.).

TABLE 21. VOLUMES OF GROUNDWATER
Years: 1975-76. NRA Region: Thames

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 22

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
5200	19000	4000	6100	1200	13000	Start WL	-	Base of Chalk
4900	17000	3800	5700	1100	11000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
5200	19000	4000	6100	1200	13000	Start WL	-	Datum
4900	17000	3800	5700	1100	11000	End WL	-	Datum
330	1600	220	400	110	1200	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 56% (min.) and 76% (max.).

TABLE 22. VOLUMES OF GROUNDWATER
Years: 1975-76. NRA Region: Southern

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 23

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
9200	41000	5800	7500	3400	33000	Start WL	-	Base of Chalk
9000	40000	5600	7200	3400	33000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
9200	41000	5800	7500	3400	33000	Start WL	-	Datum
9000	40000	5600	7200	3400	33000	End WL	-	Datum
180	440	170	280	18	160	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 52% (min.) and 50% (max.).

TABLE 23. VOLUMES OF GROUNDWATER
Years: 1975-76. NRA Region: Wessex

UK Hydrometric Areas. Control WL = 1975max.
Start = 1975 max. End = 1976 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 24

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
3800	13000	2900	3800	880	8800	Start WL	-	Base of Chalk
3800	13000	2900	3700	880	8800	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
3800	13000	2900	3800	880	8800	Start WL	-	Datum
3800	13000	2900	3700	880	8800	End WL	-	Datum
24	49	24	48	.07	.73	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 30% (min.) and 16% (max.).

TABLE 24. VOLUMES OF GROUNDWATER
Year: 1976. UK Total

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
31000	100000	23000	32000	7500	69000	Start WL	-	Base of Chalk
29000	92000	22000	29000	6700	63000	End WL	-	Base of Chalk
25000	82000	19000	25000	6000	57000	Datum	-	Base of Chalk
5400	19000	3800	6700	1500	13000	Start WL	-	Datum
3300	11000	2600	4500	730	6100	End WL	-	Datum
2000	8700	1200	2200	790	6500	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 47% (min.) and 56% (max.).

TABLE 25. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 26

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 1

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
2000	3600	1700	2200	240	1400	Start WL	-	Base of Chalk
1900	3400	1700	2100	220	1300	End WL	-	Base of Chalk
1900	3400	1700	2100	220	1300	Datum	-	Base of Chalk
91	240	69	120	22	120	Start WL	-	Datum
31	50	31	47	.48	2.5	End WL	-	Datum
60	190	38	70	21	120	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 27% (max.).

TABLE 26. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 27

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
24	31	24	31	0	0	Start WL	-	Base of Chalk
22	28	22	28	0	0	End WL	-	Base of Chalk
15	19	15	19	0	0	Datum	-	Base of Chalk
9.2	12	9.2	12	0	0	Start WL	-	Datum
7.0	8.6	7.0	8.6	0	0	End WL	-	Datum
2.3	3.2	2.3	3.2	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 46% (min.) and 35% (max.).

TABLE 27. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 29

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
350	1100	220	390	130	730	Start WL	-	Base of Chalk
330	1000	210	380	120	630	End WL	-	Base of Chalk
320	1000	210	380	110	620	Datum	-	Base of Chalk
27	120	7.6	15	19	110	Start WL	-	Datum
4.1	15	2.1	3.8	2.0	11	End WL	-	Datum
23	110	5.5	11	17	97	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 17% (min.) and 23% (max.).

TABLE 28. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 30

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
.12	2.1	.01	.01	.11	2.1	Start WL	-	Base of Chalk
.05	.62	0	0	.05	.62	End WL	-	Base of Chalk
.05	.62	0	0	.05	.62	Datum	-	Base of Chalk
.06	1.4	.01	.01	.06	1.4	Start WL	-	Datum
0	0	0	0	0	0	End WL	-	Datum
.06	1.4	.01	.01	.06	1.4	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 19% (min.) and 87% (max.).

TABLE 29. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 33

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 5

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
1100	2100	1100	1800	53	270	Start WL	-	Base of Chalk
920	1500	890	1400	25	120	End WL	-	Base of Chalk
630	880	630	880	.31	1.6	Datum	-	Base of Chalk
500	1200	450	930	53	270	Start WL	-	Datum
280	650	260	530	24	120	End WL	-	Datum
220	560	190	400	29	150	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 26% (min.) and 21% (max.).

TABLE 30. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 34

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 6

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
4600	9200	4000	5200	610	4000	Start WL	-	Base of Chalk
4200	7300	3800	4900	380	2400	End WL	-	Base of Chalk
3600	5300	3400	4200	180	1200	Datum	-	Base of Chalk
1000	3800	560	1100	430	2800	Start WL	-	Datum
570	2000	370	760	200	1200	End WL	-	Datum
420	1900	190	290	230	1600	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 31% (min.) and 30% (max.).

TABLE 31. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 35

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 7

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
1500	3000	1300	1700	210	1300	Start WL	-	Base of Chalk
1300	2500	1200	1600	140	850	End WL	-	Base of Chalk
1200	2000	1100	1400	95	590	Datum	-	Base of Chalk
260	1000	140	270	110	740	Start WL	-	Datum
120	430	79	170	42	260	End WL	-	Datum
140	580	64	110	72	480	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 30% (min.) and 29% (max.).

TABLE 32. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 36

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 8

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
880	1800	760	1100	120	730	Start WL	-	Base of Chalk
760	1300	700	1000	61	350	End WL	-	Base of Chalk
570	820	550	680	24	140	Datum	-	Base of Chalk
310	1000	210	430	98	590	Start WL	-	Datum
190	530	150	320	37	210	End WL	-	Datum
120	490	61	110	61	380	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 25% (min.) and 22% (max.).

TABLE 33. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 37

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 9

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
2300	7900	1700	2400	620	5600	Start WL	-	Base of Chalk
2200	7100	1600	2300	540	4800	End WL	-	Base of Chalk
2000	6300	1500	2100	470	4300	Datum	-	Base of Chalk
310	1600	170	280	140	1300	Start WL	-	Datum
190	780	120	220	63	560	End WL	-	Datum
130	800	46	61	80	740	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 85% (min.) and 90% (max.).

TABLE 34. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 38

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 10

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
870	3300	740	1200	130	2100	Start WL	-	Base of Chalk
770	2500	660	1000	100	1500	End WL	-	Base of Chalk
550	1700	490	700	67	1000	Datum	-	Base of Chalk
320	1500	250	480	66	1000	Start WL	-	Datum
210	800	180	320	35	480	End WL	-	Datum
100	730	74	160	31	560	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 32% (min.) and 74% (max.).

TABLE 35. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 39

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 11

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
4300	16000	3200	4700	1100	11000	Start WL	-	Base of Chalk
3900	14000	2900	4300	970	9700	End WL	-	Base of Chalk
3000	10000	2300	3200	690	6900	Datum	-	Base of Chalk
1300	5500	870	1400	410	4100	Start WL	-	Datum
930	3900	650	1000	280	2800	End WL	-	Datum
350	1700	220	400	130	1300	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 66% (min.) and 78% (max.).

TABLE 36. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 40

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 12

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
940	2100	790	1200	140	890	Start WL	-	Base of Chalk
870	1900	740	1100	130	830	End WL	-	Base of Chalk
790	1800	660	980	130	800	Datum	-	Base of Chalk
150	300	130	210	17	93	Start WL	-	Datum
87	150	81	120	5.6	29	End WL	-	Datum
62	150	51	87	11	64	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 41% (min.) and 38% (max.).

TABLE 37. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 41

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 13

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
880	1300	860	1200	16	160	Start WL	-	Base of Chalk
850	1300	830	1100	15	150	End WL	-	Base of Chalk
810	1200	800	1100	15	150	Datum	-	Base of Chalk
70	110	68	93	1.9	19	Start WL	-	Datum
34	44	34	43	.10	1.0	End WL	-	Datum
35	68	34	50	1.8	18	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 57% (min.) and 53% (max.).

TABLE 38. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 42

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 14

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
7200	37000	4000	4900	3200	32000	Start WL	-	Base of Chalk
7000	37000	3800	4700	3200	32000	End WL	-	Base of Chalk
6700	36000	3500	4300	3200	32000	Datum	-	Base of Chalk
480	1300	410	620	69	690	Start WL	-	Datum
310	570	290	420	15	150	End WL	-	Datum
170	750	120	200	54	540	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 73% (min.) and 81% (max.).

TABLE 39. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 43

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 15

Total		Chalk		Cover				
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval		
2800	9600	2100	2700	690	6900	Start WL	-	Base of Chalk
2600	8900	2000	2500	650	6500	End WL	-	Base of Chalk
2300	8300	1700	2100	630	6300	Datum	-	Base of Chalk
450	1300	390	610	65	650	Start WL	-	Datum
290	630	270	410	22	220	End WL	-	Datum
160	630	120	200	43	430	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 61% (min.) and 75% (max.).

TABLE 40. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 44

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 16

Total		Chalk		Cover		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval
1000	3000	850	1100	190	1900	Start WL - Base of Chalk
1000	2800	820	1000	180	1800	End WL - Base of Chalk
940	2700	760	930	180	1800	Datum - Base of Chalk
97	240	87	140	9.4	94	Start WL - Datum
56	92	55	82	.97	9.7	End WL - Datum
41	140	32	60	8.4	84	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 62% (min.) and 68% (max.).

TABLE 41. VOLUMES OF GROUNDWATER
Year: 1976. Hydrometric Area: 53

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 19

Total		Chalk		Cover		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval
2.0	2.1	2.0	2.1	0	0	Start WL - Base of Chalk
1.3	1.3	1.3	1.3	0	0	End WL - Base of Chalk
0	0	0	0	0	0	Datum - Base of Chalk
2.0	2.1	2.0	2.1	0	0	Start WL - Datum
1.3	1.3	1.3	1.3	0	0	End WL - Datum
.72	.72	.72	.72	0	0	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 7% (min.) and 7% (max.).

TABLE 42. VOLUMES OF GROUNDWATER
Year: 1976. NRA Region: Yorks

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 20

Total		Chalk		Cover		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	Storage Interval
2000	3600	1800	2200	240	1400	Start WL - Base of Chalk
1900	3400	1700	2200	220	1300	End WL - Base of Chalk
1900	3400	1700	2100	220	1300	Datum - Base of Chalk
100	250	79	130	22	120	Start WL - Datum
38	59	38	56	.48	2.5	End WL - Datum
62	190	41	73	21	120	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 27% (max.).

TABLE 43. VOLUMES OF GROUNDWATER
Year: 1976. NRA Region: Anglia

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 21

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
11000	25000	9000	13000	1700	13000	Start WL	-	Base of Chalk
9700	21000	8400	12000	1300	9200	End WL	-	Base of Chalk
8300	16000	7400	9600	890	6800	Datum	-	Base of Chalk
2400	8800	1500	3000	860	5800	Start WL	-	Datum
1400	4400	990	2000	370	2400	End WL	-	Datum
1100	4400	560	990	490	3400	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 35% (min.) and 38% (max.).

TABLE 44. VOLUMES OF GROUNDWATER
Year: 1976. NRA Region: Thames

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 22

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
5100	19000	3900	5800	1200	13000	Start WL	-	Base of Chalk
4700	16000	3600	5300	1100	11000	End WL	-	Base of Chalk
3500	12000	2800	3900	750	7900	Datum	-	Base of Chalk
1600	7000	1100	1900	480	5200	Start WL	-	Datum
1100	4700	830	1300	320	3300	End WL	-	Datum
450	2400	290	560	160	1800	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 58% (min.) and 77% (max.).

TABLE 45. VOLUMES OF GROUNDWATER
Year: 1976. NRA Region: Southern

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 23

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
9000	41000	5600	7200	3400	33000	Start WL	-	Base of Chalk
8700	40000	5400	6900	3300	33000	End WL	-	Base of Chalk
8300	39000	5000	6300	3300	33000	Datum	-	Base of Chalk
700	1700	610	920	88	810	Start WL	-	Datum
430	770	410	580	21	180	End WL	-	Datum
270	960	210	340	67	620	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 63% (min.) and 72% (max.).

TABLE 46. VOLUMES OF GROUNDWATER
Year: 1976. NRA Region: Wessex

UK Hydrometric Areas. Control WL = 1975max.
Start = 1976 min. End = 1976 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 24

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
3800	13000	2900	3700	880	8800	Start WL	-	Base of Chalk
3600	12000	2800	3500	830	8300	End WL	-	Base of Chalk
3300	11000	2400	3000	810	8100	Datum	-	Base of Chalk
550	1500	480	750	74	740	Start WL	-	Datum
350	720	330	490	23	230	End WL	-	Datum
200	780	150	260	52	520	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 61% (min.) and 74% (max.).

TABLE 47. VOLUMES OF GROUNDWATER
Years: 1988-90. UK Total

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
32000	100000	24000	33000	7700	71000	Start WL	-	Base of Chalk
31000	100000	23000	32000	7600	70000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
32000	100000	24000	33000	7700	71000	Start WL	-	Datum
31000	100000	23000	32000	7600	70000	End WL	-	Datum
710	2100	560	1000	150	1100	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 36% (min.) and 36% (max.).

TABLE 48. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 26

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 1

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3700	1800	2200	250	1500	Start WL	-	Base of Chalk
2000	3600	1700	2200	250	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2000	3700	1800	2200	250	1500	Start WL	-	Datum
2000	3600	1700	2200	250	1400	End WL	-	Datum
38	110	29	56	9.0	50	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 28% (max.).

TABLE 49. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 27

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
25	32	25	32	0	0	Start WL	-	Base of Chalk
24	31	24	31	0	0	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
25	32	25	32	0	0	Start WL	-	Datum
24	31	24	31	0	0	End WL	-	Datum
.93	1.2	.93	1.2	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 75% (min.) and 62% (max.).

TABLE 50. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 29

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
380	1300	230	410	160	870	Start WL	-	Base of Chalk
350	1100	210	390	130	730	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
380	1300	230	410	160	870	Start WL	-	Datum
350	1100	210	390	130	730	End WL	-	Datum
34	160	11	23	23	130	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 22% (min.) and 25% (max.).

TABLE 51. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 30

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
.38	2.6	.20	.31	.17	2.2	Start WL	-	Base of Chalk
.08	1.3	0	0	.08	1.3	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
.38	2.6	.20	.31	.17	2.2	Start WL	-	Datum
.08	1.3	0	0	.08	1.3	End WL	-	Datum
.29	1.2	.20	.31	.09	.90	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 2% (min.) and 46% (max.).

TABLE 52. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 33

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 5

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
1200	2300	1200	2000	61	310	Start WL	-	Base of Chalk
1100	2000	1100	1800	49	250	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1200	2300	1200	2000	61	310	Start WL	-	Datum
1100	2000	1100	1800	49	250	End WL	-	Datum
120	290	110	230	12	63	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 21% (min.) and 17% (max.).

TABLE 53. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 34

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 6

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
4700	9800	4100	5300	680	4400	Start WL	-	Base of Chalk
4700	9400	4000	5200	640	4200	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
4700	9800	4100	5300	680	4400	Start WL	-	Datum
4700	9400	4000	5200	640	4200	End WL	-	Datum
92	380	50	83	43	290	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 25% (min.) and 29% (max.).

TABLE 54. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 35

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 7

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
1500	3200	1300	1800	220	1400	Start WL	-	Base of Chalk
1500	3100	1300	1700	210	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1500	3200	1300	1800	220	1400	Start WL	-	Datum
1500	3100	1300	1700	210	1400	End WL	-	Datum
27	100	15	26	12	78	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 26% (min.) and 26% (max.).

TABLE 55. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 36

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 8

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
910	2000	780	1100	140	830	Start WL	-	Base of Chalk
880	1800	760	1100	120	730	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
910	2000	780	1100	140	830	Start WL	-	Datum
880	1800	760	1100	120	730	End WL	-	Datum
32	120	17	26	16	98	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 21% (min.) and 23% (max.).

TABLE 56. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 37

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 9

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
2300	7800	1700	2400	610	5500	Start WL	-	Base of Chalk
2200	7600	1600	2300	580	5200	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2300	7800	1700	2400	610	5500	Start WL	-	Datum
2200	7600	1600	2300	580	5200	End WL	-	Datum
42	280	14	20	27	250	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 84% (min.) and 90% (max.).

TABLE 57. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 38

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 10

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
910	3100	790	1300	120	1800	Start WL	-	Base of Chalk
870	2800	760	1200	110	1600	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
910	3100	790	1300	120	1800	Start WL	-	Datum
870	2800	760	1200	110	1600	End WL	-	Datum
40	230	30	61	11	170	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 26% (min.) and 70% (max.).

TABLE 58. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 39

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 11

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
4600	17000	3400	5000	1200	12000	Start WL	-	Base of Chalk
4500	17000	3300	4800	1200	12000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
4600	17000	3400	5000	1200	12000	Start WL	-	Datum
4500	17000	3300	4800	1200	12000	End WL	-	Datum
96	-22	120	230	-25	-250	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 14% (min.) and 930% (max.).

TABLE 59. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 40

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 12

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
950	2100	820	1200	130	810	Start WL	-	Base of Chalk
920	2000	790	1200	130	770	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
950	2100	820	1200	130	810	Start WL	-	Datum
920	2000	790	1200	130	770	End WL	-	Datum
35	91	29	52	5.2	39	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 48% (max.).

TABLE 60. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 41

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 13

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
920	1400	900	1200	18	180	Start WL	-	Base of Chalk
880	1300	860	1200	16	160	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
920	1400	900	1200	18	180	Start WL	-	Datum
880	1300	860	1200	16	160	End WL	-	Datum
41	74	40	60	1.4	14	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 61% (min.) and 51% (max.).

TABLE 61. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 42

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 14

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
7300	38000	4000	5000	3300	33000	Start WL	-	Base of Chalk
7200	37000	4000	4900	3200	32000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
7300	38000	4000	5000	3300	33000	Start WL	-	Datum
7200	37000	4000	4900	3200	32000	End WL	-	Datum
88	260	75	130	13	130	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 65% (min.) and 65% (max.).

TABLE 62. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 43

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 15

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
2800	9700	2100	2700	700	7000	Start WL	-	Base of Chalk
2800	9700	2100	2700	700	7000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2800	9700	2100	2700	700	7000	Start WL	-	Datum
2800	9700	2100	2700	700	7000	End WL	-	Datum
11	25	10	24	.13	1.3	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 43% (min.) and 23% (max.).

TABLE 63. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 44

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 16

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
1000	3000	850	1100	190	1900	Start WL	-	Base of Chalk
1000	2900	840	1100	190	1900	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
1000	3000	850	1100	190	1900	Start WL	-	Datum
1000	2900	840	1100	190	1900	End WL	-	Datum
9.2	29	7.7	15	1.4	14	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 56% (min.) and 61% (max.).

TABLE 64. VOLUMES OF GROUNDWATER
Years: 1988-90. Hydrometric Area: 53

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 19

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2.4	2.4	2.4	2.4	0	0	Start WL	-	Base of Chalk
2.0	2.0	2.0	2.0	0	0	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2.4	2.4	2.4	2.4	0	0	Start WL	-	Datum
2.0	2.0	2.0	2.0	0	0	End WL	-	Datum
.38	.38	.38	.38	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 8% (min.) and 8% (max.).

TABLE 65. VOLUMES OF GROUNDWATER
Years: 1988-90. NRA Region: Yorks

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 20

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3700	1800	2300	250	1500	Start WL	-	Base of Chalk
2000	3600	1800	2200	250	1400	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2000	3700	1800	2300	250	1500	Start WL	-	Datum
2000	3600	1800	2200	250	1400	End WL	-	Datum
39	110	30	57	9.0	50	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 28% (max.).

TABLE 66. VOLUMES OF GROUNDWATER
Years: 1988-90. NRA Region: Anglia

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 21

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
11000	26000	9200	13000	1900	13000	Start WL	-	Base of Chalk
11000	25000	9000	13000	1700	12000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
11000	26000	9200	13000	1900	13000	Start WL	-	Datum
11000	25000	9000	13000	1700	12000	End WL	-	Datum
350	1300	220	410	130	920	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 30% (min.) and 38% (max.).

TABLE 67. VOLUMES OF GROUNDWATER
Years: 1988-90. NRA Region: Thames

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 22

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
5500	20000	4200	6300	1300	14000	Start WL	-	Base of Chalk
5300	20000	4000	6000	1300	14000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
5500	20000	4200	6300	1300	14000	Start WL	-	Datum
5300	20000	4000	6000	1300	14000	End WL	-	Datum
140	210	150	290	-14	-80	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 18% (min.) and 22% (max.).

TABLE 68. VOLUMES OF GROUNDWATER
Years: 1988-90. NRA Region: Southern

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 23

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
9200	41000	5800	7500	3400	34000	Start WL	-	Base of Chalk
9000	41000	5600	7200	3400	33000	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
9200	41000	5800	7500	3400	34000	Start WL	-	Datum
9000	41000	5600	7200	3400	33000	End WL	-	Datum
160	430	140	240	20	190	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 60% (min.) and 59% (max.).

TABLE 69. VOLUMES OF GROUNDWATER
Years: 1988-90. NRA Region: Wessex

UK Hydrometric Areas. Control WL = 1975max.
Start = 1988 max. End = 1990 min. Datum = Base of chalk.
Units: millions of cubic metres
Catchment Number: 24

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
3800	13000	2900	3800	890	8900	Start WL	-	Base of Chalk
3800	13000	2900	3700	890	8900	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
3800	13000	2900	3800	890	8900	Start WL	-	Datum
3800	13000	2900	3700	890	8900	End WL	-	Datum
20	55	18	39	1.6	16	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 43% (max.).

TABLE 70. VOLUMES OF GROUNDWATER
Year: 1990. UK Total

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
31000	100000	23000	32000	7700	72000	Start WL	-	Base of Chalk
29000	94000	22000	30000	6900	64000	End WL	-	Base of Chalk
25000	82000	19000	25000	6000	57000	Datum	-	Base of Chalk
5800	22000	4000	6900	1700	15000	Start WL	-	Datum
3600	12000	2700	4600	890	7700	End WL	-	Datum
2200	9500	1300	2300	860	7200	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 58% (max.).

TABLE 71. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 26

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 1

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3600	1700	2200	250	1400	Start WL	-	Base of Chalk
1900	3400	1700	2100	220	1300	End WL	-	Base of Chalk
1900	3400	1700	2100	220	1300	Datum	-	Base of Chalk
88	240	64	100	24	130	Start WL	-	Datum
26	39	25	38	.23	1.2	End WL	-	Datum
62	200	38	66	24	130	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 46% (min.) and 29% (max.).

TABLE 72. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 27

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
24	31	24	31	0	0	Start WL	-	Base of Chalk
21	27	21	27	0	0	End WL	-	Base of Chalk
15	19	15	19	0	0	Datum	-	Base of Chalk
9.1	11	9.1	11	0	0	Start WL	-	Datum
6.8	8.2	6.8	8.2	0	0	End WL	-	Datum
2.3	3.2	2.3	3.2	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 34% (max.).

TABLE 73. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 29

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 3

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
350	1100	210	390	140	740	Start WL	-	Base of Chalk
320	1000	210	380	120	630	End WL	-	Base of Chalk
320	1000	210	380	110	620	Datum	-	Base of Chalk
26	130	5.9	10	20	120	Start WL	-	Datum
1.6	5.9	.76	1.3	.82	4.5	End WL	-	Datum
25	120	5.1	8.9	19	110	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 20% (min.) and 25% (max.).

TABLE 74. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 30

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 4

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
.08	1.3	0	0	.08	1.3	Start WL	-	Base of Chalk
.05	.62	0	0	.05	.62	End WL	-	Base of Chalk
.05	.62	0	0	.05	.62	Datum	-	Base of Chalk
.03	.73	0	0	.03	.73	Start WL	-	Datum
0	0	0	0	0	0	End WL	-	Datum
.03	.73	0	0	.03	.73	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 19% (min.) and 86% (max.).

TABLE 75. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 33

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 5

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
1100	2000	1100	1800	49	250	Start WL	-	Base of Chalk
900	1500	870	1400	21	110	End WL	-	Base of Chalk
630	880	630	880	.31	1.6	Datum	-	Base of Chalk
470	1100	420	870	49	250	Start WL	-	Datum
260	590	240	490	21	100	End WL	-	Datum
210	530	180	380	28	150	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 27% (min.) and 21% (max.).

TABLE 76. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 34

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 6

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
4700	9400	4000	5200	640	4200	Start WL - Base of Chalk
4200	7500	3800	4900	400	2500	End WL - Base of Chalk
3600	5300	3400	4200	180	1200	Datum - Base of Chalk
1000	4100	580	1100	460	3000	Start WL - Datum
610	2200	390	780	220	1400	End WL - Datum
430	1900	190	300	240	1600	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 31% (min.) and 31% (max.).

TABLE 77. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 35

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 7

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
1500	3100	1300	1700	210	1400	Start WL - Base of Chalk
1400	2500	1200	1600	140	850	End WL - Base of Chalk
1200	2000	1100	1400	95	590	Datum - Base of Chalk
280	1100	160	300	120	760	Start WL - Datum
130	460	93	200	42	260	End WL - Datum
140	610	66	100	76	500	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 29% (min.) and 29% (max.).

TABLE 78. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 36

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 8

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
880	1800	760	1100	120	730	Start WL - Base of Chalk
760	1400	700	1000	62	360	End WL - Base of Chalk
570	820	550	680	24	140	Datum - Base of Chalk
310	1000	210	430	99	600	Start WL - Datum
190	540	150	320	38	220	End WL - Datum
120	480	59	110	61	380	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 25% (min.) and 22% (max.).

TABLE 79. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 37

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 9

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
2300	7900	1700	2400	620	5600	Start WL	-	Base of Chalk
2200	7200	1600	2300	540	4900	End WL	-	Base of Chalk
2000	6300	1500	2100	470	4300	Datum	-	Base of Chalk
310	1600	170	280	140	1300	Start WL	-	Datum
190	810	120	200	68	610	End WL	-	Datum
130	770	51	74	76	700	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 82% (min.) and 88% (max.).

TABLE 80. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 38

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 10

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
910	3500	770	1200	140	2200	Start WL	-	Base of Chalk
790	2600	680	1100	110	1600	End WL	-	Base of Chalk
550	1700	490	700	67	1000	Datum	-	Base of Chalk
360	1700	290	540	76	1200	Start WL	-	Datum
240	900	200	360	39	540	End WL	-	Datum
120	830	86	180	37	650	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 29% (min.) and 74% (max.).

TABLE 81. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 39

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 11

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
4500	17000	3300	4800	1200	12000	Start WL	-	Base of Chalk
4100	15000	3000	4400	1100	11000	End WL	-	Base of Chalk
3000	10000	2300	3200	690	6900	Datum	-	Base of Chalk
1600	7200	990	1600	560	5600	Start WL	-	Datum
1100	5100	730	1100	390	3900	End WL	-	Datum
430	2100	260	450	170	1700	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 65% (min.) and 80% (max.).

TABLE 82. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 40

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 12

Total		Chalk		Cover		Storage Interval
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	
940	2100	790	1200	140	880	Start WL - Base of Chalk
870	1900	740	1100	130	820	End WL - Base of Chalk
790	1800	660	980	130	800	Datum - Base of Chalk
150	290	140	210	14	77	Start WL - Datum
85	140	81	120	4.3	22	End WL - Datum
64	150	55	93	9.6	55	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 40% (min.) and 35% (max.).

TABLE 83. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 41

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 13

Total		Chalk		Cover		Storage Interval
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	
880	1300	870	1200	16	160	Start WL - Base of Chalk
850	1300	840	1100	15	150	End WL - Base of Chalk
810	1200	800	1100	15	150	Datum - Base of Chalk
71	110	69	91	1.9	19	Start WL - Datum
40	50	40	50	.02	.16	End WL - Datum
31	60	29	42	1.8	18	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 60% (min.) and 57% (max.).

TABLE 84. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 42

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 14

Total		Chalk		Cover		Storage Interval
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax	
7200	38000	4000	4900	3300	33000	Start WL - Base of Chalk
7000	37000	3800	4700	3200	32000	End WL - Base of Chalk
6700	36000	3500	4300	3200	32000	Datum - Base of Chalk
520	1500	430	630	90	900	Start WL - Datum
330	680	300	430	25	250	End WL - Datum
190	850	120	210	65	650	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 75% (min.) and 83% (max.).

TABLE 85. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 43

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 15

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2800	9700	2100	2700	710	7100	Start WL	-	Base of Chalk
2600	9100	2000	2500	660	6600	End WL	-	Base of Chalk
2300	8300	1700	2100	630	6300	Datum	-	Base of Chalk
470	1400	390	610	79	790	Start WL	-	Datum
310	740	270	410	33	330	End WL	-	Datum
160	660	120	200	46	460	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 63% (min.) and 77% (max.).

TABLE 86. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 44

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 16

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
1000	3000	840	1100	190	1900	Start WL	-	Base of Chalk
990	2800	810	1000	180	1800	End WL	-	Base of Chalk
940	2700	760	930	180	1800	Datum	-	Base of Chalk
89	220	80	130	8.9	89	Start WL	-	Datum
51	83	51	75	.77	7.7	End WL	-	Datum
38	140	30	54	8.1	81	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 64% (min.) and 70% (max.).

TABLE 87. VOLUMES OF GROUNDWATER
Year: 1990. Hydrometric Area: 53

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 19

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2.0	2.0	2.0	2.0	0	0	Start WL	-	Base of Chalk
1.2	1.2	1.2	1.2	0	0	End WL	-	Base of Chalk
0	0	0	0	0	0	Datum	-	Base of Chalk
2.0	2.0	2.0	2.0	0	0	Start WL	-	Datum
1.2	1.2	1.2	1.2	0	0	End WL	-	Datum
.81	.81	.81	.81	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 6% (min.) and 6% (max.).

TABLE 88. VOLUMES OF GROUNDWATER
Year: 1990. NRA Region: Yorks

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 20

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
2000	3600	1800	2200	250	1400	Start WL	-	Base of Chalk
1900	3400	1700	2200	220	1300	End WL	-	Base of Chalk
1900	3400	1700	2100	220	1300	Datum	-	Base of Chalk
97	250	73	120	24	130	Start WL	-	Datum
33	48	32	46	.23	1.2	End WL	-	Datum
64	200	41	70	24	130	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 46% (min.) and 29% (max.).

TABLE 89. VOLUMES OF GROUNDWATER
Year: 1990. NRA Region: Anglia

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 21

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
11000	25000	9000	13000	1800	13000	Start WL	-	Base of Chalk
9700	21000	8400	12000	1300	9400	End WL	-	Base of Chalk
8300	16000	7400	9600	890	6800	Datum	-	Base of Chalk
2400	9000	1600	3000	890	6000	Start WL	-	Datum
1400	4600	1000	2000	390	2600	End WL	-	Datum
1100	4400	560	980	500	3400	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 35% (min.) and 38% (max.).

TABLE 90. VOLUMES OF GROUNDWATER
Year: 1990. NRA Region: Thames

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 22

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
5400	21000	4100	6100	1400	15000	Start WL	-	Base of Chalk
4900	18000	3700	5500	1200	12000	End WL	-	Base of Chalk
3500	12000	2800	3900	750	7900	Datum	-	Base of Chalk
1900	9000	1300	2100	640	6800	Start WL	-	Datum
1400	6000	930	1500	430	4500	End WL	-	Datum
560	3000	350	630	210	2300	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 57% (min.) and 79% (max.).

TABLE 91. VOLUMES OF GROUNDWATER
Year: 1990. NRA Region: Southern

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 23

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
9000	41000	5600	7300	3400	34000	Start WL	-	Base of Chalk
8800	40000	5400	6900	3300	33000	End WL	-	Base of Chalk
8300	39000	5000	6300	3300	33000	Datum	-	Base of Chalk
740	1900	630	940	110	1000	Start WL	-	Datum
450	870	420	600	29	270	End WL	-	Datum
280	1100	210	340	76	720	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 65% (min.) and 75% (max.).

TABLE 92. VOLUMES OF GROUNDWATER
Year: 1990. NRA Region: Wessex

UK Hydrometric Areas. Control WL = 1975max.
Start = 1990 min. End = 1990 min. - 10m. Datum = O.D.
Units: millions of cubic metres
Catchment Number: 24

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
3800	13000	2900	3700	900	9000	Start WL	-	Base of Chalk
3600	12000	2800	3500	840	8400	End WL	-	Base of Chalk
3300	11000	2400	3000	810	8100	Datum	-	Base of Chalk
560	1600	470	740	88	880	Start WL	-	Datum
360	820	320	480	34	340	End WL	-	Datum
200	800	150	250	54	540	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 63% (min.) and 75% (max.).

TABLE 93. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 42009 Candover

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 12/3/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 2

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
33	50	33	50	0	0	Start WL	-	Base of Chalk
32	49	32	49	0	0	End WL	-	Base of Chalk
22	33	22	33	0	0	Gauge level	-	Base of Chalk
12	18	12	18	0	0	Start WL	-	Gauge level
11	16	11	16	0	0	End WL	-	Gauge level
1.1	1.8	1.1	1.8	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 61% (min.) and 38% (max.).

TABLE 94. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 42007 Alre

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 12/3/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
36	55	36	55	0	0	Start WL	-	Base of Chalk
34	52	34	52	0	0	End WL	-	Base of Chalk
24	36	24	36	0	0	Gauge level	-	Base of Chalk
13	19	13	19	0	0	Start WL	-	Gauge level
11	16	11	16	0	0	End WL	-	Gauge level
2.0	3.0	2.0	3.0	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 51% (min.) and 35% (max.).

TABLE 95. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 42008 Cheriton

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 12/3/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
20	33	20	33	0	0	Start WL	-	Base of Chalk
19	31	19	31	0	0	End WL	-	Base of Chalk
15	24	15	24	0	0	Gauge level	-	Base of Chalk
5.1	9.6	5.1	9.6	0	0	Start WL	-	Gauge level
4.1	7.6	4.1	7.6	0	0	End WL	-	Gauge level
.97	2.0	.97	2.0	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 24% (max.).

TABLE 96. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 42010 Itchen (Highbridge)

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 12/3/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
170	260	170	260	.00	.02	Start WL	-	Base of Chalk
160	250	160	250	.00	.02	End WL	-	Base of Chalk
88	130	88	130	.00	.01	Gauge level	-	Base of Chalk
81	130	81	130	.00	.01	Start WL	-	Gauge level
75	120	75	120	.00	.01	End WL	-	Gauge level
5.9	11	5.9	11	.00	.00	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 52% (min.) and 30% (max.).

TABLE 97. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 42009 Candover

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1976min.
Start = 2/4/76 End = 31/7/76
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
35	53	35	53	0	0	Start WL	-	Base of Chalk
34	51	34	51	0	0	End WL	-	Base of Chalk
23	35	23	35	0	0	Gauge level	-	Base of Chalk
11	17	11	17	0	0	Start WL	-	Gauge level
11	16	11	16	0	0	End WL	-	Gauge level
.72	1.5	.72	1.5	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 55% (min.) and 28% (max.).

TABLE 98. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 42007 Alre

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1976min.
Start = 2/4/76 End = 31/7/76
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
32	49	32	49	0	0	Start WL	-	Base of Chalk
31	48	31	48	0	0	End WL	-	Base of Chalk
22	35	22	35	0	0	Gauge level	-	Base of Chalk
9.5	14	9.5	14	0	0	Start WL	-	Gauge level
8.9	13	8.9	13	0	0	End WL	-	Gauge level
.59	1.1	.59	1.1	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 61% (min.) and 36% (max.).

TABLE 99. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 42008 Cheriton

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1976min.
Start = 2/4/76 End = 31/7/76
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
18	30	18	30	0	0	Start WL	-	Base of Chalk
18	29	18	29	0	0	End WL	-	Base of Chalk
15	22	15	22	0	0	Gauge level	-	Base of Chalk
3.9	7.3	3.9	7.3	0	0	Start WL	-	Gauge level
3.7	6.8	3.7	6.8	0	0	End WL	-	Gauge level
.23	.48	.23	.48	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 47% (min.) and 24% (max.).

TABLE 100. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 42010 Itchen (Highbridge)

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1976min.
Start = 2/4/76 End = 31/7/76
Units: millions of cubic metres
Catchment Number: 0

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
160	250	160	250	0	0	Start WL	-	Base of Chalk
160	240	160	240	0	0	End WL	-	Base of Chalk
88	130	88	130	0	0	Gauge level	-	Base of Chalk
75	120	75	120	0	0	Start WL	-	Gauge level
72	110	72	110	0	0	End WL	-	Gauge level
2.3	4.6	2.3	4.6	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 57% (min.) and 30% (max.).

TABLE 101. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 42009 Candover

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1988min.
Start = 17/3/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 2

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
35	54	35	54	0	0	Start WL	-	Base of Chalk
35	53	35	53	0	0	End WL	-	Base of Chalk
23	35	23	35	0	0	Gauge level	-	Base of Chalk
12	19	12	19	0	0	Start WL	-	Gauge level
12	18	12	18	0	0	End WL	-	Gauge level
.47	1.0	.47	1.0	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 50% (min.) and 25% (max.).

TABLE 102. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 42007 Alre

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1988min.
Start = 17/3/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 3

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval		
33	51	33	51	0	0	Start WL	-	Base of Chalk
31	48	31	48	0	0	End WL	-	Base of Chalk
21	33	21	33	0	0	Gauge level	-	Base of Chalk
12	18	12	18	0	0	Start WL	-	Gauge level
9.9	15	9.9	15	0	0	End WL	-	Gauge level
1.8	2.9	1.8	2.9	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 51% (min.) and 34% (max.).

TABLE 103. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 42008 Cheriton

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1988min.
Start = 17/3/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
23	37	23	37	0	0	Start WL	-	Base of Chalk
22	34	22	34	0	0	End WL	-	Base of Chalk
17	26	17	26	0	0	Gauge level	-	Base of Chalk
5.7	10	5.7	10	0	0	Start WL	-	Gauge level
4.3	7.6	4.3	7.6	0	0	End WL	-	Gauge level
1.4	2.8	1.4	2.8	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 47% (min.) and 25% (max.).

TABLE 104. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 42010 Itchen (Highbridge)

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1988min.
Start = 17/3/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
170	260	170	260	.00	.02	Start WL	-	Base of Chalk
160	250	160	250	.00	.02	End WL	-	Base of Chalk
88	130	88	130	.00	.01	Gauge level	-	Base of Chalk
81	130	81	130	.00	.01	Start WL	-	Gauge level
76	120	76	120	.00	.01	End WL	-	Gauge level
4.9	9.4	4.9	9.4	.00	.00	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 50% (min.) and 28% (max.).

TABLE 105. VOLUMES OF GROUNDWATER
Year: 1989 Gauge: 42009 Candover

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1989min.
Start = 24/4/89 End = 31/7/89
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
35	53	35	53	0	0	Start WL	-	Base of Chalk
35	52	35	52	0	0	End WL	-	Base of Chalk
23	36	23	36	0	0	Gauge level	-	Base of Chalk
12	18	12	18	0	0	Start WL	-	Gauge level
11	17	11	17	0	0	End WL	-	Gauge level
.79	1.3	.79	1.3	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 63% (min.) and 41% (max.).

TABLE 106. VOLUMES OF GROUNDWATER
Year: 1989 Gauge: 42007 Alre

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1989min.
Start = 24/4/89 End = 31/7/89
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
32	50	32	50	0	0	Start WL	-	Base of Chalk
31	47	31	47	0	0	End WL	-	Base of Chalk
22	34	22	34	0	0	Gauge level	-	Base of Chalk
11	16	11	16	0	0	Start WL	-	Gauge level
8.7	13	8.7	13	0	0	End WL	-	Gauge level
1.8	3.1	1.8	3.1	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 31% (max.).

TABLE 107. VOLUMES OF GROUNDWATER
Year: 1989 Gauge: 42008 Cheriton

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1989min.
Start = 24/4/89 End = 31/7/89
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
20	33	20	33	0	0	Start WL	-	Base of Chalk
20	31	20	31	0	0	End WL	-	Base of Chalk
16	24	16	24	0	0	Gauge level	-	Base of Chalk
4.6	8.5	4.6	8.5	0	0	Start WL	-	Gauge level
3.9	7.0	3.9	7.0	0	0	End WL	-	Gauge level
.75	1.5	.75	1.5	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 50% (min.) and 26% (max.).

TABLE 108. VOLUMES OF GROUNDWATER
Year: 1989 Gauge: 42010 Itchen (Highbridge)

Itchen Catchment. Control WL = 1975max. Fixed catchment = 1989min.
Start = 24/4/89 End = 31/7/89
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
170	270	170	270	.00	.04	Start WL	-	Base of Chalk
170	260	170	260	.00	.03	End WL	-	Base of Chalk
92	140	92	140	.00	.02	Gauge level	-	Base of Chalk
82	130	82	130	.00	.02	Start WL	-	Gauge level
77	120	77	120	.00	.02	End WL	-	Gauge level
4.7	8.6	4.7	8.6	.00	.00	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 50% (min.) and 29% (max.).

TABLE 109. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 39019 Lambourn

Kennet Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 1/4/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
48	74	48	74	0	0	Start WL	-	Base of Chalk
46	69	46	69	0	0	End WL	-	Base of Chalk
30	46	30	46	0	0	Gauge level	-	Base of Chalk
18	28	18	28	0	0	Start WL	-	Gauge level
15	23	15	23	0	0	End WL	-	Gauge level
2.5	5.0	2.5	5.0	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 45% (min.) and 23% (max.).

TABLE 110. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 39028 Dun

Kennet Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 1/4/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
8.1	14	8.1	14	0	0	Start WL	-	Base of Chalk
7.7	13	7.7	13	0	0	End WL	-	Base of Chalk
5.6	9.0	5.6	9.0	0	0	Gauge level	-	Base of Chalk
2.4	5.2	2.4	5.2	0	0	Start WL	-	Gauge level
2.1	4.4	2.1	4.4	0	0	End WL	-	Gauge level
.37	.83	.37	.83	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 30% (min.) and 14% (max.).

TABLE 111. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 39043 Kennet (Knighton)

Kennet Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 1/4/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
34	45	34	45	0	0	Start WL	-	Base of Chalk
30	40	30	40	0	0	End WL	-	Base of Chalk
19	25	19	25	0	0	Gauge level	-	Base of Chalk
15	19	15	19	0	0	Start WL	-	Gauge level
11	14	11	14	0	0	End WL	-	Gauge level
3.9	5.2	3.9	5.2	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 26% (min.) and 21% (max.).

TABLE 112. VOLUMES OF GROUNDWATER
Year: 1975 Gauge: 39016 Kennet (Theale)

Kennet Catchment. Control WL = 1975max. Fixed catchment = 1975min.
Start = 1/4/75 End = 31/8/75
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
290	600	270	430	17	170	Start WL	-	Base of Chalk
280	570	260	410	16	160	End WL	-	Base of Chalk
140	240	140	210	3.1	31	Gauge level	-	Base of Chalk
150	370	140	230	14	140	Start WL	-	Gauge level
140	330	120	200	13	130	End WL	-	Gauge level
14	34	13	22	1.1	11	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 34% (min.) and 37% (max.).

TABLE 113. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 39019 Lambourn

Kennet Catchment. Control WL = 1975max. Fixed catchment 1976min.
Start = 15/3/76 End = 15/8/76
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
41	62	41	62	0	0	Start WL	-	Base of Chalk
40	60	40	60	0	0	End WL	-	Base of Chalk
28	43	28	43	0	0	Gauge level	-	Base of Chalk
13	19	13	19	0	0	Start WL	-	Gauge level
12	17	12	17	0	0	End WL	-	Gauge level
1.3	2.1	1.3	2.1	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 51% (min.) and 33% (max.).

TABLE 114. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 39028 Dun

Kennet Catchment. Control WL = 1975max. Fixed catchment 1976min.
Start = 15/3/76 End = 15/8/76
Units: millions of cubic metres
Catchment Number: 3

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
5.8	11	5.8	11	0	0	Start WL	-	Base of Chalk
5.6	10	5.6	10	0	0	End WL	-	Base of Chalk
4.2	6.7	4.2	6.7	0	0	Gauge level	-	Base of Chalk
1.6	3.9	1.6	3.9	0	0	Start WL	-	Gauge level
1.4	3.4	1.4	3.4	0	0	End WL	-	Gauge level
.17	.54	.17	.54	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 28% (min.) and 9% (max.).

TABLE 115. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 39043 Kennet (Knighton)

Kennet Catchment. Control WL = 1975max. Fixed catchment 1976min.
Start = 15/3/76 End = 15/8/76
Units: millions of cubic metres
Catchment Number: 4

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
27	36	27	36	0	0	Start WL	-	Base of Chalk
27	36	27	36	0	0	End WL	-	Base of Chalk
18	24	18	24	0	0	Gauge level	-	Base of Chalk
9.2	12	9.2	12	0	0	Start WL	-	Gauge level
9.1	12	9.1	12	0	0	End WL	-	Gauge level
.01	.27	.01	.27	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 276% (min.) and 9% (max.).

TABLE 116. VOLUMES OF GROUNDWATER
Year: 1976 Gauge: 39016 Kennet (Theale)

Kennet Catchment. Control WL = 1975max. Fixed catchment 1976min.
Start = 15/3/76 End = 15/8/76
Units: millions of cubic metres
Catchment Number: 0

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
260	490	250	390	10	100	Start WL	-	Base of Chalk
250	470	240	380	8.9	89	End WL	-	Base of Chalk
140	210	140	200	1.2	12	Gauge level	-	Base of Chalk
120	280	110	190	9.0	90	Start WL	-	Gauge level
120	250	110	180	7.7	77	End WL	-	Gauge level
6.6	23	5.2	10	1.3	13	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 50% (min.) and 53% (max.).

TABLE 117. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 39019 Lambourn

Kennet Catchment. Control WL = 1975max. Fixed catchment 1988min.
Start = 15/4/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 2

Total		Chalk		Cover		Storage Interval		
Vmin	Vmax	Vmin	Vmax	Vmin	Vmax			
44	67	44	67	0	0	Start WL	-	Base of Chalk
41	62	41	62	0	0	End WL	-	Base of Chalk
32	49	32	49	0	0	Gauge level	-	Base of Chalk
12	18	12	18	0	0	Start WL	-	Gauge level
9.1	13	9.1	13	0	0	End WL	-	Gauge level
2.5	5.0	2.5	5.0	0	0	Start WL	-	End WL

Contribution to total 'Start-End' from elastic storage: 47% (min.) and 25% (max.).

TABLE 118. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 39028 Dun

Kennet Catchment. Control WL = 1975max. Fixed catchment 1988min.
Start = 15/4/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 3

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
7.9	14	7.9	14	0	0	Start WL - Base of Chalk
8.2	15	8.2	15	0	0	End WL - Base of Chalk
5.6	9.0	5.6	9.0	0	0	Gauge level - Base of Chalk
2.3	4.8	2.3	4.8	0	0	Start WL - Gauge level
2.6	5.7	2.6	5.7	0	0	End WL - Gauge level
-.33	-.89	-.33	-.89	0	0	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 39% (min.) and 15% (max.).

TABLE 119. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 39043 Kennet (Knighton)

Kennet Catchment. Control WL = 1975max. Fixed catchment 1988min.
Start = 15/4/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 4

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
33	44	33	44	0	0	Start WL - Base of Chalk
31	41	31	41	0	0	End WL - Base of Chalk
19	26	19	26	0	0	Gauge level - Base of Chalk
14	18	14	18	0	0	Start WL - Gauge level
12	15	12	15	0	0	End WL - Gauge level
2.1	2.6	2.1	2.6	0	0	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 25% (min.) and 21% (max.).

TABLE 120. VOLUMES OF GROUNDWATER
Year: 1988 Gauge: 39016 Kennet (Theale)

Kennet Catchment. Control WL = 1975max. Fixed catchment 1988min.
Start = 15/4/88 End = 31/8/88
Units: millions of cubic metres
Catchment Number: 0

Total Vmin	Total Vmax	Chalk Vmin	Chalk Vmax	Cover Vmin	Cover Vmax	Storage Interval
320	670	300	470	19	190	Start WL - Base of Chalk
300	620	290	450	16	160	End WL - Base of Chalk
180	350	170	250	9.5	95	Gauge level - Base of Chalk
140	320	130	220	9.8	98	Start WL - Gauge level
130	270	120	200	6.8	68	End WL - Gauge level
15	50	12	21	2.9	29	Start WL - End WL

Contribution to total 'Start-End' from elastic storage: 48% (min.) and 54% (max.).

APPENDIX E
ANNUAL HYDROGRAPHS OF DAILY FLOWS FOR THE SELECTED YEARS

E.1 Introduction

Below, hydrographs of daily flow during a calendar year are presented for the catchments and years that were analyzed: 1975, 1976, 1988 and 1989. The maximum of the discharge scale is the same for all years for one station, and determined by the maximum flow on record for that station. Apart from the time plot of daily flows, the graphs also display the base flow line which was separated from the daily flows by a standard Institute of Hydrology algorithm (Section 7). On the graphs the period of analysis is indicated by two bold vertical lines. The graphs are grouped by year to facilitate the comparison of runoff patterns in the catchments. Some features of the presented graphs are commented on below.

E.2 Comments

River Kennet (catchments 39016, 39019, 39028, 39043)

General: The flows recorded in the Kennet at Theale (39016) are not solely derived from Chalk; approximately 10% of the catchment, i.e. the Enbourne catchment, has a predominantly impervious geology of Eocene clays. The responsiveness of the Enbourne catchment results in some high runoff peaks at Theale, higher than expected from a pure Chalk catchment. The different response to precipitation is also reflected in a lower BFI, 0.54 instead of 0.95 in the upstream Chalk catchments (39019, 39028 and 39043), indicating that baseflow comprises a lower fraction of the total runoff than in the other catchments.

A groundwater augmentation scheme has been in operation, pumping water into the River Lambourn when flows were low. This discharge into the river is easily recognisable on the hydrographs, but dates may be verified with the following list of dates when the scheme was operated (provided by Thames NRA):

1 September - 5 December 1975
23 August - 17 November 1976
5 September - 27 September 1989
18 October - 24 November 1990

Apart from groundwater abstraction, there are artificial influences on river flows by mills (in the upper Kennet, 39043) and flows in and out of the Kennet and Avon Canal (in the Dun, 39028). These practises influence more the distribution during a day or week than the total volume of water, and will therefore not have much influence on the volume of base flow which has been calculated.

1975: The hydrograph of the Kennet at Knighton shows some prolonged and relatively high peaks (two to three times the flow recorded during the rest of the summer, and lasting several weeks). These peaks do not occur at the upstream gauging station at Marlborough (39037). Furthermore, the station description mentions occurrences of drowning due to weed growth and a very flat gradient. It was therefore assumed that drowning took place. These peaks do not influence the total <u>volume</u> of base flow to a sufficiently large extent to reject the data for analysis, because the over-estimation balances out the under-estimation.

1976: The only remarkable feature of the 1976 hydrographs, apart from the very low flows, is the sudden increase in flows towards the end of August in the Lambourn at Shaw (39019). This is a result of the operation of the Lambourn groundwater augmentation scheme. The period of analysis therefore has an end date of 15 August.

1988: The hydrographs of this year present a good example of the general statement made above, with short, high runoff peaks in the Kennet at Theale (39016) which are hardly repeated in the other catchments. The sudden dip in the flow record of the Lambourn at Shaw (39019) at the beginning of May is not a data error and probably due to a large but short-term abstraction upstream of the gauging station. The resulting loss in baseflow volume was measured and amounts to 2% of total baseflow during the period that was analysed.

1989: Although the natural recession as derived from the hydrographs continued until October, the operation of the groundwater augmentation scheme from the beginning of September, with a marked impact on the flows in the Lambourn, resulted in a shorter season of analysis. The recession did not start until mid-April.

River Itchen (42007, 42008, 42009, 42010)

General: The irregularity of daily flows as they appear on the hydrographs, is mainly a result of the water management performed for the benefit of the extensive watercress beds and fish farms in the upstream part of the Itchen catchment. The irregularity does not significantly affect the calculated base flow volume.

The operation of the Candover and Alre groundwater augmentation schemes do have an impact on the calculated volume of base flow. The Candover scheme affects riverflow mainly in the Candover Stream and to a small extent in the other rivers in the Itchen catchment (Southern Water Authority, 1979, p.84). The Alre scheme affects flows mainly in the River Alre and to a lesser extend the flow gauged in the other rivers in the Itchen catchment (Southern Science, 1991, p.18). When the schemes were operated, only the directly affected catchments were not analysed. The relevant operational dates are:

Candover scheme
8 May - 10 November 1975 (a few short pumping tests)
3 May - 22 December 1976
9 August - 8 December 1989

Alre scheme
8 May 1989 - 8 February 1990 (severe test pumping)

1975: The flow in all catchments is in recession from the beginning of April until the end of July, when the gauged flows start to increase. The test pumping in the Candover catchment has taken place for 15 days from 8 May, for 10 days from 1 August and for 5 days from 17 August. The total volume pumped was estimated at 0.9×10^6 m^3 (Southern Water Authority, 1979, p.34-35), which is 10% of the estimated total baseflow runoff volume from the Candover catchment. The pumping tests have not visibly altered the hydrographs in the Candover, and the flow data have not been rejected for analysis. However, caution has to be taken in interpreting the resulting baseflow volume. Because of the limited impact on Candover flows itself, the baseflow from peripheral catchments may be assumed unaltered by the pumping tests.

1976: The Candover groundwater augmentation scheme was in operation for most of the summer (from the beginning of May until the end of August), which meant that the measured flows in the Candover catchment were unsuitable for analysis. The depletion of Alre streamflow was estimated at 0.1×10^6 m^3, which is 1% of the calculated baseflow runoff and therefore negligible. The depletion of Itchen flows was estimated at 0.2×10^6 m^3, less than 1% of the calculated baseflow volume, and this can therefore also be ignored (after Southern Water Authority, 1979, p.83).

1988: The flows in all but one catchment were in recession from mid-February, whereas the recession started one month later in the Alre. This difference could be attributed to a difference in the physical characteristics of the Chalk that underlies the catchments. A sustained peak in groundwater levels has been observed in the Northern boundary of the catchment, probably due to the extremely impermeable nature of the Chalk (Southern Science, 1991, p.3). This phenomenon would explain a slow release of the stored water and a delayed start of the recession. Towards the end of August flows start to increase again.

1989: Flows are very irregular in the Alre due to the operation of the groundwater augmentation scheme. The effect of the pumping has been analysed elsewhere (Southern Science, 1991). As a result the 1989 data for the Alre catchment have not been analysed. The groundwater augmentation scheme in the Candover catchment was in operation from the beginning of August, which limited the period that was analysed.

Figure E.1a Kennet at Theale (39016): Hydrograph with separated baseflow for 1975

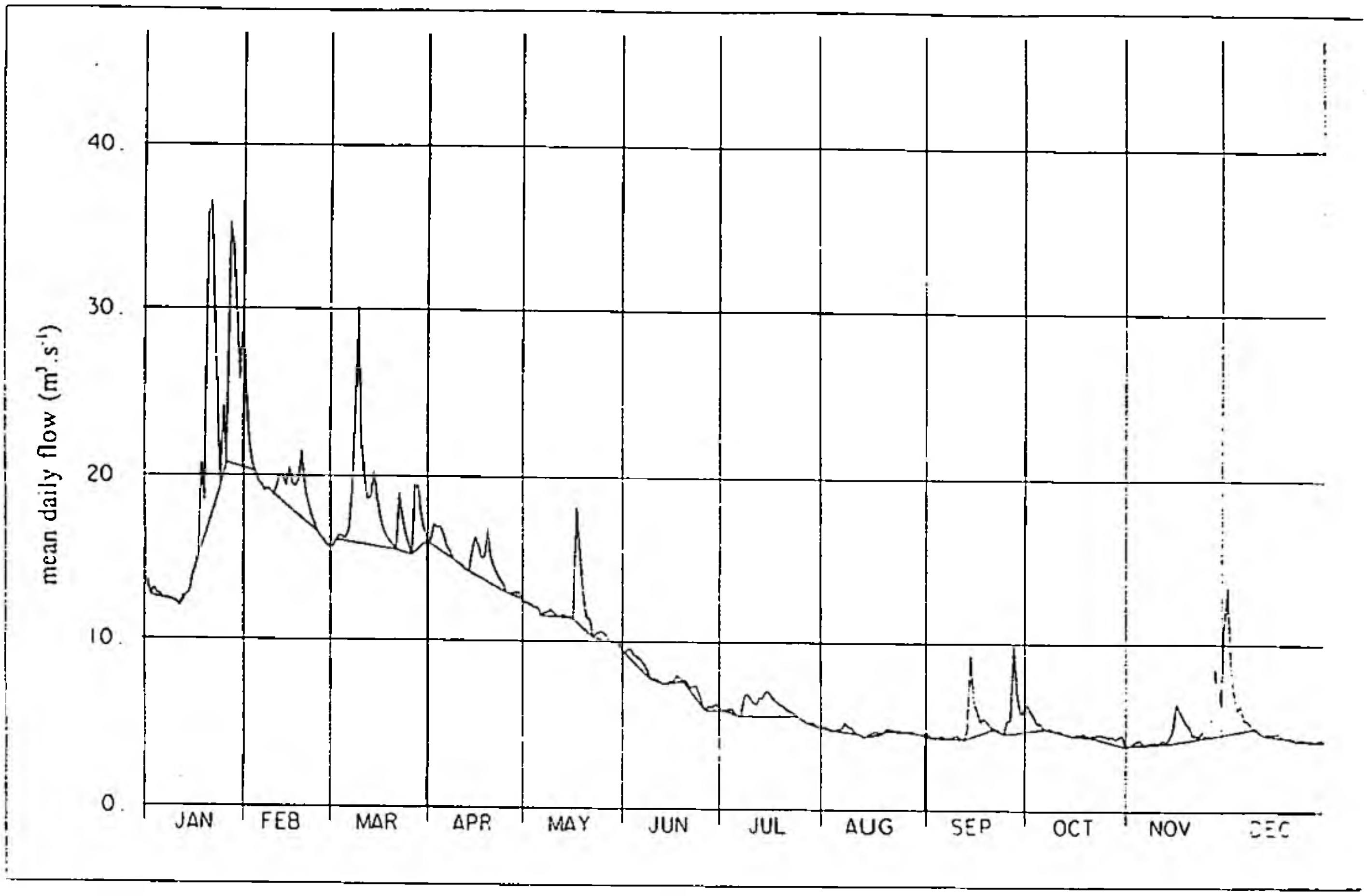


Figure E.1b Lambourn at Shaw (39019): Hydrograph with separated baseflow for 1975

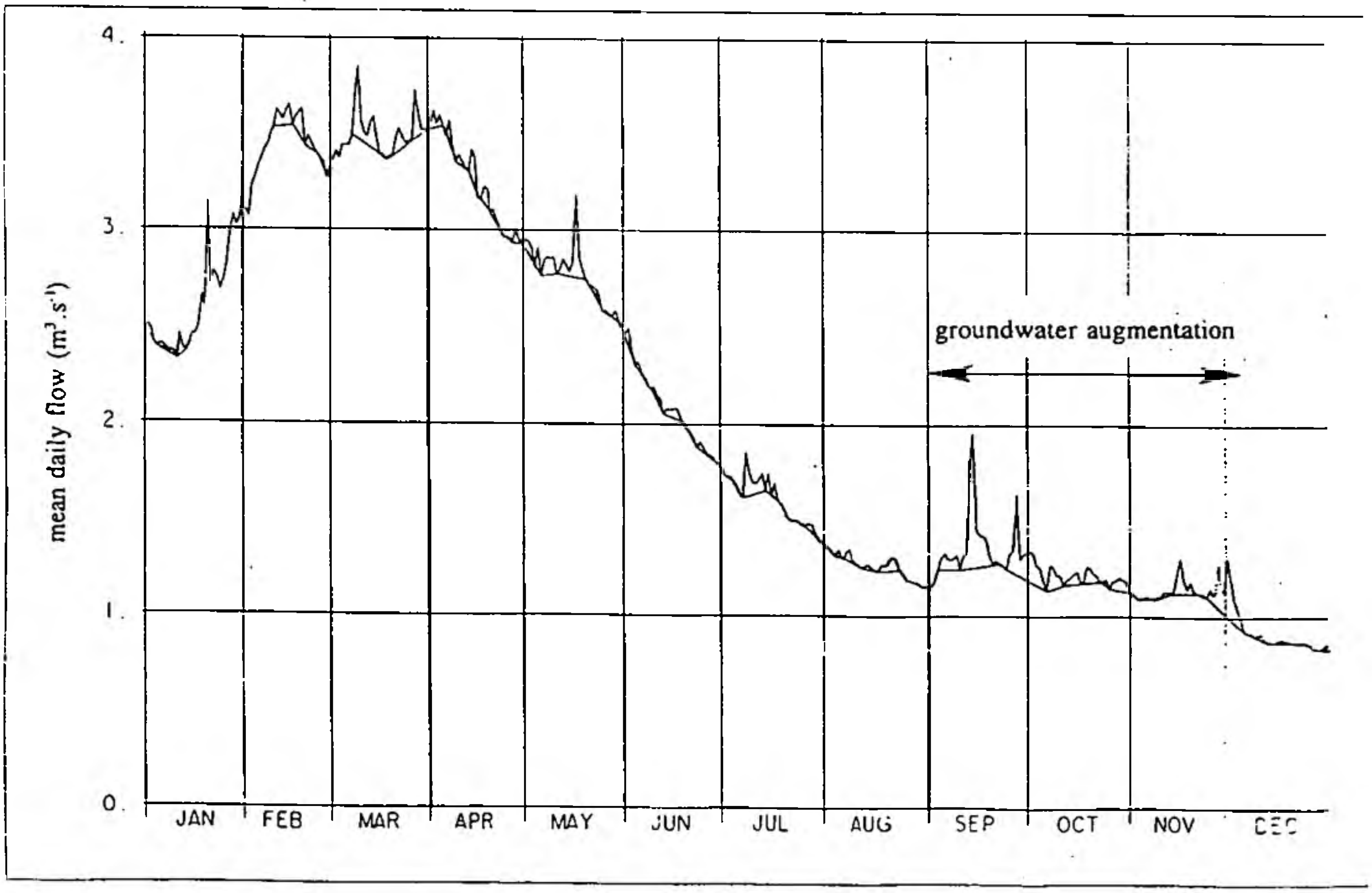


Figure E.1c Dun at Hungerford (39028): Hydrograph with separated baseflow for 1975

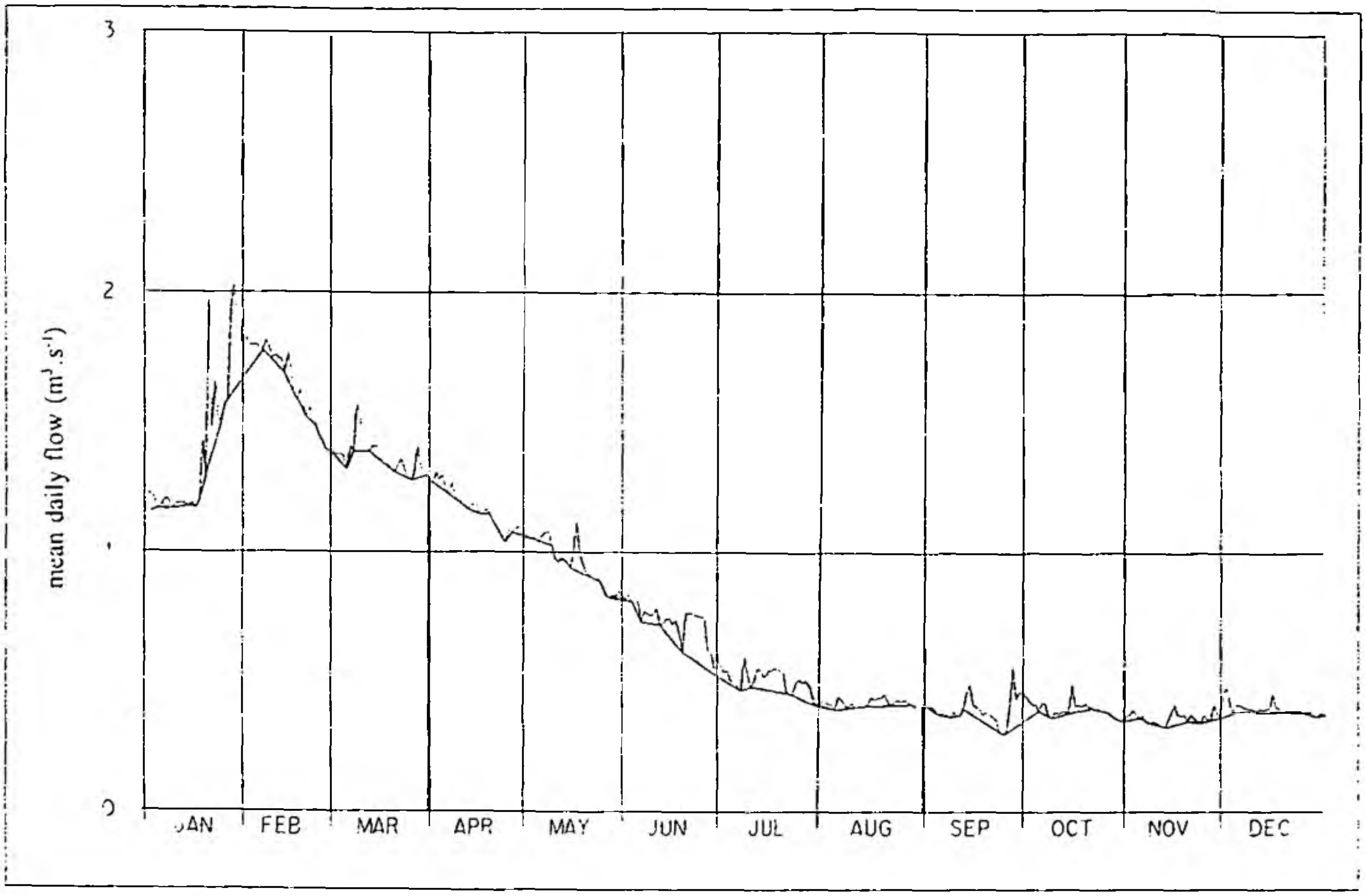


Figure E.1d Kennet at Knighton (39043): Hydrograph with separated baseflow for 1975

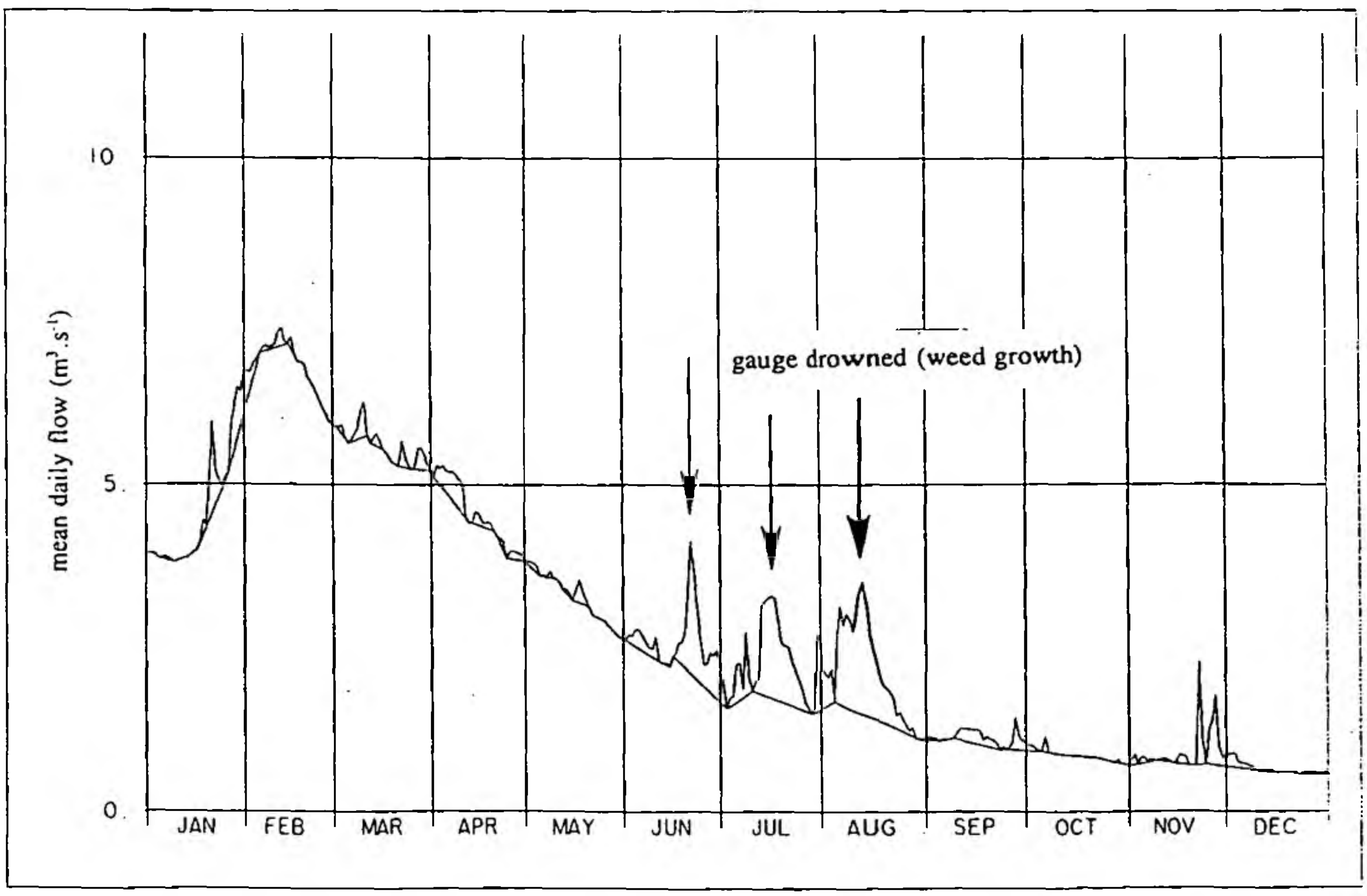


Figure E.2a Kennet at Theale (39016): Hydrograph with separated baseflow for 1976

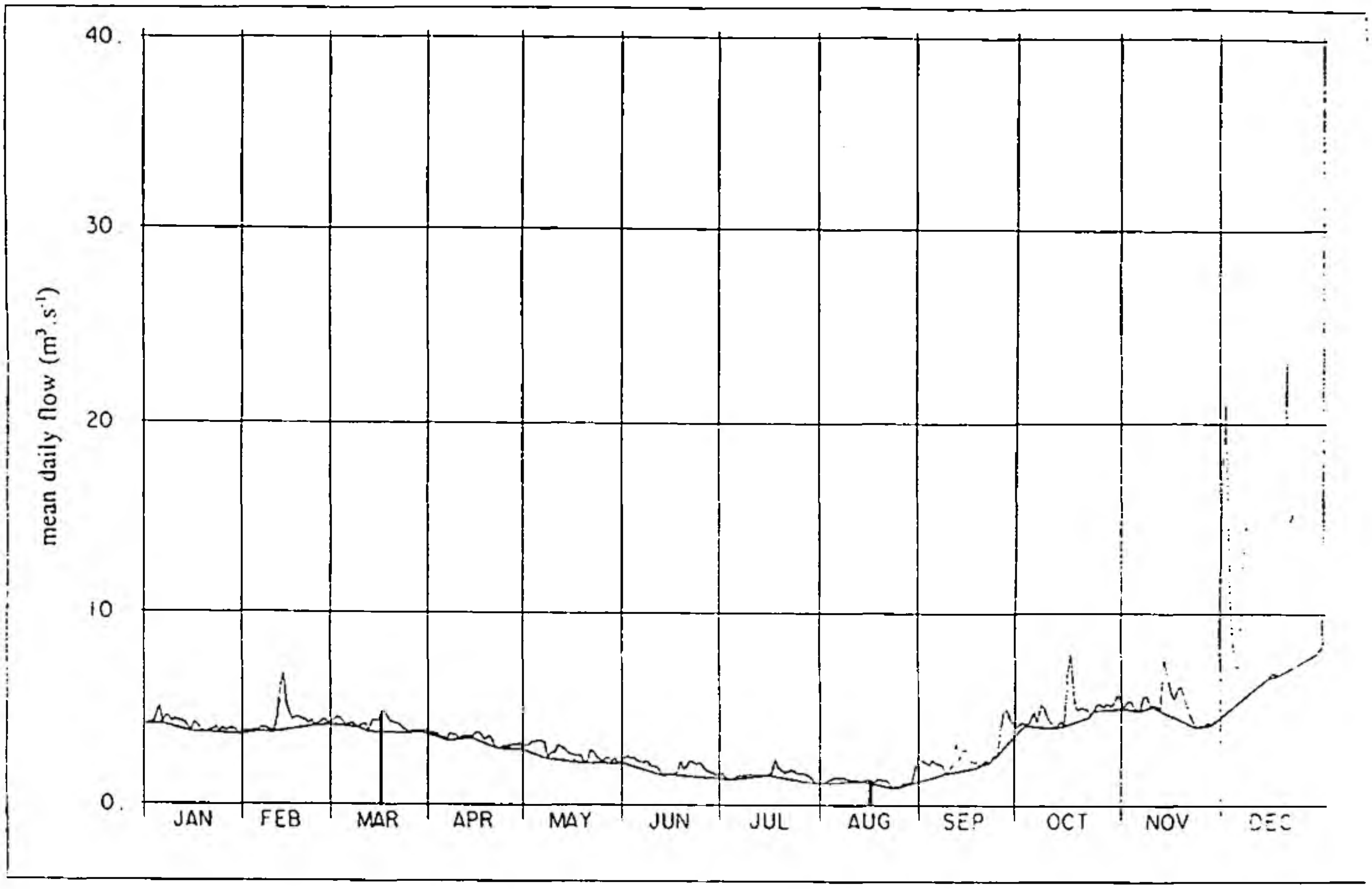


Figure E..2b Lambourn at Shaw (39019): Hydrograph with separated baseflow for 1976

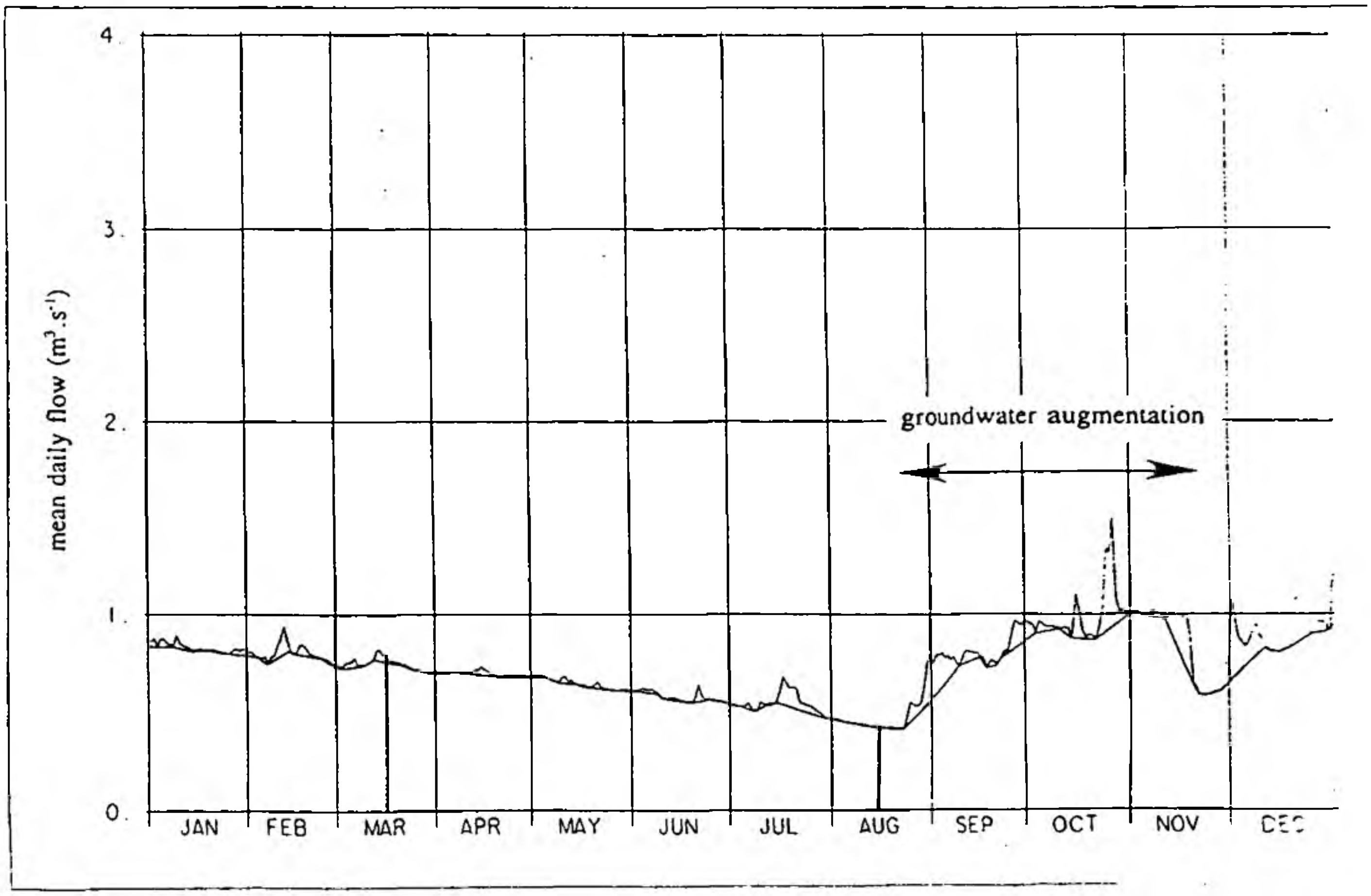


Figure E.2c Dun at Hungerford (39028): Hydrograph with separated baseflow for 1976

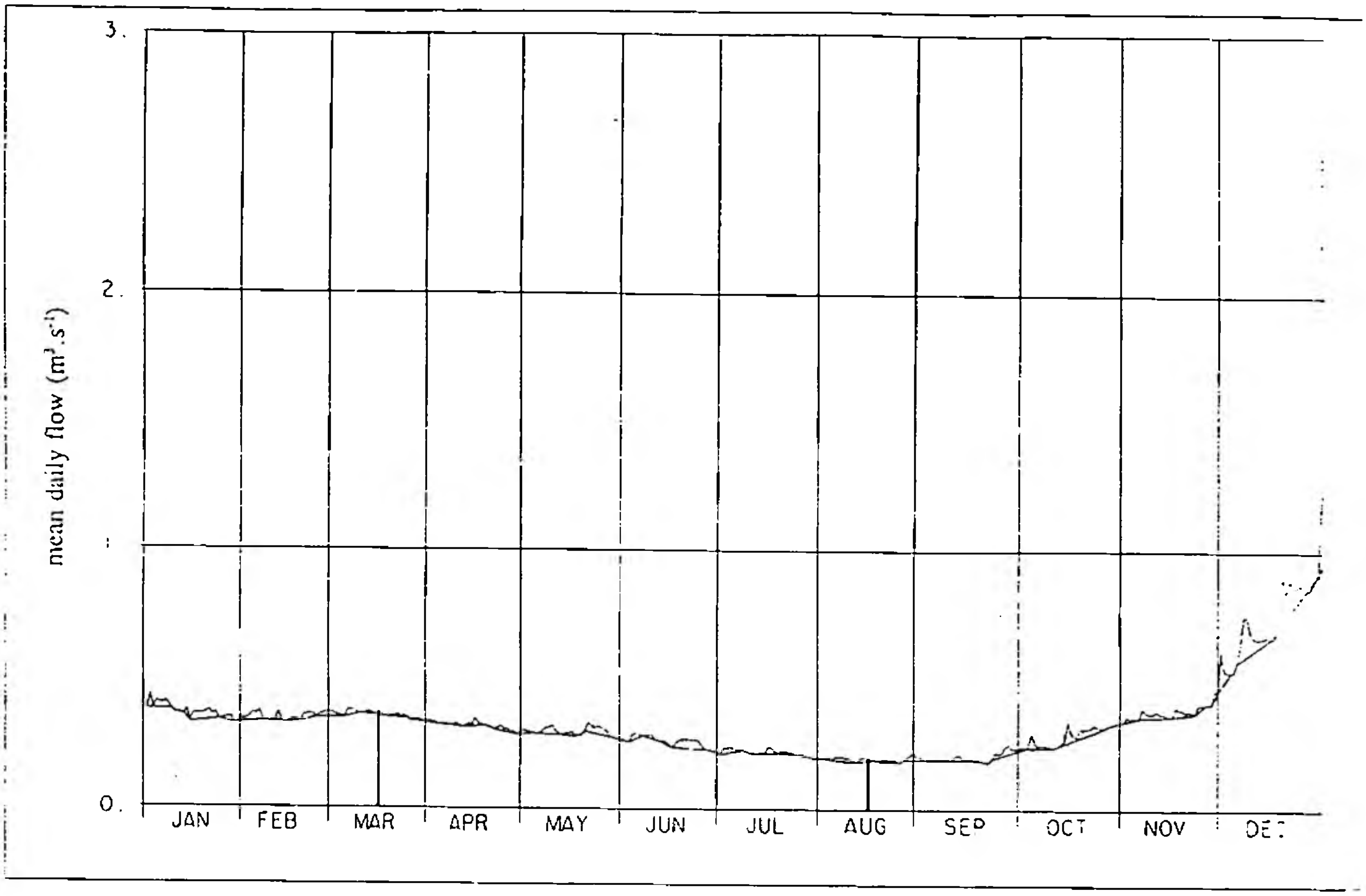


Figure E.2d Kennet at Knighton (39043): Hydrograph with separated baseflow for 1976

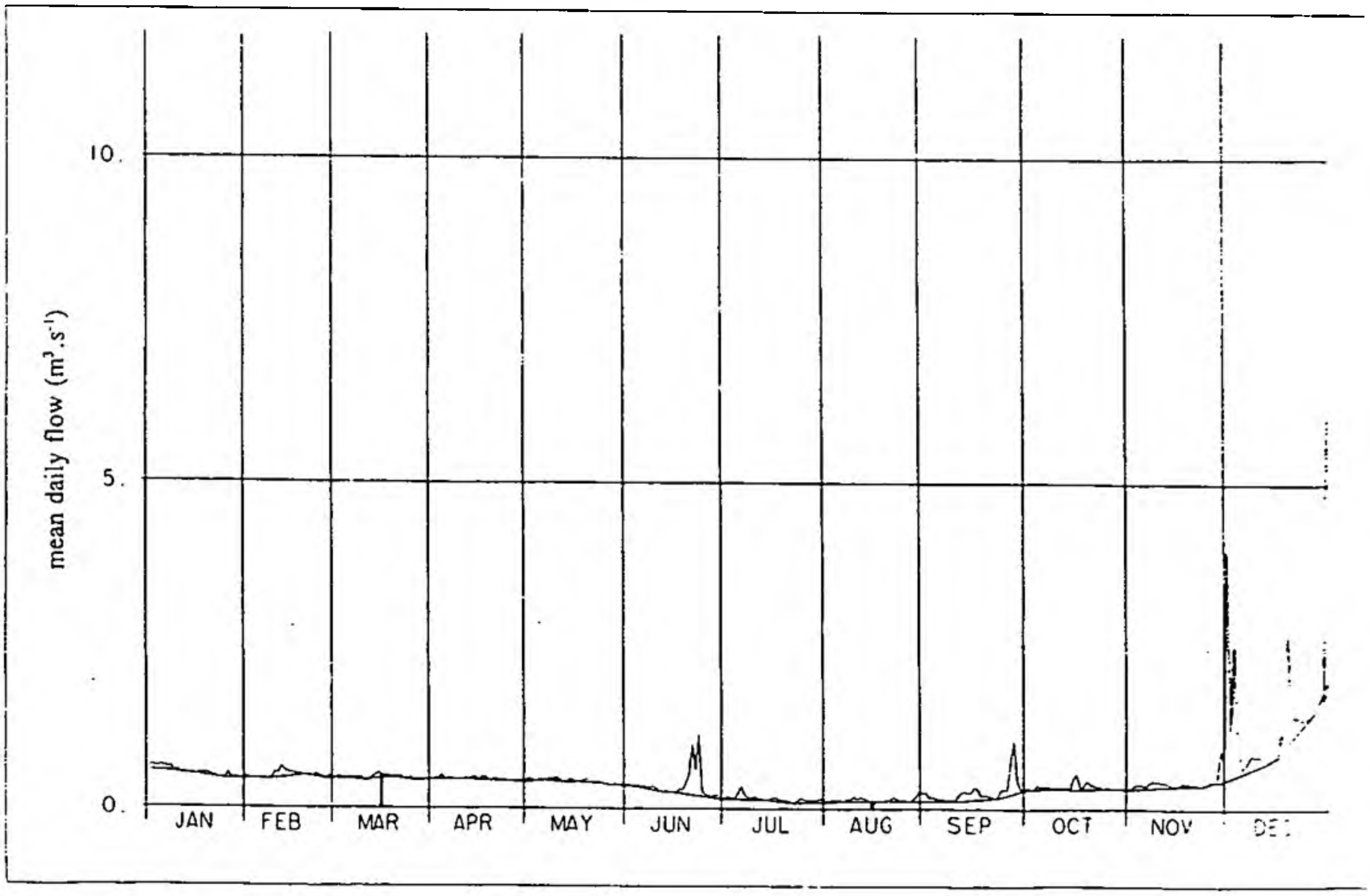


Figure E.3a Kennet at Theale (39016): Hydrograph with separated baseflow for 1988

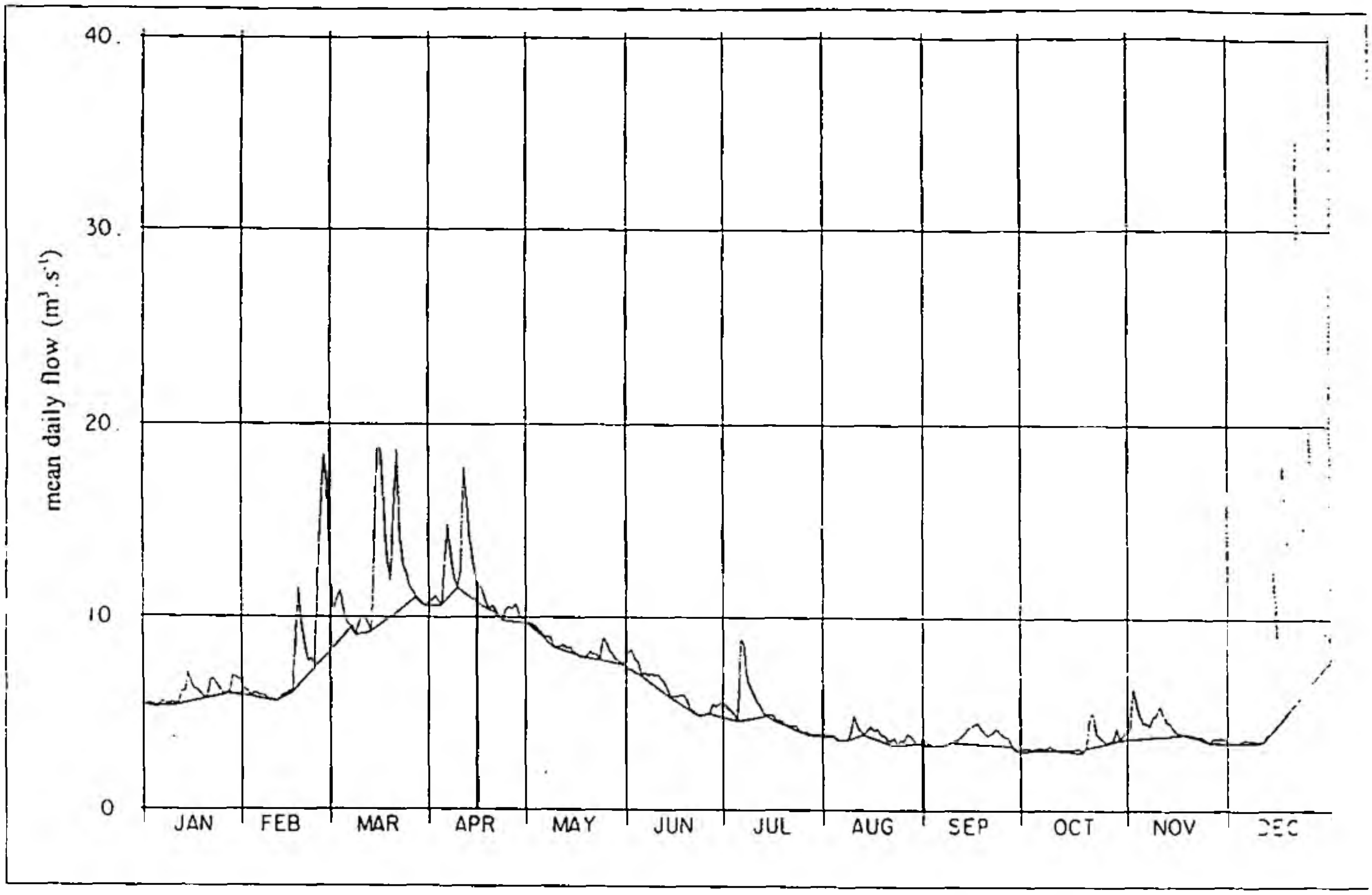


Figure E.3b Lambourn at Shaw (39019): Hydrograph with separated baseflow for 1988

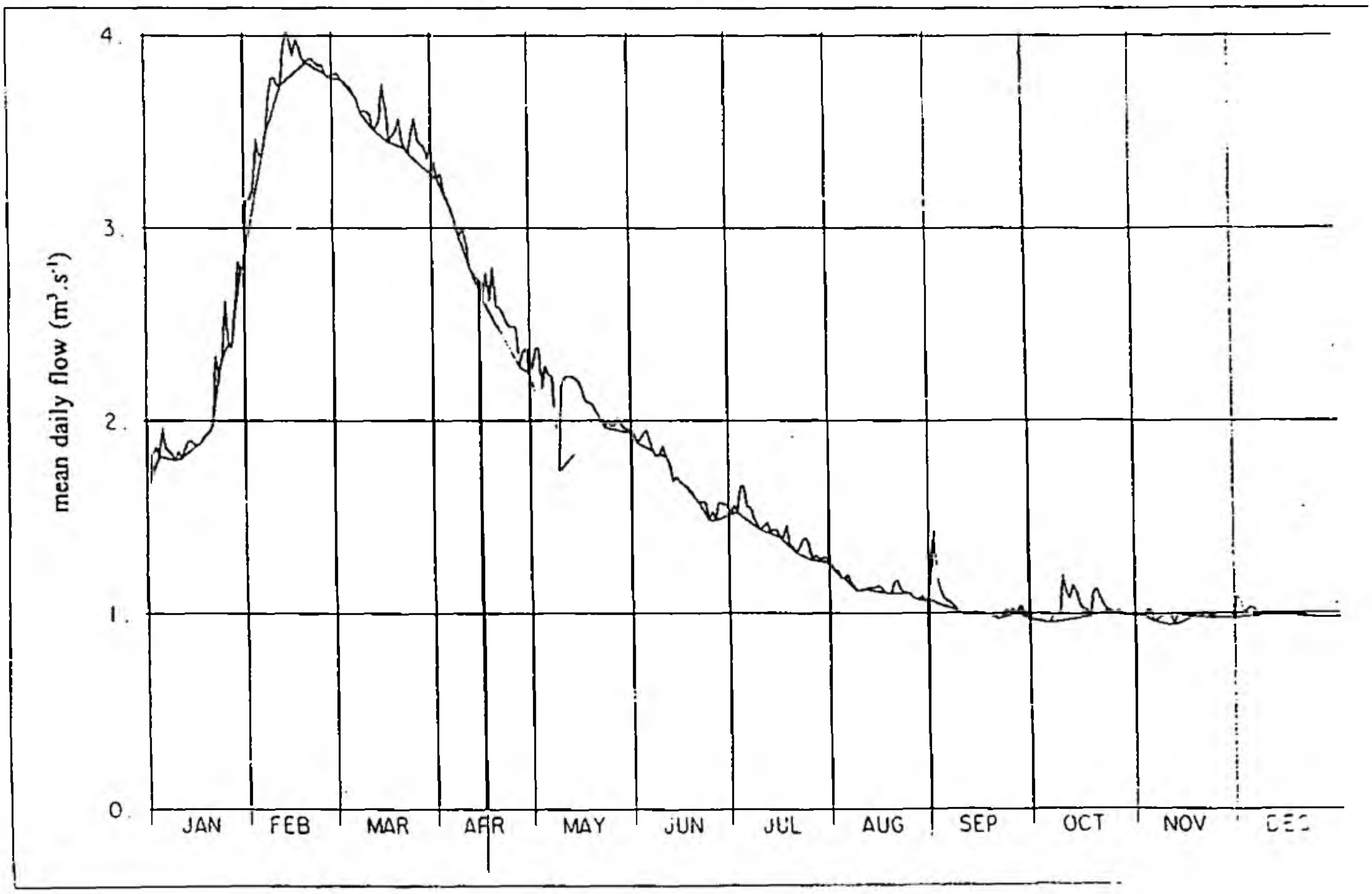


Figure E.3c Dun at Hungerford (39028): Hydrograph with separated baseflow for 1988

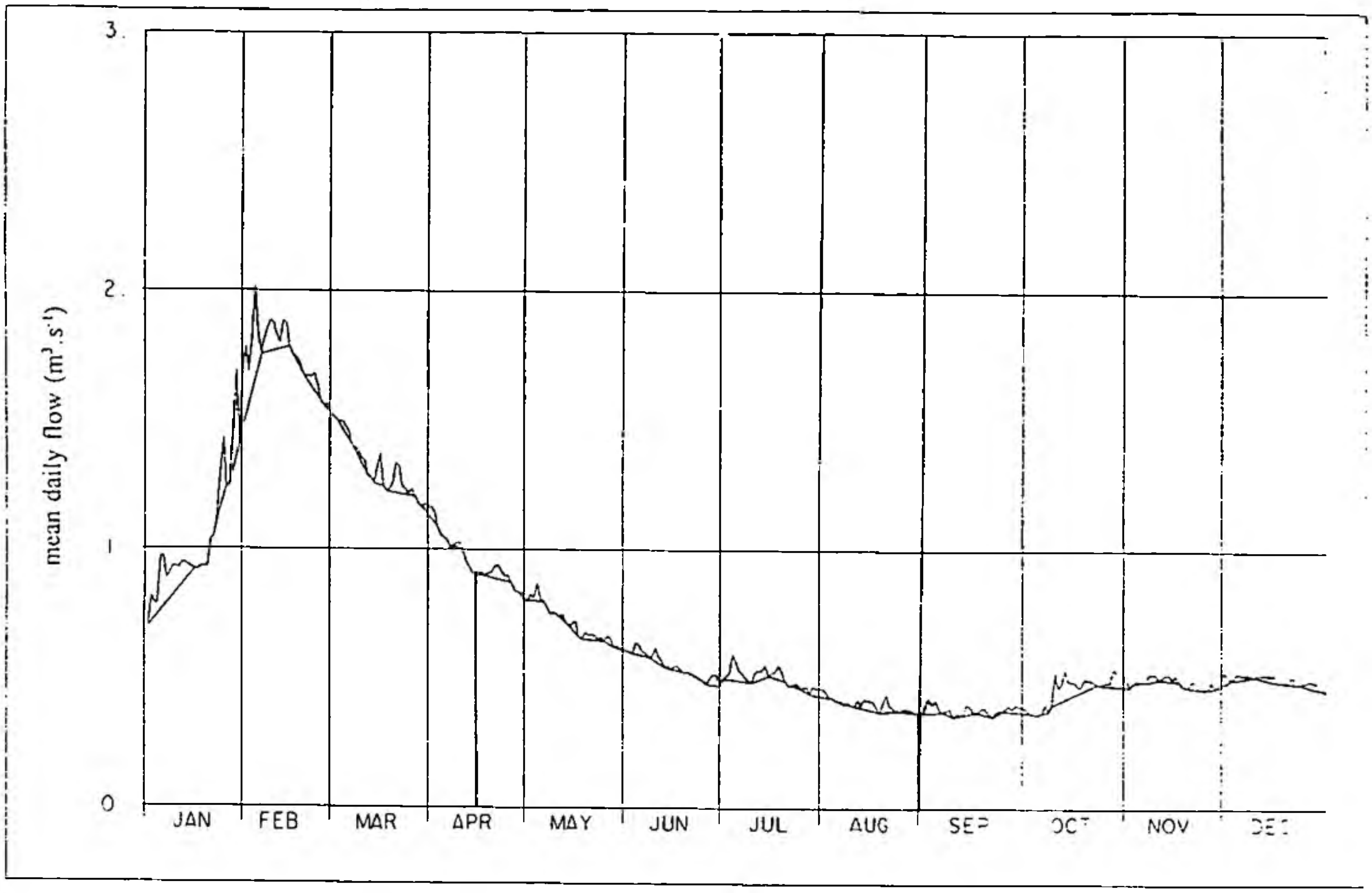


Figure E..3d Kennet at Knighton (39043): Hydrograph with separated baseflow for 1988

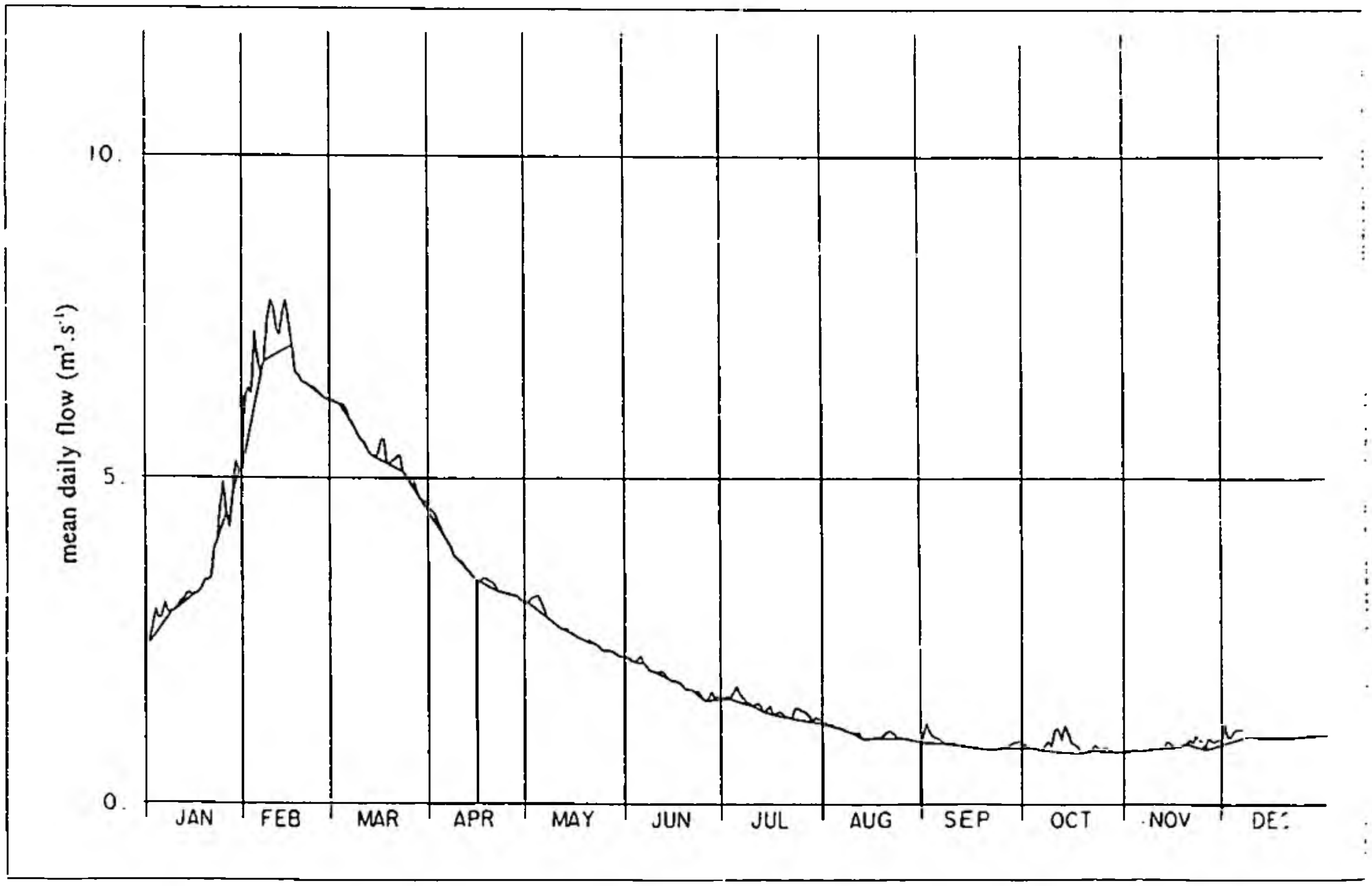


Figure E.4a Kennet at Theale (39016): Hydrograph with separated baseflow for 1989

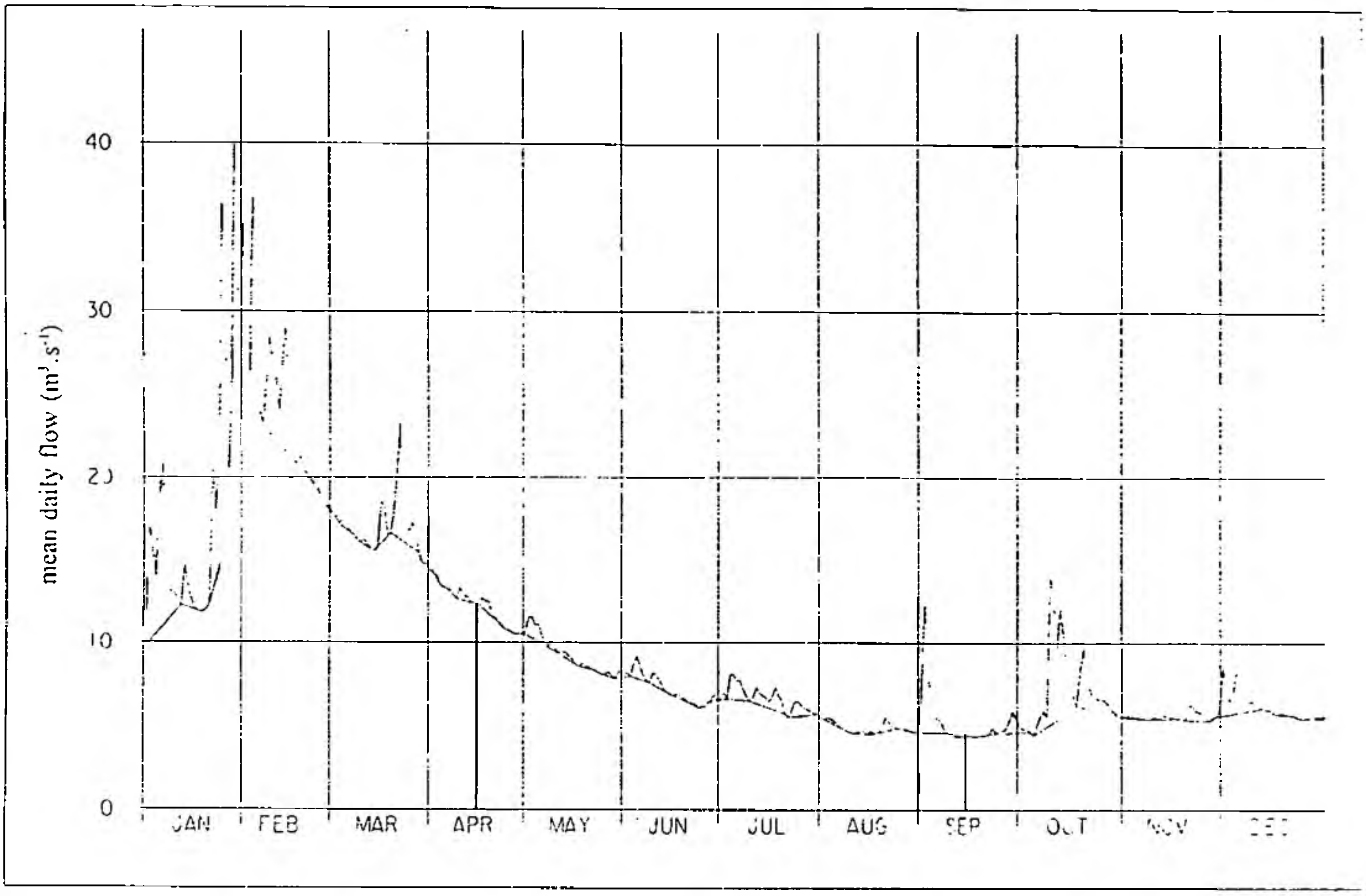


Figure E.4b Lambourn at Shaw (39019): Hydrograph with separated baseflow for 1989

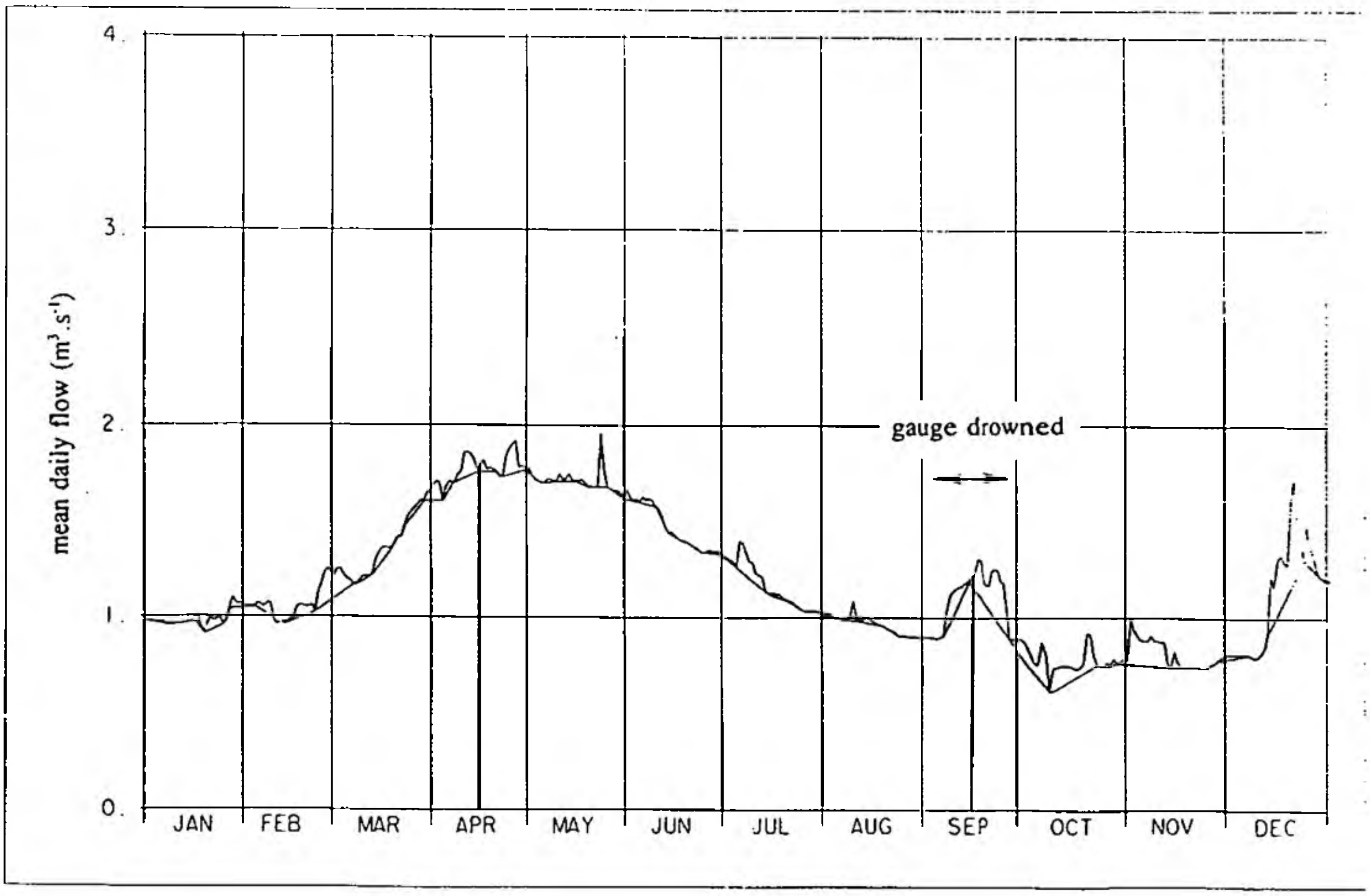


Figure E.4c Dun at Hungerford (39028): Hydrograph with separated baseflow for 1989

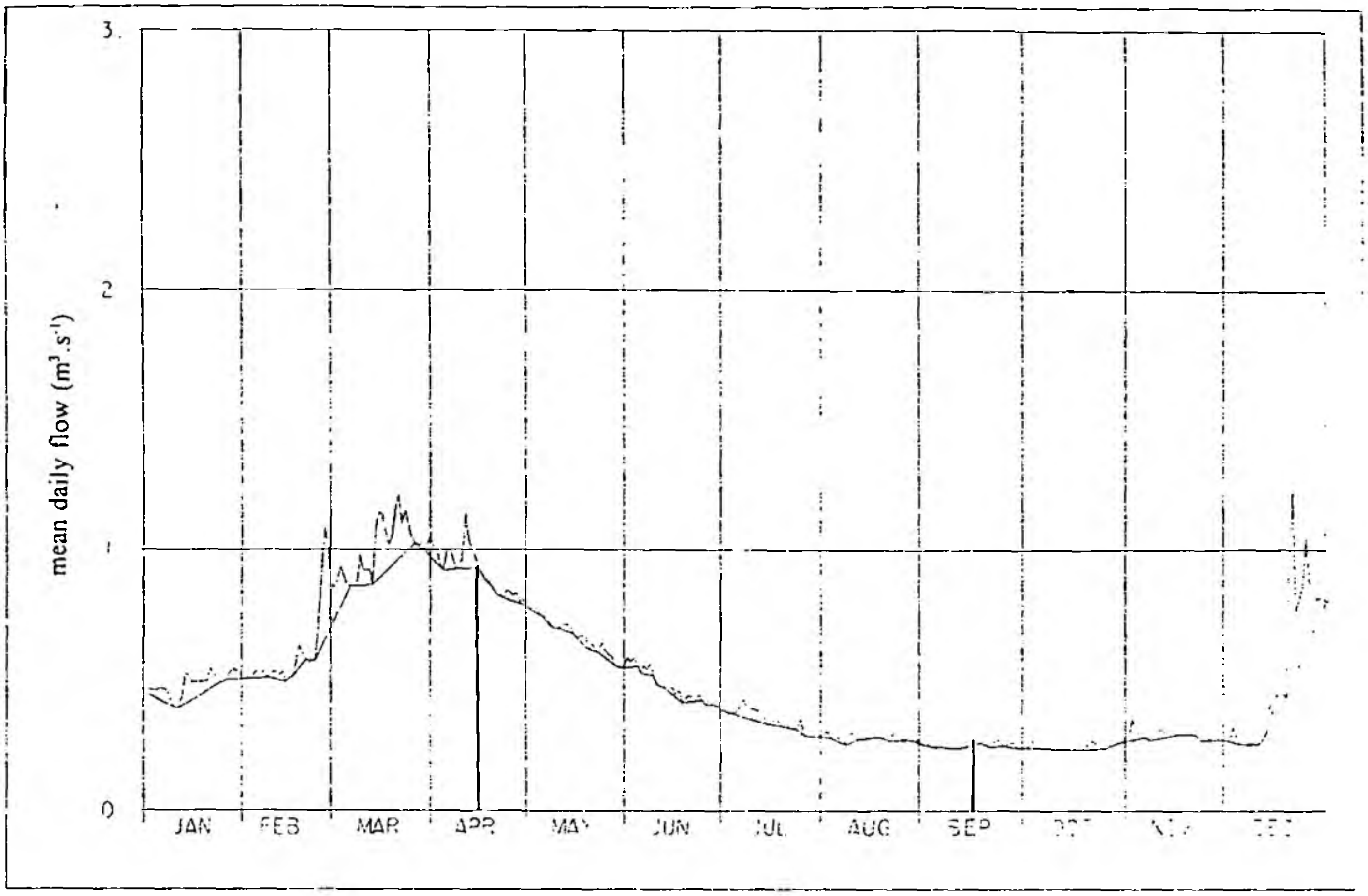


Figure E.4d Kennet at Knighton (39043): Hydrograph with separated baseflow for 1989

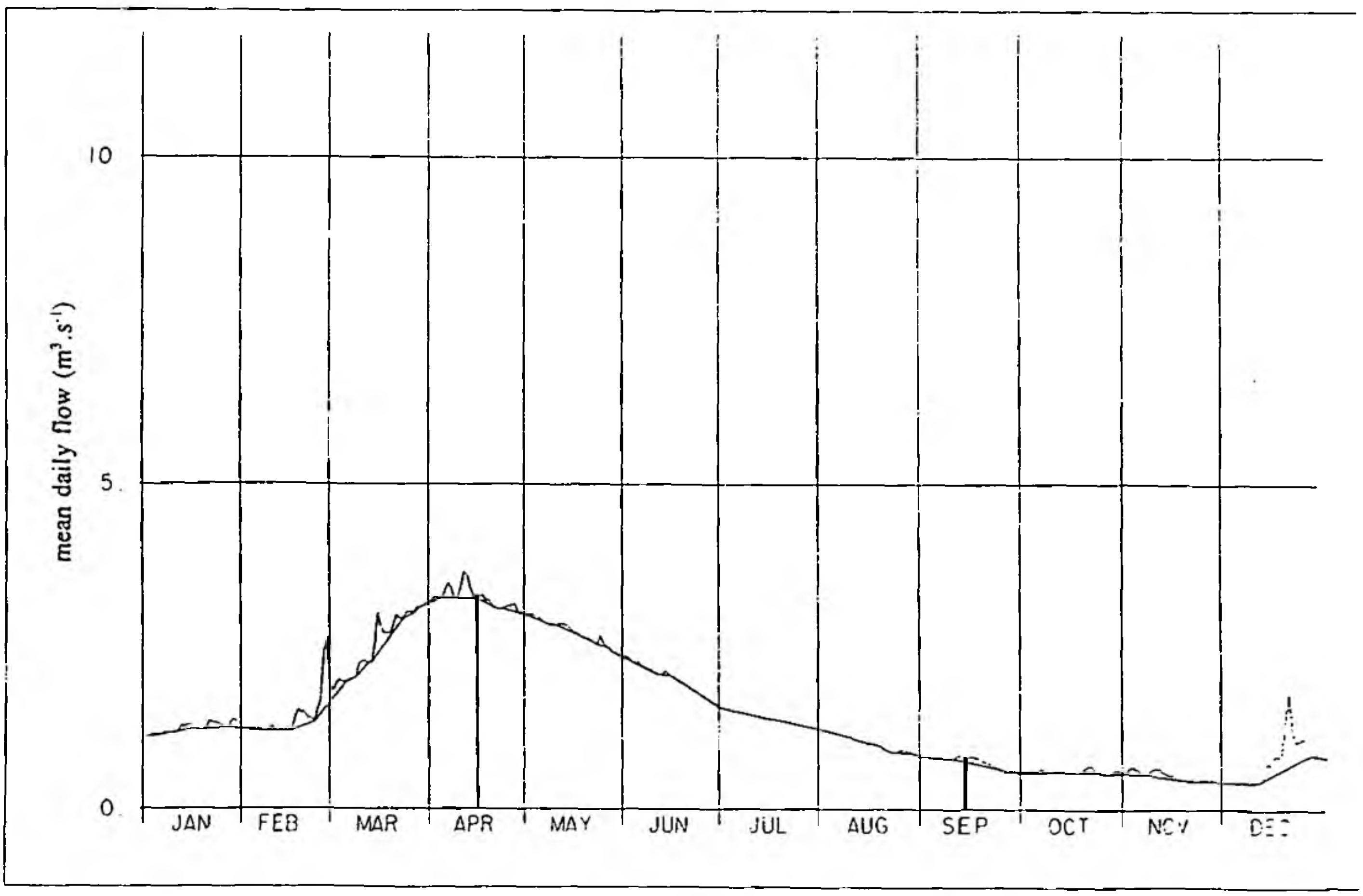


Figure E.5a Alre at Drove Lane, Alresford (42007): Hydrograph with separated flow for 1975

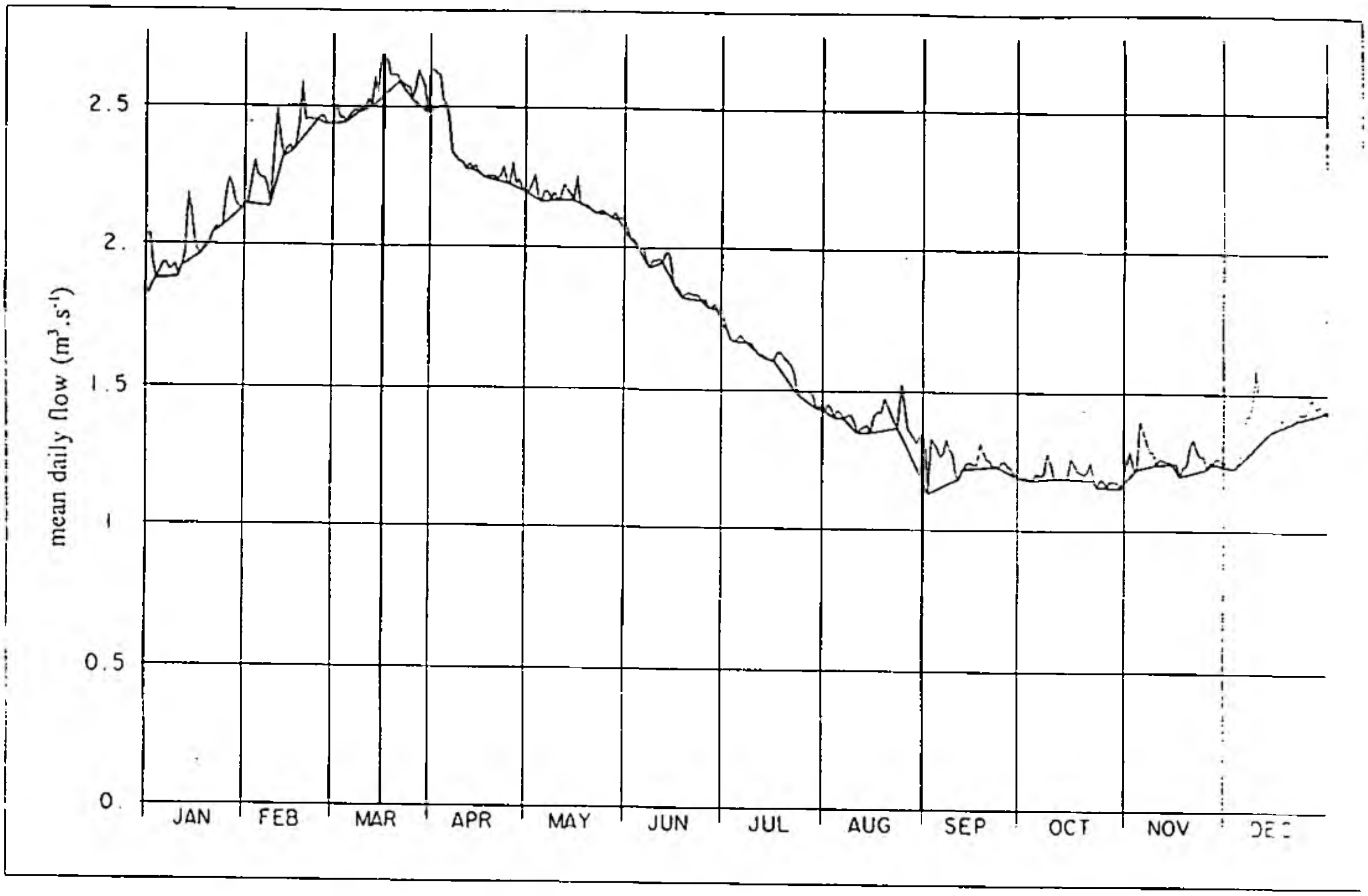


Figure E.5b Cheriton Stream at Sewards Bridge (42008): Hydrograph with separated flow for

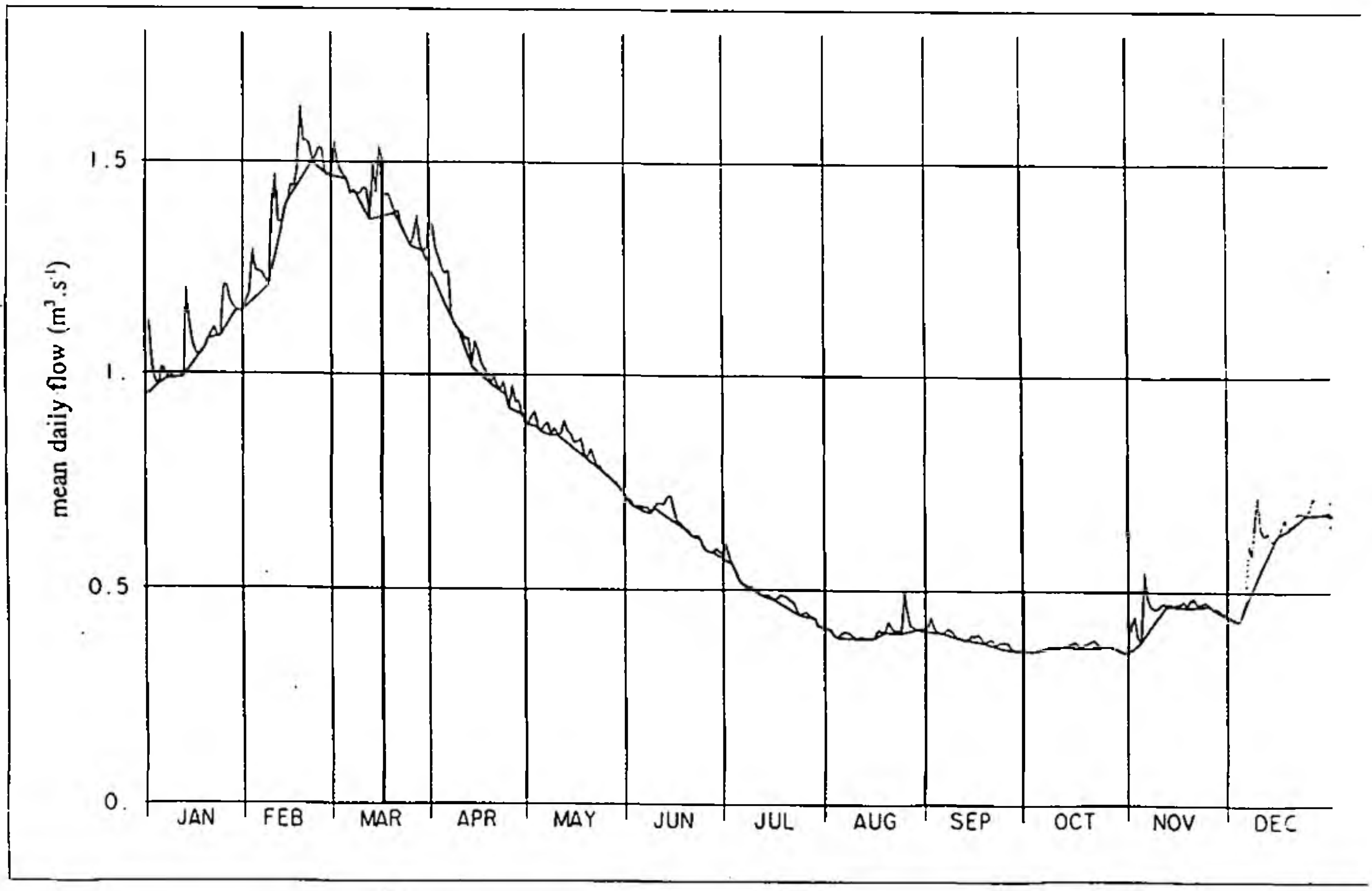


Figure E.5c Candover Stream at Borough Bridge (42009): Hydrograph with separated flow for 1975

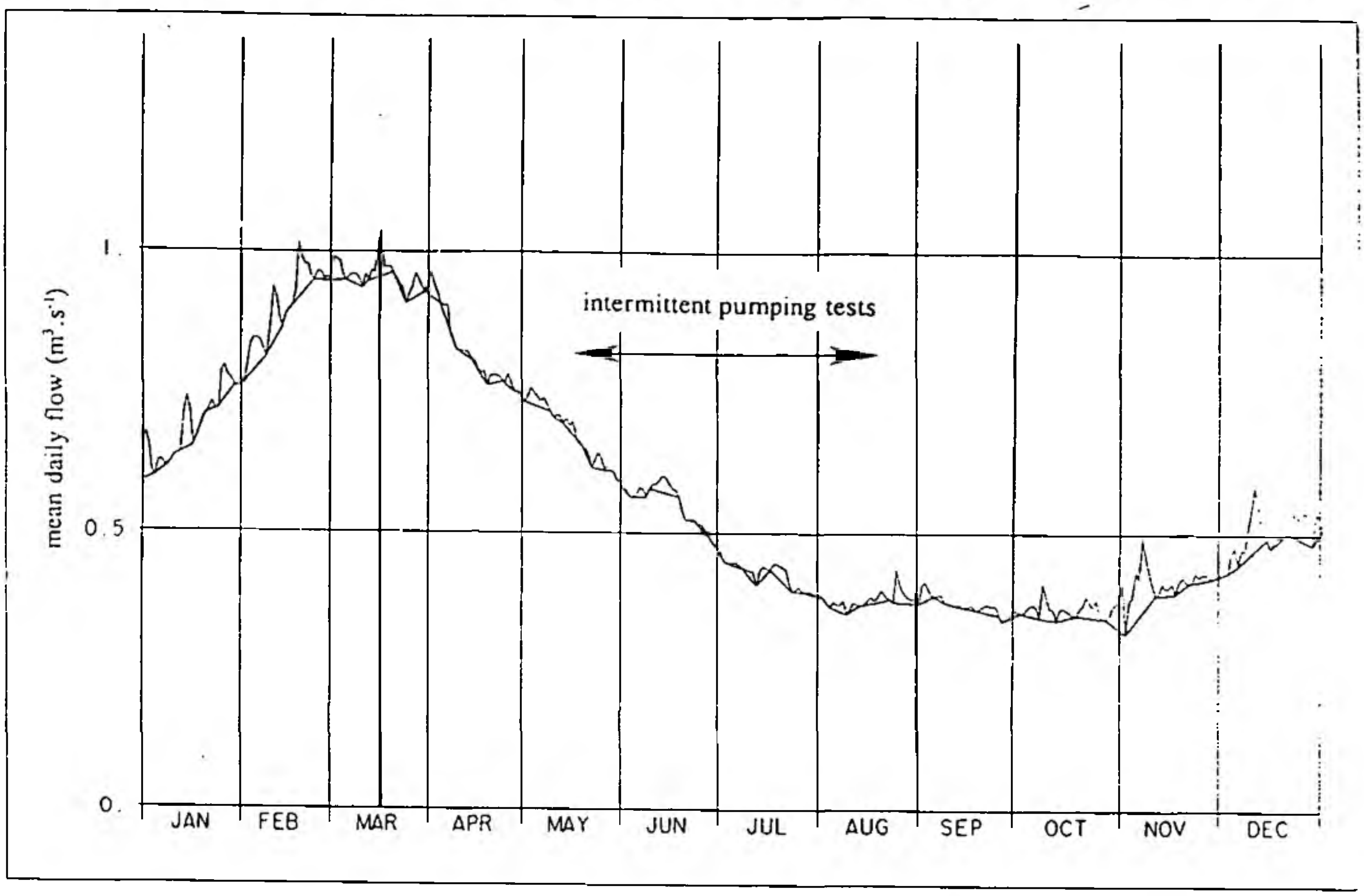


Figure E.5d Itchen at Highbridge + Allbrook (42010): Hydrograph with separated flow for 1975

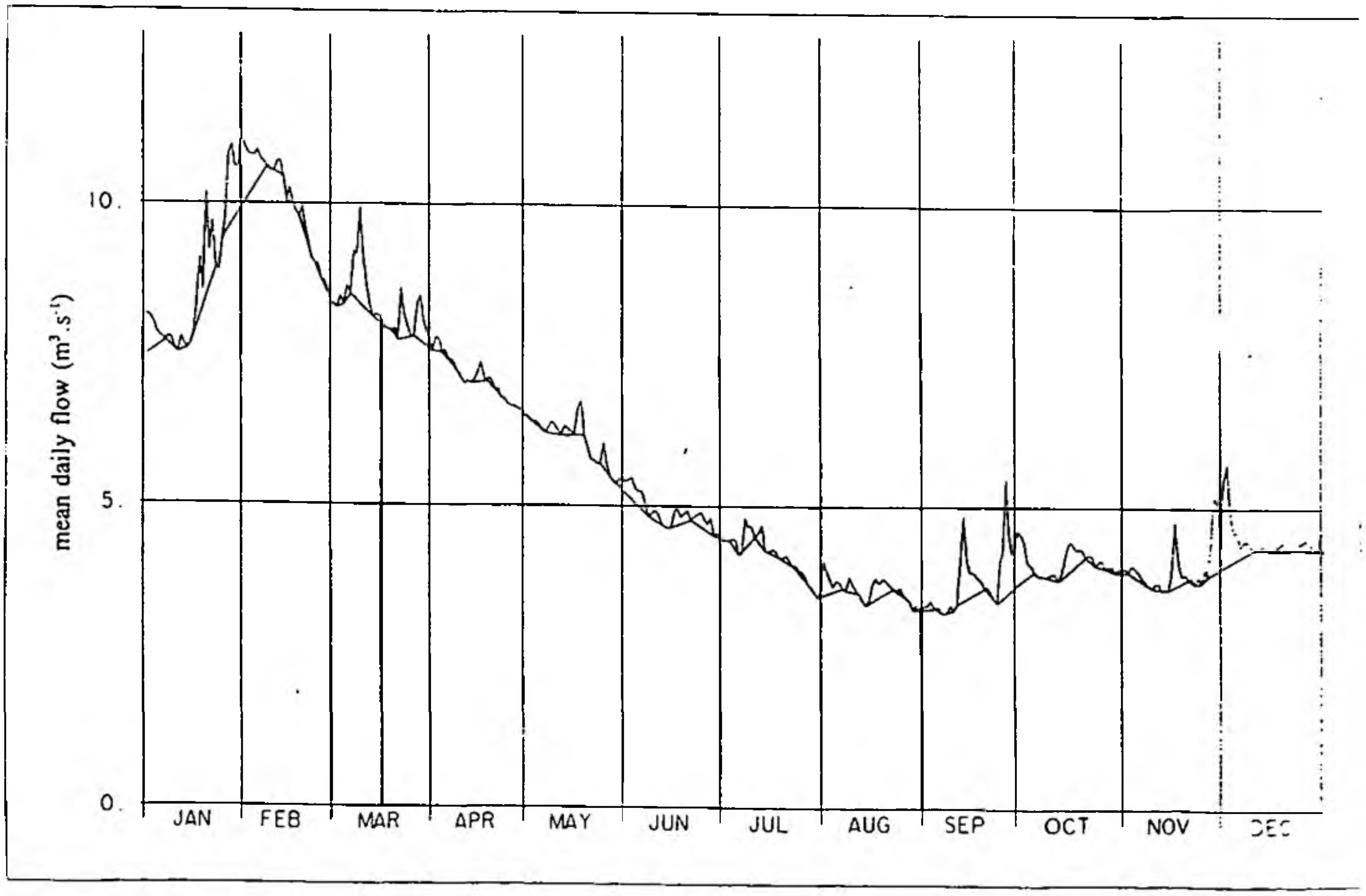


Figure E.6a Alre at Drove Lane, Alresford (42007): Hydrograph with separated flow for 1976

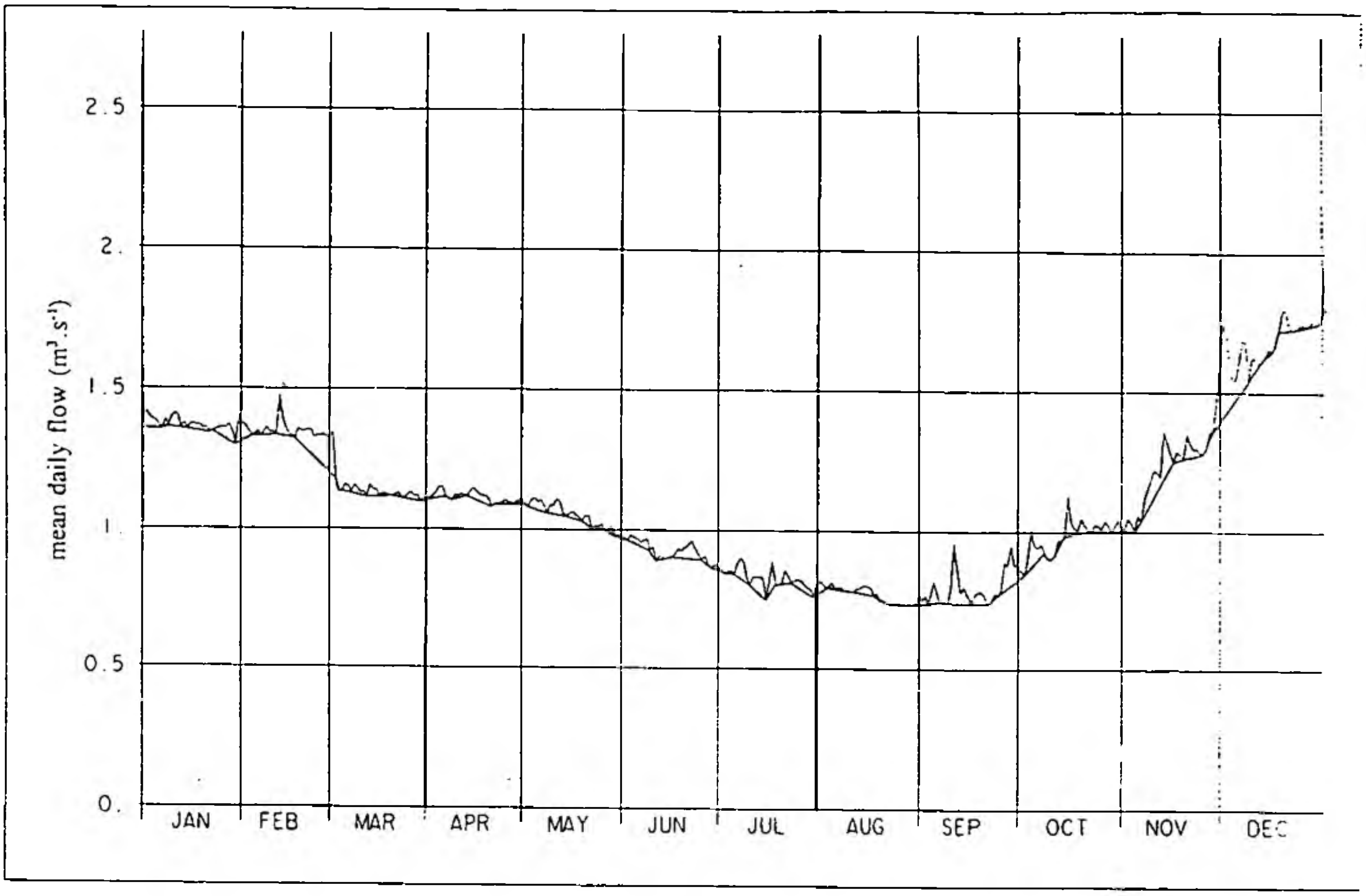


Figure E.6b Cheriton Stream at Sewards Bridge (42008): Hydrograph with separated flow for 1976

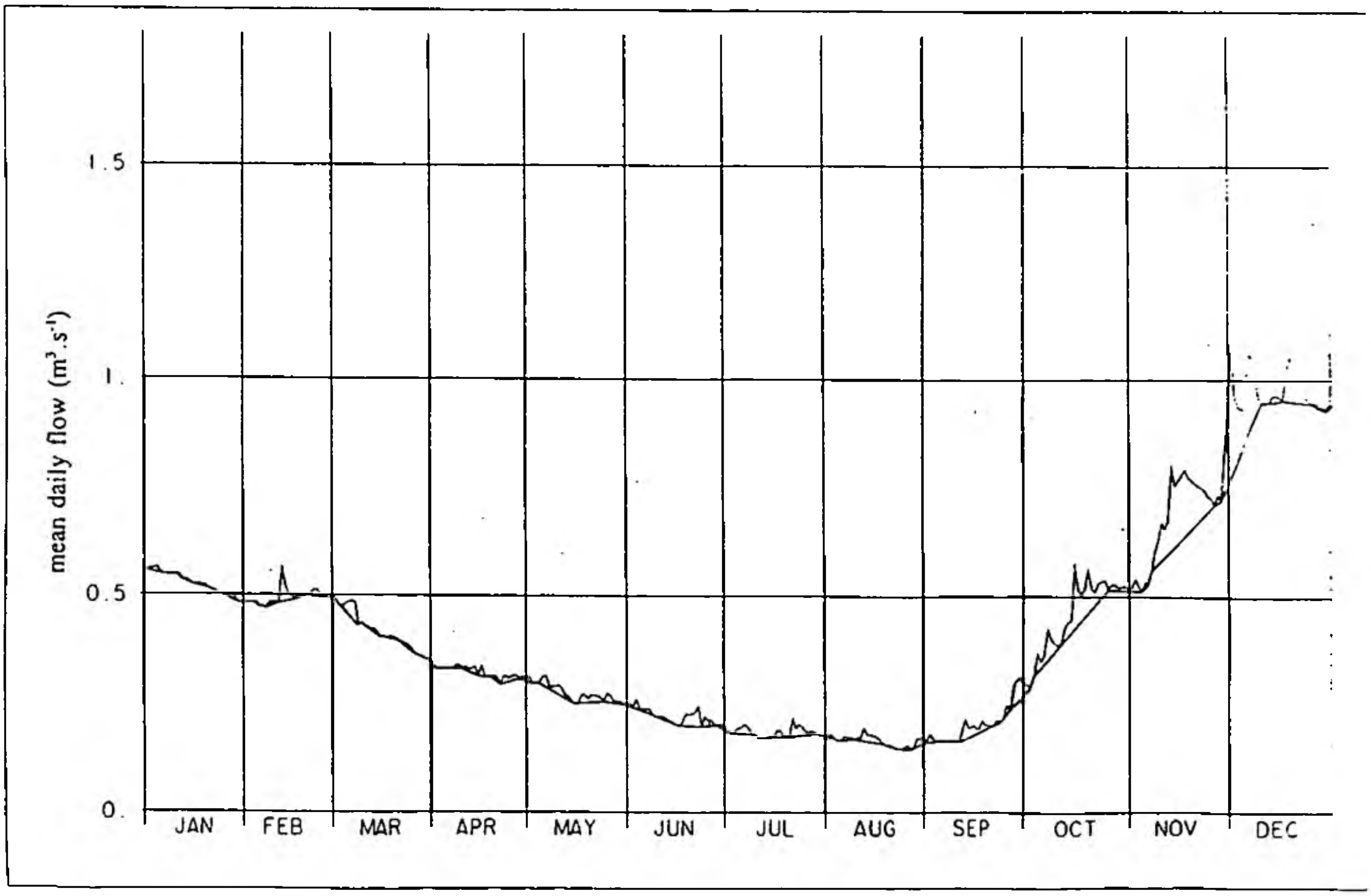


Figure E.6c Candover Stream at Borough Bridge (42009): Hydrograph with separated flow for 197

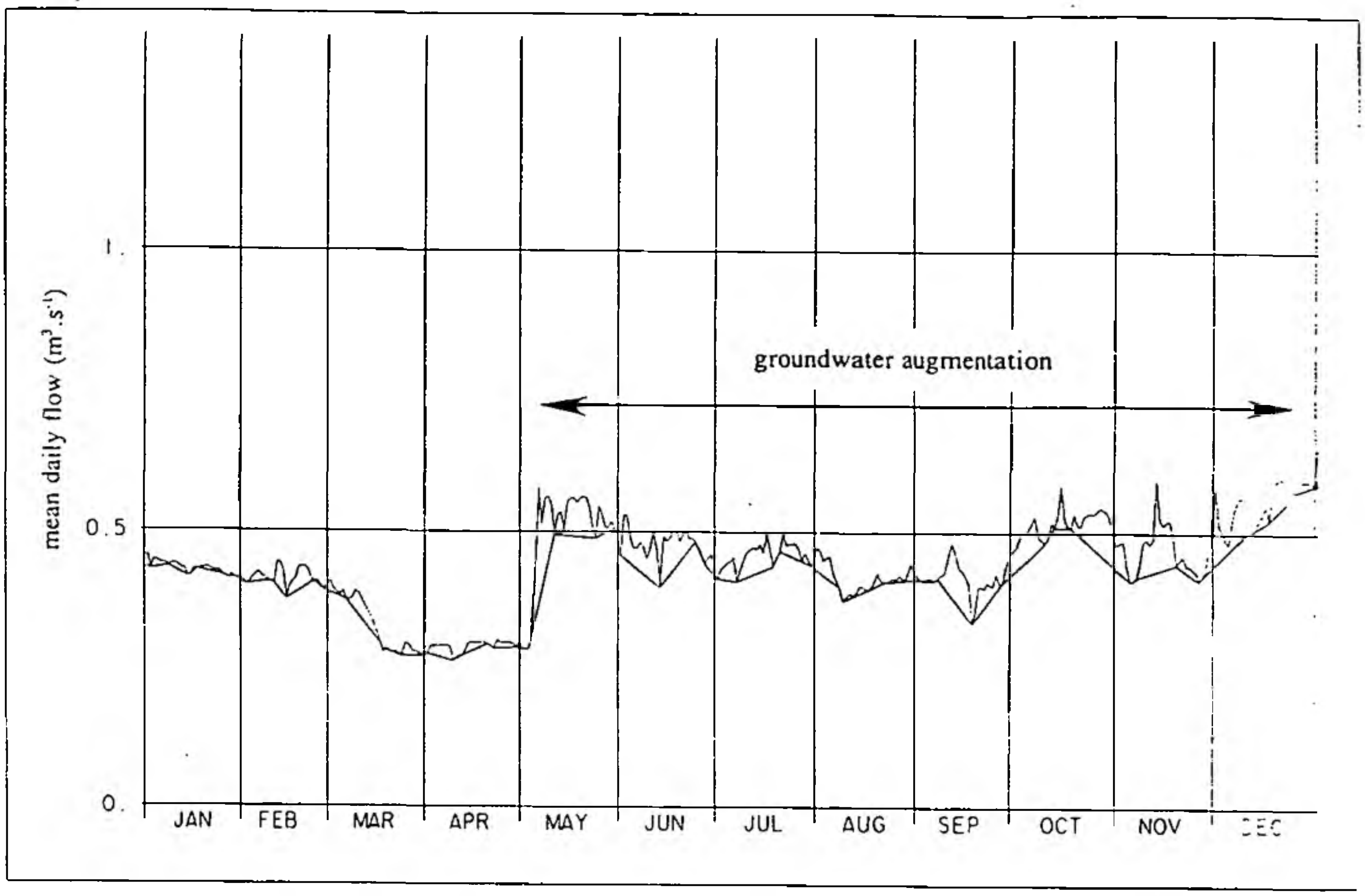


Figure E.6d Itchen at Highbridge+Allbrook (42010): Hydrograph with separated flow for 1976

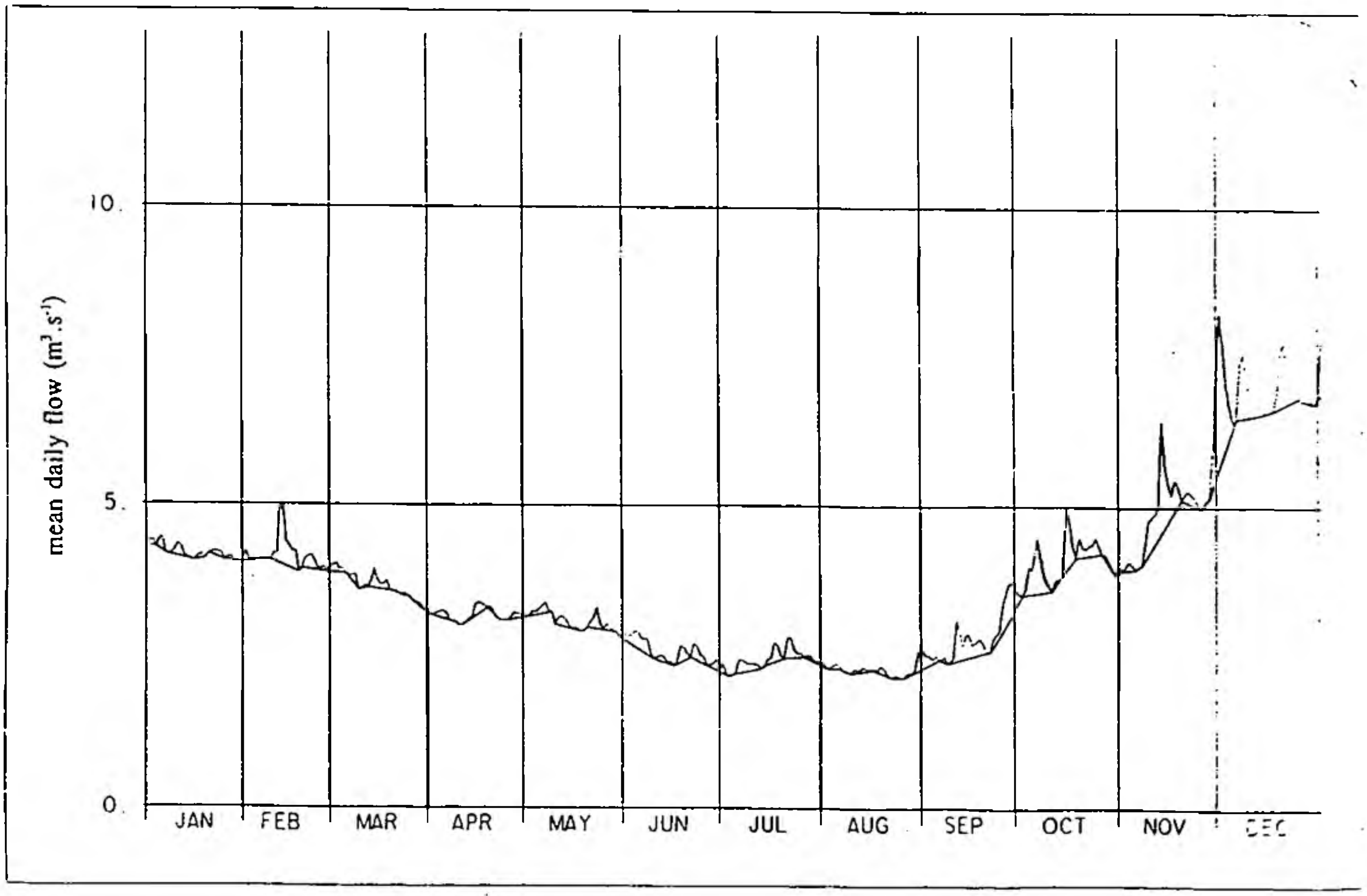


Figure E.7a Alre at Drove Lane, Alresford (42007): Hydrograph with separated flow for 1988

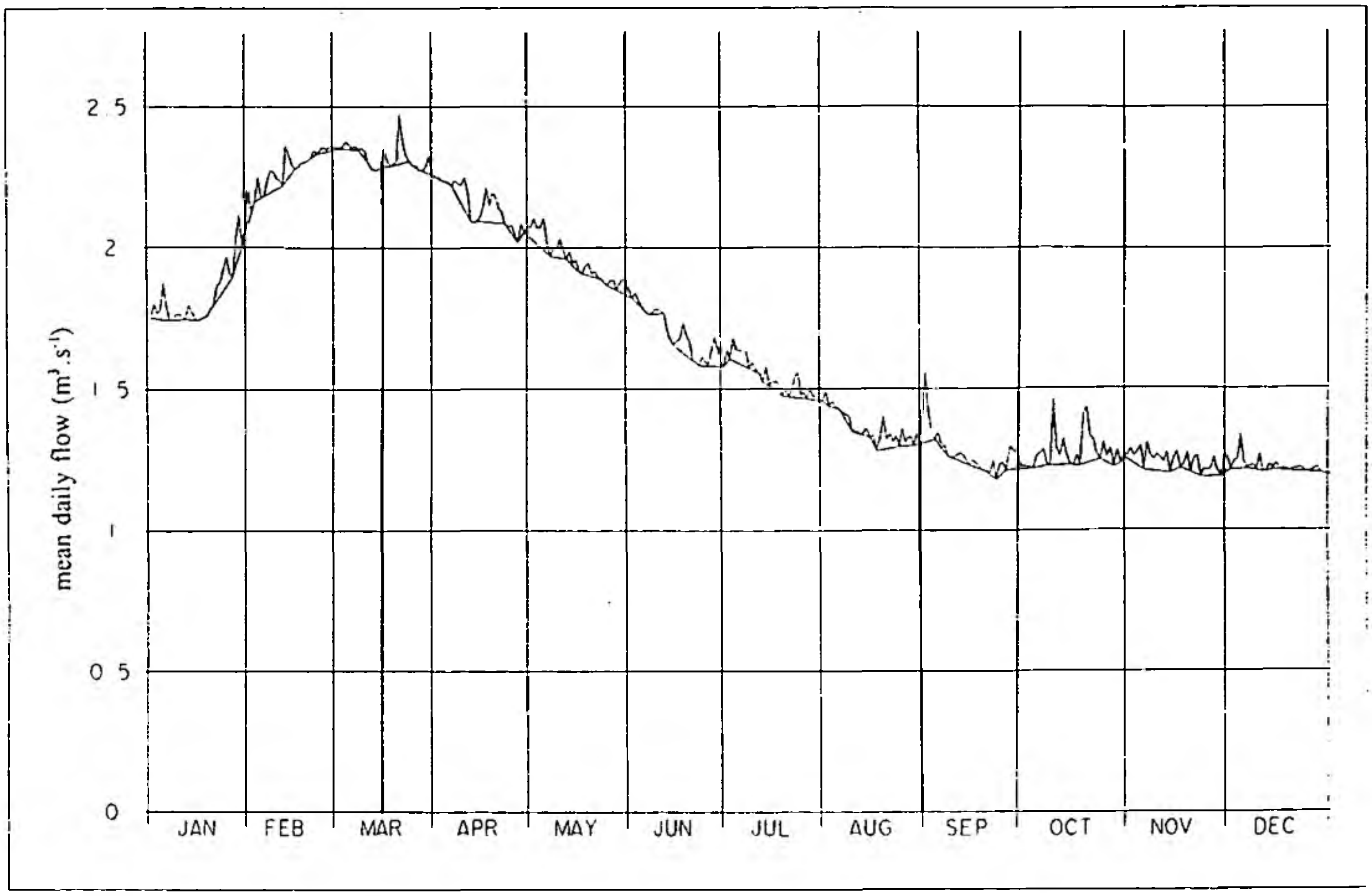


Figure E.7b Cheriton Stream at Sewards Bridge (42008): Hydrograph with separated flow for 1988

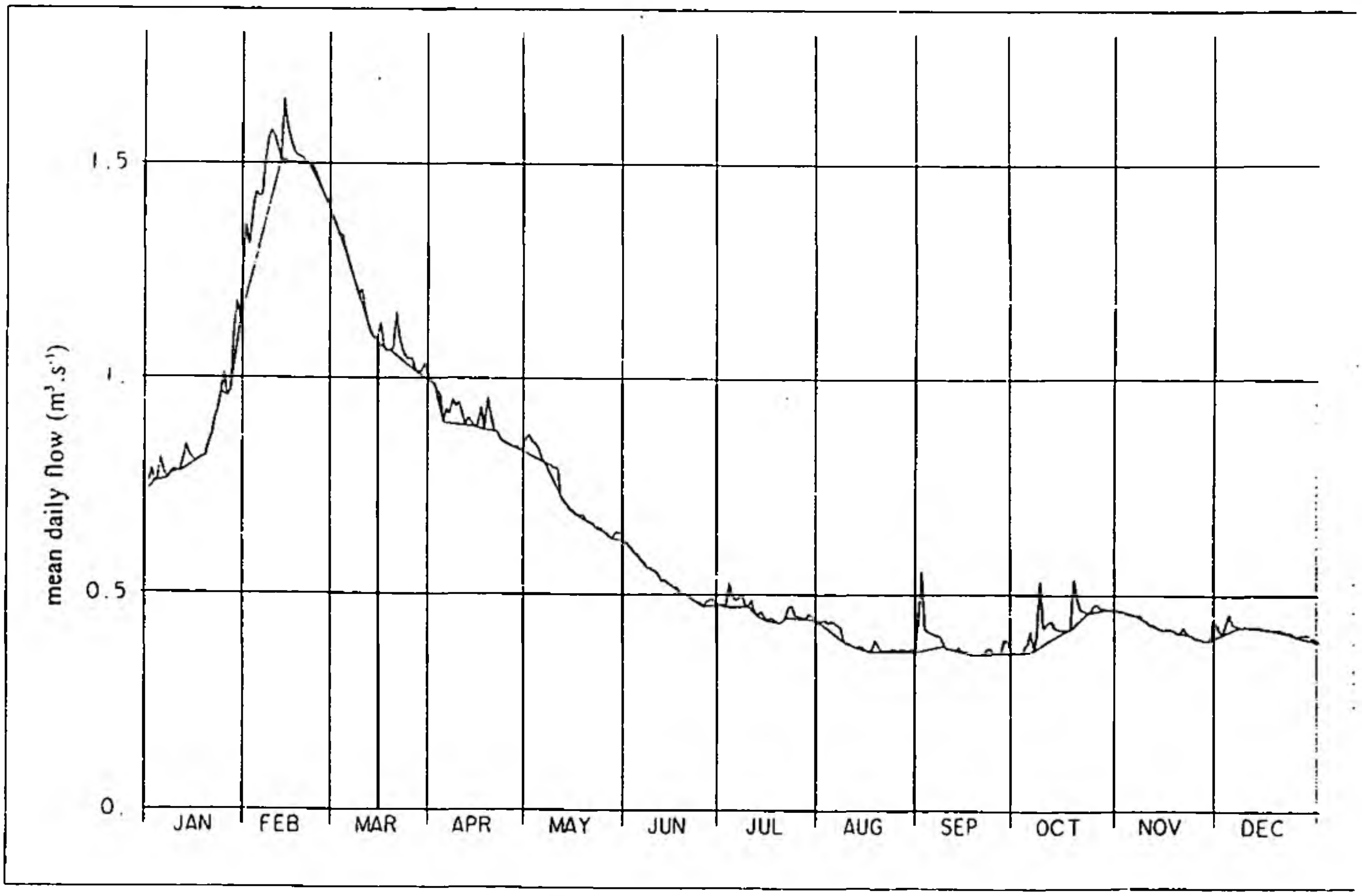


Figure E.7c Candover Stream at Borough Bridge (42009): Hydrograph with separated flow for 1988

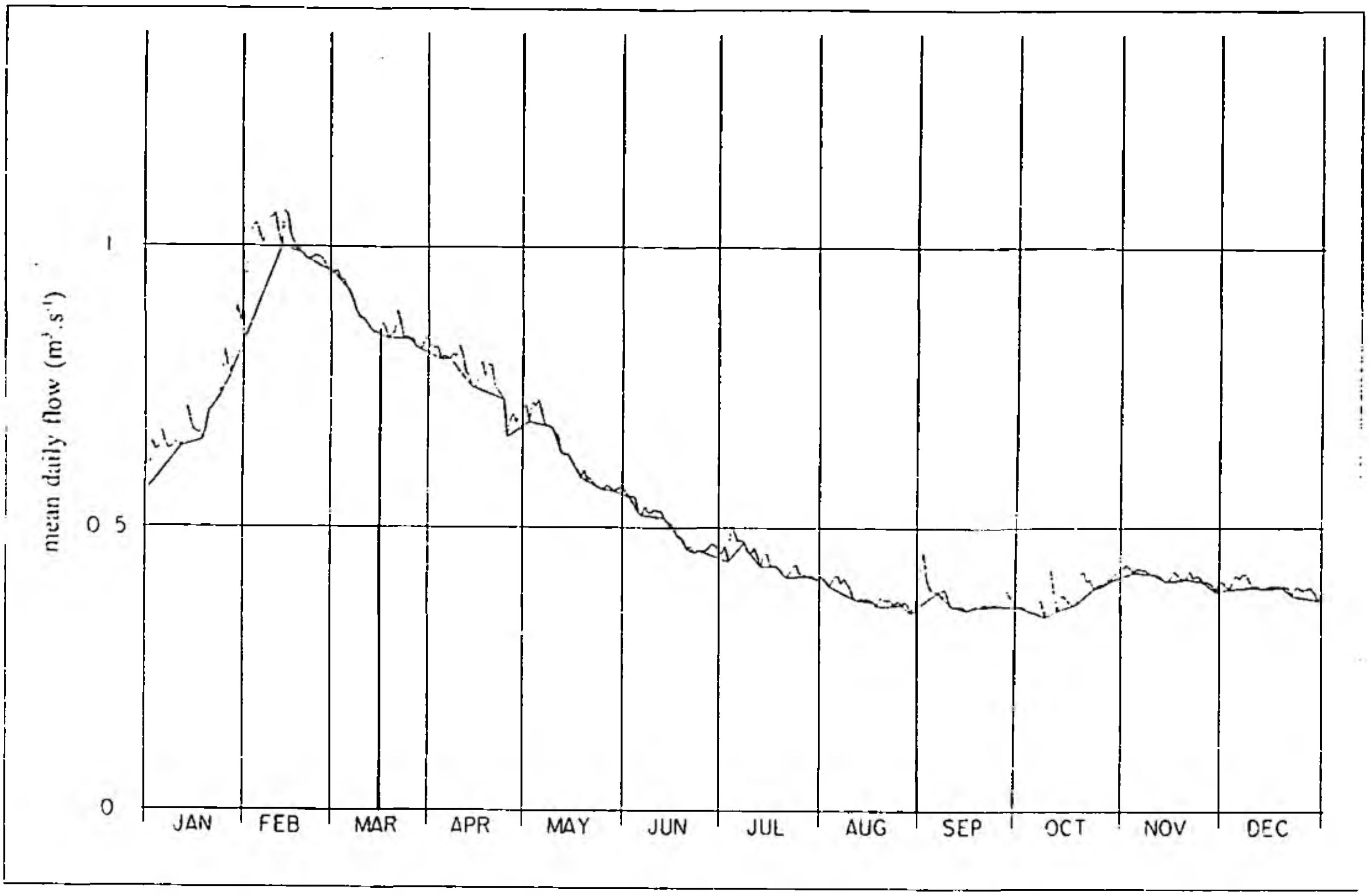


Figure E.7d Itchen at Highbridge+Allbrook (42010): Hydrograph with separated flow for 1988

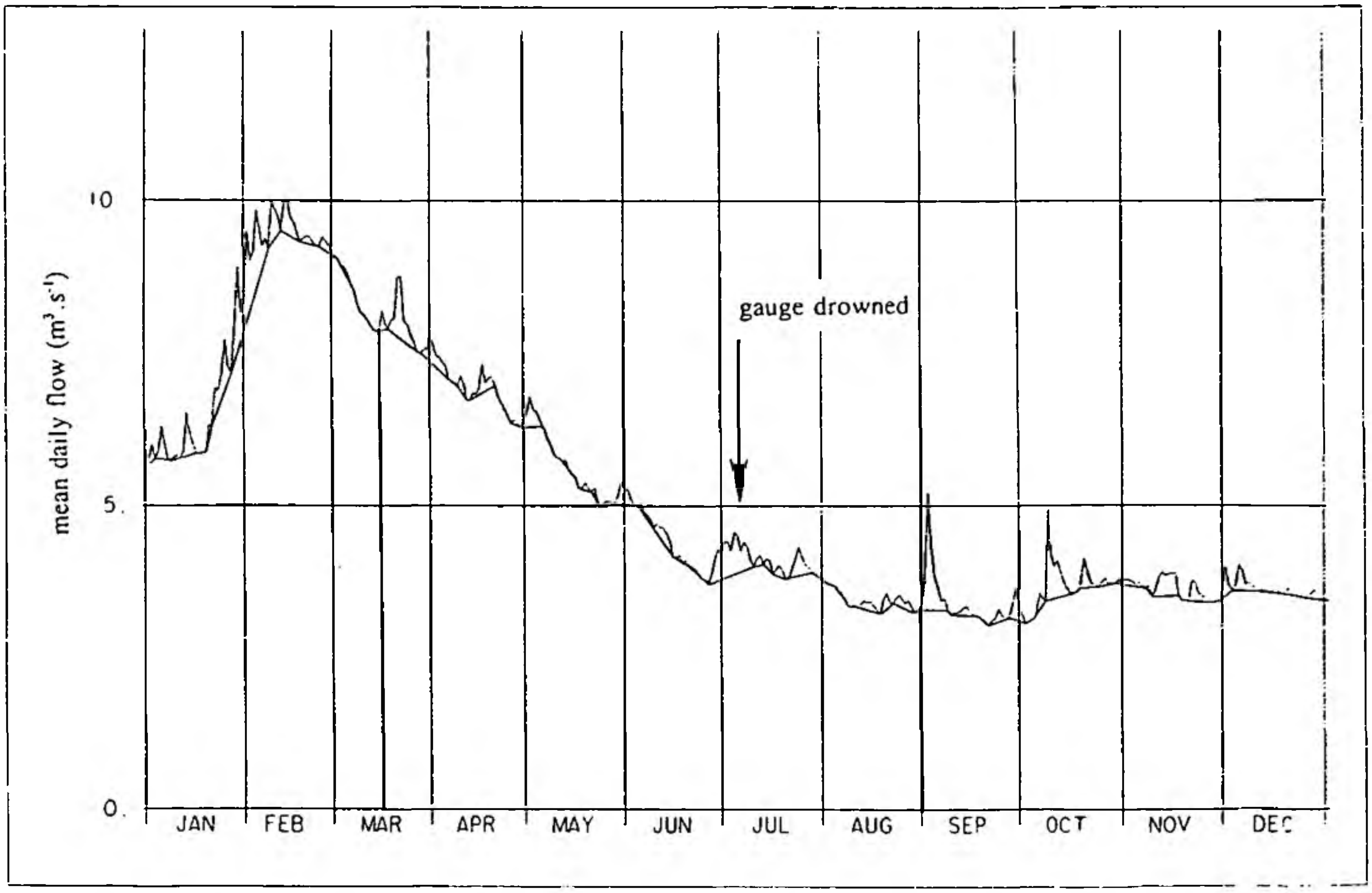


Figure E.8a Alre at Drove Lane, Alresford (42007): Hydrograph with separated flow for 1989

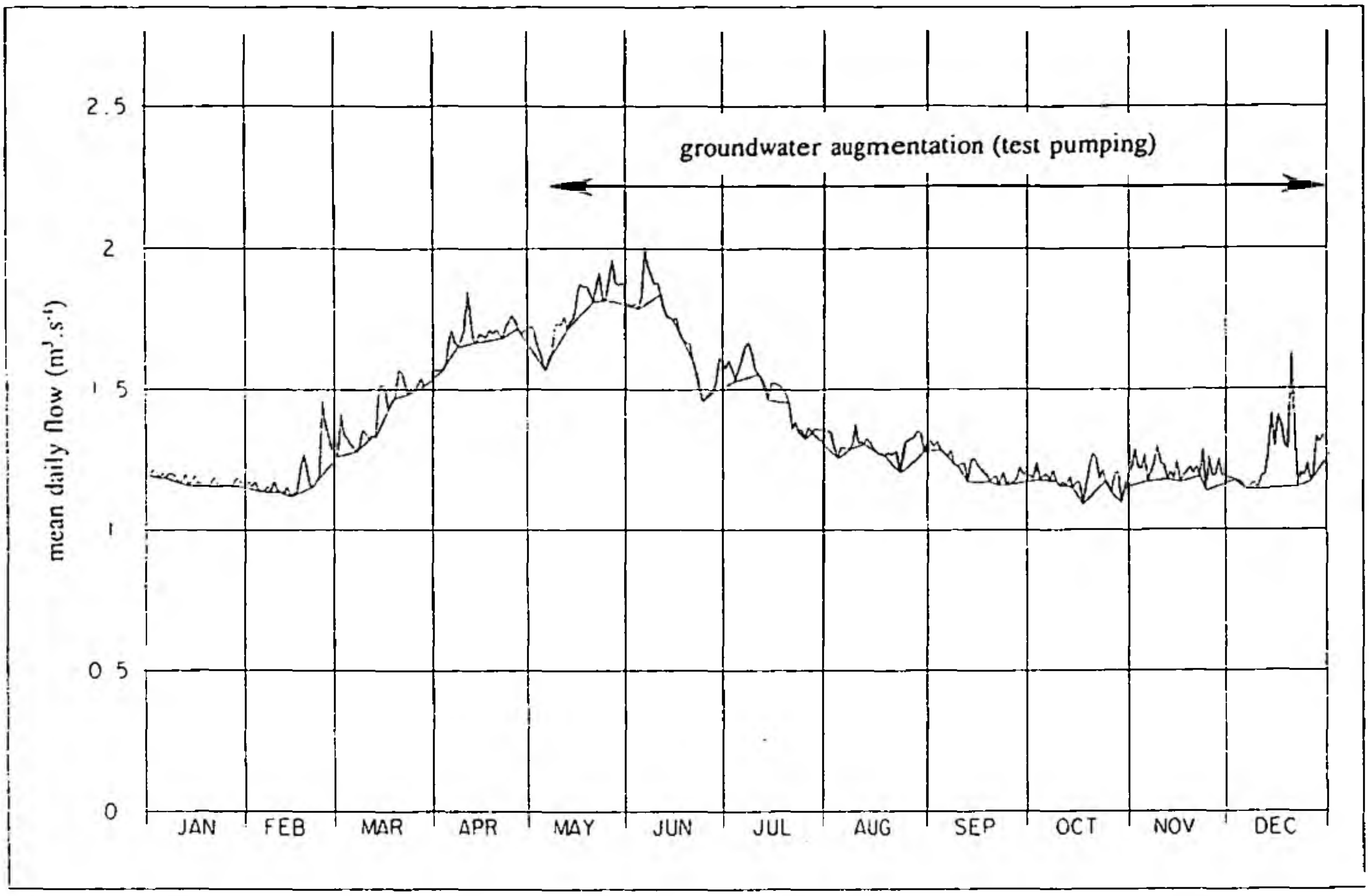


Figure E.8b Cheriton Stream at Sewards Bridge (42008): Hydrograph with separated flow for 1989

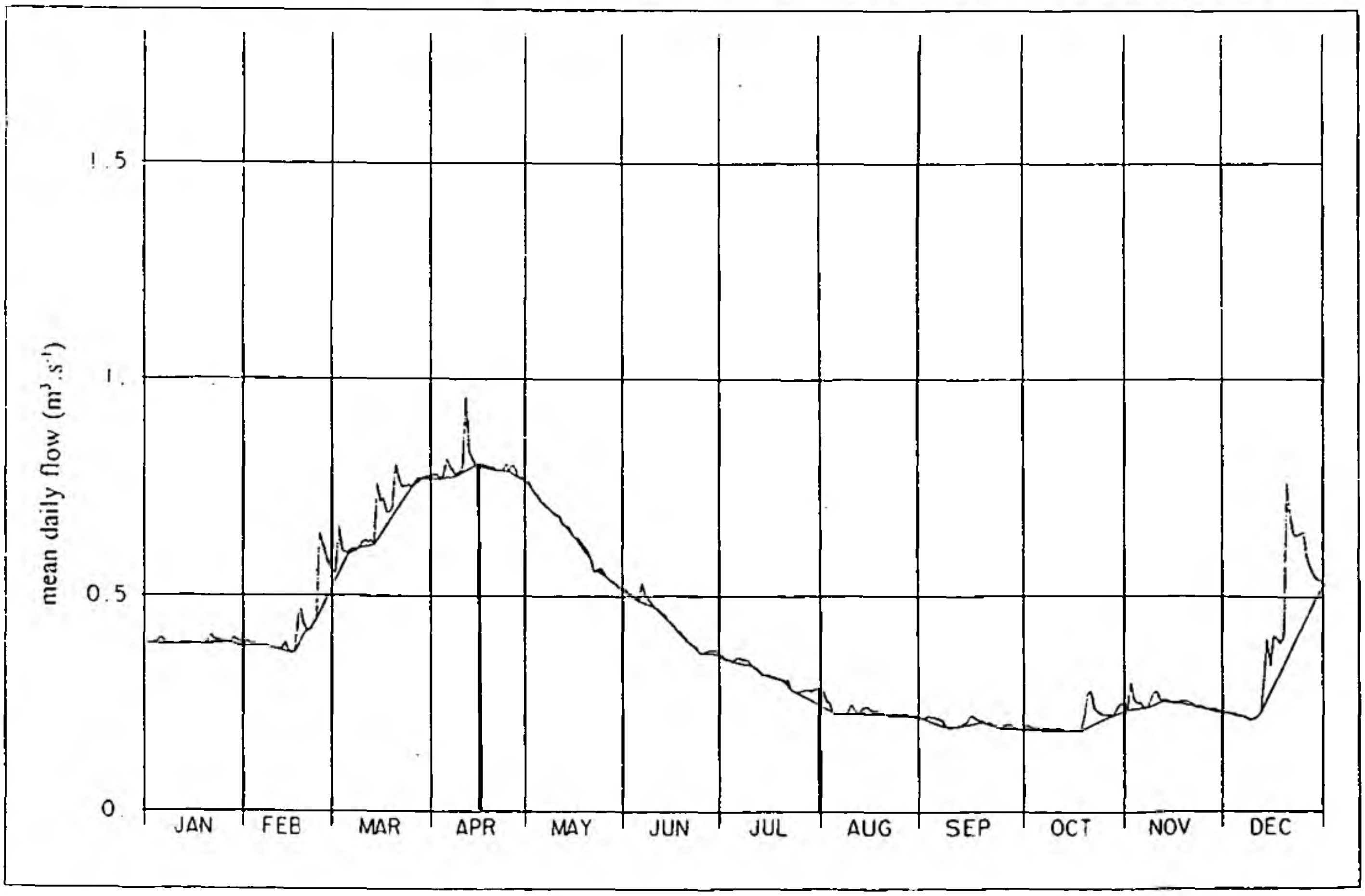


Figure **E**.8c Candover Stream at Borough Bridge (42009): Hydrograph with separated flow for 1989

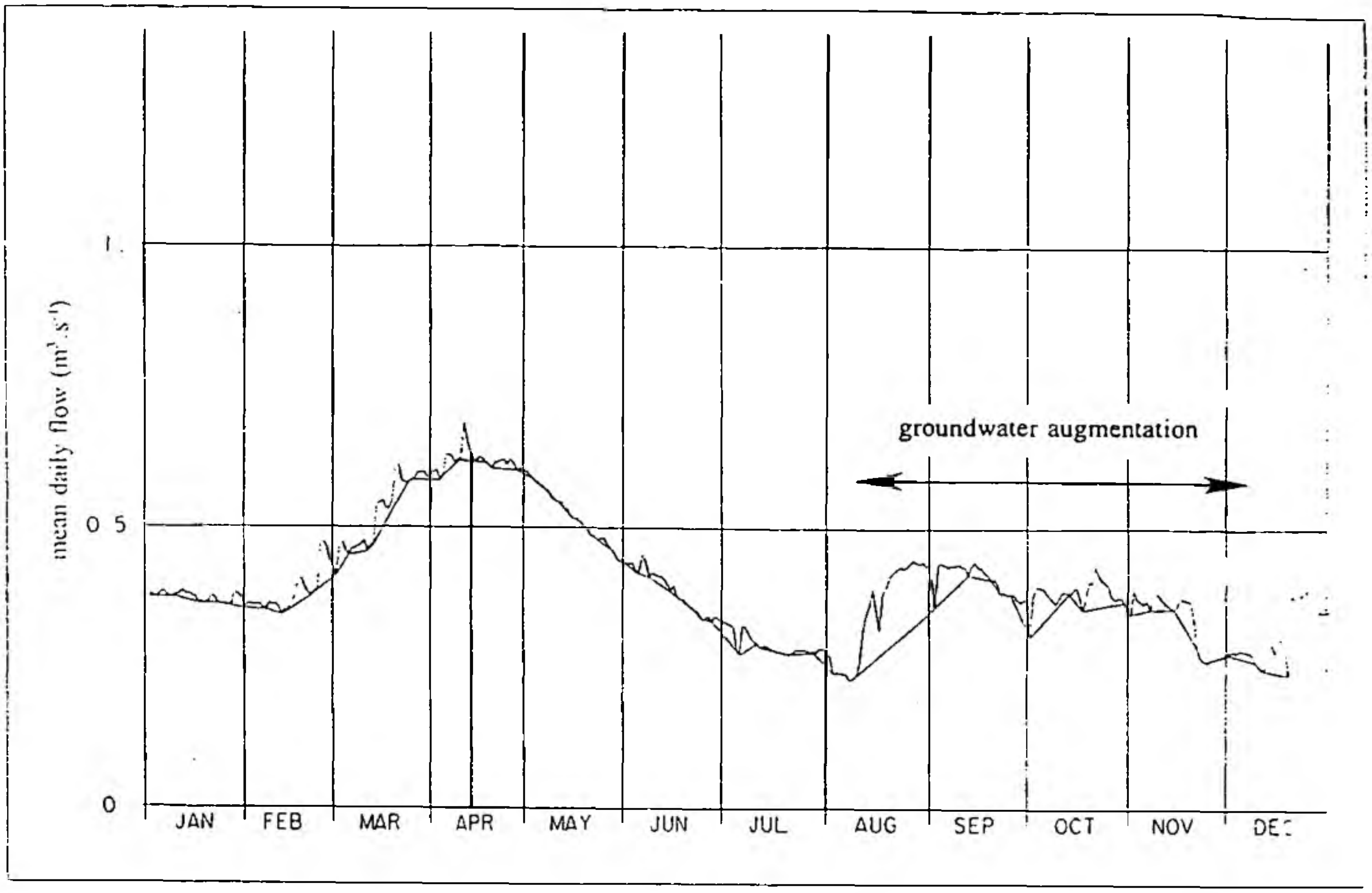
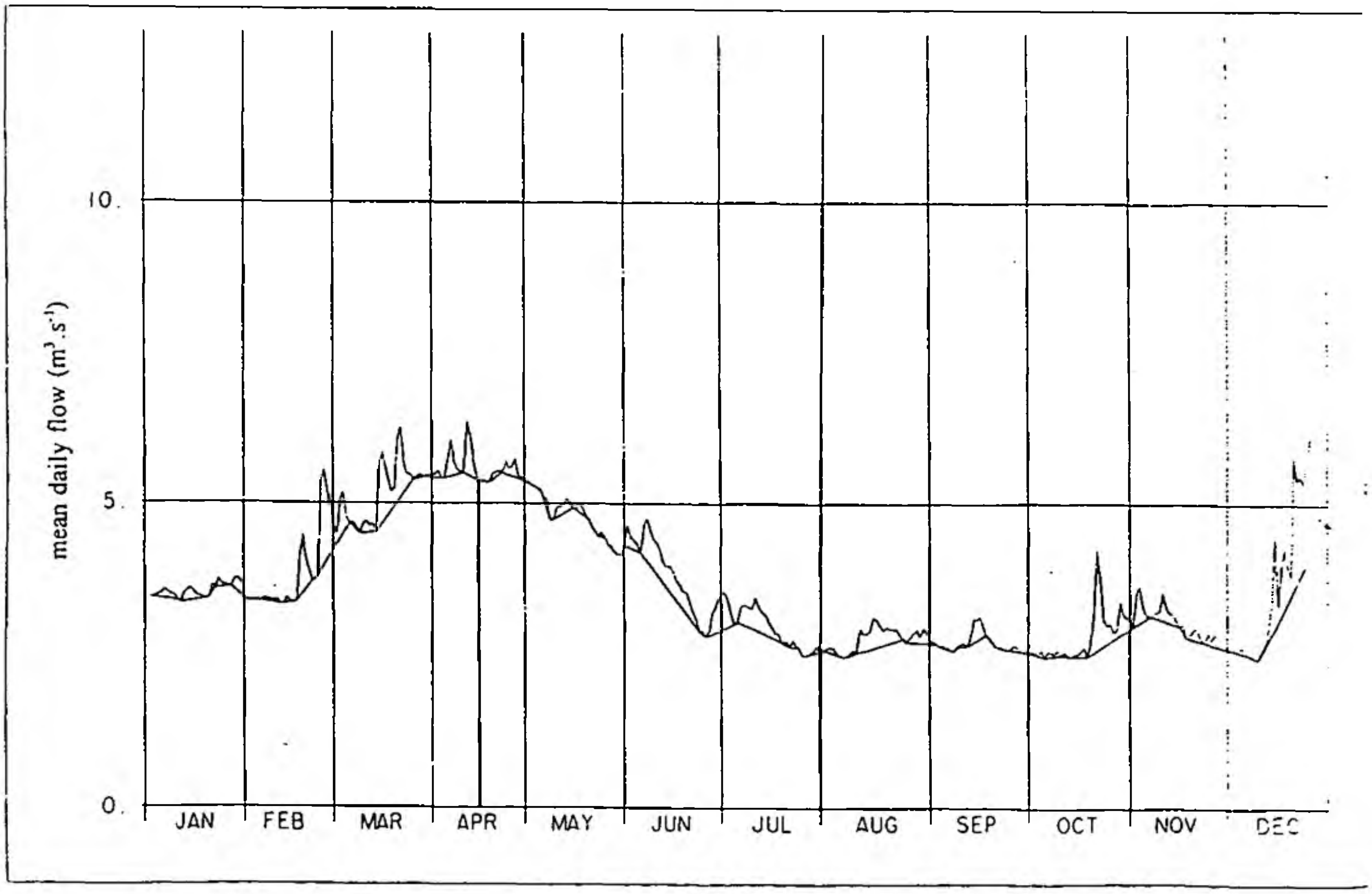
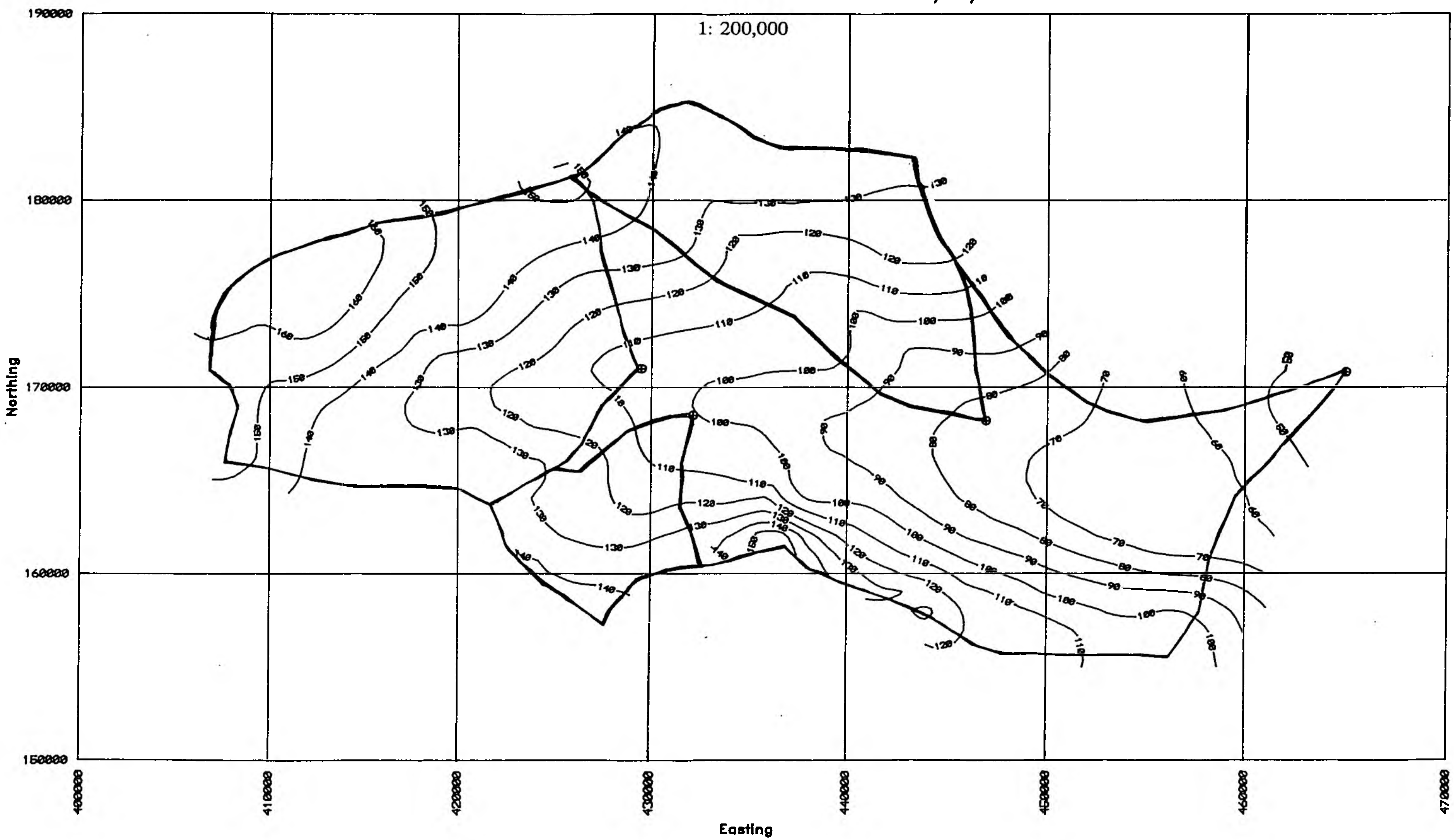


Figure **E**.8d Itchen at Highbridge+Allbrook (42010): Hydrograph with separated flow for 1989

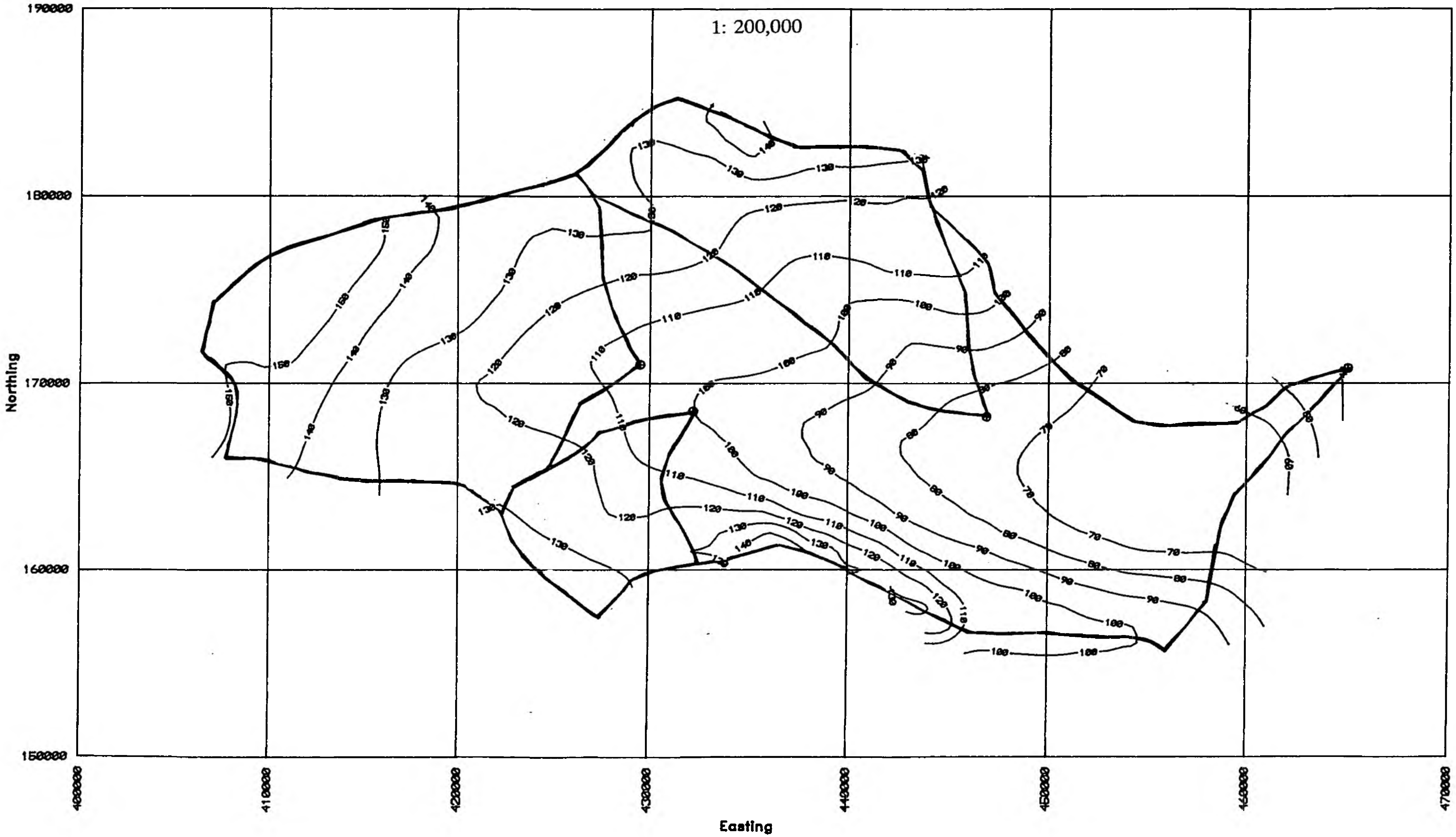


APPENDIX F
CONTOURED GROUNDWATER LEVEL PLOTS FOR THE KENNET AND ITCHEN CATCHMENTS

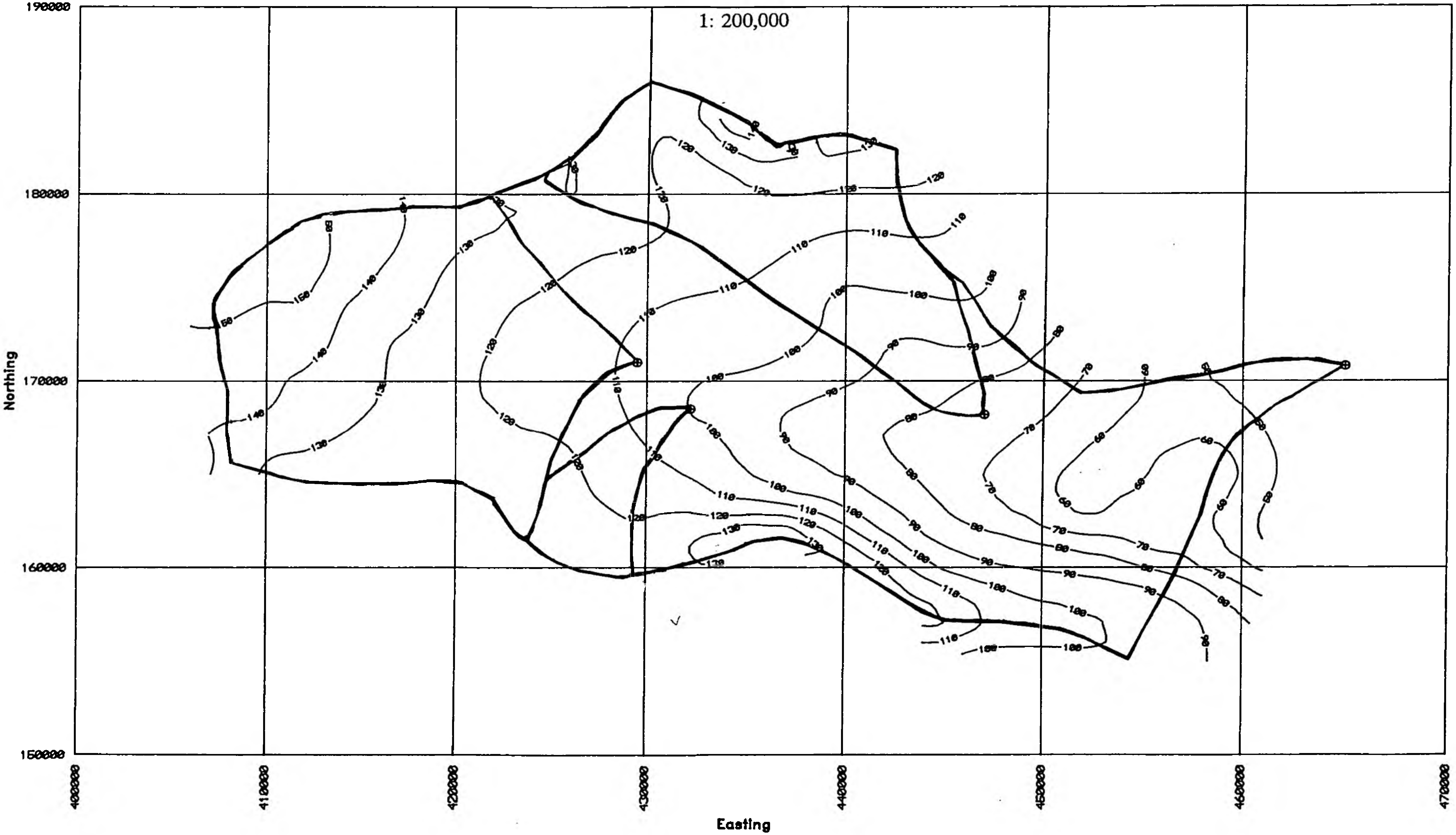
Kennet – Groundwater Levels 1/4/75



Kennet – Groundwater Levels 31/8/75

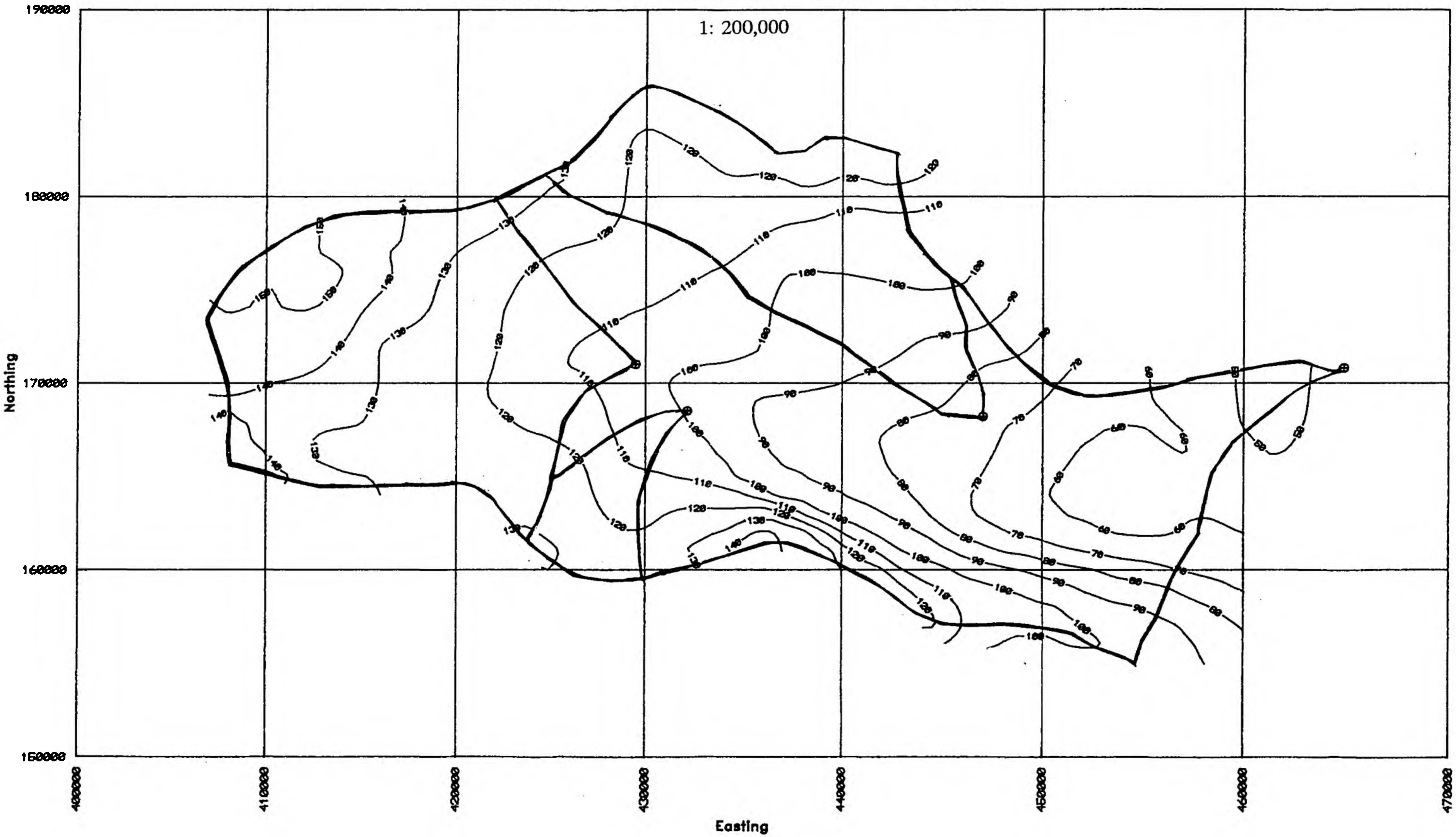


Kennet – Groundwater Levels 15/3/76

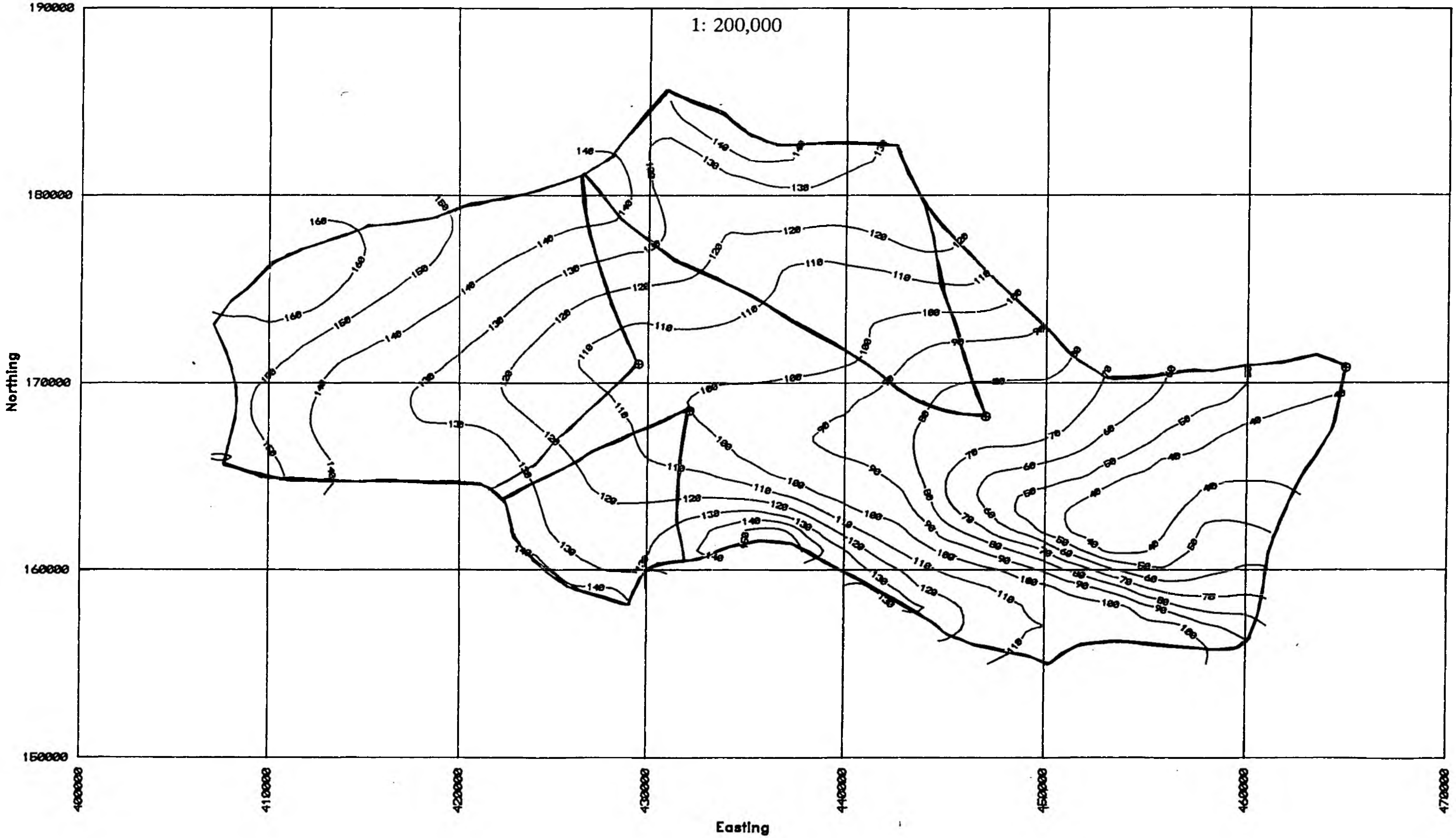


Kennet - Groundwater Levels 15/8/76

1: 200,000



Kennet - Groundwater Levels 15/4/88



Kennet – Groundwater Levels 31/8/88

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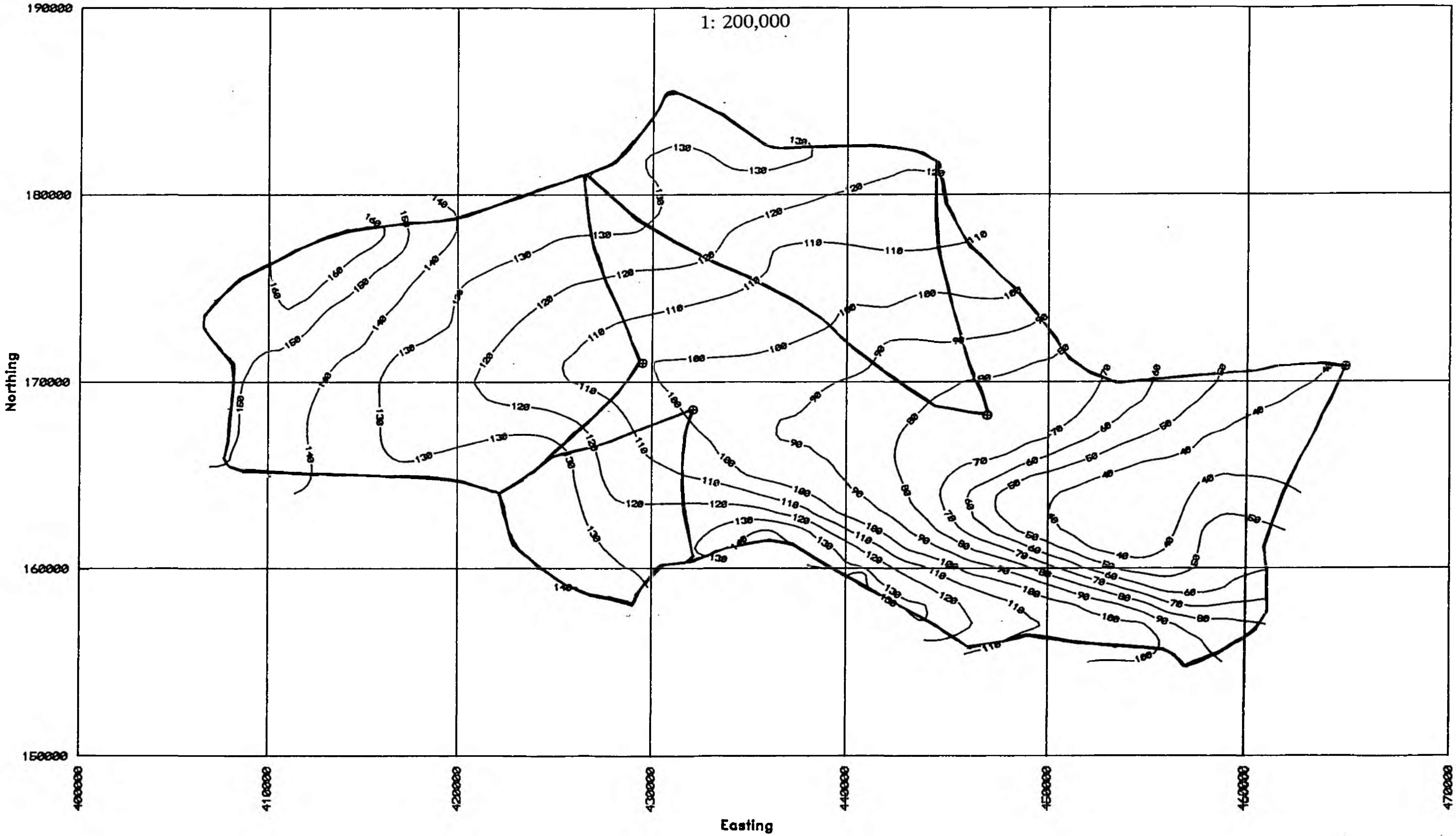
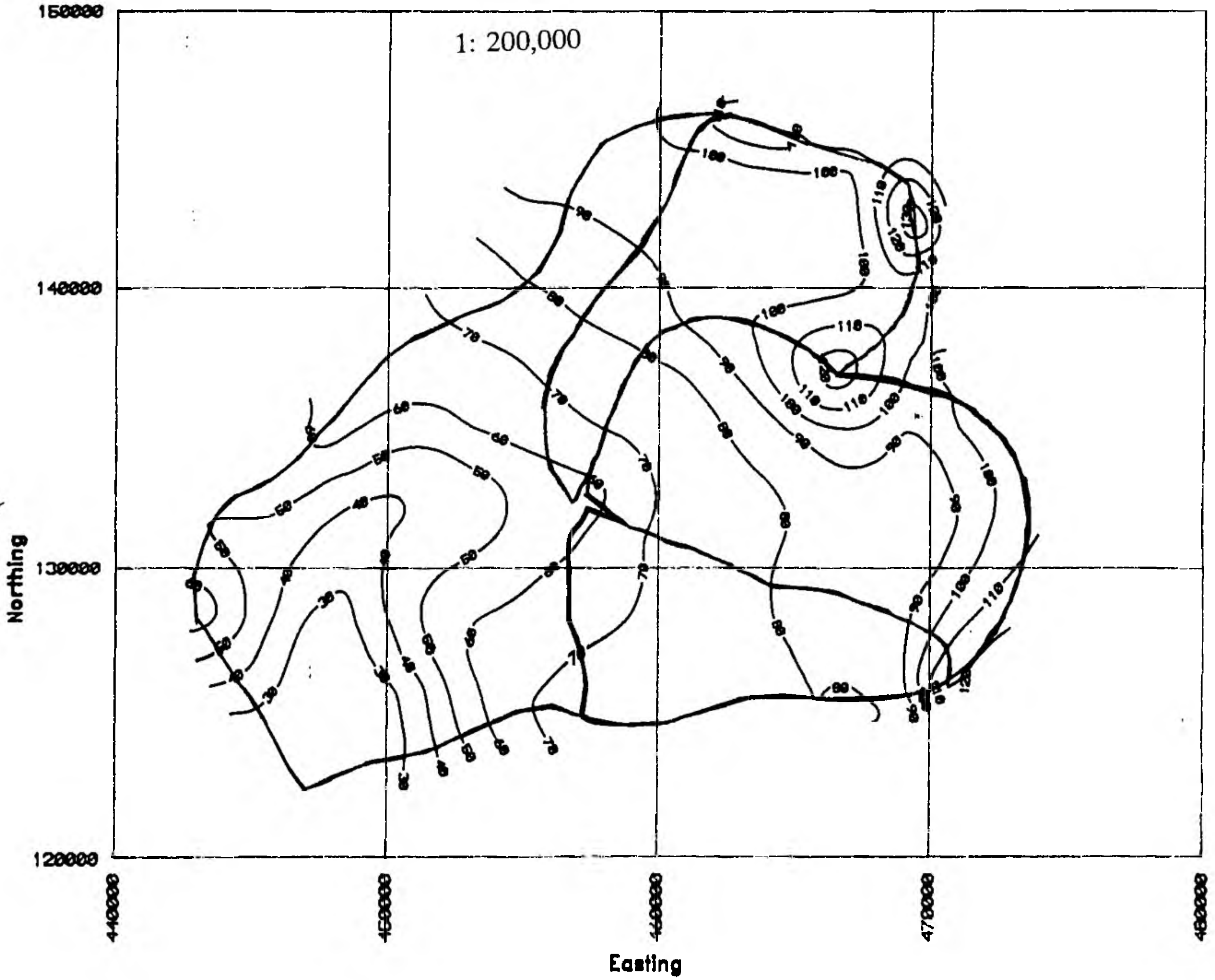
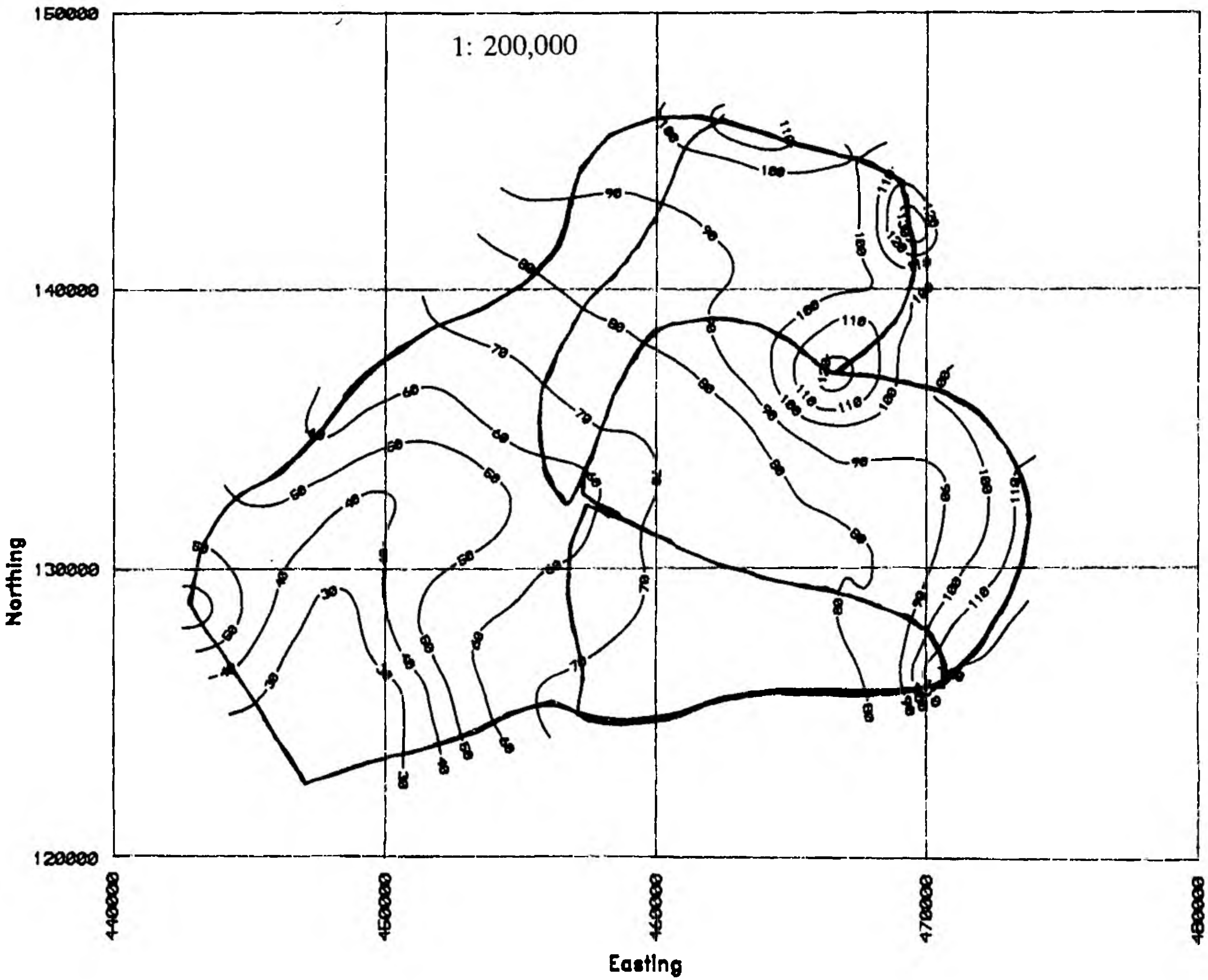


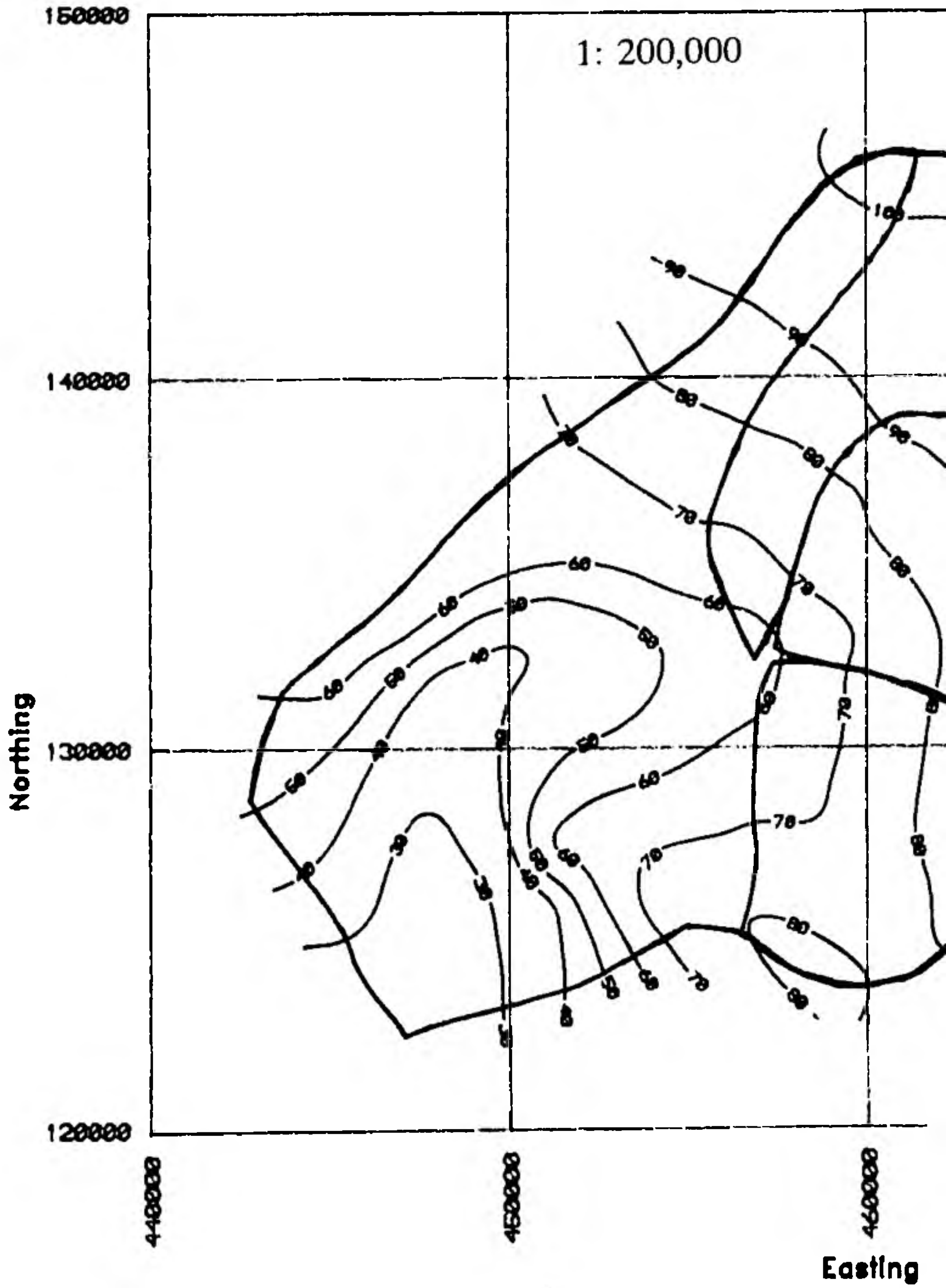
Itchen – Groundwater Levels 2/4/76



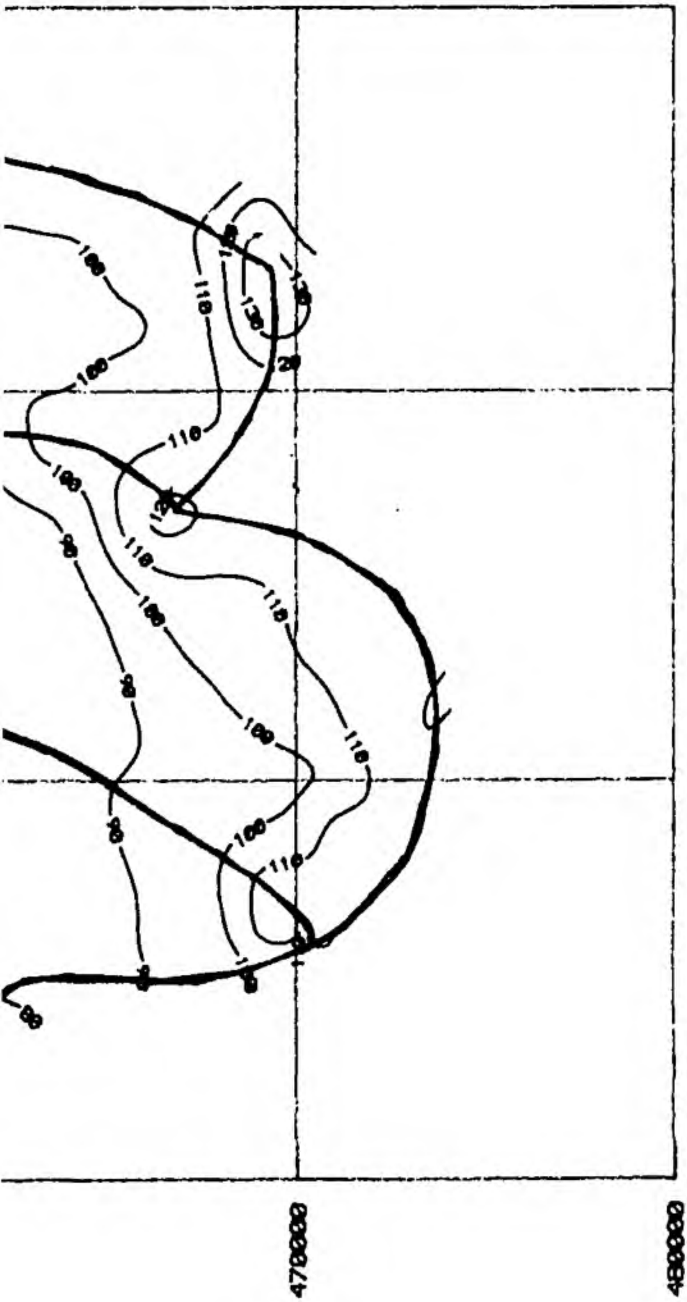
Itchen – Groundwater Levels 31/7/76



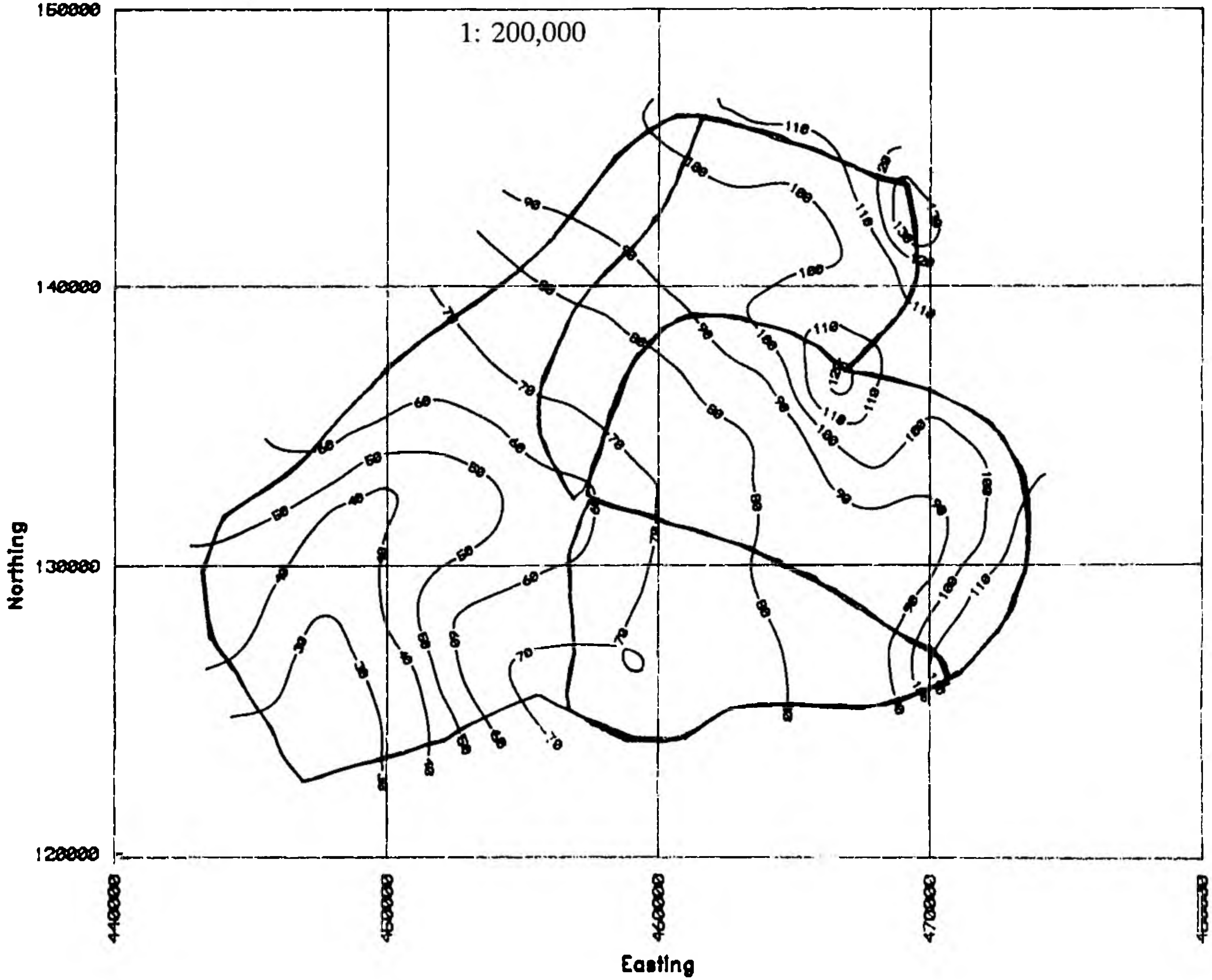
Itchen – Groundwater



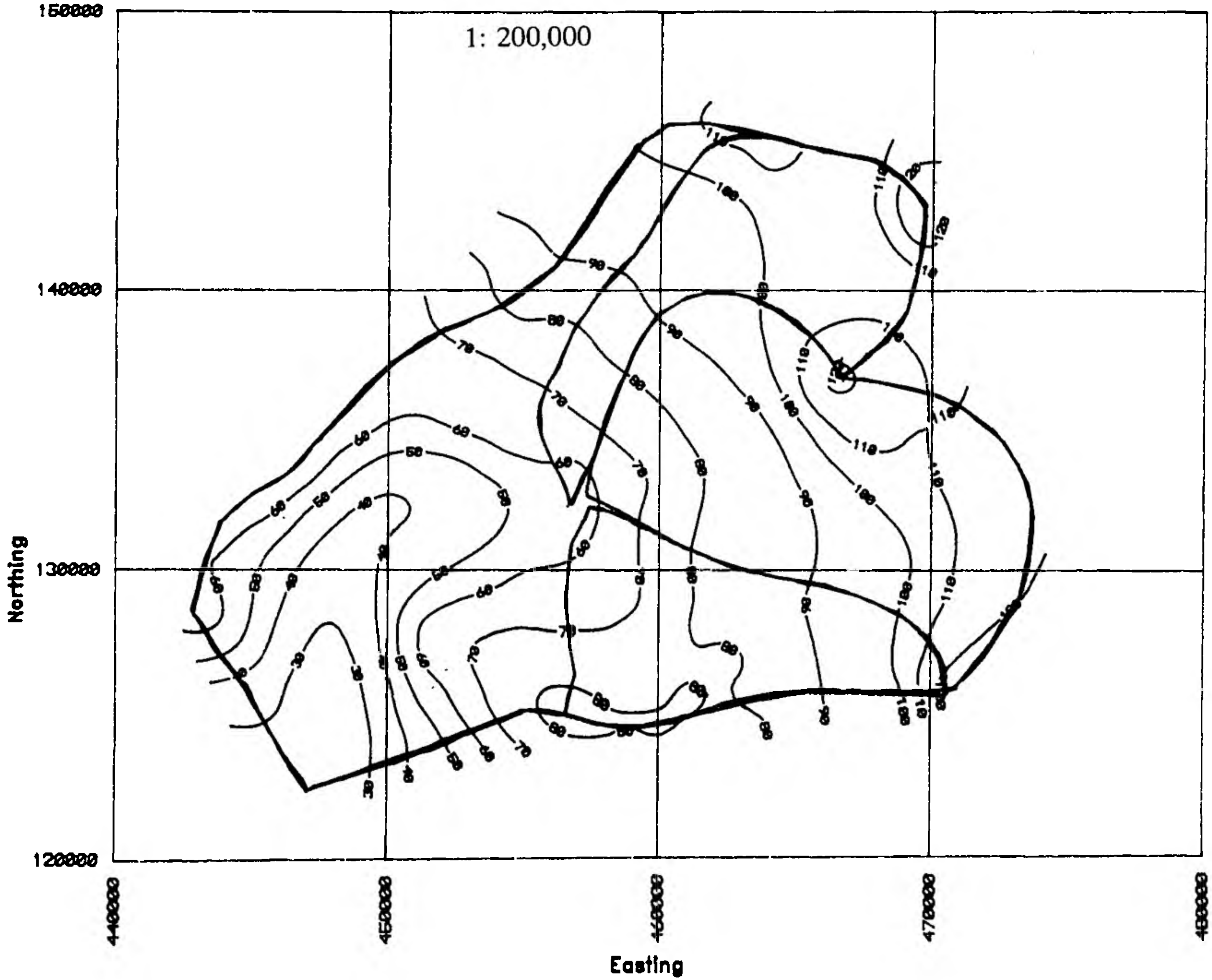
Levels 17/3/88



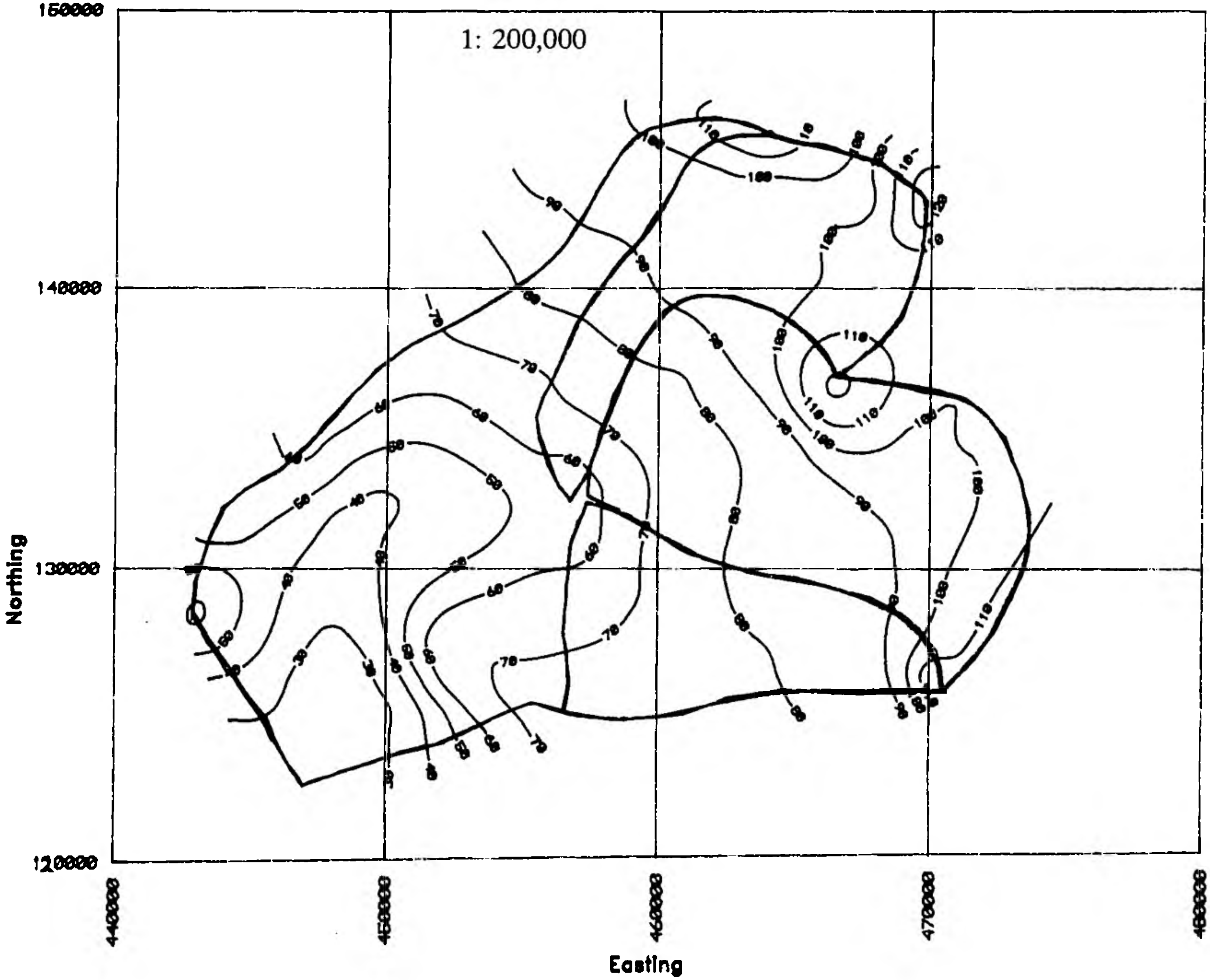
Itchen - Groundwater Levels 31/8/88



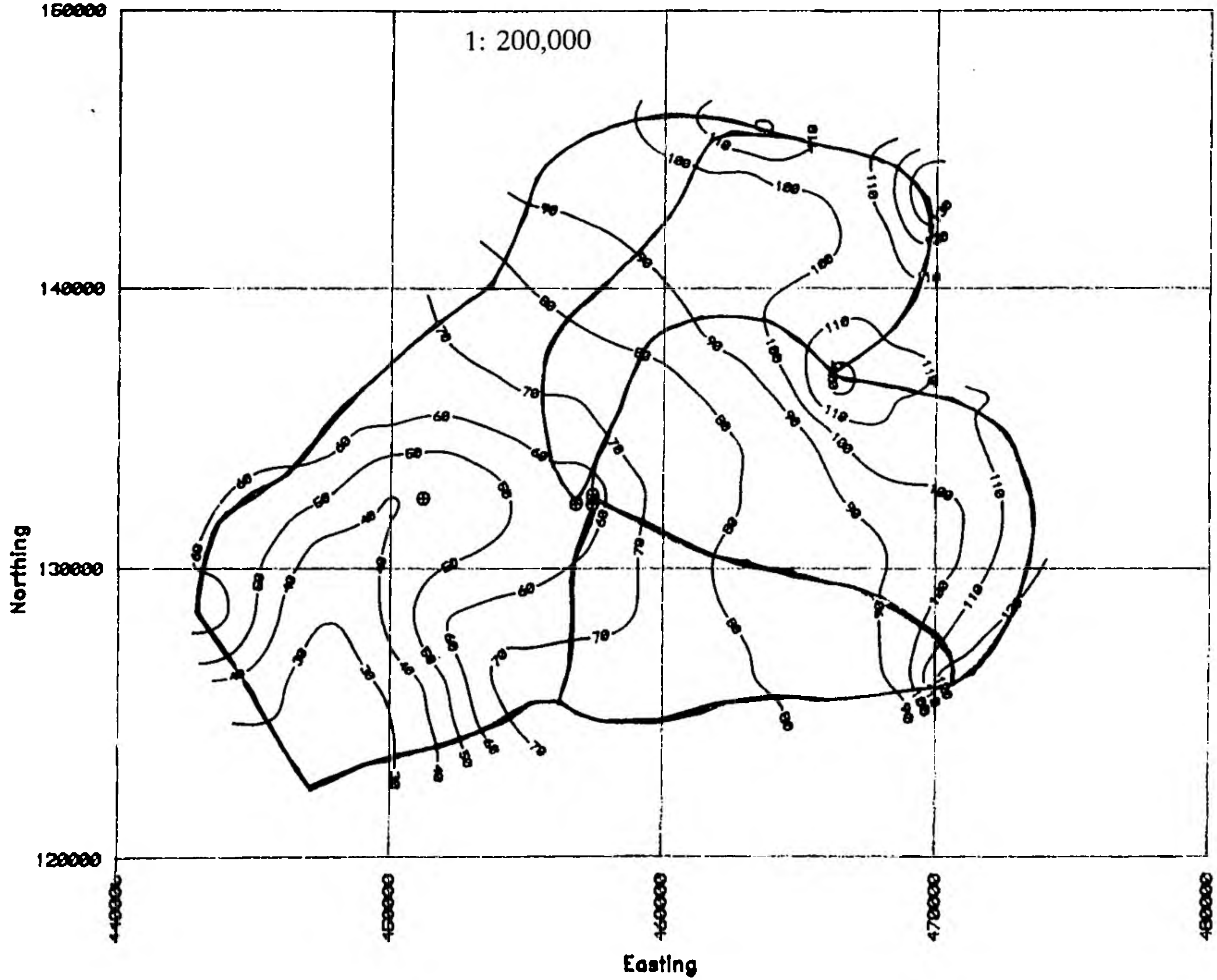
Itchen – Groundwater Levels 12/3/75



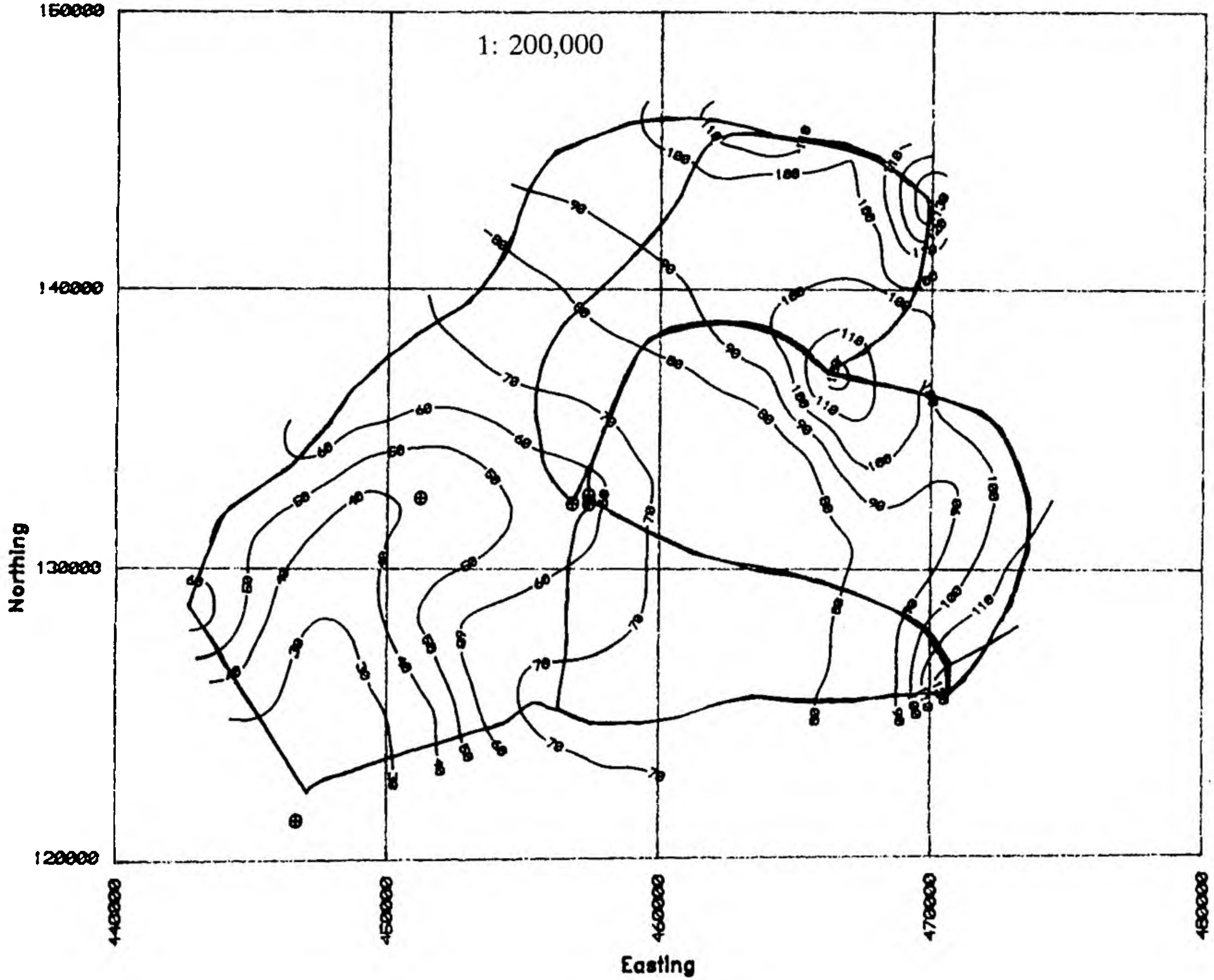
Itchen - Groundwater Levels 31/8/75



Itchen – Groundwater Levels 24/4/89



Itchen - Groundwater Levels 31/7/89



MAPS

MAP 1

Top of Chalk (m AOD)

MAP 2

Base of Middle Chalk (m AOD)

MAP 3

Base of Lower Chalk (m AOD)

MAP 4

Groundwater levels (m AOD) - April 1975

MAP 5

Groundwater levels (m AOD) - September 1976

MAP 6

Groundwater levels (m AOD) - March 1988

MAP 7

Groundwater levels (m OAD) - December 1990