

**River Glen:
River Channel Assessment - Annex A**

**A Report of the Nature, Availability and Extent of Data and Information
Relating to The River Glen and its Catchment**

August 1989

V Adams

Freshwater Environments Group

Anglian Regional Operational Investigation 447

OI/447/3/A



RIVER GLEN REPORT

ANNEX A

**A REPORT OF THE NATURE, AVAILABILITY AND EXTENT OF
DATA AND INFORMATION
RELATING TO THE RIVER GLEN AND ITS CATCHMENT**

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RAINFALL DATA

Daily and monthly rainfall data are available in various forms for the Glen catchment and are all kept on computer or filed at the N.R.A's Lincoln office.

Historical Extent of the Data

Prior to the 1960's, there appears to have been no systematic recording of rainfall, except at Irnham (NGR TF022265) in the East Glen catchment where a dataset is available for the period 1904-1968 (on microfilm at the Lincoln office). The oldest record for the West Glen catchment is that for Little Bytham, for the period 1959-1962, but data prior to about 1970 are sporadic in both spatial and temporal coverage. The oldest continuous record to the present dates only from 1972, for Old Somerby (NGR SK964339). Numerical data are available either on microfiche or from the recording cards sent in monthly by the rain-gauge observers, reporting daily and monthly totals (see Appendix R1 for extract). A summary of the spatial and temporal coverage of these is produced in Table R1.

In addition, general observations of notable rainfall events and their hydrologic impact for the period 1953-1974 have been assembled from River Board annual reports and newspaper cuttings, and are listed chronologically in Appendix R2.

Since 1980, all Meteorological Office registered recording station returns in the Glen catchment have been computerised and continuous records of daily, monthly and annual values (total, average and percentage of the average for that period) for rainfall have been obtained in hard copy for most stations (see Appendix R3). The stations are approximately 9 km apart, although more sparsely spread in the Southern half of the catchment. Their distribution is broadly as follows: West Glen catchment 9 stations; East Glen catchment 7 stations; Bourne Eau catchment 1 station; and downstream of the West & East Glen confluence 5 stations.

A summary of the datasets are listed in Table R2 and major gaps in the records are noted on Table R3. In addition to the recognised limitations of rainfall records, caution needs to be exercised with regard to data from stations at Grimsthorpe and Little Bytham, both of which are considered badly over sheltered, and Corby Glen where reliability has been questioned.

**TABLE R1: AVAILABILITY OF DAILY RAINFALL DATA FOR THE GLEN CATCHMENT
PRIOR TO 1980. (at the Lincoln office on cards or microfiche)**

STATION	AVAILABILITY	FILE NO.	MICROFILM NO. (if any)
Bourne*	Jan 1972 - Dec 1980	461A	2/30
Clipsham	Mar 1964 - July 1966	471A	2/31
Corby Glen	Nov 1974 - Dec 1982	475A	2/31
Clipsham Home Farm	Oct 1967 - Dec 1980	477A	2/31
Carlby	Oct 1979 - Dec 1980	477A	2/31
Grimsthorpe	Sept 1969 - Dec 1982	495A	2/31
Grimsthorpe Nursery	Oct 1968 - Nov 1970	502A	2/32
Irnham	Jan 1904 - Dec 1968	514A	2/33
	Nov 1939 - Dec 1964	514B	cards only
Little Bytham	Jan 1959 - June 1962	523A	2/34
Old Summerby	Mar 1972 - Dec 1980	342A	2/35
Ropsley	Jan 1964 - Dec 1973	555A	2/36
Surfleet Sluice	Jan 1964 - Feb 1977	563A	2/37
Tongue End	Jan 1964 - Dec 1980	515A	2/37
Welby C of E	Mar 1962 - Jan 1965	584A	2/38
	Jan 1964 - June 1967	584B	cards only
Wilsthorpe	Sept 1961 - Dec 1963	593A	2/38
	Jan 1964 - Dec 1980	593B	2/39
Welby	Sept 1974 - Dec 1980	595A	2/39

* data obtained for 1972 - See Appendix 1.

TABLE R2: RAINGAUGE NETWORK AND DATA AVAILABILITY FOR THE GLEN CATCHMENT FROM 1980 (COMPUTERISED)

STATION NAME & NUMBER (in any)		RECORDS BEGUN	YEARS OBTAINED	GRID REF
Pinchbeck Marsh	156280		1981 - 1989	TF526326
Langtoft	154209		1983 - 1986	TF121125
Langtoft School	154201		1986 - 1989	
Tongue End	156194	1947	1981 - 1989	TF151185
Surfleet Sluice		1964		TF280293
Wilsthorpe	155989	1961	1981 - 1987	TF081148
Lound	156215	1961	1981 - 1984	TF079194
Imham		1939		TF022265
Grimsthorpe		1969	1983 - 1987	TF047231
				TF059239
Ropsley STW	155592	1963	1985 - 1989	TF001336
				TF993341
Welby	155492	1961	1985 - 1989	SK975383
Manthorpe STW	155962		1984/5 - 1989	TF067164
Old Somerby	154818		1981 - 1989	SK964339
Corby Glen	154982		1984/5 - 1989	SK992246
Castle Bytham	155271		1987 - 1989	SK985174
Carlby	156000		1981 - 1989	TF049142
Easton Wood			1984 - 1985	
Clipsham (Home Farm)	155233	1963		SK969163
Bassingthorpe		1968		SK967286
Birkholme	155011		1982 - 1989	SK969235
Ridds Farm	154934		1984/5; 1987/9	SK938255
Bourne p/s	156225		1981 - 1987	

TABLE R3: MAJOR GAPS IN STATION DATASETS FOR THE PERIOD 1980 TO PRESENT.

STATION NAME	GAPS IN DAILY DATA AND OTHER OBSERVATIONS OF THE DATA SET QUALITY	
	Year	Month(s)
Pinchbeck Marsh	1987	January Significant Met. Office correction, 1982, 1986, 1988
Langtoft	1983	January - August inclusive
	1986	September, November, December
Langtoft School	1986	January - August inclusive, October
	1987	March
		Significant Met. Office correction 1988
Tongue End		
Surfleet Sluice		
Wilsthorpe	1982	June
	1984	January and October
	1985	September/October (miscellaneous days)
	1986	December
	1987	January, May - December inclusive
		Extensive Met. Office correction 1981-83.
Irnham		
Grimsthorpe		
Ropsley STW	1986	May, August, September
Welby	1985	October - December inclusive
	1986	October (5 days)
Manthorpe STW	1986	May - August inclusive
	1987	January, December
Old Somerby	1985	January
		Extensive Met. Office correction 1988-89
		Significant correction 1987, 1981, 1982
Corby Glen		
Castle Bytham	1988	November
		Significant Met. Office correction 1987
Carlby		Significant Met. Office correction 1982, 1987
Easton Wood		
Clipsham (Home Farm)	1986	August - December inclusive
		Significant Met. Office correction 1981-1985
		extensive correction 1986
Bassingthorpe		

Birkholme	1982 January and February 1985 September 1986 August Significant Met. Office correction 1982-5, 1987 Extensive correction 1988, 1989
Ridds Farm	January 1987 - February 1989 inclusive
Bourne p/s	1981 - 1987 inclusive except May (1981), November and December (1983)

STREAMFLOW DATA

1. Gauging Station Records

All gauging station data for the catchment have been entered onto the computer in the Flow Processing System (FPS) at the Lincoln office and can be downloaded on request. A full set of hard copy files are also available there, photocopies of which are appended herein. There are 14 stations in the Glen catchment and their distribution is broadly as follows:

RIVER COURSE	NO. OF GAUGING STATIONS
West Glen and tributaries	8
East Glen	3
Bourne Eau	1
Downstream of Kates Bridge	2

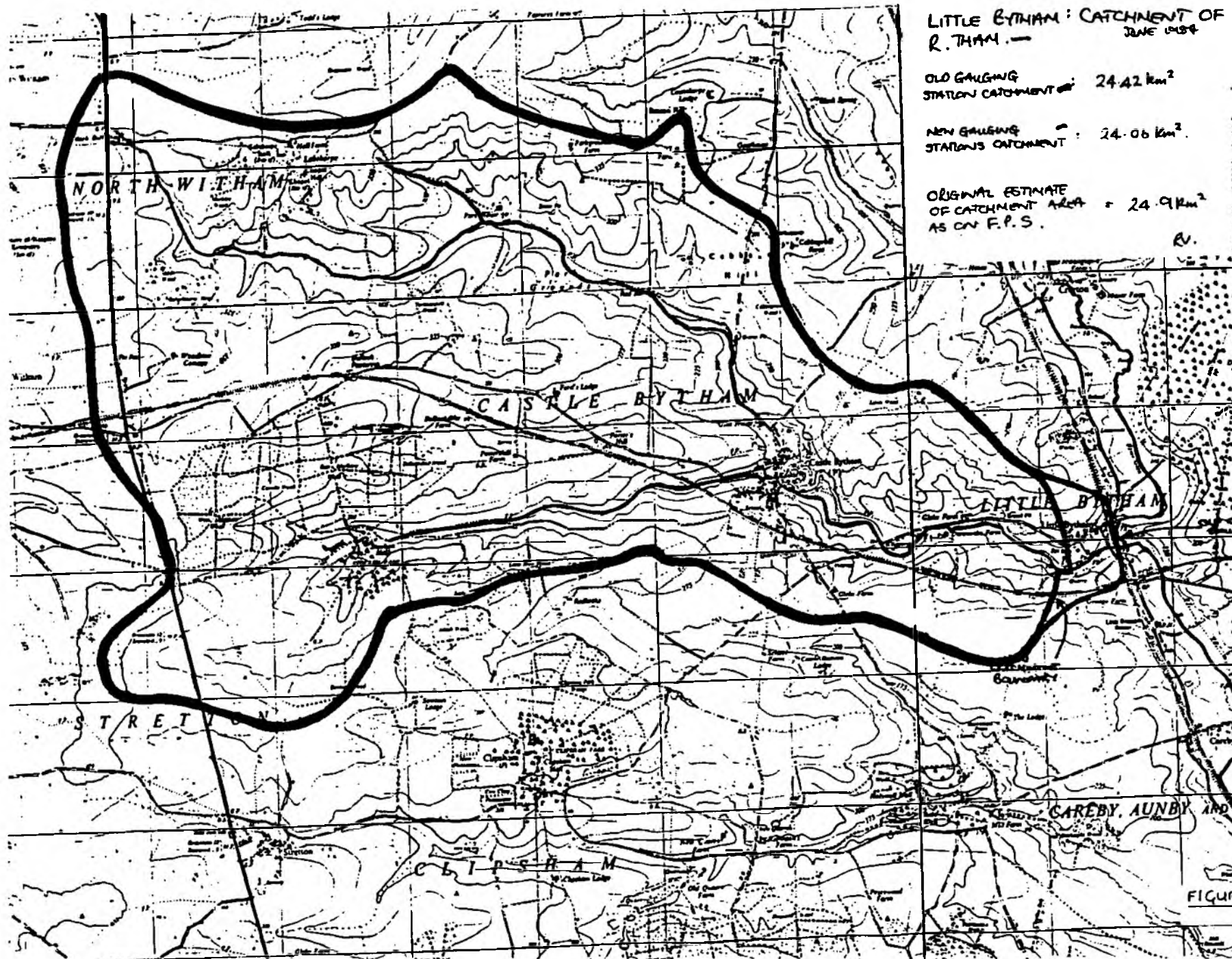
The majority of the gauging stations were set up during the 1960's with the records at Kates Bridge and King Street being the longest, dating from 1960, whilst that at Bourne on the Bourne Eau is the most recently established (1981). Table FD1 provides a summary of each gauging station and the length of its records, whilst Table FD2 gives an indication of the significant gaps in each dataset.

It emerges that records for Easton Wood (tributary, West Glen), Holywell Brook (tributary, West Glen), Kates Bridge and King Street are the most continuous, in comparison to stations such as Manthorpe (East Glen) where there occur several periods of unquantified flow, a result of the measuring structure (low flow weir) being unable to measure the volumes of discharge prevailing.

In addition to periods of unquantified flow, another problem of the dataset is that of reliability/continuity. In particular, flows recorded at Little Bytham need treating with some caution since the gauging station has been moved upstream during the recording period. The present catchment is now somewhat smaller than previously but, more importantly, it no longer encompasses springs at Little Bytham, which appear to considerably augment the River Tham streamflow (see Figure FD1). The situation is further complicated by the presence of two gauging stations, a main and a bypass (for high flows), numbers 3 and 4 in Table FD1, replacing the previous gauging station, No.13.

2. Current Meter Survey, January 1976 - March 1977

A report of this survey and an accompanying map have been obtained (from a River Glen file at the Lincoln office) to provide some additional information on zones of influent and effluent conditions along both the West and East Glen (see Appendix FD2). The downstream flow variation for low and high flows had been plotted and appears as Figure FD2. Whilst there is no reason to doubt the reliability of the high flow data, that relating to low flows is open to question as the small values recorded are thought to increase the margins of error to an unworkable level.



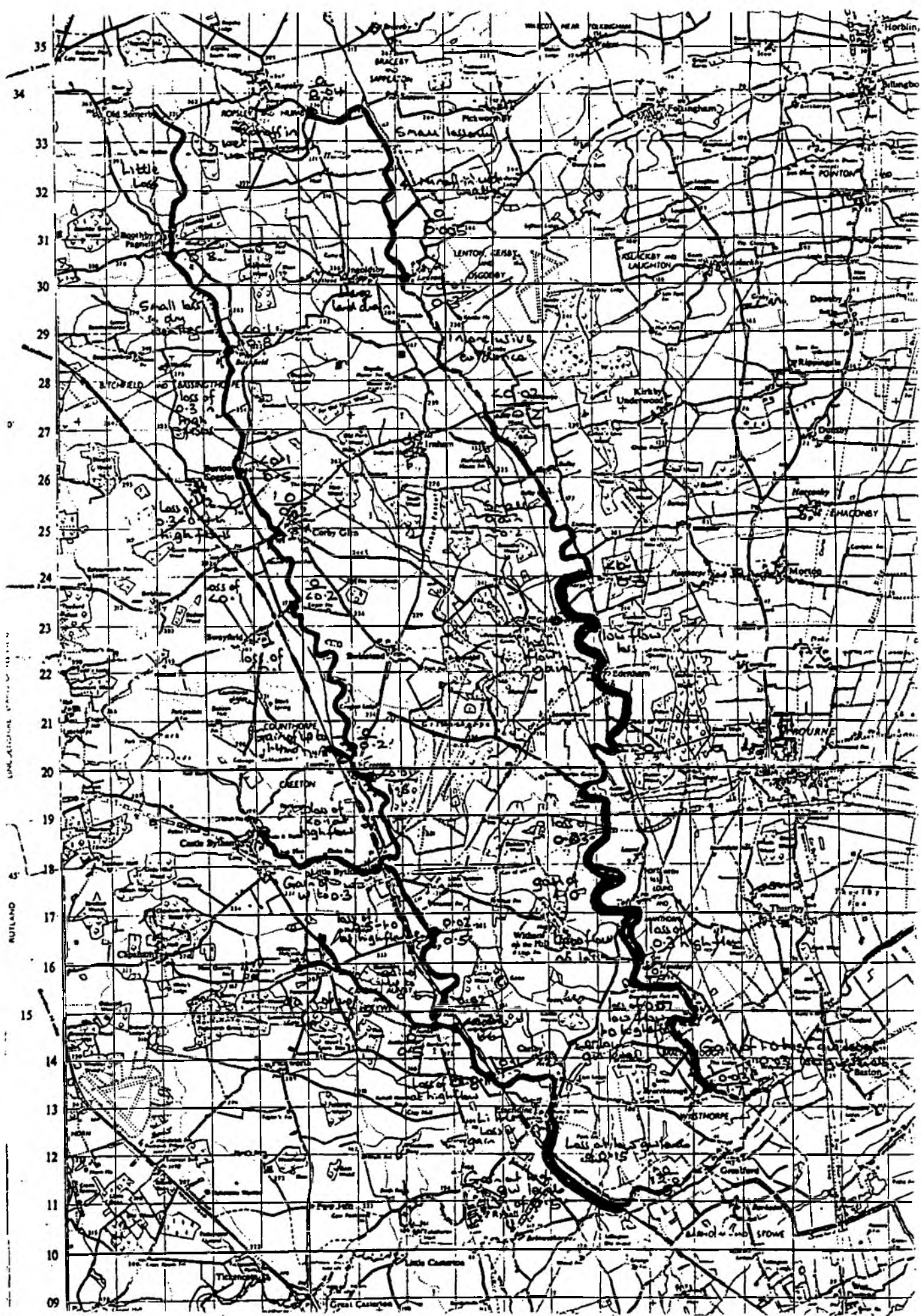
LITTLE BYTHAM: CATCHMENT OF
R. THAM. —

OLD GAUGING
STATION CATCHMENT: 24.42 km²

NEW GAUGING
STATION CATCHMENT: 24.06 km²

ORIGINAL ESTIMATE
OF CATCHMENT AREA = 24.9 km²
AS ON F.P.S.

FIGURE



UNCLASSIFIED MAP OF ENGLAND

RUSSLAND

TABLE FP2: SIGNIFICANT GAPS IN STREAM GAUGING STATION DATA

STATION NUMBER	RECORD BEGINS	SIGNIFICANT GAPS IN THE DATASET (MORE THAN 7 CONTINUOUS DAYS)	
1.	Feb 1972	none - complete to Sept 1987	
2.	Feb 1969	6.7.70 - 1.6.71	
3.			
4.			
5.	Dec 1971	none	
6.	Oct 1970	21.1.71 - 7.2.71	over upper limit
		18.3.71 - 27.3.71	over upper limit
		18.2.77 - 4.3.77	over upper limit
		1.8.86 - 21.8.86	missing
7.	Oct 1960		
8.	Feb 1969	22.2.69 - 1.3.69	over upper limit
		12.3.69 - 20.3.69	over upper limit
		18.11.74 - 25.11.74	over upper limit
		8.3.75 - 14.5.75	over upper limit
		1.1.77 - 8.11.77	missing
9.	Oct 1968	1.10.68 - 7.4.69	over upper limit
		24.4.69 - 29.4.69	over upper limit
		5.5.69 - 8.6.69	over upper limit
		26.11.69 - 2.5.70	over upper limit
		29.11.70 - 9.12.70	over upper limit
		28.12.70 - 3.1.71	over upper limit
		18.1.71 - 13.2.71	over upper limit
		17.3.71 - 30.3.71	over upper limit
		23.4.71 - 30.4.71	over upper limit
		August 1971	missing
		16.11.71 - 18.3.72	most over upper limit
		1.4.72 - 13.4.72	over upper limit
		6.12.72 - 14.12.72	over upper limit
		18.11.74 - 1.12.74	over upper limit
		20.1.75 - 31.12.75	over upper limit
		8.3.75 - 16.3.75	over upper limit
		2.2.77 - 3.3.77	over upper limit
		1.2.80 - 10.2.80	over upper limit
		27.1.84 - 8.2.84	over upper limit
10.	Oct 1960		
11.	Feb 1969	2.3.70 - 9.3.70	over upper limit
		19.8.80 - 31.8.80	over upper limit
		3.4.85 - 30.9.85	missing
		1.10.85 onwards	unavailable
12.	Nov 1981	18.9.84 - 30.9.84	missing
		19.11.85 - 18.12.85	missing
		22.10.86 - 29.10.86	missing
13.	Mar 1969	18.2.77 - 26.2.77	over upper limit
		17.3.86 onwards	missing

3. Streamflow/Baseflow Graph (see Figure FD3)

The report accompanying this may be found in Appendix FD3.

4. Miscellaneous Reports

These originate from the hydrologists at Lincoln (River Glen file) and mainly concentrate on analysing/modelling the interaction of river flow with levels of, or coherence with, groundwater levels and the regional water table. Reference photocopies are filed in this report under Appendix FD4, whilst a summary sheet listing the paper titles and authors is given in Table FD3.

5. Any Other Information

Anecdotal information appertaining to flood events has been filed under 'Channel Works' section of this report. Appendix FD5 contains 1:12 year and 1:50 year hydrographs drawn up for the West and East Glen combined and produced in association with the 1960's River Glen Improvement Scheme.

TABLE FD1: STREAM GAUGING STATIONS - GAUGED DAILY MEAN FLOW AND MONTHLY STATISTICS

STATION NAME	STATION NUMBER	GRID REF.	DRAINAGE AREA (km ²)	TYPE OF MEASUREMENT	RECORDS BEGUN	OTHER COMMENTS
1. Easton Wood	031023	SK965259	4.4	Flat V crump profile	Feb 1972	Catchment upstream entirely Boulder clay.
2. Burton Coggles	031011	SK987261	31.6	Low flow flat V crump, replacing a smaller capacity structure in 1973/4	Feb 1964	Swallowholes immediately upstream of station
3. Little Bytham Main	031030	TF0115177	24.1	Low flow weir since 1965 superceded	Mar 1986	See catchment maps for changed location
4. Little Bytham Bypass	031230	TF0125177	24.1	By steel sheet crump weir at Main, and rectangular weir at Bypass (1969)	Oct 1986	Both not on F.P.S. Local gravel tracts/spring discharges
5. Holywell Brook	031024	TF028148	22.3	Low flow flat V/simple crump	Dec 1971	Boulder Clay overlying Limestone catchment
6. Shillingthorpe	031009	TF074113	173.0	Simple crump, capacity <0.51 cumecs for low flows: improved 1970/1 to record a minimum of 1:10 year flood discharge recording	Jul 1968	
7. King Street	031202	TF109106	341.9	Standing wave flume, auto-recorder	Oct 1960	
8. Imham	031013	TF038273	71.5	Steel sheet single crump weir	Feb 1969	Lies within inlier of Lincs. Limestone
9. Manthorpe	031008	TF068160	136.2	Flat V crump weir, capacity 0.28 cumecs for low flows	Oct 1968	
10. Kates Bridge	031002	TF106149	341.9	Flat V since 1971 replacing standing wave flume broad crested weir	Oct 1960	
11. Grimsthorpe Park Brook	031014		21.0	Steel sheet crump weir	Feb 1969	Swallowholes and area of limestone
12. Bourne (u/s)	031027	TF106198	10.6	Fixed weir and sluice gate	Nov 1981	
13. Tham at Little Bytham	031012		24.9	Low flow weir 1965 to present, but now superceded by 3 and 4 above	1965	
14. Surfleet				Continuous water level recorder Staff gauge read since 1940	1968	

NB. 1. Low flow weirs fail when there are unusually high discharges

2. Gauging station files available at Lincoln in the store room (include some photos)

TABLE FP2: SIGNIFICANT GAPS IN STREAM GAUGING STATION DATA

STATION NUMBER	RECORD BEGINS	SIGNIFICANT GAPS IN THE DATASET (MORE THAN 7 CONTINUOUS DAYS)	
1.	Feb 1972	none - complete to Sept 1987	
2.	Feb 1969	6.7.70 - 1.6.71	
3.			
4.			
5.	Dec 1971	none	
6.	Oct 1970	21.1.71 - 7.2.71	over upper limit
		18.3.71 - 27.3.71	over upper limit
		18.2.77 - 4.3.77	over upper limit
		1.8.86 - 21.8.86	missing
7.	Oct 1960		
8.	Feb 1969	22.2.69 - 1.3.69	over upper limit
		12.3.69 - 20.3.69	over upper limit
		18.11.74 - 25.11.74	over upper limit
		8.3.75 - 14.5.75	over upper limit
		1.1.77 - 8.11.77	missing
9.	Oct 1968	1.10.68 - 7.4.69	over upper limit
		24.4.69 - 29.4.69	over upper limit
		5.5.69 - 8.6.69	over upper limit
		26.11.69 - 2.5.70	over upper limit
		29.11.70 - 9.12.70	over upper limit
		28.12.70 - 3.1.71	over upper limit
		18.1.71 - 13.2.71	over upper limit
		17.3.71 - 30.3.71	over upper limit
		23.4.71 - 30.4.71	over upper limit
		August 1971	missing
		16.11.71 - 18.3.72	most over upper limit
		1.4.72 - 13.4.72	over upper limit
		6.12.72 - 14.12.72	over upper limit
		18.11.74 - 1.12.74	over upper limit
		20.1.75 - 31.12.75	over upper limit
		8.3.75 - 16.3.75	over upper limit
		2.2.77 - 3.3.77	over upper limit
		1.2.80 - 10.2.80	over upper limit
		27.1.84 - 8.2.84	over upper limit
10.	Oct 1960		
11.	Feb 1969	2.3.70 - 9.3.70	over upper limit
		19.8.80 - 31.8.80	over upper limit
		3.4.85 - 30.9.85	missing
		1.10.85 onwards	unavailable
12.	Nov 1981	18.9.84 - 30.9.84	missing
		19.11.85 - 18.12.85	missing
		22.10.86 - 29.10.86	missing
13.	Mar 1969	18.2.77 - 26.2.77	over upper limit
		17.3.86 onwards	missing

TABLE FD3:

SOUTHERN LINCOLNSHIRE LIMESTONE GROUNDWATER INVESTIGATIONS

(PAPERS AVAILABLE IN THE APPENDICES)

1. Rushton, K.R. and Tomlinson, L.M. (March 1988) 'Groundwater Resources of the Southern Lincolnshire Limestone' (extracts), Dept. of Civ. Eng., Birmingham University.
2. Burgess, D.B. and Smith, E.J. (1979) 'The Effect of Groundwater Development: the Case of the Southern Lincolnshire Limestone Aquifer.'
3. Rushton, K.R. et al. (undated) 'An Improved Understanding of Flow in a Limestone Aquifer Using Field Evidence and Mathematical Models.'
4. (1980) 'Southern Lincolnshire Limestone: Springflow, Baseflow and Groundwater Storage.'
5. Smith, E.J. (November 1977) 'Southern Lincolnshire Limestone Aquifer: River Flows - River Glen.' Report 1 - West Glen. Report 2 - East Glen.
- 5a. Smith, E.J. (1977) 'Cessation of River Flows - Lower Reaches of the West Glen.'
6. Smith, E.J. (June 1977) 'Southern Lincolnshire Limestone Investigation: Re-evaluation of Runoff and Groundwater Discharge of the River Glen Catchment, 1961-1977 - Report 2.'
7. Smith, E.J. (May 1977) 'Southern Lincolnshire Limestone Investigation: Re-evaluation of the Groundwater Discharge Component and its Relationship to Groundwater Levels - Report 2.'
8. 'Southern Lincolnshire Limestone: Groundwater Level Fluctuation at Outcrop.'
9. 'Fluctuation of the Artesian Overflow Boundary.'
10. 'Relationships Between Groundwater Levels and Flows at Shillingthorpe.'

RIVER GLEN GROUNDWATER FILE (AT LINCOLN)

- Paper 1. Groundwater Recharge - S. Lincs. Limestone Aquifer: Report of Mathematical Modelling - an Empirical Distribution of Recharge. 22.12.87.
- Paper 2. Glen Catchment - Lincolnshire Limestone Simulation Model Investigation - Strathclyde University. A resume of a thesis using a combined watershed/groundwater model. 1977.
- Paper 3. Holywell Brook, Creeton and Little Bytham - notes on the condition of the streams. 16.6.76.
- Paper 4. Southern Lincolnshire Limestone - Groundwater Discharge Statistics, St. Peter's Pool, Bourne.
- Paper 5. Southern Lincolnshire Limestone - Resume of Recharge Calculations.

River West Glen: 1972-1972 Variation in Spring Flows and Baseflow Downstream

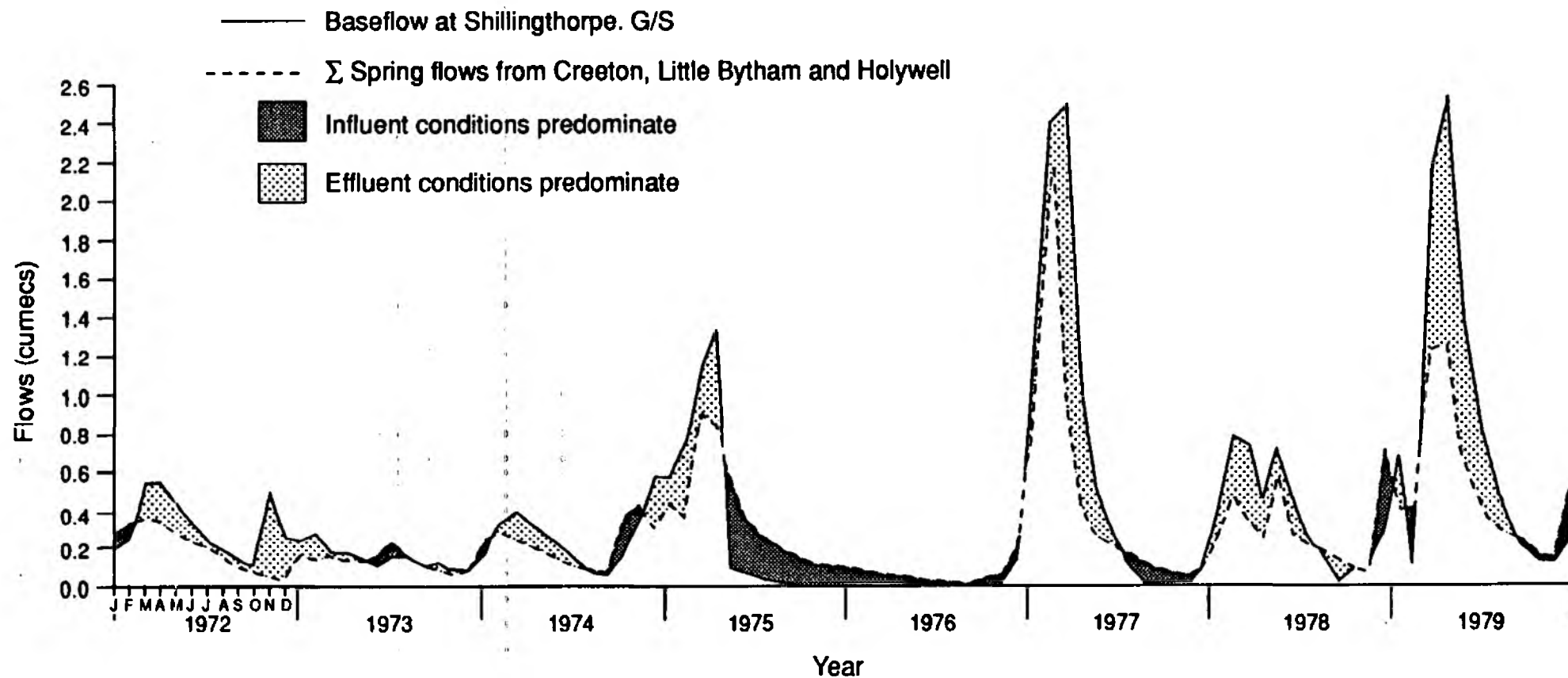


Figure F103

ABSTRACTIONS

There are two principal sources of data relating to water abstractions:

- a. Abstraction Licence Consents Register (computerised)
- b. Annual abstraction licence returns (paper field)

Both datasets are kept with the hydrologists at Anglian Water's Lincoln office (contact: Andy Baxendale).

a. ABSTRACTION LICENCE CONSENTS REGISTER

This is a catalogue of all abstraction licences granted within specified catchment areas by Anglian Water and its predecessors. It gives information on the maximum amount of water a licensee is permitted to abstract (in thousand cubic metres per annum, TCMA's), the location at which the abstraction may occur, and the abstracted water's first use. In the Glens, this is almost exclusively for spray irrigation, whilst abstractions for public water supply are apparently totally absent. For spray irrigation, consents are calculated on the basis that up to 80% of irrigation equipment is in use on any one day, and that water application is not more than 2.54 mm per day.

A hard copy output of all licenced consents for the Glen catchment appears in Appendix AB1.

For catchment numbers 31/11 and 31/12, the West and East Glen respectively, those licences granted in respect of surface water supply (ie. river courses) have been isolated; those appertaining to abstractions from the various subsurface strata (ie. groundwater) are of no immediate interest. From the licence number, the actual consent form was located, from which daily values of the maximum amount of abstraction permissible has been obtained.

b. ANNUAL ABSTRACTION LICENCE RETURNS

This dataset consists of record sheets of actual amounts of water abstracted in any one year by any one licensee, completed and returned to Anglian Water by the licensee on an obligatory basis. They are required to record the volume of water abstracted, preferably monthly or daily. Appendix AB2 shows these values, together with maximum permitted abstraction p.a. and per day, on yearly summary sheets for all the licenced abstractors in the West and East Glen catchments.

However, faults in the recording devices/lack of recording device has meant that some of the dataset comprises estimated values. In addition, there is much variation in the conscientiousness of the licensees as regards accurate and detailed completion of returns. How far these returns represent the actual amounts abstracted remains open to question for two reasons:

1. A licensee would be unlikely to complete a return revealing abstraction in excess of the licenced amount, since Anglian Water also has the power to prosecute in such matters. On the Glens though, data suggests that licences are unused or underutilised rather than being illegally overexploited.
2. There is no way of estimating the annual amount of water being abstracted illegally, although random checks during periods of peak demand, eg. spray irrigation in dry weather, is thought to limit such activity.

Since the legislation requiring water abstractions to be licenced only came into effect in 1966, following the Water Resources Act of 1963, returns are only available from this date. However, certain trends can be picked up over the 23 year period to the present:

1. A reduction in recent years (1980s) in the exercise of licenced rights, probably related significantly to the absence of any extended periods of dry weather during which many crops require spray irrigation, eg. at Witham-on-the-Hill (East Glen), significant abstraction occurred in 1972 and 1974, whilst there has been none from 1980 to date.
2. The predominance of spray irrigation as the stated first use of the abstracted water is reflected in the monthly breakdown (where supplied by the licensee). There is a marked clustering of abstraction in the period May - September, and especially in the period June - August. Indeed, several of the consents issued permit abstraction only in the summer months.
3. The East Glen has noticeably fewer licenced abstractions along its length than does the West Glen. On both rivers, the majority of consents have been seldom used, although a few licensees on the West Glen abstract significant proportions of their permitted maximums from the watercourse most years, eg. at Careby (NGR: TF024162) about 0.75 TCMA's are abstracted through the months June - August, and at Carlby (NGR: TF034142), about 0.45 TCMA's are frequently abstracted in comparison to the licenced amount of 2.273 TCMA's. There are also several smaller abstractions at Greatford (NGR: TF087120) which, in combination, constitute a fairly regular and perhaps significant outflow from the watercourse.
4. The overall volume of abstractions from the East and West Glens is apparently only a fraction of the river flow during the period of abstraction, eg. in 1982, whilst flows for the period July to August were in the region 247 - 723Ml in the stretch of the West Glen Little Bytham - Holywell Brook, the maximum permitted abstractions through the same reach amounted to just 20Ml.

In addition to the licences dealt with above, further licences appertain to the River Glen (d/s Kates Bridge), the Bourne Eau, and other tributaries of the Glens (see Appendix AB3).

EFFLUENTS

All permitted effluents in the catchment have been recorded on the computerised COPA register. For each effluent, the following are recorded:

1. National Grid Reference
2. COPA file reference number
3. Descriptive location

Item No.2 is prefixed by either PR (indicating a private effluent) or AW (indicating an Anglian Water effluent), whilst the suffix indicates the type of effluent (see Table E1).

For the purposes of this study so far, only details of effluent discharges direct to the West or East Glen have been obtained. These are the consents coded NF (non-tidal, freshwater) and with discharge points along the watercourse. These were abstracted from a COPA printout of all consents within 15 km or 10 km grid squares covering the catchment (see Appendix E1). Details of the consents were then found on the actual consent notices, housed in the COPA register file room at Aqua House, Peterborough (contact: Ann Somerville). Appendix E2 is a list of the maximum permitted flow of all the relevant private effluent consents. Copies of consents for Anglian Water Sewage Treatment works are available at the Spalding office c/o Roger Eynstone. The maximum permitted discharges for these are listed in Appendix E3.

Limitations of the Data

There is much variability in the degree of detail of the stipulated conditions on the original consents:

1. Date - Older consents (Welland River Board) tend to be more specific as regards maximum permitted volume, particularly on the less significant consents.
2. Perceived Significance - maximum volumes do not appear to have been stipulated where the estimated effluent or its distance from the receiving water course is beyond certain limits.
3. Storm Water Outlets - no conditions have been/can be attached to these.
4. Sewage Treatment Works Overflow Outlets - for emergency use only. No conditions can therefore be applied.
5. Nature of the Stipulation - maximum permitted discharge volume is given as a daily value; there is no indication of how peaked the discharge may be within that period, although stipulating water quality thresholds in the receiving watercourse (dissolved oxygen and suspended solids) may protect the river to some extent from massive instantaneous foul effluent inputs.
6. Consent conditions state maximum permitted levels only. They may bear little relation to actual effluent inputs. There appears to be no dataset available from which the actual amount of effluent discharged in a given period can be obtained.

TABLE E1

RECOMMENDED DISCHARGE TYPE CODES FOR THE COPA REGISTER INDEX

<u>Code</u>	<u>Description</u>
LA	AW sewage treatment works final effluents
LB	Non-AW sewage treatment works final effluents - Soakaways
LC	AW surface water sewer discharges
*LK - old LP - new	Non-AW surface water drain/sewer discharges
KG	Crude sewage - emergency overflows from sewers or pumping stations
DC	Storm sewage overflows
DF	Settled storm sewage - storm tank discharges
JC	Water treatment filter backwash waters
LE	Any other water treatment plant discharges
LF	Industrial effluents
LG	Agricultural effluents

Notes

1. Outlets used for more than one type of discharge should be coded for the most frequent types, eg. use LA for an outlet taking final effluent, storm sewage and emergency overflows; DC for storm and emergency overflows.
2. Other more specific water or sewage treatment codes may also be used if desired. The above list should suffice for most situations.

* New code

ADB/SE/G.340
5.2.85

TABLE E2

**SOME SIGNIFICANT DATES IN SEWAGE TREATMENT WORKS DEVELOPMENT
IN THE RIVER GLEN CATCHMENT**

- 1961** **Approval for a private works at Boothby Pagnell**
- 1962** **Approval given for a sewage outlet at Boothby Pagnell for the Rural District Council.**
Approval given for a sewage outlet at Easton for Burghley Estates.
Approval given for an emergency overflow at Morton/Thurlby for the Rural District Council.
- 1969** **Improvements to works at Ingoldsby and Lenton (aeration) and at Ropsley (filter).**
- 1971/72** **Little Bytham STW became operational, to serve Little Bytham, Swayfield, Swinstead, Creeton and Castle Bytham. Frequency of emptying of Manthorpe septic tank stepped up.**
- 1973** **STW at Edenham, Scottlesthorne and Grimsthorpe completed.**

Bourne Eau

- 1961** **Effluent outlet approved at Bourne for:**
 1. Rubery Owen & Co. Ltd. for rainwater.
 2. Urban District Council for stormwater at two sites.
- 1966** **STW extended to include two filters and a humus tank.**

Effluent Water Quality Standards

Fairly comprehensive data is available for this in the case of Anglian Water Sewage Treatment Works outlets, but is limited for private effluent consents. For the former though, it is not always clear from the consent files when a particular set of water quality standards became operational. Reference to Table E2 herein, which outlines the significant dates in sewage works development, may give some clues.

The known water quality standards for effluents are reproduced in Table E3.

TABLE E3

A. ANGLIAN WATER SEWAGE TREATMENT OUTLETS - LEGAL WATER QUALITY EFFLUENT CONSENT CONDITIONS

Name	Grid Ref	COPA Ref	Limits	Dissolved Oxygen	Suspended Solids (mg/l)	Ammonia (mg/l)
Boothby Pagnell	SK974307	AW5NF585		15	15	
Bourne	TF110200	AW5NF365	<8250m/d >8250m/d but<13750 >13750	25 40	35 60 200	8
Burton Coggles	SK982258	AW5NF312		15	20	
Corby Glen	SK994246	AW5NF300	>300m/d <300m/d	40 15	60 15	
Edenham	TF067215	AW5NF527		15	20	
Ingoldsby	TF022302	AW5NF409		20	30	
Little Bytham	TF007181 TF011199 TF013178 TF995231	AW5NF798		20 screened storm sewage overflows - no conditions	30	
Manthorpe	TF067164	AW5NF582		15	15	
Old Somerby	SK970337	AW5NF583		15	15	
Pickworth	SK996014			descriptive		
Ropsley	TF000338	AW5NF731		20	30	
Wilsthorpe	TF081149	AW5NF543	Pre 1984 From 1984	20 descriptive eg. must undergo biological filtration	30	

B. PRIVATE EFFLUENT CONSENT WATER QUALITY CONDITIONS

TF05991102	PR5NF5162	20	60
TF10511927	PR5NF5119	50	60

NB. For both tables, dissolved oxygen values are those over 5 days at 20°C, and in the presence of alkyl thiourea. Suspended solids values are for dried, at 105°C.

WATER QUALITY DATA

Chemical monitoring of the watercourse can usefully be split into three periods.

i) 1964 - 1974

Average, maximum and minimum values for nine chemical parameters are available for a limited number of sites, as presented in the Welland and Nene River Authority Annual Reports (see Appendix WQ1). There are 4 sites on the Glen (one on the West Glen, one on the East Glen) and 8 on the Bourne Eau.

The data though is probably only of limited value since there is little continuity from year to year in the sites sampled or the number of samples taken and therefore contributing to the statistical values presented. The best datasets for the period are at the following locations:

Corby Glen for the West Glen

Edenham for the East Glen

Tongue End and Surfleet for the main River Glen

All sites on the Bourne Eau

ii) 1975 - 1988

The main source of historical water quality data for the Glens and the Bourne Eau has been the computerised '712 Statistical Summary Report' (formerly 'Welland Catchment Routine River Surveys'), produced annually since 1975. For each monitoring site a number of water quality parameters are listed and a statistical summary, eg. mean, median, standard deviation, maximum and minimum of the results of all the samples taken at that point throughout the year. It may be possible to obtain information on individual site surveys through A.W.'s archives at Huntingdon (Roger Eynstone or Ian Hill at Spalding may be able to assist). All annual 712 reports are available in hard copy in the Fisheries room at Spalding except the most recent (1988) which is available on request from Roger Eynstone, District Quality Officer at Spalding. Appendix WQ2 gives the relevant page references for each of these annual reports. For each year, there are also statistical summaries produced for 'miscellaneous springs' in selected 10 km grid squares, but these are not at Spalding although possibly available through Roger or Derrick Dann at Kettering.

Water quality data for the groundwater is also available for a number of observation and public water supply boreholes in the catchment, contained within the 712 reports referred to above.

Limitations of the data:

1. There is no real continuity from year to year in the number of samples taken at each monitoring point, eg. very few were taken in the period 1973-1974.

2. The actual number and type of parameters measured shows some variation from year to year, although certain core parameters, eg. pH, conductivity, water temperature and dissolved oxygen do prevail throughout the dataset.
3. Failure to record the flow at the time of taking the sample means that it is difficult to separate any trends in water quality from variations in dilution of any chemicals present.

In terms of 1 and 2 above, the best records during this period appear to be as follows:

West Glen	Burton Coggles
East Glen	Edenham
River Glen	Tongue End and Surfleet
Tributaries	Easton Wood, Creeton (Spring) and Holywell Brook
Bourne Eau	Old Railway Bridge, Tongue End, Green Footbridge and d/s Mays

(see Table WQ1 following)

iii) 1988 - Present

Spatial coverage of chemical monitoring for this period and for the foreseeable future is drastically less than previously (see Appendix WQ3 for current sites and Table WQ2 for a comparison of this coverage with that of 1981/82). However, the frequency of sampling has been increased, approaching the target of once a month, and a record of the results of each sampling survey are now held on computer. Thus, for about the last two years, the analysis of individual samples at named sites can be accessed (contact Ian Hill, Spalding).

TABLE WQ1: ANNUAL RECORDS OF ALL SITES MONITORED ON THE RIVER GLEN AND BOURNE EAU, 1975 - 1988

	75- 76	76- 77	77- 78	78- 79	79- 80	80- 81	81- 82	82- 83	83- 84	84- 85	85- 86	86	87	88
WEST GLEN	(* DENOTES AVAILABLE; - DENOTES NO DATA)													
Burton Coggles	-	*	*	*	*	*	*	*	*	*	*	*	*	*
Swayfield Bridge	-	*	*	*	-	-	*	*	*	*	*	*	*	*
Creeton Bridge	-	-	-	-	-	-	-	-	*	*	*	*	*	*
Carlby Bridge	-	*	*	*	-	-	-	-	*	*	*	*	*	-
Essendine Bridge	-	-	-	-	-	-	-	*	*	*	*	*	*	*
Corby Glen Bridge	*	*	*	*	*	*	*	-	-	-	-	-	-	-
EAST GLEN														
Edenham Bridge	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Wilsthorpe p/s	-	*	*	*	*	*	*	*	*	*	*	*	*	*
Braceborough	-	-	-	-	-	-	-	-	-	-	-	*	*	-
Toft A6121 Bridge	-	*	*	*	-	-	-	-	-	-	-	*	-	*
Hawthorpe Bridge	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Bulby Bridge	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Elsthorpe Bridge	-	-	-	-	-	-	*	-	-	-	-	-	-	-
Manthorpe Roadside	-	*	-	-	-	-	-	-	-	-	-	-	-	-
Woodhead (trib)	-	*	*	*	-	-	-	-	-	-	-	-	-	-
Lenton	-	-	-	-	-	-	-	-	-	-	-	-	-	*
RIVER GLEN														
Kates Bridge A15	-	-	-	-	-	-	*	*	*	*	*	*	*	*
Tongue End Bridge	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Pinchbeck Bars A151	-	-	-	-	-	-	*	*	*	*	*	*	*	-
Surfleet A16	*	*	*	*	*	*	*	*	*	*	*	*	*	*
TRIBUTARIES														
Easton Wood g/s	-	*	*	*	*	*	*	-	*	*	*	*	*	-
Creeton (spring)	-	*	*	*	*	*	*	-	*	*	*	*	*	-
Little Bytham	-	-	-	-	-	-	*	-	*	*	*	*	*	-
Holywell Brook	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B1176	-	*	*	*	*	*	*	-	*	*	*	*	*	-
Weeton Bridge	-	-	-	*	-	-	-	-	-	-	-	-	-	-
BOURNE EAU														
Road Bridge														
(d/s Mays)	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Old Railway Bridge	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Tongue End	*	*	*	*	*	*	*	*	*	*	*	*	*	-
Green Footbridge	*	*	*	*	*	*	*	*	*	*	*	*	*	-
MISCELLANEOUS														
The Deepings									*					
Osbourneby									*					
Edenham									*					
Essendine									*					
Stretton									*					

**TABLE WQ2: A COMPARISON OF THE SPATIAL COVERAGE OF CHEMICAL MONITORING
IN 1981/82 AND 1988/89 FOR THE WEST AND EAST GLENS**

1981/82	1988/89
Site	Site
Burton Coggles g/s (W. Glen)	Burton Coggles g/s (W. Glen)
Swayfield Bridge (W.Glen)	Little Bytham
Corby Glen A151 Bridge (W.Glen)	Bitchfield
Edenham d/s A151 Bridge (E. Glen)	Lenton (E. Glen)
Wilsthorpe p/s (E. Glen)	Toft
Hawthorpe Road Bridge (E. Glen)	Headwaters
Bulby Road Bridge (E. Glen)	
Elsthorpe Farm Bridge (E. Glen)	
Kates Bridge A15	E. Glen/W. Glen confluence
Tongue End Bridge	
Pinchbeck Bars Bridge A151	
Surfleet	
Easton Wood g/s (tributary)	
Creeton (spring)	
Little Bytham (R. Tham)	
Holywell Brook	
d/s Mays (Bourne Eau)	
Old Railway Bridge	
Tongue End (Bourne Eau)	
Green Footbridge (Bourne Eau)	

Water Quality Monitoring of Effluents

Records of sampling downstream of registered/permitted effluents is available in summary form on an annual basis, within the 712 Reports for the period 1976 - 1988. Appendix WQ4 lists the effluents monitored for the River Glen and Bourne Eau and the page reference in the relevant 712 reports, hard copies of which are currently stored at Spalding.

Limitations of the Data:

1. Spatial coverage is markedly clustered, there being just one site upstream of Kates Bridge (Corby Glen STW outfall) in comparison to four sites at Bourne. Additionally, it appears that data for "miscellaneous surface effluents" for 10 km grid squares could be made available (via Derrick Dann, Kettering) although the aggregated information is unlikely to be of much value.
2. There is little continuity inter and intra-annually in terms of effluent sampling frequency. This seems to be partly due to sampling being limited to effluents perceived to be a problem in terms of compliance with consent conditions.
3. The 712 Report format does not generally enable the analysis of an individual sample; the data is statistically processed on an annual basis.

Some data for the period prior to this is available for old Lincoln Division sewage works (c/o Roger Synstone), in the effluent consent files. These take the form of individual sample reports and their availability is as follows:

Boothby Pagnell (W. Glen)	Intermittently to 1966
Burton Coggles (W. Glen)	Intermittently to 1966
Old Somerby (W. Glen)	Intermittently to 1973
Ropsley (E. Glen)	Intermittently to 1965

POLLUTION INCIDENTS

There appears to be no comprehensive dataset regarding the nature, magnitude and location of these for the River Glen catchment. The following is a summary of the information that is available:

1. Qualitative Anecdotal References, 1952-1974

These have been assembled from the Welland River Board/Welland and Nene River Authority Annual Reports, and from newspaper cuttings (courtesy of Mr Herd, retired AW engineer). They are produced in chronological order as Appendix PI 1.

2. Quarterly Scientific Reports, 1974-1988

These have yet to be located (possibly at Peterborough), but are thought to contain records of significant incidents in recent years, significant being measured in terms of one or more of the following parameters:

1. Fish mortalities
2. Affecting a Public Water Supply
3. Commanding Media Attention
4. Taking many Man hours to rectify

3. Computerised Records, September 1988 - present

This is a record of all reported pollution incidents identifying:

- a. Pollution source and location
- b. Polluted water course
- c. General nature of the pollutant, eg, oil, pesticide, sewage.

A hard copy of this report is produced in Appendix PI 2. It needs to be noted though that the report fails to give any quantitative or qualitative indication of the magnitude of any of the incidents, although the record number assigned to each may refer back to a paper file from which further information may be available (contact: Roger Eynstone/Ian Hill at spalding, or for older pollutions, Derrick Dann at Kettering). In addition, it is likely that several minor pollutions with limited spatial and temporal impact have gone unrecorded.

BIOLOGICAL MONITORING

There are three aspects of biology that are monitored on the River Glen:

1. Invertebrate Sampling
2. Habitat Surveys
3. Fisheries Surveys

1. Invertebrate Sampling

Original field sheets with presence or absence of all types of aquatic invertebrates have been obtained from the biologists at spalding (contact: Chris Extence) for the period c.1978 to present (see Appendix BM 1). Prior to this, it would appear that little invertebrate sampling was carried out.

The Sampling Procedure:

At the specified site, defined by a grid reference, a 50 m reach (25 m either side of the grid point) is appraised for up to 10 minutes to identify all the different habitats from which an aggregate sample is taken, using the 'kick-sampling' technique for up to 3 minutes thereafter. The netted contents are then taken back to the laboratory, and the invertebrates present identified 'live', at least to family level and where time/ability permits, to species level.

Prior to the mid 1980's, when the Lincolnshire Quality Index (see Extence et al, 1987 - Appendix BM 2) was introduced as a means of converting individual sample results to a measure of water quality status, results were summarised as either a Trent Index score (1976-1979) and/or a BMWP score, serving a similar purpose. The LQI, thought to be a more accurate reflection of water quality than these two previously used indices, through its incorporation of both the BMWP and the ASPT (average score per taxon) has been calculated so far for surveys back to 1979. Thus, in theory, assessment of performance at a particular site over the past 10 years is possible, and any changes in the downstream variation of water quality should be ascertainable. However, in reality, the year-to-year record for the majority of sites is far from complete; whilst the period 1984-1986 inclusive is particularly void, there are other years (eg. 1988) when sampling frequency at most sites exceeded once a year.

Table BM 1 provides a summary of the record of LQI performance at all the sampling points on the Glens and the tributary, the River Tham.

Spatial coverage

This has apparently been arbitrarily chosen on a year-by-year basis, probably more related to the levels of manpower available than to any perceived need/lack of need to sample certain reaches, eg. in 1988,

TABLE BM 1: LQI PERFORMANCE AT ALL SITES ON THE RIVER GLEN

SITE NAME	GRID REF	LINCOLN QUALITY INDEX SCORE BY YEAR										
		78	79	80	81	82	83	84	85	86	87	88
WEST GLEN												
Boothby Pagnell	973307	-	-	-	-	-	-	-	-	-	-	D
Bitchfield	985286	-	D&D	-	-	D	C	-	-	-	-	C
B1176	988260	-	-	-	-	-	-	-	-	-	-	D
Corby Glen	990248	G	E&E	E	G	I	D	-	-	-	-	I
Swayfield Road	998233	-	-	-	-	-	-	-	-	-	-	D
Creeton	011199	-	-	-	-	-	-	-	-	-	-	E
Little Bytham												
R. Tham	019177	B	B&C	B	B	A	A	A	DBA	A++	A++	A+B
Aunby	027147	-	-	B	-	-	-	-	-	-	-	-
Carlby/Essendine	038137	-	A	A+	A++	A++	A++	-	-	-	-	A+
Essendine (A6121)	051127	-	-	B	-	-	-	-	-	-	-	-
d/s Essendine	050122	-	-	E&D	-	-	-	-	-	-	-	-
Railway Bridge u/s												
Banthorpe Lodge	068112	-	E&C	E	GFE	C	A++	A+	A++	A++	A++	A++2
RIVER THAM												
Cabbage Hill	986196	-	-	-	-	C	-	E	-	-	E	-
Castle Bytham	992187	-	-	-	-	-	-	E	-	-	E	-
(u/s pond)												
Castle Bytham	993183	-	-	-	-	C	-	D	-	-	C	-
(d/s pond)												
u/s Glebe Farm	004182	-	-	-	-	C	-	D	A	-	-	-
and STW												
d/s STW outlet	008181	-	-	-	-	-	-	-	D	-	-	-
Little Bytham	015178	D	C	-	C	A	B	A	C	-	B	B
EAST GLEN												
Lenton	022301	-	-	-	-	-	-	-	-	-	-	D
Bitchfield Trib.	022288	-	-	-	-	-	-	-	-	-	-	B
Hawthorpe Road	038272	-	-	-	-	-	-	-	-	-	-	D
Bulby	048260	-	E	-	E&E	D	D&D	-	-	-	-	B
u/s Elsthorpe	054245	-	-	-	D	-	-	-	-	-	-	-
Elsthorpe	054233	-	-	-	-	-	-	B	D	-	C	C
Edenham	061219	-	C	C	C&C	D	B	B	D	-	C	D
Gravel Bed d/s	066208	-	-	-	-	D	-	-	-	-	-	-
Edenham												
Pasture Hill Farm	064204	-	-	-	-	E	-	-	-	-	-	D
Toft	067170	-	-	E	A	-	-	-	-	-	E	E
u/s Manthorpe	066164	-	-	E	A	-	-	-	-	-	-	-
but d/s STW												
Manthorpe	068160	-	-	D	D	D	C	-	-	-	D	C
Braceborough	081135	-	D	C	D	C	D&A	A+	A	A++	B	A&C

TABLE BM 1: LQI SCORES FOR ALL SITES MONITORED ON THE RIVER GLEN, 1978-1988

SITE	GRID REF	YEAR										
		78	79	80	81	82	83	84	85	86	87	88
Wilsthorpe Bridge	TF098136	-	-	A++	-	-	-	-	-	-	-	-
Kates Bridge	TF106148	-	A++	A++	A++	A++	A++	-	-	-	-	-
Thurlby Fen	TF129170	C	A++	B	A	A+	A	A/B	C	A	A	D
Thurlby Fen	TF119163	-	-	A++	-	-	-	-	-	-	-	-
(FISHERIES)												
Counter Drain	TF145178	-	-	A+	-	-	-	-	-	-	-	-
Tongue End	TF152184	-	-	A	-	-	-	-	-	-	-	-
(u/s Bourne Eau)												
Tongue End	TF156190	-	A&B	A	B	A	C	A	A	C	A	B
(d/s Bourne Eau)												
Guthram Gowl	TF173225	C	B/A	C	B	C	C	-	-	-	-	-
u/s Pinchbeck	TF226257	-	-	-	-	C	-	-	-	-	-	-
Pinchbeck	TF235260	-	A&D	B	C	C	B	-	-	-	-	-
Moneybridge	TF215255	-	-	-	-	B	-	-	-	-	-	-
Surfleet	TF251282	-	-	C	-	-	-	-	-	-	-	-
Surfleet Seas End	TF275291	D	B	B	C	C	C	C	C	C&E	B	A

Nine sites were sampled on the East Glen, whilst in 1986, the figure was just 1, that site hardly being representative of the whole river as it was located only 1.5 km upstream of the river's confluence with the West Glen. There neither appears to be any correspondence with chemical monitoring points, both in terms of the number and location of sites chosen for sampline, and sampling frequency.

Temporal Coverage

The current aim of invertebrate sampling frequency is thrice yearly, whereas in the past, sampling once a year appears to have been the norm. There was little continuity in which season the samples were taken, despite this perhaps having some bearing on the final results.

Problems of the Method

Subjectivity is introduced on two counts:

- a. in estimating the percentage contribution of individual habitats to the overall reach habitat.
- b. in the definition of a reach as 'habitat-rich riffle', 'habitat-poor riffle' or 'pool', as required for eighting scores under the LQI system.

NB: For the purposes of back-calculating LQI, it was assumed that all sites downstream of Kates Bridge be classed 'pools', whilst all sites upstream be 'habitat-rich riffles' unless exceptional circumstances prevailed, eg. stagnant flow conditions.

In terms of spatial coverage, the most comprehensive datasets are for the years 1980, 1981, 1982, 1983 and 1988, whilst the sites with the most comprehensive datasets are Little Bytham and Banthorpe Lodge on the West Glen, at Little Bytham on the Tham, and at Edenham and Braceborough on the East Glen.

Finally, it needs to be noted that in addition to routine sampling surveys, some pollution incident related high-intensity (spatially) surveys and FBA investigations have also been carried out within the catchment (see Figure BM 1) showing the results of a survey to ascertain the impact on water quality of a sewage effluent at Essendine (West Glen) in 1981. A biological survey was also carried out on the River Tham in 1982 (see Appendix BM 3) to enable recommendations as to the level of sensitivity required in proposed maintenance work to be made with regard to habitat and species conservation. Also, a copy of the report of the sampling results on the River Glen in the autumn of 1988 has been obtained (see Appendix BM 4). A summary of the results is given in Figure BM 2.

Preliminary analysis of temporal change of downstream trends in LQI has been carried out (see Figure BM 3). It does not reveal any significant changes, but does seem to confirm the presence of persistent pollutions through consecutive low scores, eg. at Corby Glen where an organic effluent persistently infiltrates the watercourse.

1988 Oct/Nov BMWP
LQI
ASPT

FIGURE BM2: SUMMARY OF THE RESULTS OF
THE NOVEMBER 1988 SURVEY

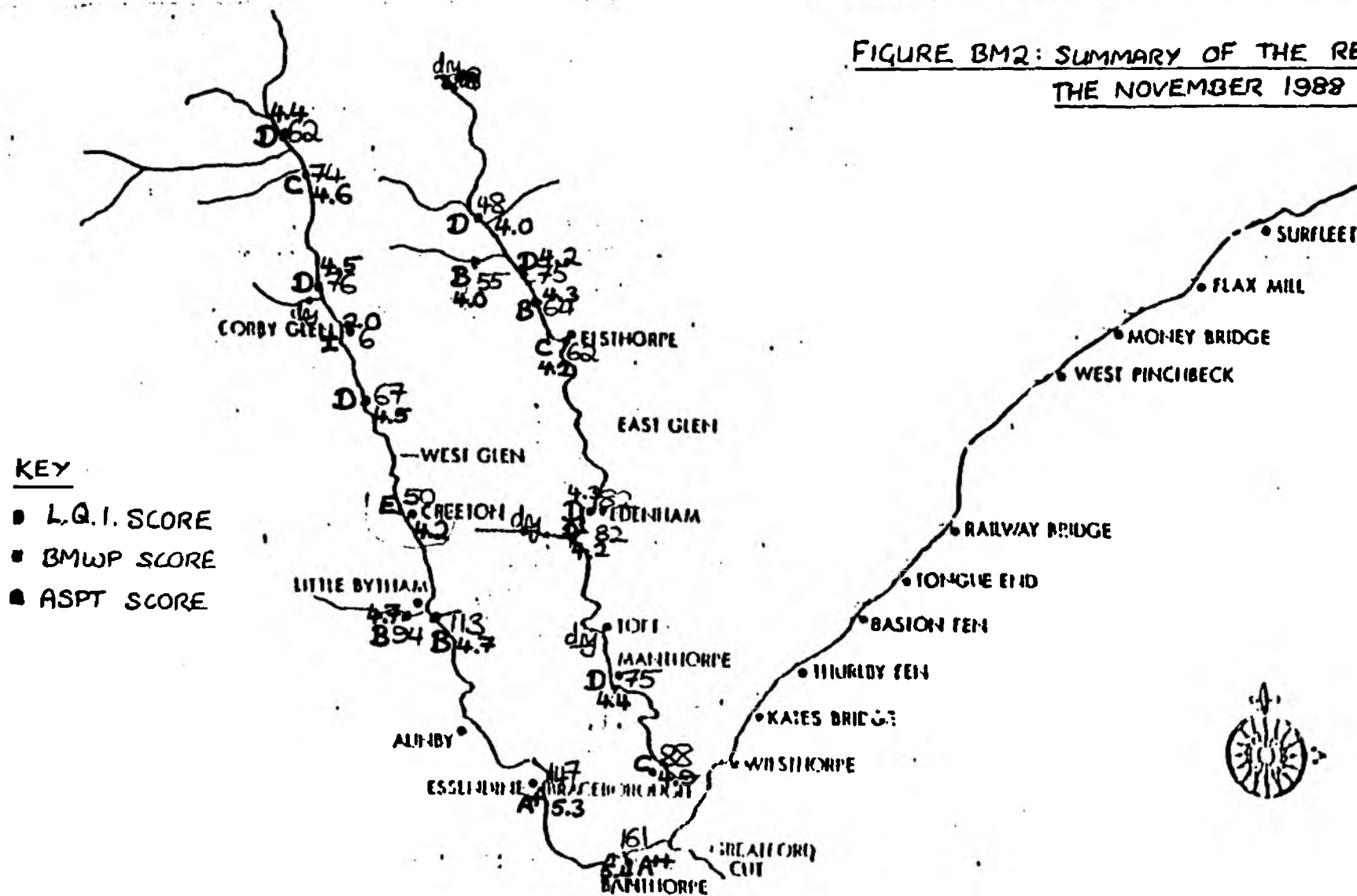
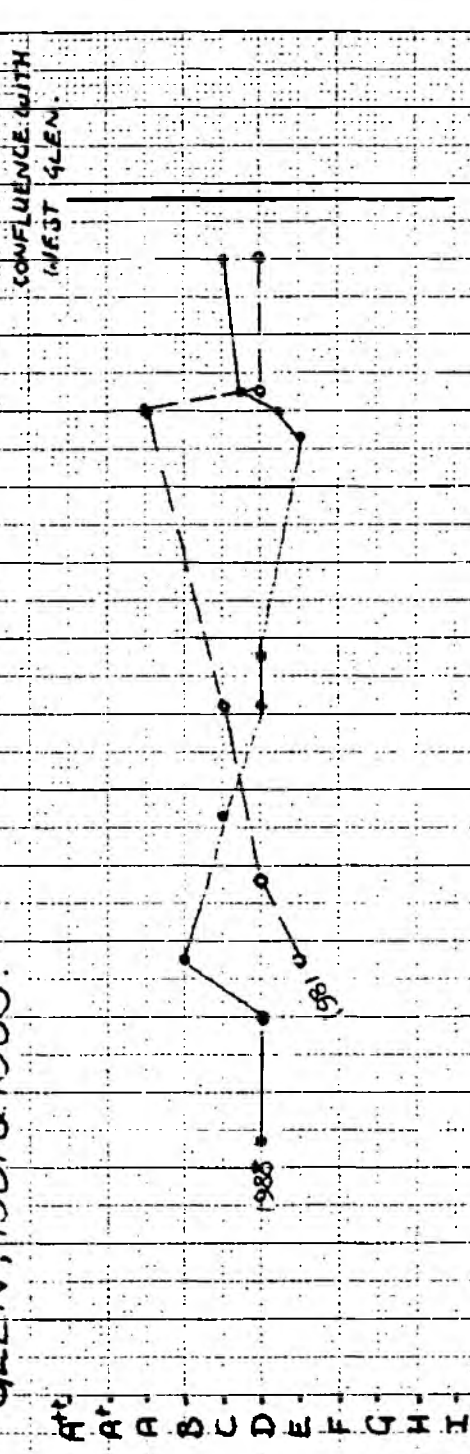
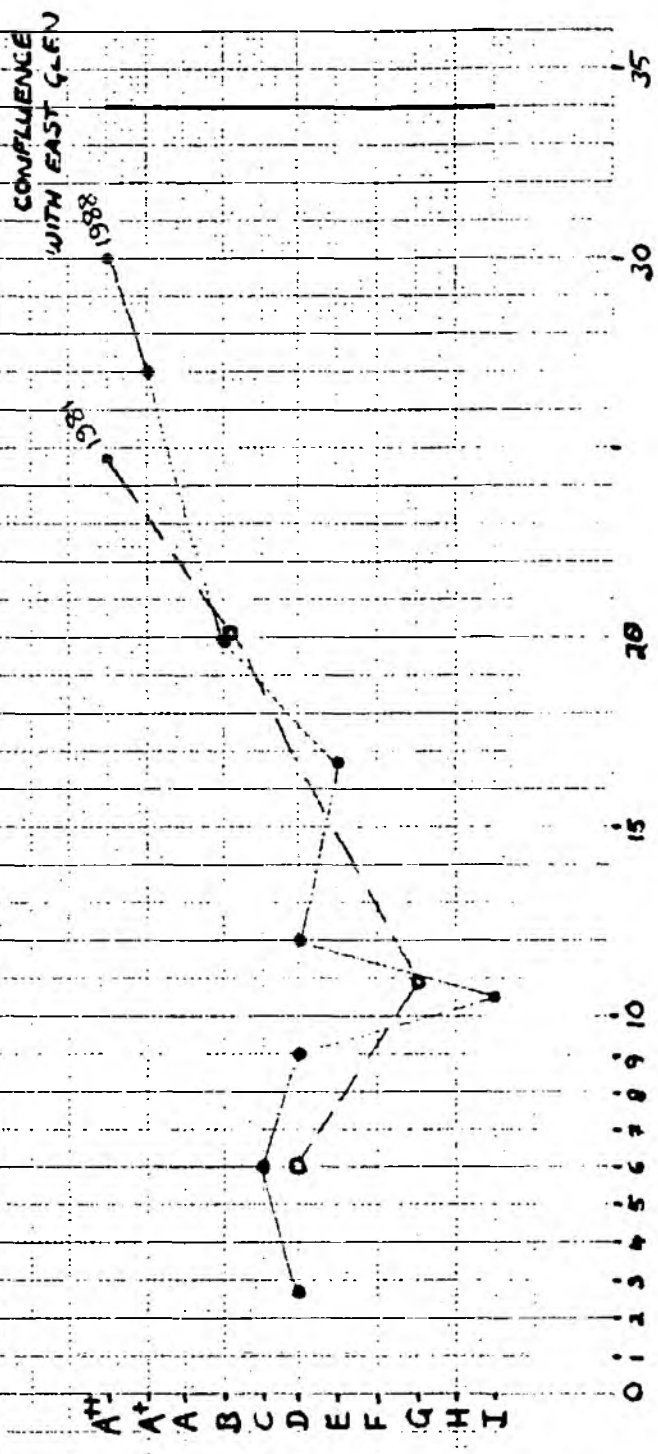


FIGURE BMB3: DOWNSTREAM VARIATION IN LQI FOR THE WEST & EAST GLEN, 1981 & 1988.

1. EAST GLEN



2. WEST GLEN



2. Habitat Surveys

It is understood that one such survey is currently being undertaken by Anglian Water for the West and East Glens on a reach-by-reach basis, each c.2500 m in length. Previous surveys of the Glens have been carried out by the NCC for the years 1969, 1971, 1973, 1974, 1976 and 1978, and a summary of the findings is produced as an extract of the "Vegetation in British Rivers" report and accompanying figures (S. M. Haslam, 1982) in Appendix BM 5.

In addition, it is hoped that aerial photographs (colour and infra-red) taken from a radio-controlled model aircraft flying at approximately 100 ft, could be of some use in identifying habitat and vegetation variation for all/some selected reaches of the river. To date, such photographs have been taken for the following two reaches:

1. East Glen between Elsthorpe and Edenham (NGR TF061231 - TF058228).
2. Lower Glen at Thurlby Fen around the nature reserve (NGR TF129170).

Other sites where it may be useful to have such photographs have been identified (see Appendix BM 6 for a list of the sites and maps thereof), but access is a problem until either crops have been cut or cattle moved from the fields. For all these sites, permission for entry has been obtained from the farmers concerned.

A list of catchment farmers is filed in Appendix BM 7 for future reference.

3. Fisheries Surveys

In the period up to 1980, it appears that no systematic (if any) fish sampling was carried out on any part of the River Glen. Thus, the only information available prior to 1980 has proved to be qualitative anecdotes from the River Board Annual Reports and local newspapers, which highlight mortalities, quality and quantity of sport, and stocking (see Appendix BM 8 for the chronological records).

The 1980 survey is thus the baseline data of fish populations and biomass, whilst subsequent surveys in 1983/84, 1986 and 1988 enable some assessment of fish population stability and trends to be made. In addition, it has allowed the recovery of the fish communities from the Summer 1976 drought, when over 700 fish died, to be monitored (see Table BM 2). However, lack of data during the 1960's and 1970's, when the dwf is reported to have fallen to a tenth of its previous value due at least in part to increased groundwater abstraction, has meant that it is not possible to test the hypothesis that the river previously supported larger fish populations under greater flow and depth conditions.

Angling rights:

There is limited angling upstream of Baston where no rights have been issued. In contrast downstream is fished by the East Midland A.C. and further downstream, by Spalding Angling Club.

Both clubs probably hold some data on fisheries, although this will be confined to areas which are known to fish well and thus play host to angling matches.

1980 Survey (see Appendix BM 9)

Carried out : September and October

Method of survey : Electrofishing

Analysis separates sites into two groups:

1. Upper Glen (u/s and including Thurlby Fen, TF119164)

13 sites : East Glen = 5
West Glen = 5
d/s confluence = 3

2. Lower Glen (d/s Thurlby Fen),

10 sites : u/s Bourne Eau = 3
d/s Bourne Eau = 7

(see Table BM 3 for sampling site details)

For the Upper Glen all statistics are based on fish >10 cm in comparison to the Lower Glen where they are based on fish >6 cm.

On the Upper Glen, low flows at the Corby Glen (1) and Elsthorpe (6) sites meant that only qualitative sampling could be carried out.

The report presents site-by-site data on the following:

1. Population number estimates
2. Population density estimates
3. Biomass estimates
4. Length frequency by year/age class for lumped "Upper Glen" or "Lower Glen" datasets.

(for accompanying graphics, see Figures BM 4 - 6)

Some data sheets by site of fish length, age, sex and numbers for this year are available from the Fisheries laboratory at Spalding (contact: Martin Stark).

It is notable that fish stocks are patchy.

TABLE BM 2: DOMINANT AGE OF FISH BY TYPE ON THE RIVER GLEN

U/S KATES BRIDGE

	1988	1986	1983/4	1980
ROACH	-	range	2-3 yr + range	range
DACE	4 & 6 yr	2 & 4 yr	2 & 5 yr	-
CHUB	4 & 5 yr	3 yr good survival	3 yr + range	-
COMMON BREAM	very low biomass	-	-	-
PIKE	range	few 2-4 yrs	3-4 yr	< 1 yr
BORWN TROUT	2 & 3 yr	< 1 yr	1-2 yr	-
OTHER SPECIES	-	gudgeon	-	-

D/S KATES BRIDGE

	1988	1986	1983/4	1980
ROACH	5 & 7 yr	av. range	2 yr	1-2 yr
DACE	2 yr	-	1-2 yr	1-2 yr
CHUB	2-12 yr	-	8 yr	2 yr
COMMON BREAM	11 & 14 yr few 2 & 3 yr	few 2 & 3 yr	1-2 yr	5 yr
PIKE	4 & 5 yr	3 & 4 yr	< 1 yr	2 yr
BROWN TROUT	1 site	1 site	-	-
1976 class poor for all species				

TABLE BM 3: FISHERIES SAMPLING SITES ON THE RIVER GLEN

SITE NAME	SITE NO.	GRID REF.
WEST GLEN		
Corby Glen/Swayfield	1	SK998234
Little Bytham	2	TF019176
Aunby	3	TF028147
Essendine	4	TF050127
Banthorpe/Shillingthorpe	5	TF067113
EAST GLEN		
Elsthorpe	6	TF055234
Edenham	7	TF064205
Toft	8	TF068171
Manthorpe	9	TF068162
Braceborough	10	TF082135
DOWNSTREAM CONFLUENCE		
Wilsthorpe	11	TF097135
Kates Bridge	12	TF107149
Thurlby Fen	13	TF119164
LOWER GLEN		
Baston Fen	14	TF145178
Baston Fen	15	TF146179
Tongue End	16	TF152184
Tongue End	17	TF153185
Railway Bridge	18	TF175208
West Pinchbeck	19	TF200245
Moneybridge	20	TF215256
Moneybridge	21	TF216256
Flax Mill	22	TF240267
Surfleet	23	TF248281

1983/4 Survey

Carried out : November/January - Upper Glen
January/March - Lower Glen

Survey method : standard electro-fishing

Analysis of the results separates the sites into two groups:

1. Upper Glen As 1980 survey, although duplicate sites omitted here,
2. Lower Glen eg. Baston Fen, Tongue End and Moneybridge.

Indeed, the report appears in two separate parts, Appendix BM 10 relating to the Upper Glen and Appendix BM 11 to the Lower Glen.

The statistics produced in these reports are as for the 1980 survey, except that both Upper and Lower Glen data relates to fish >10 cm. Again, quantitative sampling at Corby Glen and Elsthorpe was not practicable, as the reaches were too shallow to support the larger species of fish.

1986 Survey

Carried out : May - September

Survey method : Electro-fishing

Analysis of the results separates the sites into two groups as previously:

1. Upstream of Kates Bridge (including Thurlby Fen properly d/s Kates Bridge)
2. Lower Glen (from Baston Fen)

NB: There is a slight change in Site No.5, formerly Banthorpe (TF067113) and now Shillingthorpe (TF068114), 200 m downstream. Also it was not practicable to undertake quantitative sampling at Corby Glen.

The reports for 1. and 2. above were produced separately and appear here as Appendix BM 12 and BM 13 respectively.

Lumped coverage is given for year class structure and growth for the whole River Glen for each species recorded. Population density and biomass estimates are produced for both the Upper and Lower Glen, the latter computerised and also including a population density estimate for fish of all lengths as well as for fish >10 cm long. In both cases, though, the number of fish at each site is not recorded; if this information was needed, reference would have to be made to original field sheets in the fisheries laboratory.

1988 Survey

Carried out : October/November

Survey method : Electro-fishing (wrapround on Lower Glen)

Compared to previous surveys, there are several differences in the site distribution:

UPPER GLEN (d/s Thurlby Fen) - 10 sites

1. West Glen - 4 sites (Corby Glen dropped)
2. East Glen - 3 sites (Toft and Elsthorpe dropped)

LOWER GLEN (From Baston Fen) - 9 sites plus 2 on the Blue Gowt Drain

Two new sites at Guthram and Surfleet Seas End

A combined report was produced and appears as Appendix BM 14. Lumped analysis of length frequency distribution, growth and year class structure by species for the River Glen is produced and fish biomass by site has been tabled, but there appears to be no analysis or presentation of population numbers/density seems to have been included.

A breakdown of fish biomass into species contribution at each site, for fish >7 cm long (>10 cm for Upper Glen sites) and for all lengths has been obtained off the computer and is presented in Appendix BM 15. This provides a record for all sites of the numbers and weight of different fish species caught at each site, for fish >7 cm (>10 cm for some sites), and for all lengths of fish. Data on the density of fish and biomass for the above categories has also been obtained (see Appendix BM 15).

Selected data to enable comparison of the four surveys and examination of downstream variability has been plotted graphically in the following figures. Figure BM 7 is a guide to sampling site numbering used on Figures BM 9 - BM 14. Figure BM 8 shows variability in total fish population density estimates, whilst subsequent figures illustrate variability in biomass estimates in total (Fig. BM 9) and for individual chosen species (Figs. BM 10-14).

Table BM 4 provides a comparison of the dominant species for all four surveys at sites on the West and East Glens only.

Problems of the Dataset

The major problem with the fisheries data is the high degree of survey method variables, both within and between surveys, which may be reflected in the individual site results:

- a. Season of sampling
- b. Area Sampled - where a longer length has been surveyed, the effect of tightly shoaled distributions is damped, although the probability of encountering such a shoal is increased.

Table BM 5 gives an indication of the degree of sampling area variability for sites upstream of Kates Bridge.

TABLE BM 4 : DOMINANT SPECIES RECORDED BY NUMBER UPSTREAM OF KATES BRIDGE

SITE	SPECIES RECORDED - ORDER OF ABUNDANCE			
	1980	1983/4	1986	1988**
WEST GLEN				
Corby Glen (SK998243)	1. Minnows 2. numerically 3. dominant	1. 3 sp. sticklebacks 2. 3.	1. 3 sp. sticklebacks 2. Stone loach 3. Minnows	1. 2. 3.
Little Bytham (TF019176)	1. Eels 2. dominant 3. species	1. Dace 2. Minnows 3. 3 sp. sticklebacks	1. Dace 2. Roach 3. Eels	1. Dace 2. Roach 3. Brown Trout
Aunby	1. Small No. 2. mature 3. Brown Trout	1. Eels 2. Brown Trout 3. Pike	1. Dace 2. Eels 3. Brown Trout	1. Brown Trout 2. Pike 3. Eels
Essendine (TF056127)	1. No roach 2. recorded 3.	1. Dace 2. Eels 3. Brown Trout	1. Dace 2. Eels 3. Chub	1. Dace 2. Chub 3. Eels
Banthorpe* (TF068114)	1. 2. 3.	1. Dace 2. Brown Trout 3. Pike	1. Eels 2. Gudgeon 3. Pike	1. Pike 2. Eels 3. Dace

* moved 200 m downstream in 1986.

EAST GLEN

Edenham	1. Minnows 2. numerically 3. dominant	1. Minnows 2. Gudgeon 3. Stone Loach	1. Dace 2. Gudgeon 3. Chub	1. Eels 2. Roach 3. Perch
Manthorpe	1. Dace the 2. dominant species 3. >10 cm	1. Dace 2. Minnows 3. Roach	1. Dace 2. Roach 3. Minnows	1. Gudgeon 2. Roach 3. Dace
Braceborough	1. No. of Brown 2. Trout c.f. West 3. Glen. Roach 4. present	1. Dace 2. Eels 3. Pike 4. Brown Trout	1. Eels 2. Pike 3. Stone Loach	1. Dace 2. Eels 3. Pike

** Data is for all lengths.

- c. Variation in method and lower limit of recorded fish lengths used in data analysis, eg. 1988 AC Electro used on the Upper Glen and Wrapround on the Lower Glen. In addition, electro-fishing gives poor selectivity of fish <10 cm and thus, an under-estimation of early year class strengths.
- d. Variation in the sites surveyed - the most upstream sites on the West and East Glen (Corby Glen and Elsthorpe respectively) tend to have flows that are insufficient to allow quantitative sampling to be carried out

Non Routine Surveys

In addition to the above mentioned four routine surveys on the Glen, a further limited coverage survey was carried out on 14.11.88 to assess fish stocks downstream of Kates Bridge Farm. No official report of this survey has been produced, but results sheets are available in the fisheries laboratory at Spalding via Martin Stark. Table BM 6 provides a summary of the results obtained.

TABLE BM 5 : AREA SAMPLED AT SITES UPSTREAM OF KATES BRIDGE, 1980-1988.
(square metres)

	1980	1984	1986	1988
WEST GLEN				
Corby Glen	460	210	210	-
Little Bytham	1160	880	880	800
Aunby	630	861	861	997.5
Essendine	814	960	960	1692
Shillingthorpe	2040	1200	1032	1740
EAST GLEN				
Elsthorpe	180	250	250	-
Edenham	665	520	450	600
Toft	1760	1570	1570	-
Manthorpe	945	1012	1012.5	1108
Braceborough	695	620	620	1032.5
d/s CONFLUENCE				
Wilsthorpe	2160	1800	1800	1860
Kates Bridge	1160	1064	1800	980

TABLE BM 6 : NON ROUTINE SPATIALLY LIMITED SURVEY, 14.11.89.

SITE 3	D/S KATES BRIDGE WEIR	2430	TF115168
SITE 5	U/S KATES BRIDGE WEIR	2100	TF112154
SITE 7	D/S FARMHOUSE	2100	TF109152

ALL SITES AC ELECTRO-FISHED

SITE NO. 3

FISH SPECIES	TOTAL NUMBERS n-2	> 10ca NUMBERS n-2	TOTAL BIOMASS gn-2	> 10ca BIOMASS gn-2
Roach	0.001	<0.001	0.0181	0.02
Pike	0.008	0.008	0.6329	0.6329
Gudgeon	0.002	<0.001	0.02	0.006
Ruffe	0.001	<0.001	0.03	0.02
Bleak	<0.001	<0.001	0.02	0.02
Eels	0.007	0.007	0.1567	0.1567
Chub	0.04	0.04	12.66	12.64
Dace	0.1744	0.1666	4.476	4.389
Total	0.2395	0.2271	18.02	17.88

SITE NO. 5

FISH SPECIES	TOTAL NUMBERS n-2	> 10ca NUMBERS n-2	TOTAL BIOMASS gn-2	> 10ca BIOMASS gn-2
Roach	<0.001	<0.001	.1066	0.1066
Pike	0.002	0.002	0.07	0.07
Gudgeon	0.02	0.007	0.3261	0.1671
Eels	<0.001	<0.001	0.0952	0.0952
Chub	0.02	0.02	3.660	3.653
Dace	0.1157	0.11	3.142	3.076
Total	0.1623	0.1433	7.405	7.172

SITE NO. 7

FISH SPECIES	TOTAL NUMBERS n-2	> 10ca NUMBERS n-2	TOTAL BIOMASS gn-2	> 10ca BIOMASS gn-2
Pike	0.002	0.002	0.05	0.05
Chub	0.0103	0.01	1.165	1.163
Dace	0.01	0.01	0.3538	0.3211
Total	0.03	0.02	1.573	1.539

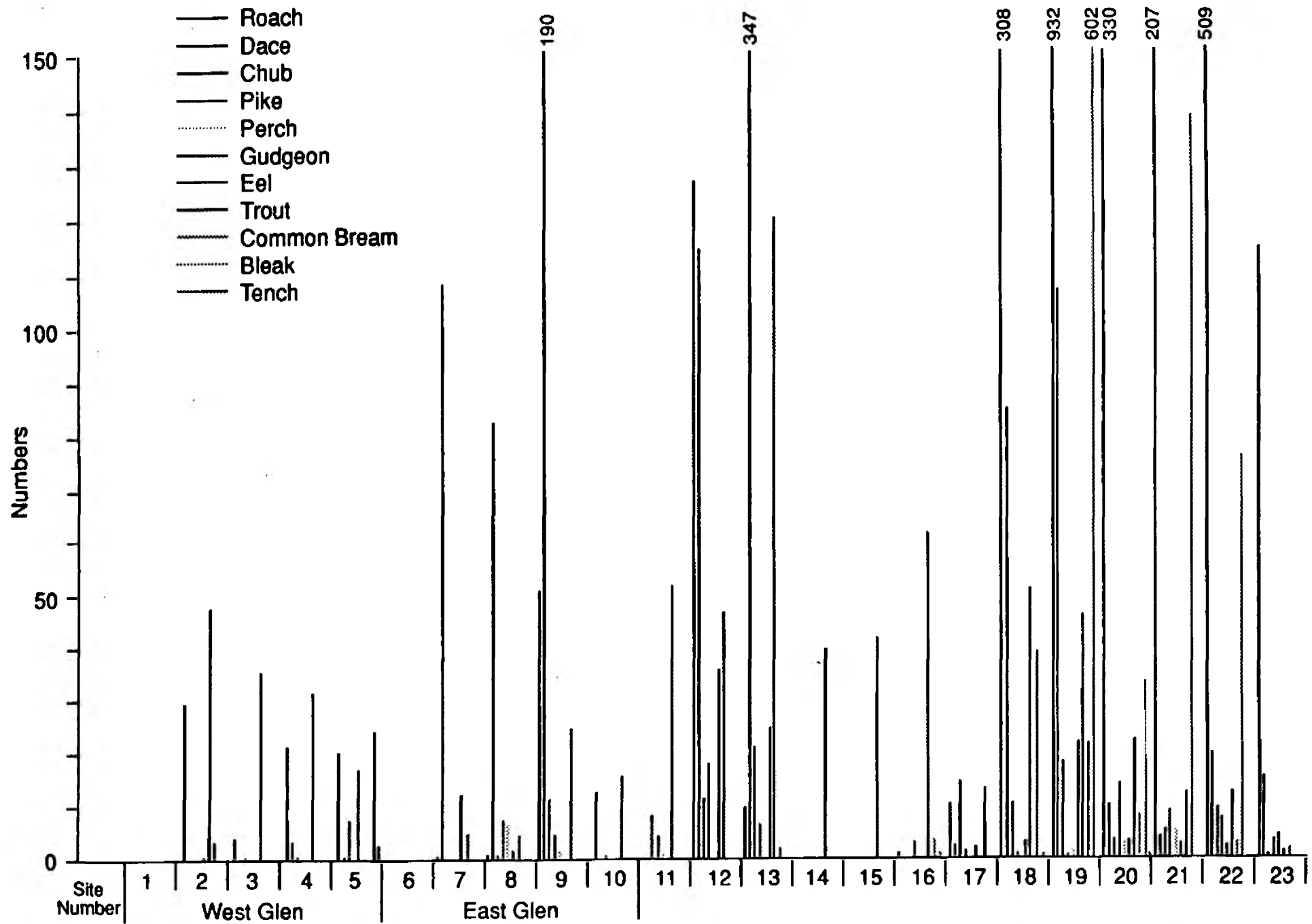


Figure BM4. 1980 Survey - Population estimates (sites 1-13 for fish $\geq 10\text{cm}$; sites 14-23 fish $\geq 6\text{cm}$)

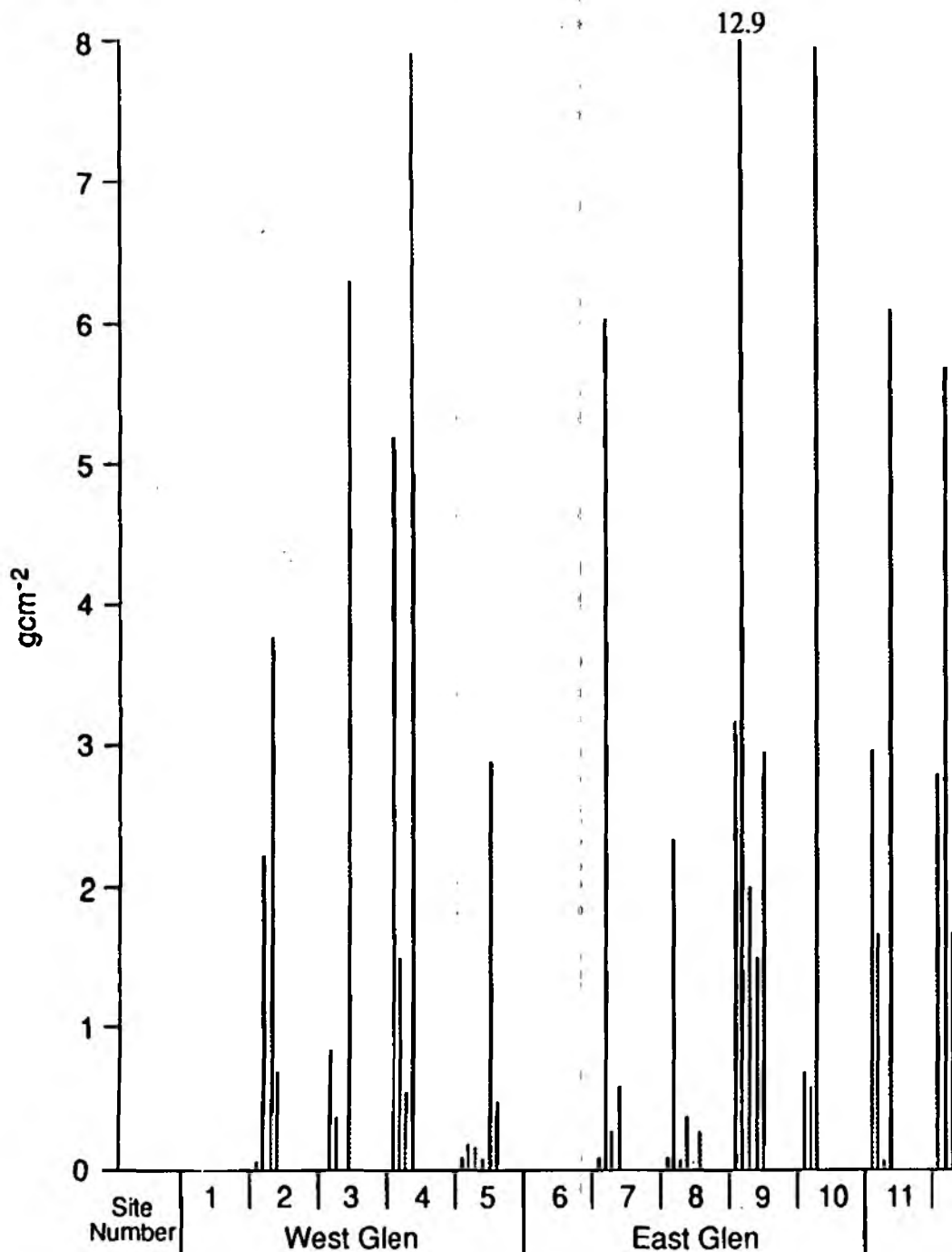
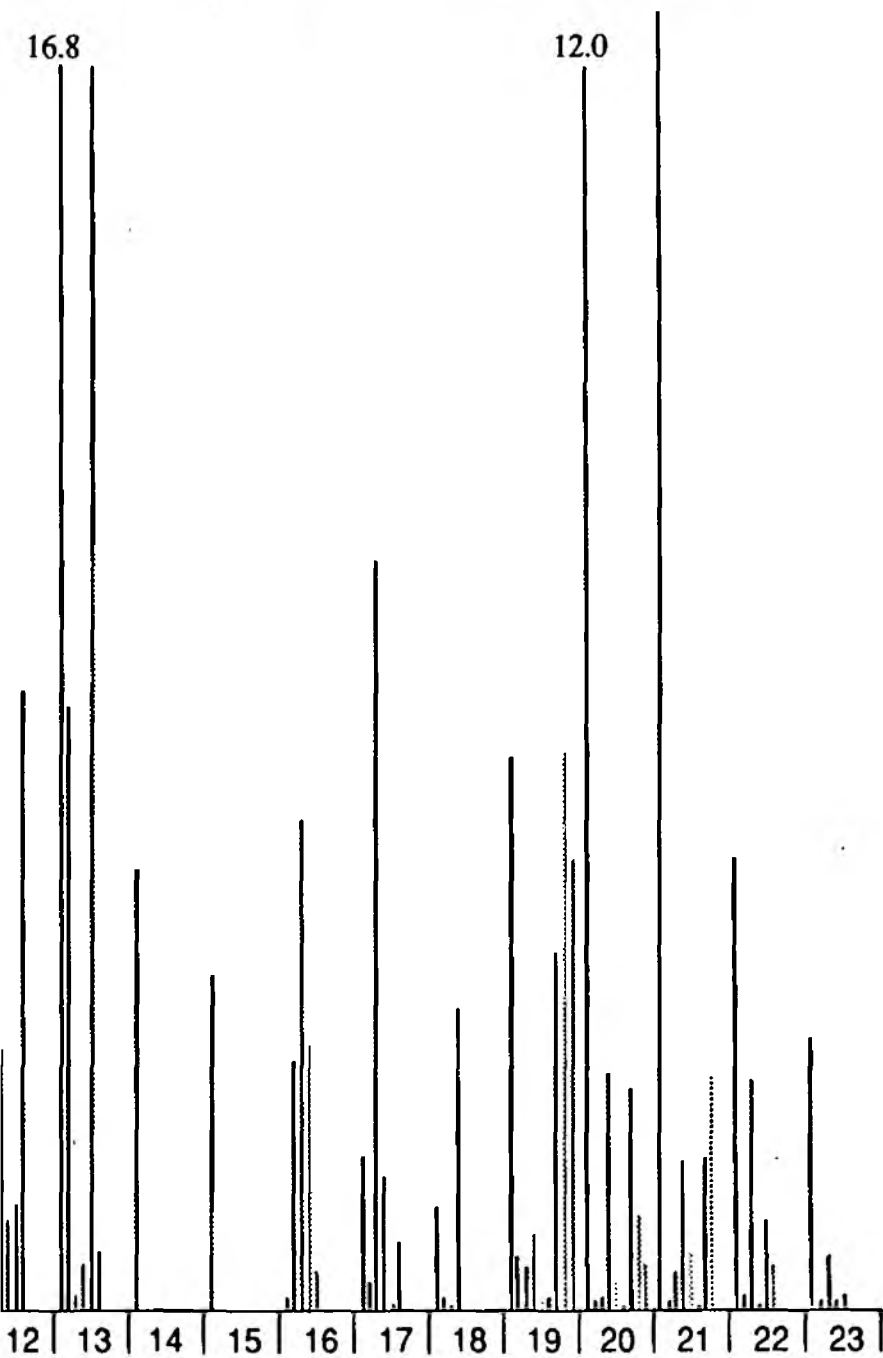


Figure BM5. 1980 Survey - Biomass estimates for all fish species.



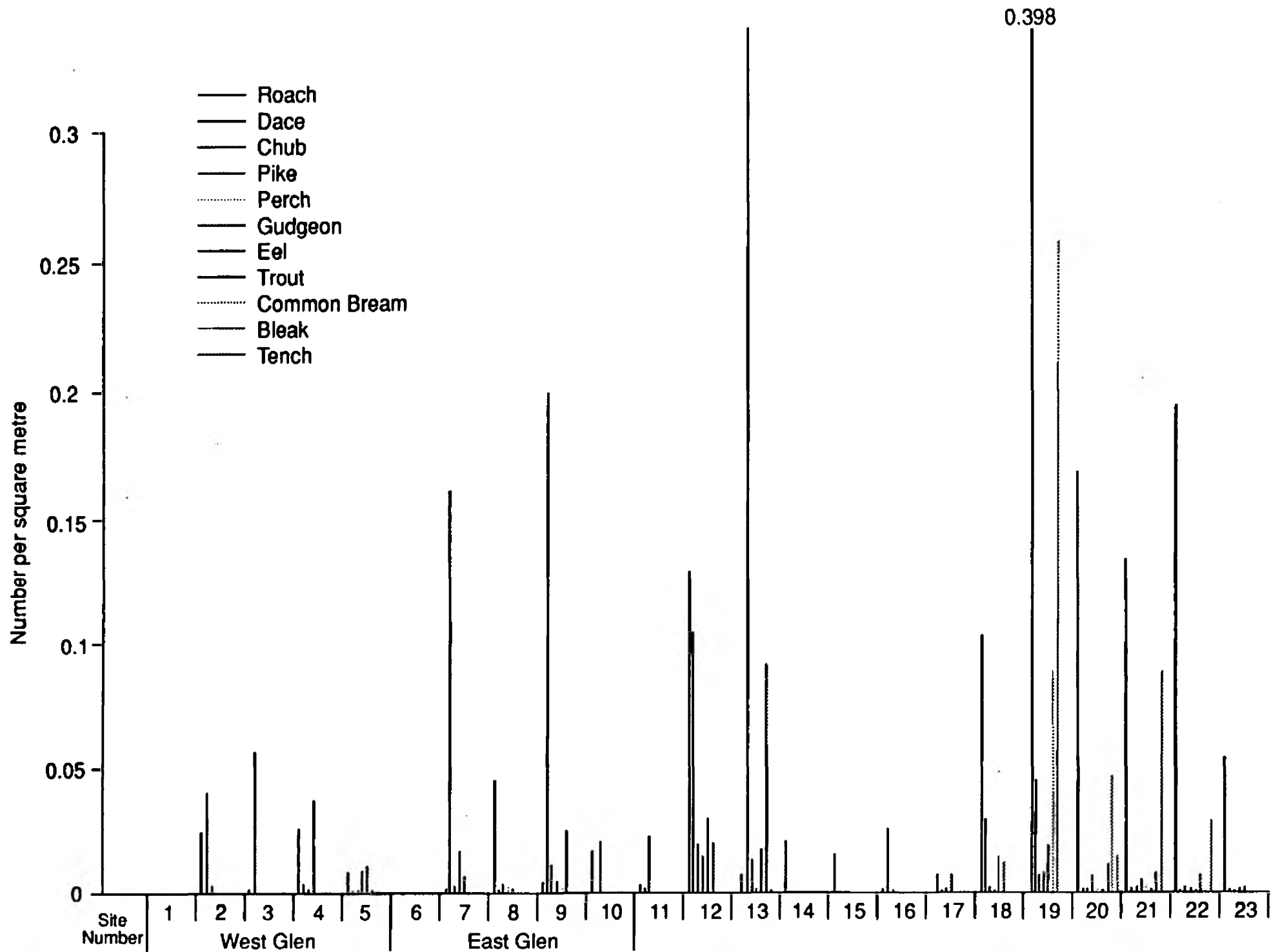


Figure BM6. 1980 Survey - Population Density estimates for all species of fish.

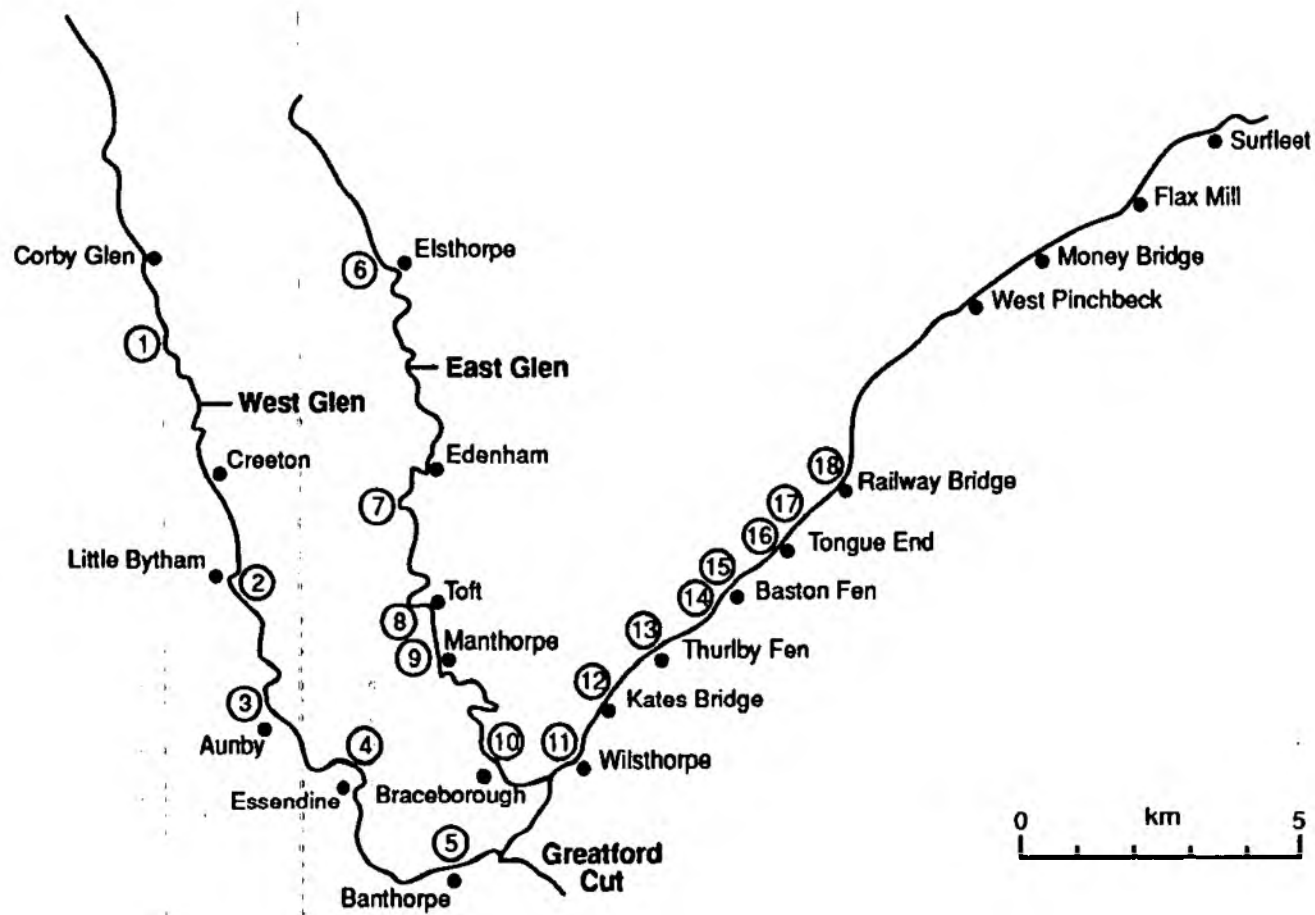


Figure BM7. Fisheries Sampling Sites on the River Glen and its Tributaries

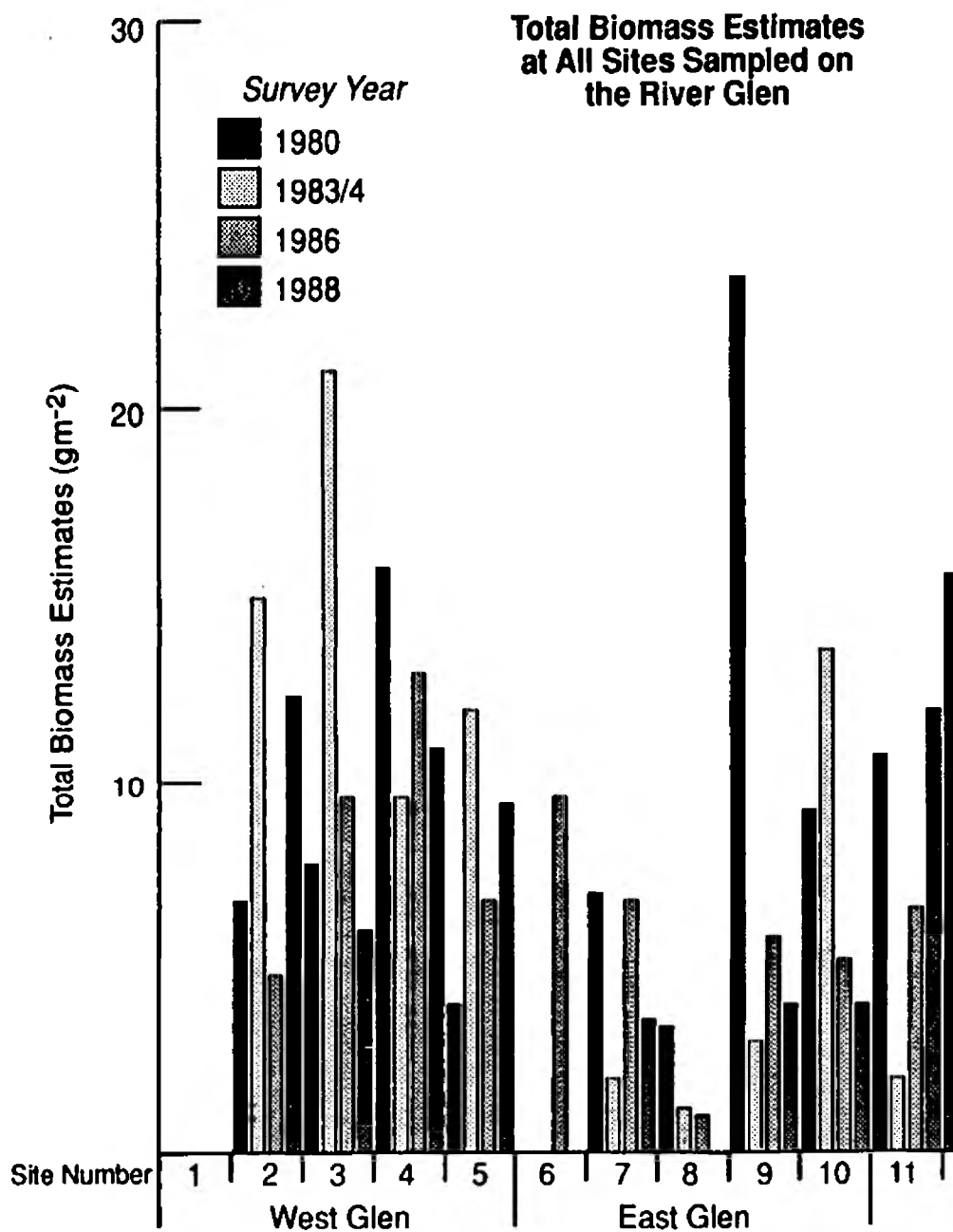
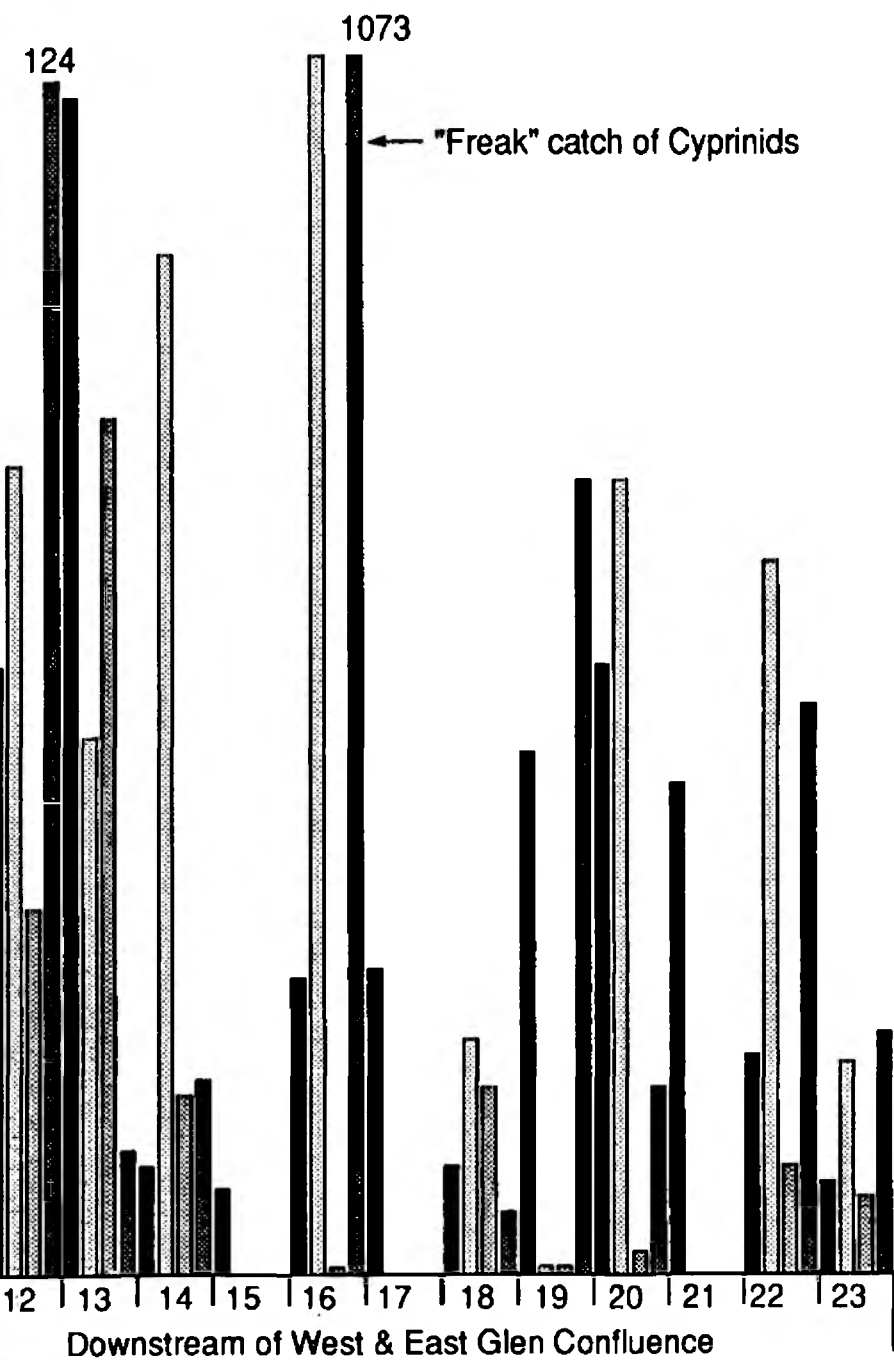


Figure BM8



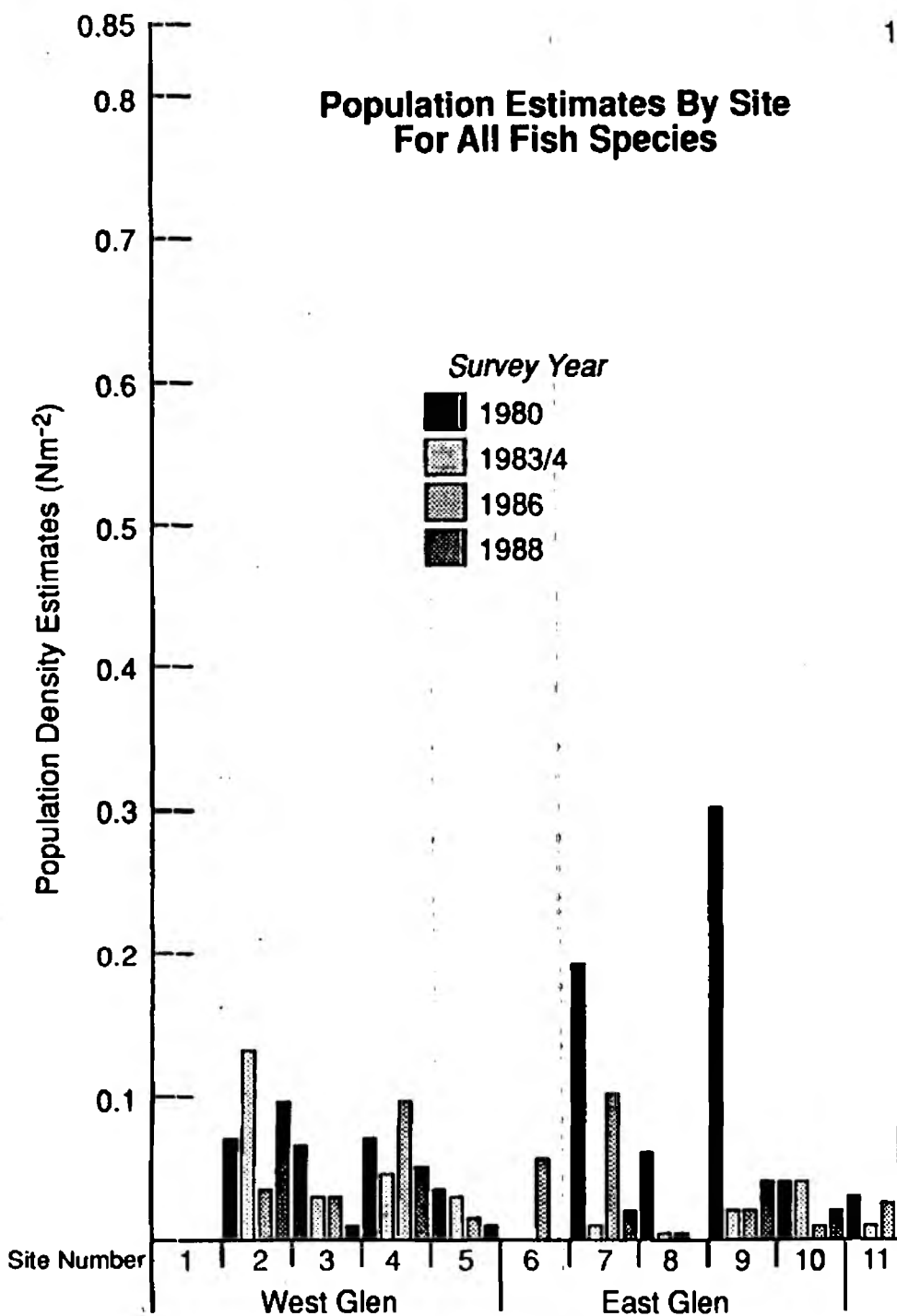
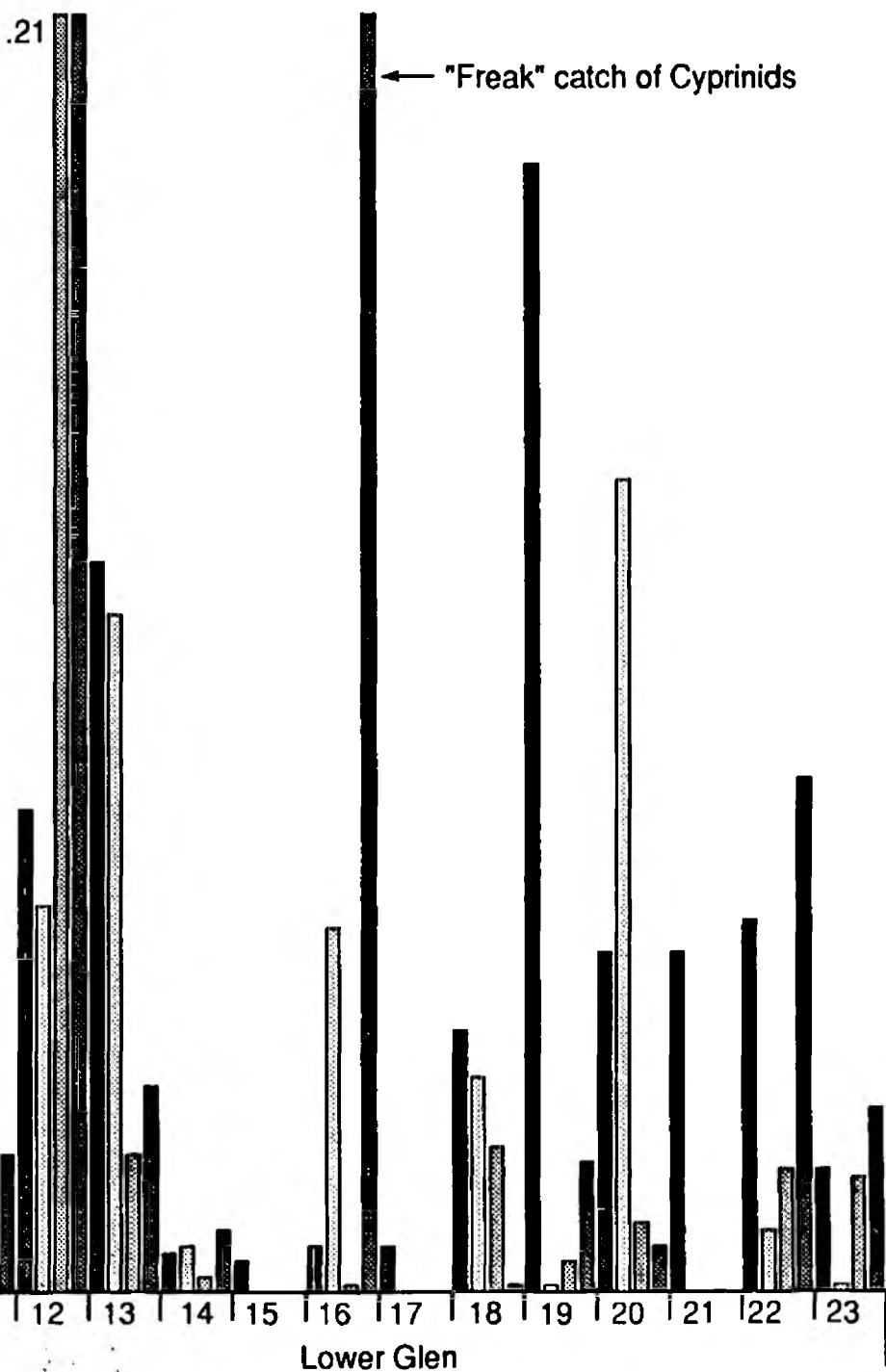


Figure RM8

.21

← "Freak" catch of Cyprinids



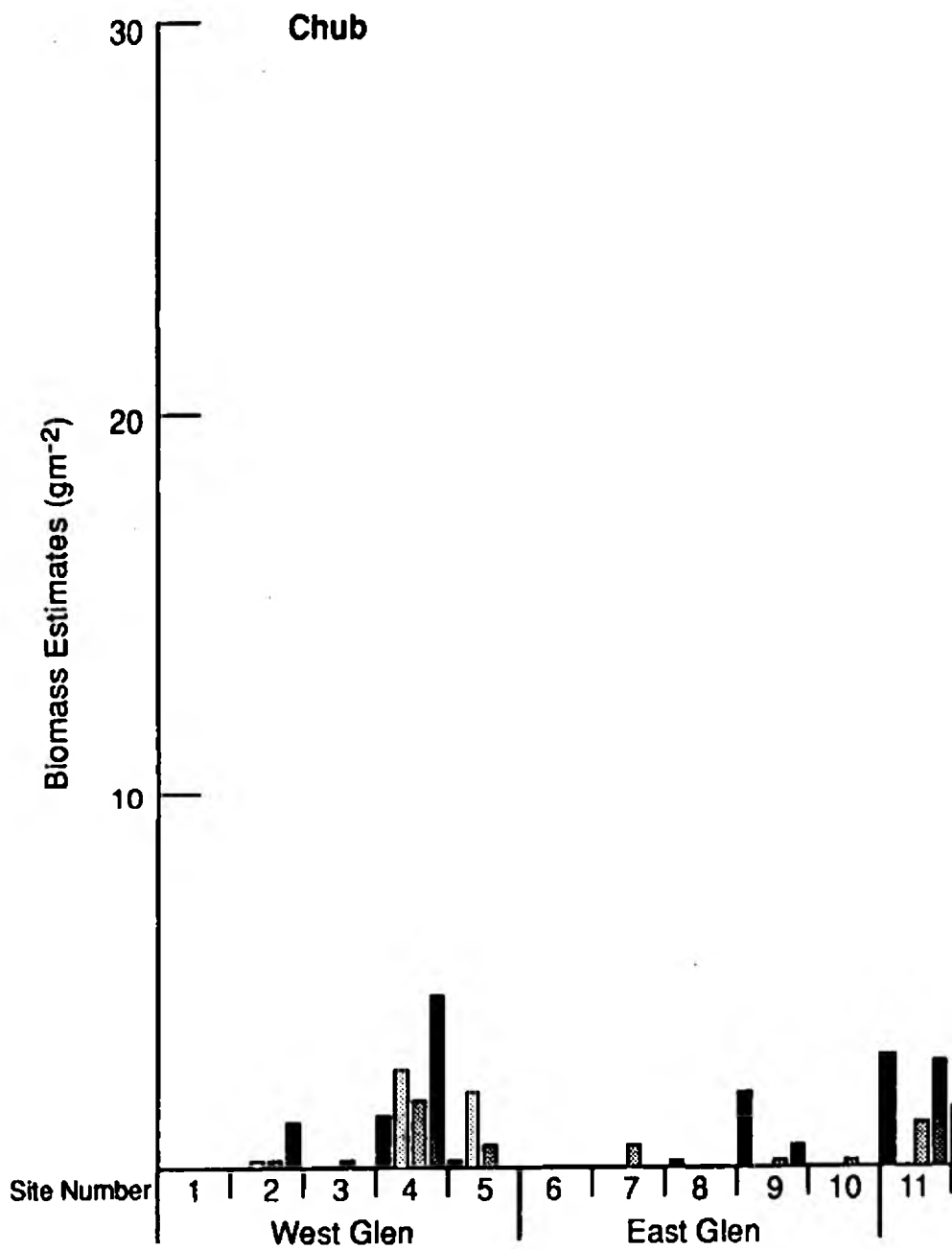
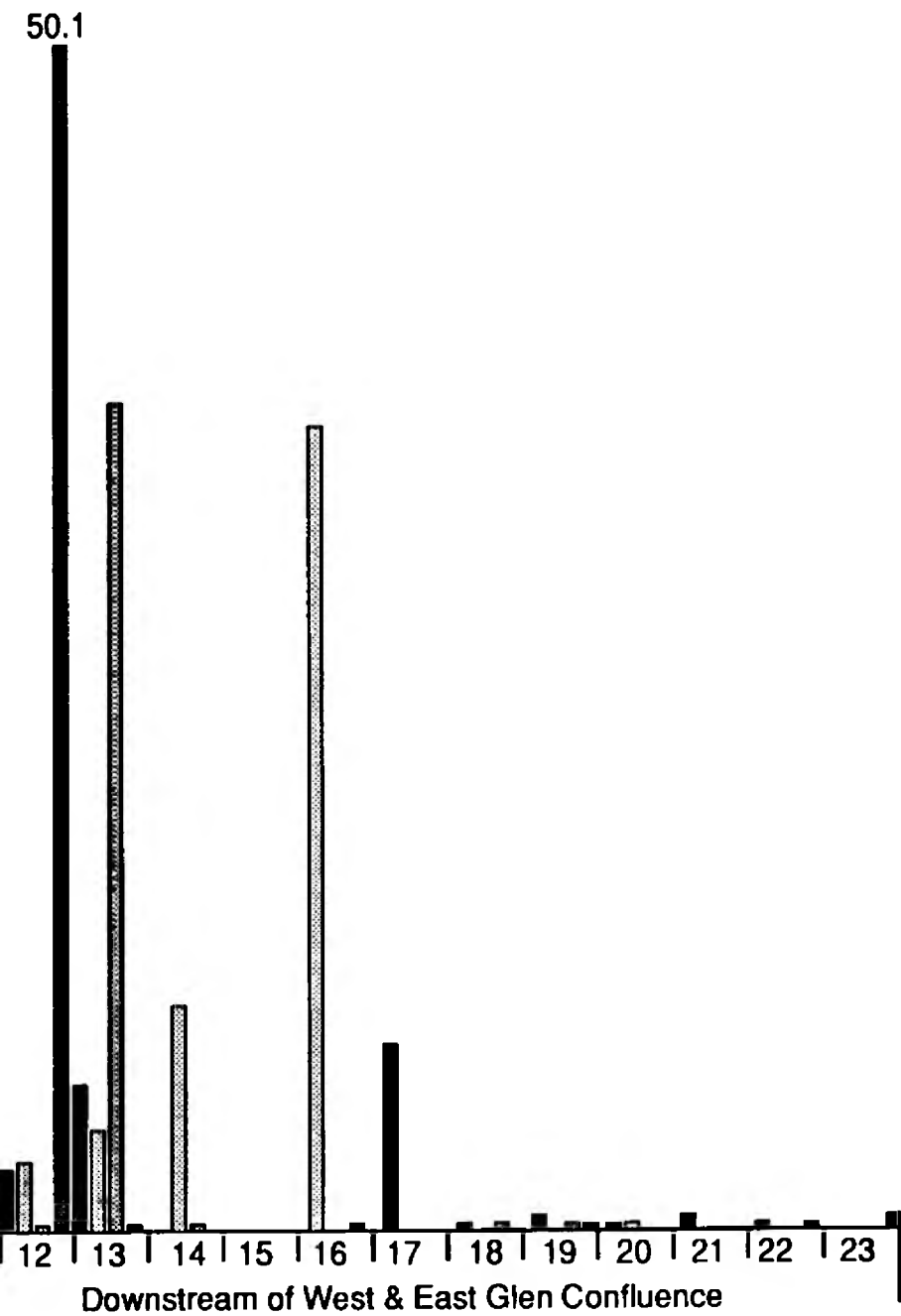


Figure BM10



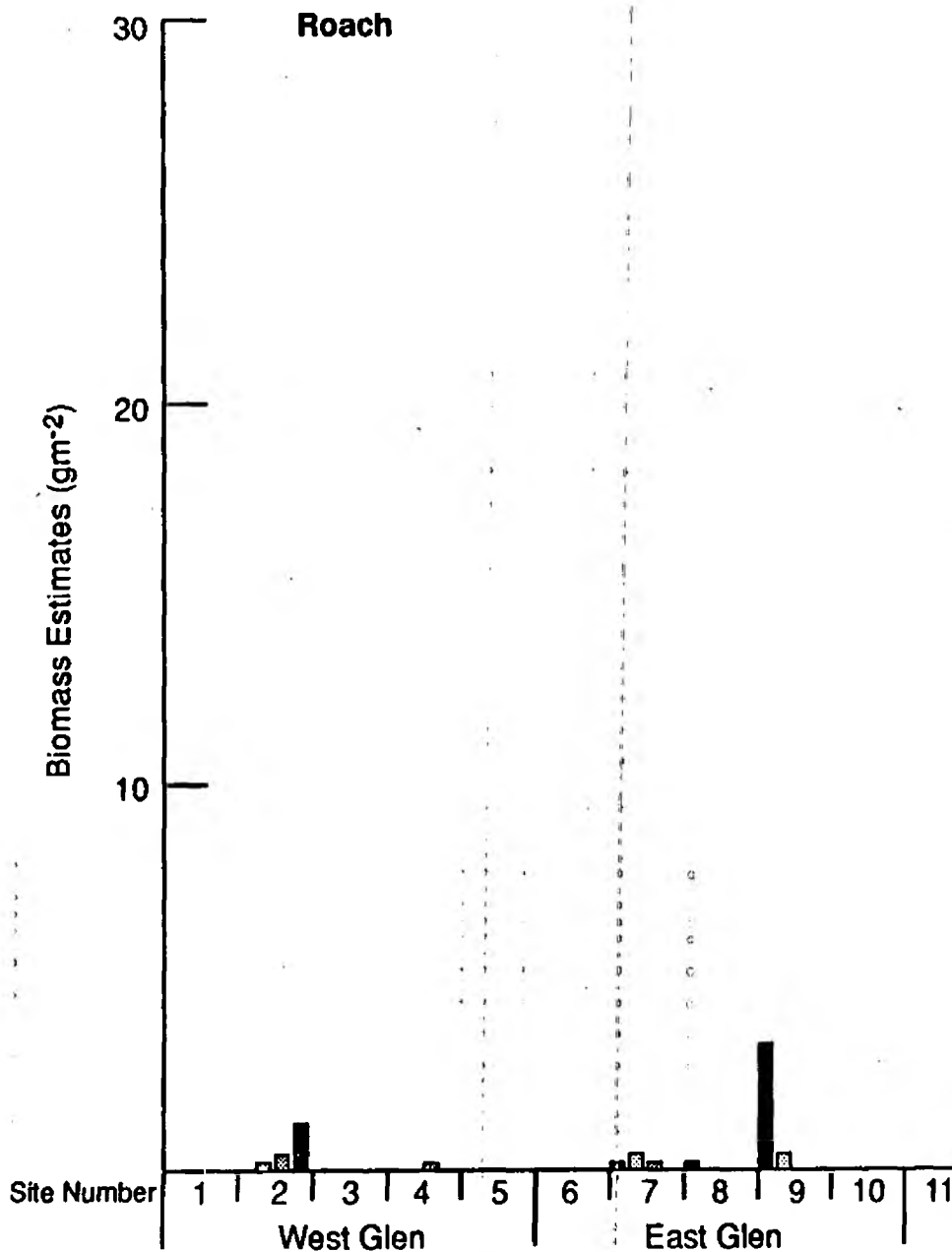
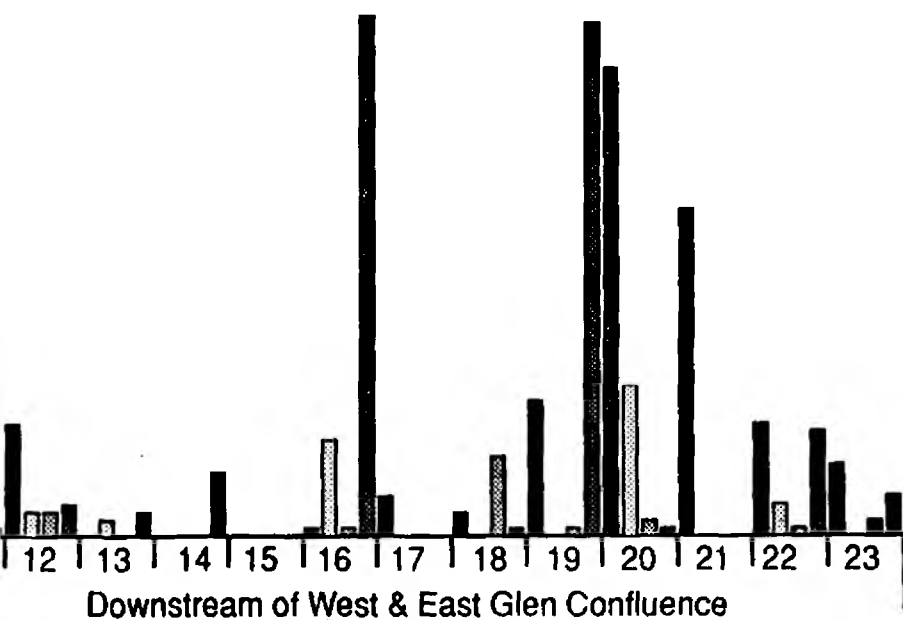


Figure BM11



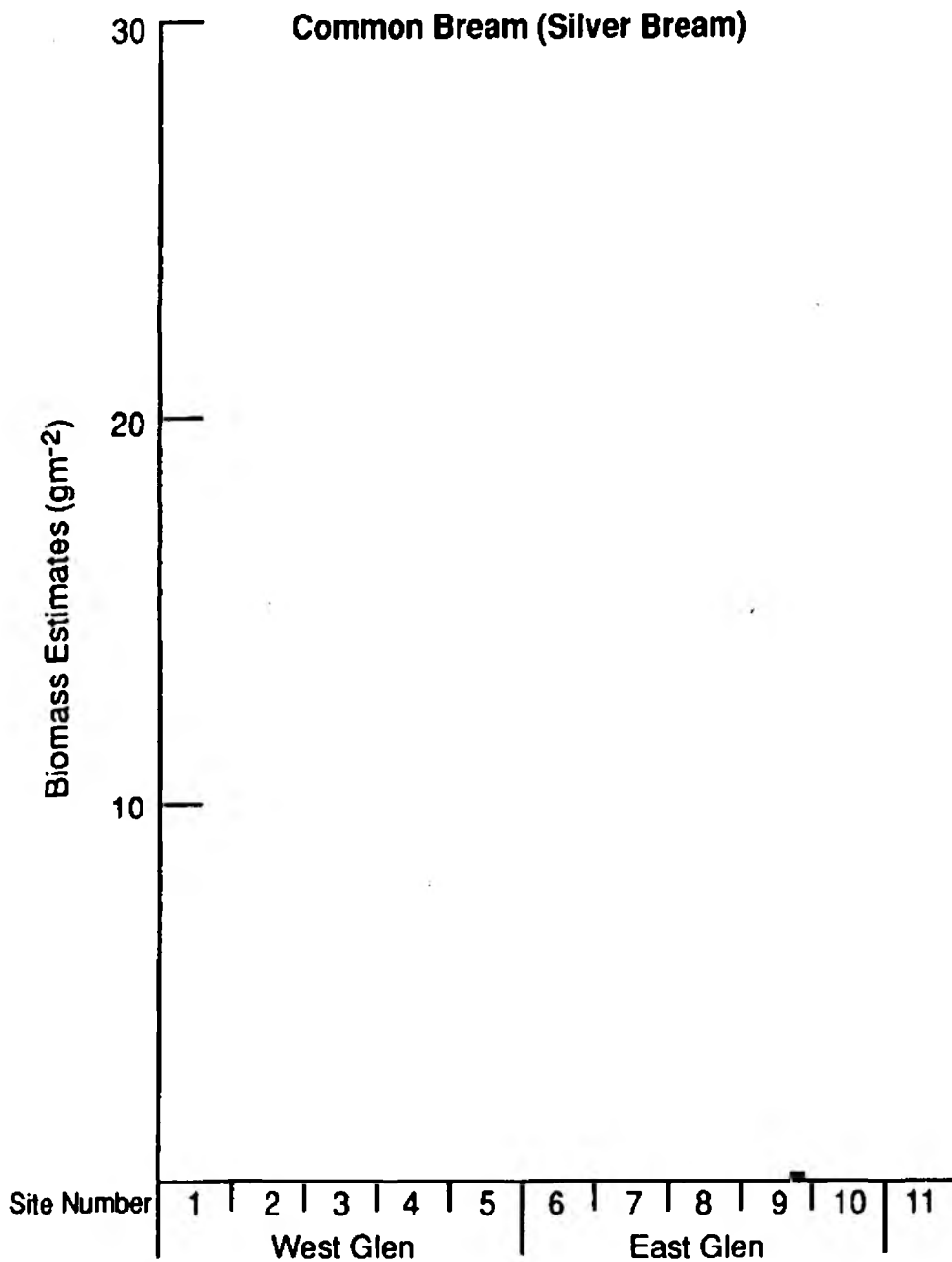
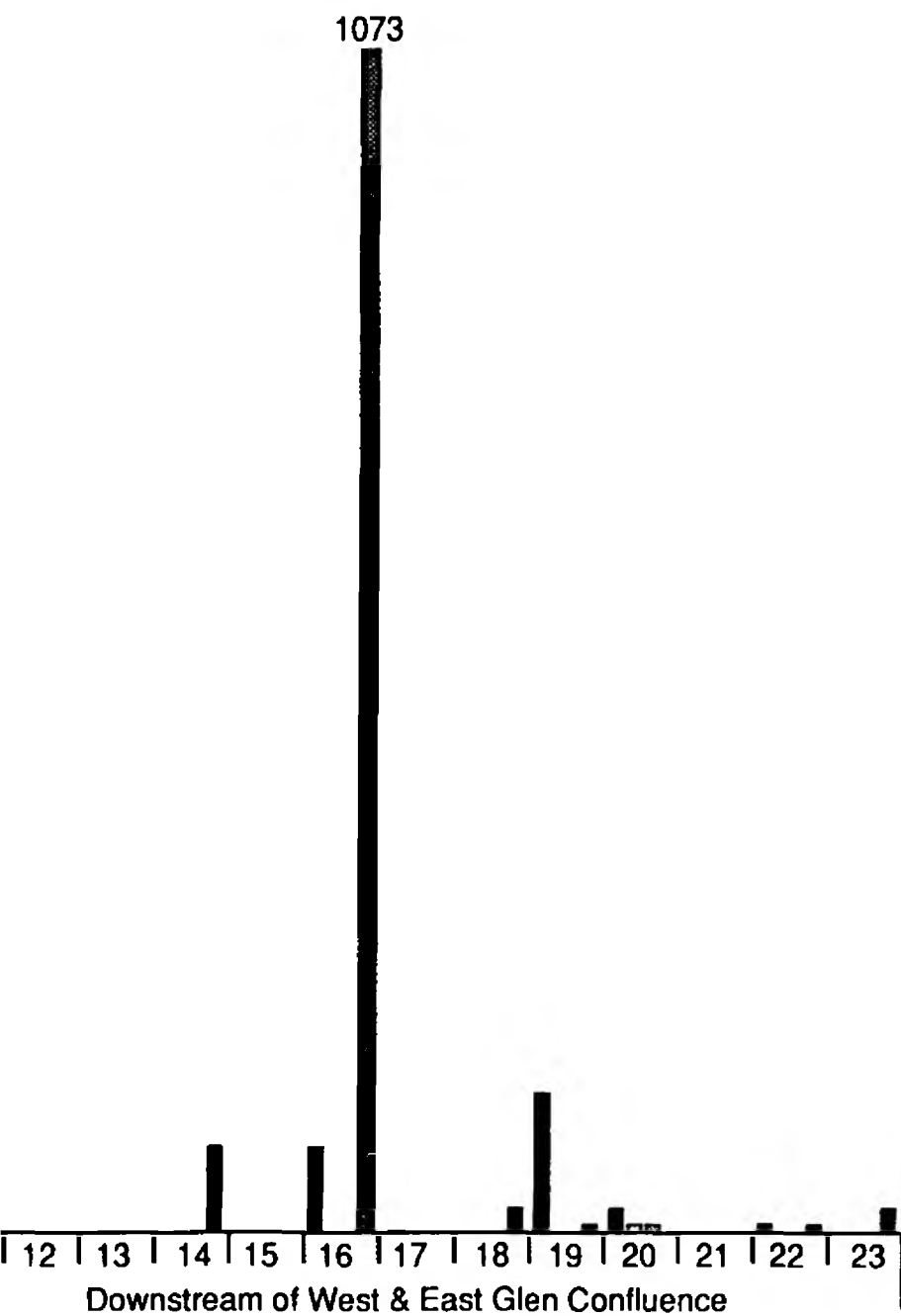


Figure BM12



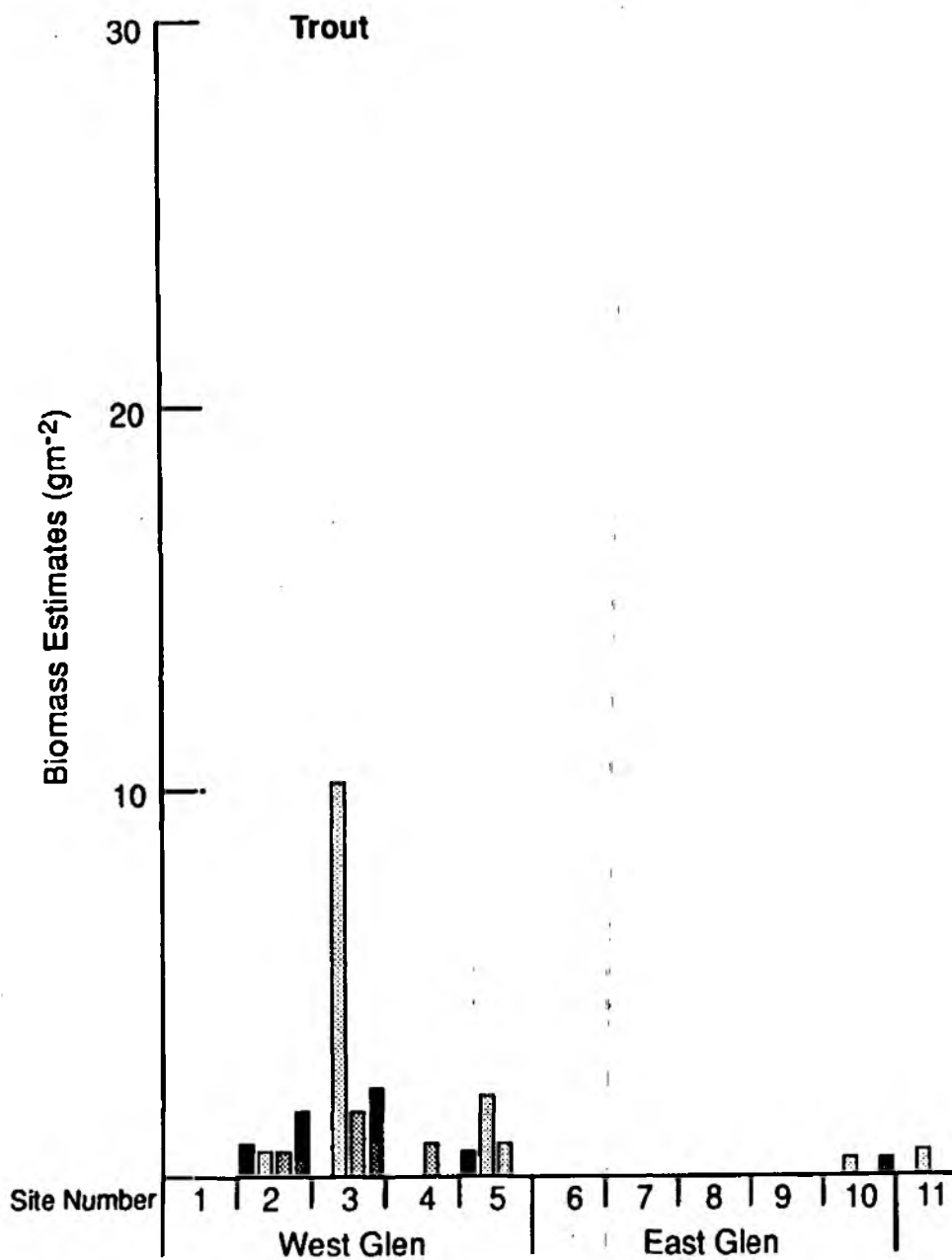
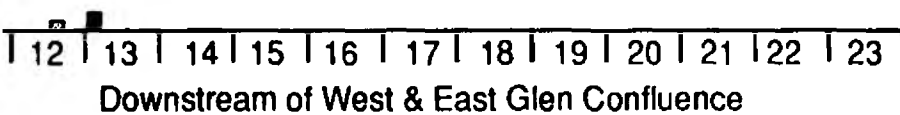


Figure BM13



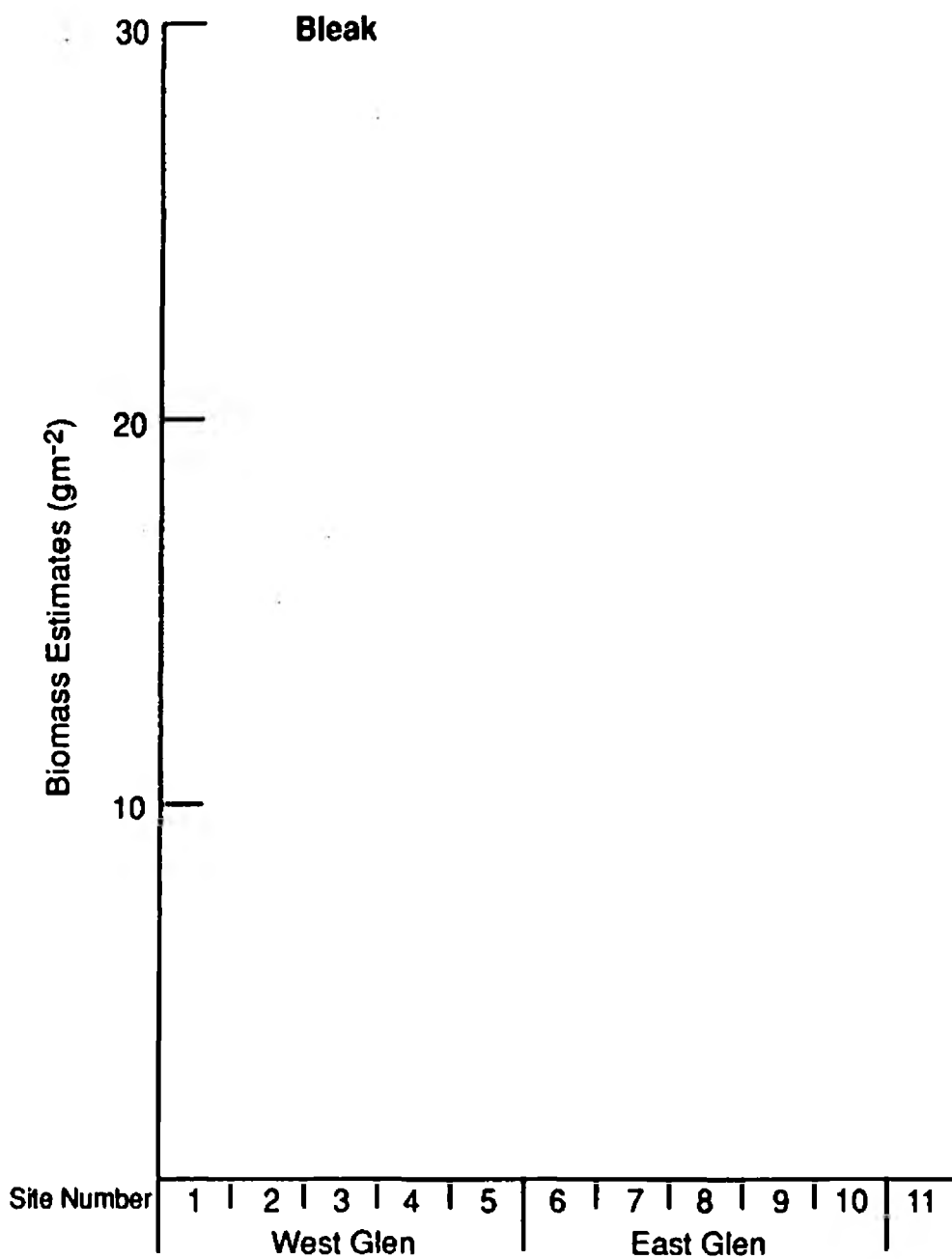


Figure BM14



LAND USE DATA

This data has been drawn from several sources and thus, there is some variability in its degree of detail and reliability. At present, only data for the catchment upstream of the East and West Glen confluence has been assembled.

The following are details of the datasets obtained, providing a range of instantaneous pictures of the catchment land use from 1931 to the present:

1. 1st Land Utilization Survey of Britain (1931) by L. Dudley Stamp.

Photocopies of the original 6" mapsheets covering catchment have been obtained from the London School of Economics (price: £17). The land use of each parcel/field was mapped by broad categories, such as 'Pasture' or 'Arable' (See Table LU1 for a list of the categories used) and is currently being transferred to a 1:25000 scale map of the catchment for comparison with No.2 below. Coverage of the catchment is totally comprehensive.

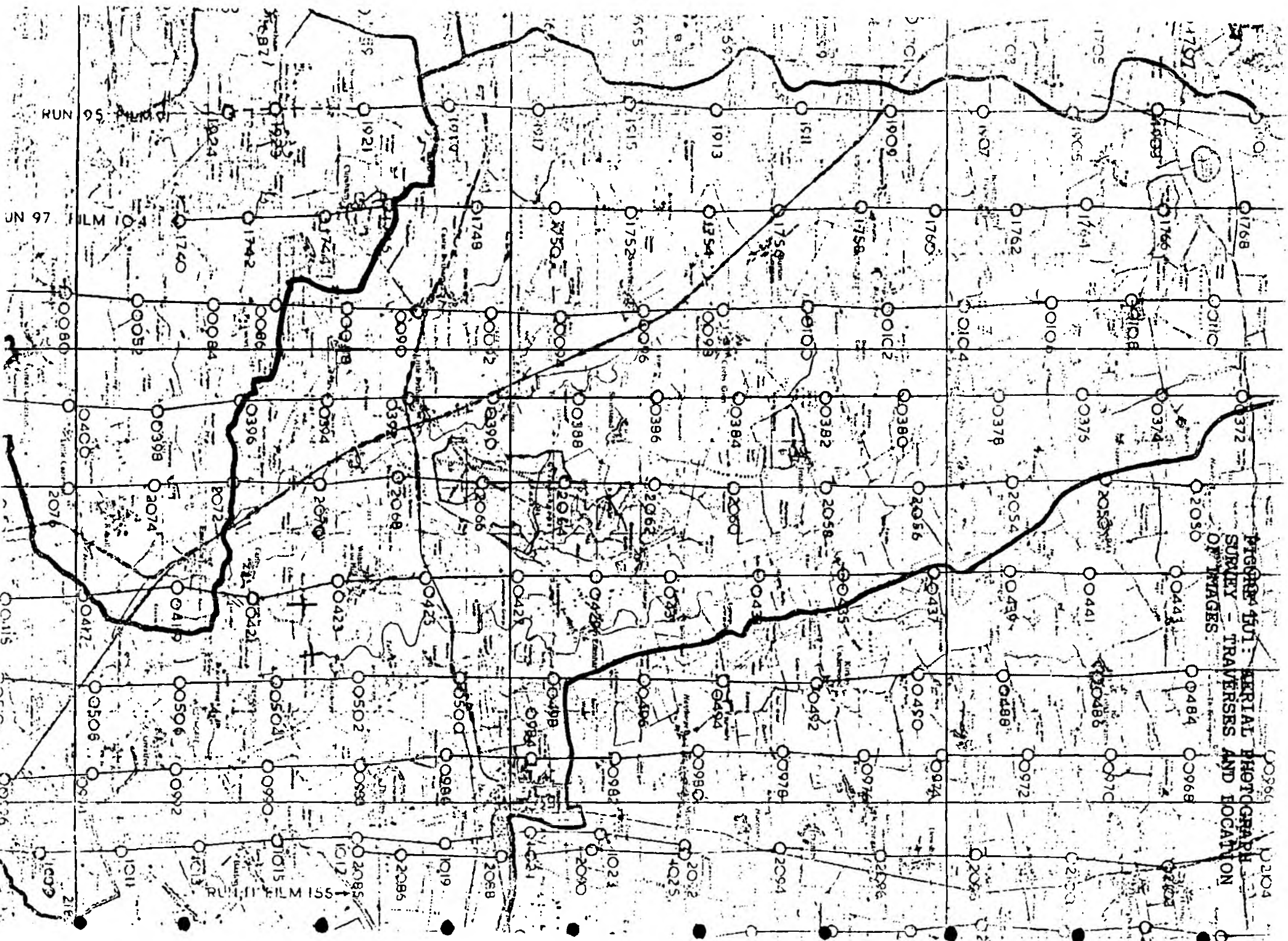
2. 2nd Land Utilization Survey of England and Wales (c.1963) by D. Stamp and A. Coleman.

Field data for the relevant area has been transposed from the original 6" maps, housed at King's College, London, to a 1:25000 scale catchment map (Item LU1 AO size) and coloured up according to land use category (see Table LU2 on separate map). There is much greater detail than for No.1 above, e.g. 'arable' is sub-divided according to actual crop, wheat, barley, oats, etc. Again, coverage is comprehensive.

3. Aerial Photograph Interpretation for the Glen Catchment (1971) by A.Hansen and J.C.Doornkamp.

- a. 218 aerial photographs in stereo pairs and at a scale of 1:12000, giving comprehensive coverage of the Glen catchment (see Figure LU1 for the flight traverse and the photograph numbering) have been recovered from the Lincoln office hydrology storeroom. Alternate images are overlain by transparencies giving a field-by-field interpretation of the land use observed. Nine broad categories were used (see Table LU3) which are roughly comparable with those used in No 1 above.
- b. A report accompanys the air photographs, in which the objective criteria by which different land uses were identified is set out (see Item LU2).
- c. An analysis of the aerial photograph interpretation appears to have been carried out. Appendix LU1 contains worksheets on which the area (km) occupied by the different land use categories for each grid square has been calculated. It is unclear how these figures were derived.

SERIAL PHOTOGRAPH INVERSES AND FOCI



- d. The 28 no. 6" map sheets mentioned in the text of the report have yet to be located.

As stated in the report, this method of land use surveying is subject to an estimated error of c. 10%, since subjective judgement is needed where land parcels do not have wholly conclusive evidence for positive crop identification, e.g. after harvest, it was reported as being difficult to distinguish hay from cereals, and unless there was good evidence to indicate otherwise, the field was categorized as 'cereal'.

4. Agricultural Census Data (Parish Summaries)

This data is assembled by MAFF/ADAS on an annual basis. Every June, a questionnaire is sent out to all farmers/landowners who are required to specify:

1. Area of holding under each land use category.
2. Head of livestock of each category kept.
3. The amount and type of labour employed.

For this study, only items 1. and 2. are of interest, and they are presented in Appendix 5 for each Parish as yearly summaries.

Several problems have been encountered in assembling a comprehensive and comparable dataset:

A. Due to MAFF confidentiality rulings, data allowing individual farmers to be identified cannot be divulged. Therefore, the spatial scale at which information is made available is the Parish, and hence, Parish Summaries are produced. Even then, to obtain the right to transpose data (Crown Copyright prevents direct photocopying), a signed statement undertaking not to republish or communicate to a third party without the Ministry's approval the information obtained, had to be completed (see Appendix LU2).

B. Although the majority of the Glen catchment lies within Lincolnshire, five parishes at its South West extremity lie within the old county of Rutland, now part of Leicestershire. Thus, it has been necessary to collect data from two separate MAFF offices, at Lincoln (contact: Miss Bray) and at Leicester (Contact: Audrey Wright). As shown in Table LU4, the temporal coverage retained by and available at each was different. Thus, truly comprehensive Parish Summary data for the catchment is (1971) by A. Hansen and J.C. Doornkamp.

(a) 218 aerial photographs in stereo pairs and at a scale of 1:12000, giving comprehensive coverage of the Glen catchment (see Figure LU1 for the flight traverses and the photograph numbering) have been recovered from the Lincoln office hydrology storeroom. Alternate images are overlain by transparencies giving a field-by-field interpretation of the land use

observed. Nine broad categories were used (see Table LU3) which are roughly comparable with those used in No. 1 above.

(b) A report accompanies the air photographs, in which the objective criteria by which different land uses were identified is set out (see Item LU2).

(c) An analysis of the aerial photograph interpretation appears to have been carried out. Appendix LU1 contains worksheets on which the area (km) occupied by the different land use categories for each grid square has been calculated. It is unclear how these figures were derived.

(d) The 28 no. 6" map sheets mentioned in the text of the report have yet to be located.

As stated in the report, this method of land use surveying is subject to an estimated error of c.10%, since subjective judgement is needed where land parcels do not have wholly conclusive evidence for positive crop identification, e.g. after harvest, it was reported as being difficult to distinguish hay from cereals, and unless there was good evidence to indicate otherwise, the field was categorized as 'cereal', only available for 1968, although for all the other years, the extent of the area for which data is lacking probably amounts to less than 10% of the total catchment.

TABLE LU1 : KEY TO SYMBOLS USED ON MANUSCRIPT FIELD SHEETS OF THE
FIRST LAND UTILISATION SURVEY, 1930-38.

A - Arable (includes tilled land, fallow, rotation grass and market gardens).

M - Meadowland and Permanent Pasture.

G - Gardens (large enough to be productive of vegetables, fruit, etc.)
Allotments, Nurseries
Areas of new housing (with gardens)
Orchards (note if arable or grass below trees)

F - Forest and Woodland, sub-divided:-

Fa - High Forest

Fb - Coppice

Fc - Scrub

Fd - New plantations

Tree species may also be added to the above symbols: c - coniferous
d - deciduous
m - mixed

thus Fb^m is mixed coppice.

H - Heathland, Commons, Rough and Hill Pasture, Moorland
(also includes abandoned quarries and waste tips which have reverted to or acquired a cover of vegetation).

P - Ponds, Lakes, Reservoirs, Ditches, Dykes, Streams, and anything containing water.

W - Wasteland - soil not productively used (i.e. Land Agriculturally Unproductive). Covers closely built-up areas, with backyards only, not gardens).
Quarries; Waste tips still in use; Industrial buildings; Mines; Cemeteries; Transport media - roads, railway lines, sidings.
Often with a statement of the exact character in the case of large areas.

This list is not definitive, only a summary: for full details, consult:-

L.D. STAMP The Land of Britain - its use and misuse (esp. pp.22-32).

L.D. STAMP and E.C. WILLETTS The Land Utilisation Survey of Britain: and outline description of the first twelve one-inch maps.

L.D. STAMP (ed) The Land of Britain - report of the Land Utilisation Survey. (In 92 parts, generally one for each country).

The Land Use data is given on Ordnance Survey County series sheets, scale 10,560. Sheet numbers are given in Roman numerals, and each county has its own.

TABLE LU3 : AERIAL PHOTOGRAPH SURVEY, 1971

LEGEND FOR PROVISIONAL LAND USE SURVEY MAPS

CEREALS

ROOT CROPS

PERMANENT GRASS

TEMPORARY GRASS

WOODLAND (MATURE)

WOODLAND (YOUNG)

ROUGH GRAZING PLUS SCRUBLANDS

URBAN

OPEN WATER

TABLE LU4 : PARISH SUMMARY DATA

YEAR	LINCOLNSHIRE		LEICESTERSHIRE Available and Obtained
	Available	Obtained	
1968	Yes	Yes	Yes
1969	Yes	No	
1970	No	No	
1971	Yes	Yes	
1972	Yes	No	
1973	Yes	No	
1974	Yes	Yes	
1975	Yes	Yes	
1976	Yes	No	
1977	Yes	Yes	
1978	Yes	No	
1979	Yes	No	
1980	Yes	Yes	
1981	Yes	No	
1982	Yes	Yes	
1983	Yes	No	
1984	Yes	No	
1985	Yes	Yes	Yes
1986	Yes	Yes	
1987	Yes	No	Yes - part

- C. There is no continuity from year to year in the item number assigned to a particular crop, e.g. sugar beet was item 16 in 1968, No.10 in years 1971-77 and No.20 from 1980-87 (see Appendix LU 3).
- D. Since 1968, land use/crop categories on the descriptive key have altered several times, apparently to continue to provide a detailed breakdown as farming practices change, e.g. the sub-division of barley into 'spring' and 'winter' was introduced in 1980, whilst the categorization of grassland as 'clover, sainfoin and temporary grass' or 'permanent grass (excluding rough grazing)' was superseded in 1975 by the categories 'grassland less than 4 years old' and 'other grassland'.
- E. The distinction made in the summaries between crops for stockfeeding and for otherwise (e.g. threshing, processing) means the total area under a particular crop may be the sum of two items/categories. This total is impossible to calculate where one item number represents several crops, e.g. in 1985, rape was categorized under item 29 (for oilseed) and under 26 (for stockfeeding), the latter in combination with savoy and kohlrabi (see Appendix LU 4).
- F. The practice of combining two or more parishes' data onto one summary sheet, to prevent individual farmer identification, tends to hinder further attempts to obtain an overview of the spatial variation within the catchment, particularly when the parishes combined are not even adjacent to one another! That said, maps showing the inter-parish variation in the five dominant crops grown there for the years 1968, 1974, 1977, 1980 and 1987 have been produced and appear as Figures 2 - 6.

5. Land Drainage - Levels of Service Maps, June 1986

These 'area of benefit' maps, drawn up by Anglian Water, delineate urban land up to the highest known flood level and agricultural land up to 8" above that same level. Within this area, land is further sub-divided into the following categories

- MAFF Grade 1 Agricultural land
- MAFF Grade 2 Agricultural land
- MAFF Grade 3 Agricultural land
- MAFF Grade 4 Agricultural land
- MAFF Grade 5 Agricultural land
- Urban land
- Other (including gravel pits and recreational areas)

For the West and East Glens, plans are to a scale of 1 : 10,000 whilst those for the Lower Glen are at a scale of 1 : 50,000. These provide comprehensive coverage of the Main River reaches (see Appendix LU6 for copies thereof) and are housed at Peterborough (contact: Andrew Hunter-Blair).

Table LU5 provides a summary of the extent of each of the land classification categories along the river.

TABLE LU5 : FLOODPLAIN LAND CLASSIFICATION (< 8 FOOT CONTOUR)
FOR THE RIVER GLEN, c.1968.

SHEET NUMBER	AREA WITHIN 8FT CONTOUR	MAFF LAND GRADE (Ha)					URBAN AREA	NON-AGRIC AREA
		1	2	3	4	5		
West Glen								
SK92NE	126.8	-	-	3.2	11.5	-	-	-
SK93SE	18	-	-	18	-	-	-	-
SK92SE	41.9	-	-	25.8	16.1	-	-	-
TF01SW	105.1	-	-	103.5	-	-	1.6	-
TFO1SE	644.3	-	372.7	240.9	-	-	18.5	12.2
TFO1NW	122.6	-	-	85.5	34.5	-	2.6	-
TFO2SW	52.5	-	-	21.3	29.2	-	-	2
TOTALS	1111.2	0	373	498	91	-	22.7	14.2
Tributaries								
RIVER THAM								
SK91NE	24.9	-	-	3.2	11.5	-	5.9	4.3
TF01NW	20.6	-	-	16.7	1.8	-	3.9	-
HOLYWELL BROOK								
TF01SW	13.2	-	-	13.2	-	-	-	-
TF01NW	14.4	-	-	6.6	4.6	-	0.9	2.3
TOTALS	73.1	-	-	39.7	17.9	-	10.7	6.6
EAST GLEN								
TF01SE	144.9	-	73.3	67.1	-	-	1	3.5
TF01NE	205.5	-	-	200.2	-	-	2.1	3.2
TF02SE	201.3	-	-	198.7	-	-	2.6	-
TF02NE	14.4	-	-	9.6	4.8	-	-	-
TF02NW	143.3	-	-	109.2	32	-	-	2.1
TF03SW	3.8	-	-	3.8	-	-	-	-
TOTALS	713.2	-	73	589	37	-	5.7	8.8
RIVER GLEN								
TF01SE	132.8	-	16.7	111.8	-	-	4.3	-
TF11SW	33.6	-	-	33.6	-	-	-	-
TF11NW	7.1	-	-	7.1	-	-	-	-
TOTALS*	173.5	-	16.7	153	-	-	4.3	-
Tributaries								
BOURNE EAU								
TF01NE	10.3	-	-	-	-	-	10.3	-
TF02SE	63	-	-	-	-	-	63	-
CAR DYKE								
TF11NW	104.7	-	-	81.4	-	-	14.7	8.6
TOTALS*	178	-	-	81.4	-	-	88	8.6

NB: * = incomplete coverage of the floodplain.

(Source: Land Drainage Levels of Service - Survey of Benefit Areas on the River Glen and Tributaries, June 1986)

LAND DRAINAGE DATA

Significant and widespread land use change in the West and East Glen catchments since the 1930's, from predominantly woodland and grassland to intensive cereal cultivation, seems to suggest that many field drainage schemes have been undertaken over the last sixty years. As the area is not within any Internal Drainage Board operational areas, and Anglian Water's responsibility extends only to Main River reaches (see Channel Capital Works section), then these works will have been carried out by individual farmers according to their perception of need.

It has been ascertained that a dataset exists for field drainage schemes, compiled by MAFF/ADAS and available through their Field Drainage Experimental Unit (contact: Dr Adrian Armstrong) at Trumpington, Cambridgeshire. This records when and where approval has been given by the Ministry for a grant to be made to the applicant farmer (under the Farm Capital Grants Scheme and the Farm and Horticultural Development Scheme), to enable the necessary works to be carried out; 95% of all such works qualified for a grant. In addition, the dataset contains technical information on the drainage schemes approved, as well as a record of the existing land use at the time of the application and its intended use once the land has been drained. Thus, the conversion of land from, for example, permanent pasture to arable or root crops ought to be identifiable.

Limitations associated with the dataset:

1. Access
 - a. Due to MAFF confidentiality rulings, no data can be divulged by them which would allow individual farmers to be identified. Thus, the smallest spatial scale for which data (aggregated) is available is that of the Parish.
 - b. The records are currently held on magnetic tape, compatible only with a now defunct ICL system. Therefore, to access the database will require a program to convert it to a form recognizable by the MAFF/ADAS's present system. The cost of this has been loosely quoted at £500 - £1000 by Dr Armstrong.
2. Temporal Coverage - complete coverage has only been assured for the period 1971-1981. The latter represents the date when the RCGS and FHDS were superseded by the "Agricultural and Horticultural Development Scheme" and the "Agricultural and Horticultural Grant Scheme"; these do not require prior approval for schemes submitted.
3. Inherent Limitations - an approval from the MAFF for grant aid in no way binds the former to carry out the proposed works within a specified period, if at all, eg. the 1974 regional statistical summary (MAFF/ADAS) was artificially enhanced by an impending cut in grant rates; farmers submitted details of proposed schemes whilst the higher rates were still available. It was subsequently revealed that several of these were not carried out.

The MAFF/ADAS publications "A Digest of Drainage Statistics (1978)" and "Drainage Statistics, 1978-80" (1981), which outline the content of this dataset and present an analysis by region of the drainage statistics have been passed on by Dr Armstrong and are Items LD 1 and LD 2 in the appendices.

CHANNEL CAPITAL WORKS AND MAINTENANCE

Information relating to this has been drawn from three main sources:

1. Anglian Water 'in house' Capital Works Grant Aid submissions and project appraisal reports. Some of these are available from the Operations office at Spalding (contact: Terry), but the main features of these schemes have been noted and incorporated into the appendices following. The oldest of these is the 1960 River Glen Improvement Scheme report.
2. Anecdotal newspaper cuttings and recollections (courtesy of Mr Roy Herd), dating back to c.1880's.
3. River Glen and tributaries maintenance files from the Operations office for details back to c.1985.

Information drawn from all of the above has been compiled chronologically in the appendices as follows:

CW1	East Glen	-	1954 - 1988
CW2	West Glen	-	1887 - present
CW3	Bourne Eau	-	1948 - 1987
CW4	Lower Glen	-	consequences of major rainfall events, 1821 - 1987
CW5	Lower Glen	-	Engineering Works 1821 - present
CW6	Lower Glen	-	copy of 1883 'state of the channel' report, by Kingston & Harrison.
CW7	All Glens	-	All recorded riparian clearance and maintenance work, 1952 - 1989.

There appear to be many gaps in the data obtained, not only temporally but also in terms of the amount of detail of the works carried out which has been recorded, eg. the depth of dredging at a particular location cannot be known.

GEOLOGY OF THE GLEN CATCHMENTS

References

1. STRAW, A. & CLAYTON, K.M. 1979 "The Geomorphology of the British Isles: Eastern and Central England" Methuen.
2. WYATT, R.J. 1971 "New Evidence for Drift-filled Valleys in Leicestershire and Southern Lincolnshire." Bull. Geol. Surv. Gt. Brit. 37, pp.29-55.
3. STAMP, L.D. (Ed.) 1942 "Report of the Land Utilization Survey Part 76 - 77", Geographical Publications Ltd.

A 1:25000 geological map has been produced and is enclosed as a separate.

Hard Rock Geology

The present day East and West Glens flow roughly in parallel North - South aligned valleys, incised into a broadly West Southwest - East Northeast folded Jurassic plateau of Oolite (limestone) and Lias, the majority overlain to various depths by Glacial Drift. Research by Straw and Clayton (1971), Wyatt (1971), and Kent (1939) all point to the catchment being traversed in preglacial (Anglian) times by West - East flowing rivers, which are thought to bisect the present day Glens at the following:

1. Little Bytham - Witham-on-the-Hill - Toft - Thurlby
2. Burton Coggles - c.Keisby (TF02252862)

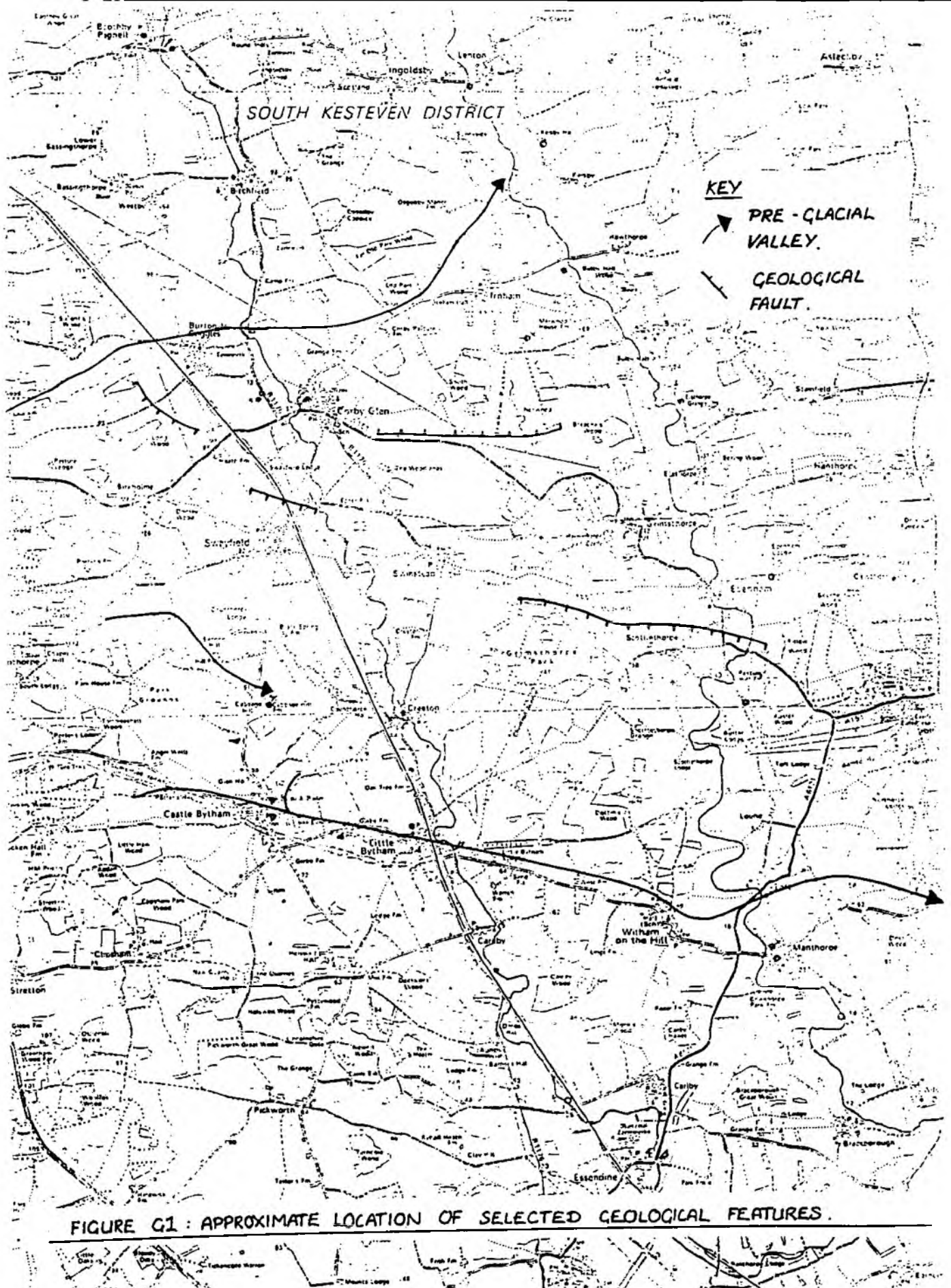
It is thought that the latter was initiated along the Colsterworth - Burton Coggles strip of softer Upper Estuarine Clays, coincident with a synclinal axis. The evidence for numbers 1 and 2 above is uninterrupted spreads of Glacial Drift across the West Glen valley.]

Figure G1 shows the approximate location of several geological features.

Superficial Deposits

During the pre Wolstonian/Flandrain, fluvially transported sands and gravels/alluvium derived from Jurassic and Triassic rocks (sub glacial outwash) were deposited to depths of <19 m on the valley floor, eg. at Castle Bytham and Little Bytham Sand Pit (TF03011743). These overlie the Hoxnian erosional profile of gradient c.1:1000, hanging 30 m at the Fen margin, the Upper Estuarine Series, Kellaways Beds and Oxford Clay. The Burton Coggles - Osgodby drift filled sub-valley is incised into the Lincolnshire limestone in the present West Glen valley and into the Great Oolite Series overlain by Kellaways on the East Glen near Osgodby.

Whilst the sheet of till covering the catchment appears to have consisted mainly of bluish-grey chalky Boulder Clay, there is some chalk and flints and some fragments/boulders of local Jurassic rocks. The drift in these buried valleys is predominantly sand and gravel (Castle Bytham - Thurlby) or sand/gravel with Glacial Clay, particularly in the centre of the valley, eg. SK97982606 where 3.9 m sand and



gravel underlie 4.6 m Boulder Clay, and at SK95912815 where 3.4 m gravel underlie 16.8 m Boulder Clay.

The present day alignment of the Glens is thought to be post Wolstonian/Chalky Boulder Clay Glacial, as they incise 10 - 20 m into and through the till, except at Burton Coggles where downcutting is contained within the drift layer, which is a maximum of 30.3 m Boulder Clay at SK96192653 on the Upper Lincolnshire Limestone. Both rivers are thought to have originated at a late stage in the ice melt/deglaciation, once the preglacial valleys had been blocked by drift infilling, eg. Straw and Clayton suggest that two channels may have confluenced around Burton Coggles to find a mutual outlet, ie. the line of the present West Glen valley through a blanket of ground moraine. It would appear that this was at a higher level than the present valley, as this shows no glacial deposits Southeast of Burton Coggles. An alternative hypothesis (Kent, 1939) was that the Glens and the parallel Upper Witham represent successive ice marginal drainage channels and the interfluvial Boulder Clay deposits represent terminal moraines at the boundary of the Devensian ice sheet and proglacial Lake Fenland, whose western shore was thought to bisect the catchment.

During the post-glacial period under periglacial conditions, first- and second- order dry valleys developed and meltwater erosion resulted in widespread removal of pre-Devensian drift. The post-glacial period also saw the occurrence of "valley bulging", which is thought to have been influential in meander development (Harrod 1972).

By about 9500 BP, erosion on any scale had ceased as forests developed across the catchment. However, since the 1800's, human activity has resulted in the extension of the drainage network within the catchment, as more intensive cultivation necessitated land drainage.

Borehole Data

Geological profiles recorded when the boreholes were first sunk, are available for many of the bores in the West and East Glen catchment. For the purposes of this study so far, well records have only been obtained for those boreholes adjacent to or within c.0.5 mile of the main river watercourses. These are listed in Table GD1 and copies of the record sheets may be found under Appendix GD2. Figures GD2a - 2c provide a summary of the profiles downriver on the East and West Glens separately.

If data from further boreholes is required, then the file reference number and the borehole location can be read off Appendix GD3. All borehole records are kept at AW's Lincoln office, with the hydrologists.

TABLE G1: SITES FOR WHICH BOREHOLE GEOLOGICAL PROFILES HAVE BEEN OBTAINED - EAST AND WEST GLEN MAIN RIVER CORRIDORS














Site No.	Name	Grid Ref.	Approx. Distance from Main River (km)
WEST GLEN			
340b	Old Somerby	SK96893371	0
12	Boothby Pagnell	SK971309	0.325
422	Boothby Pagnell	SK97543077	0.150
443	Bitchfield	SK97492859	0
166a	Corby Glen	SK98962513	0.35
	Corby Glen	SK99742518	
442	Swayfield	SK99822338	0.50
438	Creeton	TF01181991	0
68	Little Bytham	TF01311903	0.3
81	Little Bytham	TF01301810	0.3
421	Careby	TF025158	0.025
EAST GLEN			
45	Humby	TF006322	0.80
437	Ropsley	TF00043378	0.3
436	Lenton	TF02153014	c.0
432	Imham	TF03712731	0.075
434	Elsthorpe	TF05612478	0.05
240	Elsthorpe	TF060239	0.25
69	Edenham Lodge	TF071222	0.875
435	Pasture Hill	TF066201	0.425
179	Manthorpe	TF07051589	0.25

NB: Other sites have been obtained, but the classification is unclear.

FIGURE GD2a.

BOREHOLE - GEOLOGICAL STRATA DATA

KEY

-  LINCOLNSHIRE LIMESTONE
-  UPPER ESTUARINE SERIES
-  NORTHAMPTON SANDSTONE
-  LOWER ESTUARINE SERIES
-  UPPER LIAS
-  KELLAWAYS BEDS
-  CORNBRASH
-  (GLACIAL) DRIFT | ALLUVIUM
-  OXFORD CLAY
-  GREAT OOLITIC LIMESTONE
-  GREAT OOLITIC (BLISWORTH) CLAY
-  BOULDER CLAY
-  POSSIBLE FAULT

West Glen - Borehole Geological Strata

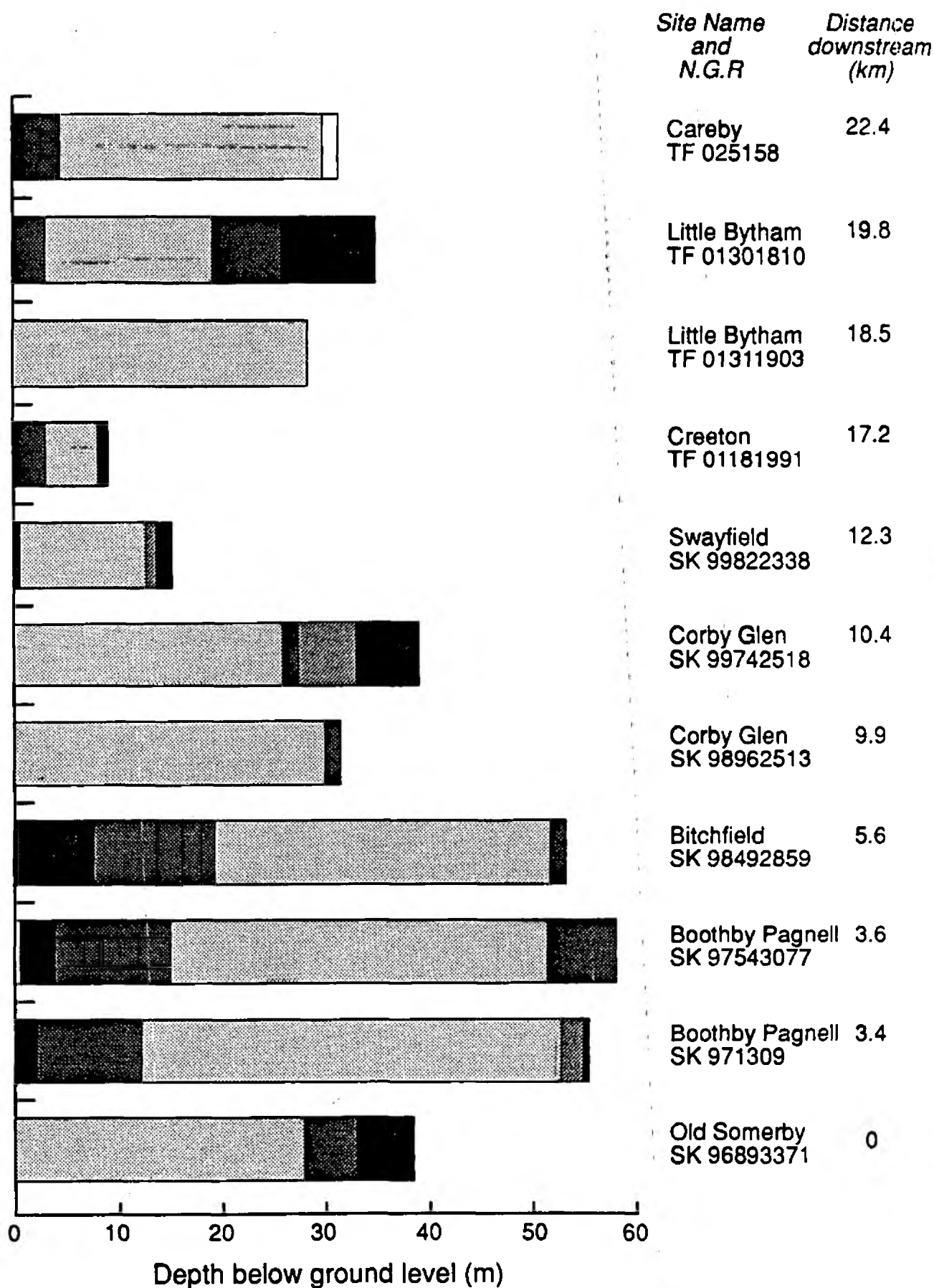


Figure GD2b

East Glen - Borehole Geological Strata

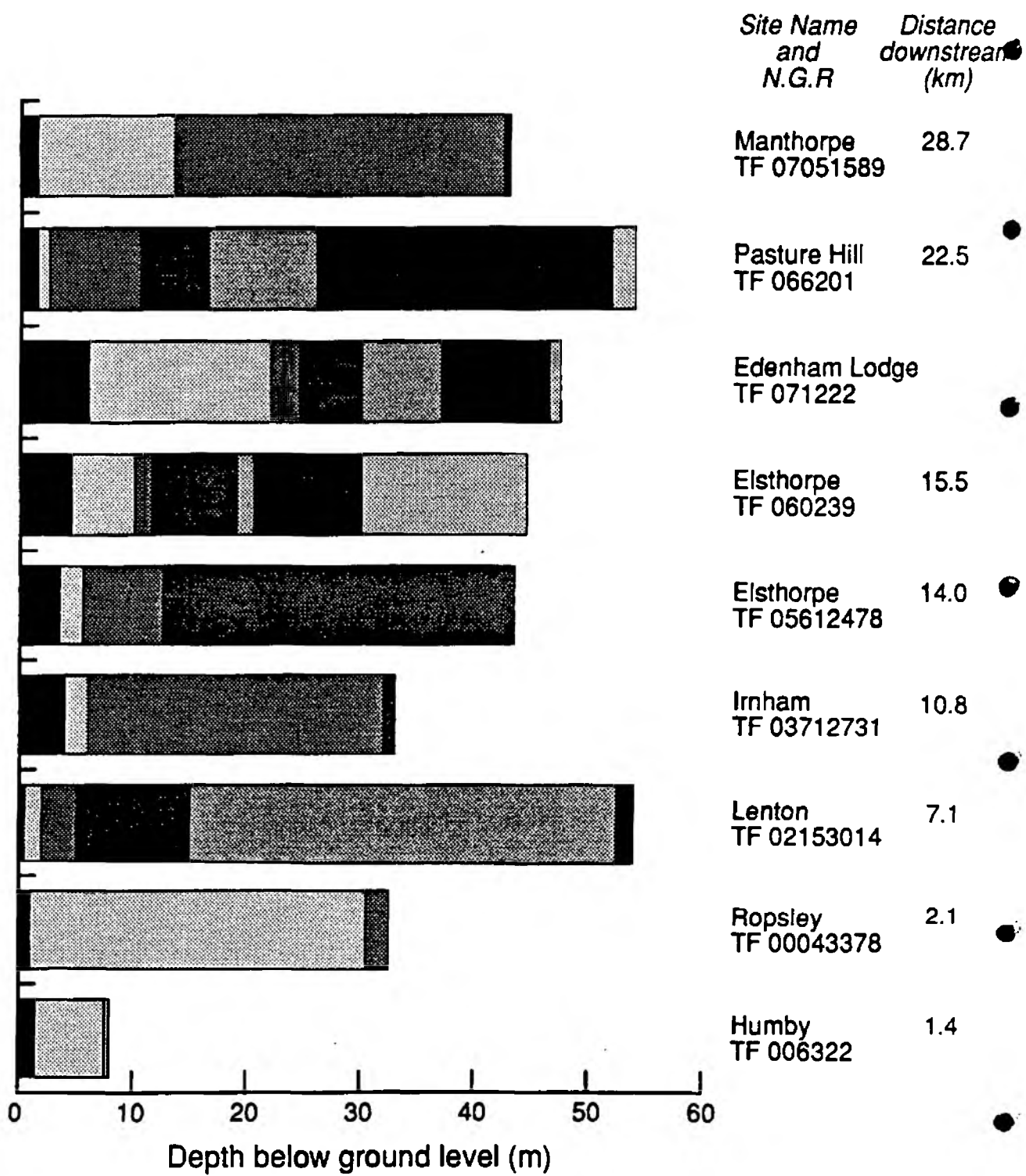


Figure GD2c

Address and Telephone List

Roy Herd (retired drainage engineer).	Four Winds Low Road Spalding	(0775)2860	Channel works
Alistair Ferguson (Project Co-ordinator)	Apex House Peterborough	(0733)555667 Extn.2102	Anything - our man inside!
Andy Baxendale (Hydrologist)	Aqua House Harvey Street Lincoln	(0522)513100	Rainfall Runoff S.M.D.
Allan Bond (Hydrology)			Abstractions Groundwater
Miss Bray Mrs Bullivant (MAFF/ADAS)	Ceres House 2 Searby Road Lincoln	(0522)29951 Extn.397	Land Use - Parish Summaries
Mrs Audrey Wright (MAFF/ADAS)	Tigers Rd. Saffron Rd, Wigston Leicester.		Land Use - Parish Summaries
Shirley McLean (Geog. Info. Officer)	L.S.E. London	01-405-7686	1st Land Utilization Survey of Britain
Alice Coleman (Land-use lab.)	Room 448 King's College Surrey Street London	01-836-5454	2nd Land Utilization Survey of Britain.
Geoff Petts (big boss)	Loughborough University	(0509)222791	Money!
Geography Department	"	(0509)263171	
Graham Read	Loughborough	(0509)261070	Model aircraft photos.
Dr.Adrian Armstrong (MAFF/ADAS)	Field drainage Experimental Unit Anstey Hall Trumpington Cambs.	(0223)840011	Parish Land Drainage Data.
Alison Whiteman (Management Services)	Peterborough	(0733)555667 Extn.4216	Any Queries regarding Computer Operation
Chris Extence (Biologist)	Spalding	(0775)762123	Invert. & Habitat

			Data
Martin Stark (Fisheries Scientist)	"	"	Fisheries Surveys
Roger Eynstone (District Quality Officer)	"	"	Chemical Sampling/ Pollution Incident Data
Ian Hill (Assistant)	"	"	
Derrick Dann (District Quality Officer)	Kettering		Older Chemical Sampling Info.
Terry (Superintendent)	Spalding		Channel Maintenance
Andrew Hunter-Blair (Flood Defence)	Peterborough	(0733)555667	Flood- plain Benefit Maps.