Institute of Hydrology

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Natural Environment Research Council

DERIVATION OF THEORETICAL FLOWS FOR THE COLLIFORD RESERVOIR MODEL

(A report of contract work to South West Water Services Ltd under IH project T05056V1)

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1. PROJECT AIMS

The Colliford Model is a computer model which will represent the Colliford Reservoir System managed by South West Water Services Limited. Theoretical flows will be a major input into this computer model and the Institute of Hydrology was required to generate a record of synthetic natural daily mean flows at specified locations in the Colliford operational region.

Data were to be generated for up to fifty years where possible and in units of cumecs. Notes on how the data were derived were to accompany the generated data; a statistical comparison of the synthetic and historical flows is presented in this final report of the project.

Synthetic natural daily mean flows were required at the following locations:

1.1 Gauging Stations

Name	Catchment (with Surface Water Archive Number or National Grid Reference)
Restormel	Fowey (48011)
Bastreet	Withey Brook (47013)
Pillaton Mill	Lynher (47004)
Trekievesteps	Fowey (48001)
Craigshill Wood	St Neot (48009)
Trengoffe	Warleggan (48004)
Delank	Delank (49003)
Denby	Camel (49001)
Trebrownbridge	Seaton (48010)
Tideford	Tiddy (47009)
Gwills	Gannel (49004)
Tregony	Fal (48003)
Truro	Kenwyn (48005)
Ponsanooth	Kennal (48007)
Trenear	Cober (NGR-SW 677311)
Helston	Cober (48006)
St Erth	Hayle (49007)

1.2 Intakes

Kennal Vale	Kennal (NGR-SW 746370)
Rialton	Porth (NGR-SW 848623)

1.3 Reservoir inflows

Colliford	St Neot (NGR-SX 179710)
Siblyback	(NGR-SX 232703)

Porth	Porth (NGR-SW 863621)
Crowdy	(NGR-SW 719363)
Stithians	(NGR-SW 437288)
Drift	(NGR-SW 437288)

1.4 Other

Gunnislake	Tamar (047001)

2. DATA COLLECTION

Most of the data required for the study were available on the Surface Water Archive at the Institute of Hydrology. These included rainfall, flow and Penman evapotranspiration, and information on individual catchments, catchment areas and duration and quality of data stored. Other data were retrieved from South West Water Services Ltd.

2.1 Flow Data

Daily mean flows for 16 of the gauging stations were collated from the Surface Water Archive. Four of the catchments were natural, the remainder being influenced by public water supply abstraction, reservoir releases, sewage or drainage from mines and industry. A full list of the flow data collected is provided in Table 1.

2.2 Rainfall Data

Rainfall data for the catchments were derived using the CADRE computer program which utilises the "IH Triangle Method" of deriving catchment daily rainfall. This method is documented in IH Report 87, (Jones, 1983). Rainfall data were obtained initially for a period dating back to 1961 and where possible, a longer duration dataset has been derived. Details of the rainfall data collated are provided in Table 1.

2.3 Penman Evapotranspiration (PE)

In the absence of sufficient data and time to calculate Penman Evapotranspiration for each catchment, P.E. data were derived from the Meteorological Office Rainfall and Evaporation Calculation System (MORECS, Thompson, *et al.*, 1982) records stored on the ORACLE database at IH. Monthly P.E. values of grass for the various MORECS squares covering the catchments were obtained for the period 1961-89 and a mean daily value derived for the purpose of the computer modelling. Pre-61 MORECS data were not available and therefore an estimate of the daily P.E. in this period was derived from the monthly mean MORECS data (1961-89). Details of the MORECS data are given in Table 2.

Table 1 Available Rainfall and Flow Data

CATCHMENT	PERIOD OF RAINFALL	PERIOD OF GAUGED FLOWS
Fowey at Restormel (48011)	1941-89	1961-89*
Withey Brook at Bastreet (47013)	1944-89*	1973-89
Lynher at Pillaton Mill (47004)	1944-89	1963-89
Fowey at Trekeivesteps (48001)	1961-89*	1957-89*
St Neot at Craigshill Wood (48009)	1974-89*	1971-80
Warleggan at Trengoffe (48004)	1974-89*	1969-89*
Delank at Delank (49003)	1961-89	1967-89
Camel at Denby (49001)	1940-89*	1964-89
Seaton at Trebrownbridge (48010)	1961-89	1969-89*
Tiddy at Tideford (47009)	1953-89*	1969-89
Gannel at Gwills (48004)	1939-89	1969-89
Fal at Tregony (48003)	1952-89*	1978-89
Kenwyn at Truro (48005)	1939-89	1968-89*
Kennal at Ponsanooth (48007)	1939-89	1968-89
Trenear (N/A)	N/A	N/A
Cober at Helston (48006)	1952-89*	1968-89*
Hayle at St. Erth (49002)	1952-89	1968-89

*(contains missing values)

Table 2 MORECS P.E. Data collected

MORECS SQUARE	PERIOD
176	1961-89
177	1961-89
186	1961-89
187	1961-89
188	1961-89
190	1961-89

2.4 Abstraction and Release Data

South West Water provided all available abstraction data and data on reservoir releases and diversions (Table 3). On the advice of South West Water, sewage inputs into rivers were considered insignificant, probably amounting to approximately 6% of the flows, a difference which could be introduced into a flow record by gauging errors alone. Details of mine drainage, mine pumping, industrial abstractions and returns were unavailable.

Table 3 Abstraction and release data collected

LOCATION	DATA TYPE	PERIOD OF AVAILABLE DATA
Colliford Weir	Reservoir Releases	1988-1990*
Siblyback Weir	Reservoir Releases	1973-1990*
Bastreet	Daily Abstractions	1960-1989
Wendron	Daily Abstractions	1974-1989
Delank	Daily Abstractions	1964-1989
Kennal Vale	Daily Abstractions	1975-1985
Restormel	Daily Abstractions	1961-1989
Trekeivesterps	Daily Abstractions	1961-1989
Releath	Daily Abstractions	1975-1985
Siblyback	Siblyback to Withey Brook Diversions	1975-1989

2.5 Other Data

Catchment areas and details of land use, geology and topography in the various catchments have been obtained from the Surface Water Archive for most of the catchments and from the relevant maps for the remainder.

3. DATA MANAGEMENT

To facilitate rapid analysis of the data, the HYDATA (Hydrological Database System) software has been utilised. This PC based software package, developed and marketed by the Institute of Hydrology, has provision to store and present daily rainfall, streamflow and evaporation data in time series format and perform basic statistical computations such as the production of flow duration curves.

1. <u>Flow Data</u>

   All daily flow data were loaded onto HYDATA. To derive naturalised flows, a FORTRAN program was written to perform the necessary functions of adding abstraction data or subtracting any release data from the observed flows. This program also writes the necessary code for loading data onto HYDATA in the output file.

2. <u>Rainfall Data</u>

   Daily rainfall data were derived from the CADRE program and after some manual editing, the data were formatted using a program which outputs the data in the required code for entry onto HYDATA.

3. <u>Penman Evapotranspiration</u>

   An SQL program (MORECS) was used to retrieve monthly totals of P.E. for the MORECS squares in the study area. Mean daily totals of P.E. were then derived from another program (Fortran) which also coded the data into a suitable format for HYDATA loading.

4. COMPUTER MODELLING

The rainfall-runoff model used in the project for the purpose of deriving historical flows was a version of HYRROM. This modelling package, commercially available from NERC Institute of Hydrology, has been developed for PC usage from the Institute's suite of lumped conceptual rainfall runoff modelling programmes. Whilst models could have been tailored to suit each catchment these would have required more detailed input information and much more time to apply. Given the time scale and the information and resources available, the ease of application and limited input requirements made HYRROM the most appropriate choice for this application. The consequences of this choice are discussed in detail in section 6. In HYRROM, flows are predicted using a simple, but realistic, representation of the physical processes which govern water flow in a catchment. The model incorporates interception, soil, groundwater and runoff stores, and includes some representation of the losses due to evapotranspiration. The model can be calibrated manually by the user or automatically using the in-built Rosenbrock optimisation routine.

The basic approach to modelling is a generally accepted one in which the available observed data is split into two: using one part to fit or calibrate the model, and the second part to test how the model performs in prediction mode. This is known as the 'Split record test'.

In both fitting and testing, an objective function is employed to assess when the agreement between the observed, Q_{obs}, and predicted flows Q_{pred}, is acceptable. The choice of objective function, F, is dependent on the type of result required by the particular catchment simulation. The most commonly used function and the one incorporated in HYRROM is a simple sum of square of the residuals:

$$F = \sqrt{\frac{\Sigma[Q_{pred} - Q_{obs}]^2}{N}}$$

When no further reduction in the value of F can be effected by modifying the parameter values then the optimum fit of the model-generated flow values on the observed data set has been achieved. A more detailed discussion of parameter optimisation and the applications of conceptual models is provided in Blackie and Eeles (1985).

5. DERIVATION OF NATURALISED FLOWS

5.1 Methods

After identifying which catchments were influenced by either abstractions or returns, gauged flows for these catchments were modified accordingly. The derivation of artificial flows for locations with no data was more problematic, and regression analysis was applied to generate a synthetic record for these sites.

In order to obtain the most accurate estimate of the natural flow at a gauging station, any missing flow, abstraction or release data in the records were excluded from the naturalisation periods. Consequently, the periods of naturalised flows may be less than the period of observed flows. It was also necessary to use a period with a complete flow record for the optimisation of the model.

5.2 Summary of naturalisation procedures for each site

This section presents a summary of how the naturalised flows were derived for each site, the periods for which these flows were obtained, and the periods selected for the optimisation analysis using HYRROM.

5.2.1 Gauging Stations

The artificial influences on the gauging stations are given below (Table 5).

Table 5 Artificial influences on Gauging Stations

Station		Artificial influences[1]
A.	Restormel	PWS Abstractions, Colliford and Siblyback reservoirs
B.	Bastreet	PWS Abstractions, Diversions from Siblyback
C.	Pillaton Mill	PWS Abstractions, Diversions from Siblyback
D.	Trekeivesteps	PWS Abstractions, Siblyback reservoir operation
E.	Craigs Hill Wood	Colliford reservoir
F.	Trengoffe	None
G.	Delank	PWS Abstractions
H.	Denby	PWS Abstractions, Sewage from Bodmin
I.	Trebrownridge	None
J.	Tideford	None
K.	Gwills	Mine drainage may affect low flows
L.	Tregony	Moderate modification by industrial abstractions and returns
M.	Truro	None
N.	Ponsanooth	PWS Abstractions, Stithians reservoir
O.	Trenear	No information available
P.	Helston	PWS Abstractions, industrial abstractions, mine pumping
Q.	St. Erth	Mine drainage may affect flows moderately

1. Source: Surface Water Archive. Hydrometric Register and Statistics.

The periods and methods by which a naturalised flow record (Q_N) was derived, are as follows:

A. RESTORMEL

The naturalised flow of the Fowey at Restormel was derived in 3 stages:

1961-67 Q_N = Q_G (Restormel) + Restormel Abstractions + Trekeivesteps Abstractions

1968-82 Q_N = Q_G (Restormel) + Restormel Abstractions - Q_G (Trekeivesteps) + Q_M (Trekeivesteps)*

1983-89 Q_N = Q_G (Restormel) + Restormel Abstractions - Q_G (Trekeivesteps) + Q_M (Trekeivesteps) - Colliford Releases + Colliford Inflows**

* See D Below
** See appendix 2.3 A

B. BASTREET

Q_N = Q_G (Withey Brook) + Bastreet Abstractions - Siblyback Diversions
Period of Naturalised Flows: 1975-89
Optimisation Period: 5/4/80 - 31/12/86

C. PILLATON MILL

$Q_N = Q_G$ (Lynher) + Bastreet Abstractions - Sibleyback Diversions
Period of Naturalised Flows: 1975-89
Optimisation Period: 5/4/80 - 31/12/86

D. TREKEIVESTEPS

1962-67 Q_N = Q_G (Trekeivesteps) + Trekeivesteps Abstractions
1968-89 Q_N = Model prediction from above period
Optimisation Period: 27/6/62 - 30/4/64

E. CRAIGSHILL WOOD

$Q_N = Q_G$ (St. Neot)
Period of Naturalised Flows: 1971-80
Optimisation Period: 16/4/77 - 31/12/80

F. TRENGOFFE

$Q_N = Q_G$ (Warleggan)
Period of Naturalised Flows: 1969-89
Optimisation Period: 18/5/85 - 31/12/89

G. DELANK

$Q_N = Q_G$ (Delank) + Delank Abstractions
Period of Naturalised Flows: 1968-89
Optimisation Period: 7/4/80 - 31/12/86

H. DENBY

$Q_N = Q_G$ (Camel) + Delank Abstractions - Sewage*
Period of Naturalised flows: 1965-89
Optimisation Period: 6/4/80 - 31/12/86
*Excluded

I. TREBROWNBRIDGE

$Q_N = Q_G$ (Seaton)
Period of Naturalised Flows: 1969-89
Optimisation Period: 15/5/80 - 31/12/86

J. TIDEFORD

$Q_N = Q_G$ (Tiddy)
Period of Naturalised Flows: 1969-89
Optimisation Period: 18/5/70 - 31/12/75

K. GWILLS

$Q_N = Q_G$ (Gannel) - Mine Drainage*
Period of Naturalised Flows: 1969-89
Optimisation Period: 8/4/84 - 31/12/89
*Excluded

L. TREGONY

$Q_N = Q_G$ (Fal) $\pm$ Industrial Inputs/Abstractions*
Period of Naturalised Flows: 1978-89
Optimisation Period: 25/4/84 - 31/12/88
*Excluded

M. TRURO

$Q_N = Q_G$ (Kenwyn)
Period of Naturalised Flows: 1968-89
Optimisation Period: 1/3/80 - 31/12/85

N. PONSANOOTH

$Q_N = Q_G$ (Kennal) + Kennal Vale Abstractions - Stithians Operation*
Period of Naturalised Flows: 1975-85
Optimisation Period:
*Insufficient date $\therefore$ excluded (see note in appendix 2.1 N)

O. TRENEAR

In absence of any data, flows for the Trenear were derived from the naturalised flows at the Helston gauging station. This involved simply adjusting the Helston flows by applying a multiplication factor of 0.474, the ratio of the estimated catchment area of the Trenear to the catchment area of the Cober at Helston.

P. HELSTON

$Q_N = Q_G$ (Cober) + Wendron Abstractions + Releath Abstractions - Stithians Input*
Period of Naturalised Flows: 1974-89
Optimisation Period: 12/4/82 - 31/12/84
*Insufficient data led to the exclusion of this input

Q. ST. ERTH

$Q_N = Q_G$ (Hayle) - Mine Drainage*
Period of Naturalised Flows 1968-89
Optimisation Period: 5/4/80 - 31/12/86
*Excluded

6. ASSESSMENT OF MODEL PREDICTIONS

The aim of this section is to assess the accuracy with which the model simulated the observed (naturalised) flows in order that the user is made aware of any potential errors in the extended periods of records produced from the model predictions.

6.1 Summary statistics

For the 16 gauging stations for which either natural flows were available or naturalised flows were produced from the observed flows, abstractions, etc, the results of the modelling exercises are summarised initially in Table 6 and in greater detail in the tables and figures in appendix 2.

The tables give the observed (naturalised) and predicted monthly mean flows for the duration of the records and also summarise the observed and predicted flows as % volume and % time in each of 30 intervals covering the observed flow range. Flow duration curve comparisons are presented in standard format. Time series comparisons for a sample year during the prediction test periods are also presented. In most catchments the year chosen is 1988 except where this was part of the optimisation period.

From Table 6 and the tables and figures in appendix 2 it can be seen that the performance of the HYRROM modelling package is generally good, with volume flows predicted to within ±5% and the flow volumes and durations comparing well in each interval except at the extreme high flows. The time series plots confirm this good overall performance with close simulation of the time distribution of flow but underestimation of the extreme peaks beyond the 5% exceedance level. This aspect is discussed in greater detail in 6.3.2 below.

6.2 Sources of error

The sources of differences between observed (naturalised) and predicted flows can be summarised as follows :

1. INACCURATE INPUT DATA

   - errors at gauging stations (i.e. in the water level observations and in the structure or section ratings)
   - errors in the measurement of release, abstraction and reservoir diversion data
   - assumptions in deriving estimates of catchment areal rainfall
   - use of averaged regional evaporation data
   - incomplete information and assumptions concerning the magnitude and significance of sewage, industrial and agricultural influences in catchments

Table 6. Cumulative gauged (G) or naturalised (N) and model predicted flows in comparison periods

CATCHMENT	COMPARISON PERIOD	CUMULATIVE FLOWS (cumec days) OBSERVED	PREDICTED	% ERROR
Fowey to Restormel	1962-89	46774 (N)	45419	-2.9
Withey Brook to Bastreet	1975-89	3407 (N)	3307	-2.9
Lynher to Pillaton Mill	1975-89	23421 (N)	22514	-3.9
Fowey to Trekievesteps	1963-66	1620 (N)	1500	-7.4
St Neot to Craigshill Wood(n)	1976-80	1416 (G)	1348	-4.7
Warleggan to Trengoffe(n)		(G)		
Delank to Delank	1979-89	3425 (N)	3439	+0.4
Camel to Denby	1966-89	51714 (N)	50861	-1.7
Seaton to Trebrownbridge(n)	1973-89	6368 (G)	6416	+0.7
	1970-72	978	1258	+28.5
Tiddy to Tideford(n)	1970-80	3452 (G)	3450	-0.1
Gannel to Gwills	1970-89	5040 (G)	5276	+4.7
Fal to Tregony	1979-89	8162 (G)	8447	+3.4
Kenwyn to Truro(n)	1969-88	2583 (G)	2555	-1.1
Kennal to Ponsanooth	(Flow - underestimated) (N)			
Cober to Helston	1974-88	5361 (N)	4908	-8.4
Hayle to St Erth	1969-89	7518 (G)	7220	-3.9

(n) indicates natural catchment

2. MODEL LIMITATIONS

- use of a lumped catchment model
- use of a daily time interval model
- compounding effect of errors in the optimisation period input data on the model performance
- the assumption that each catchment is 'watertight'
- limitations of the simplified concepts contained in the HYRROM Model package.

The most probable sources of error in each catchment are summarised in appendix 2. Sources common to all catchments are discussed in section 6.3.

6.3 General limitations

6.3.1 Input data

Errors in the input data will each have both systematic and random elements which will vary from catchment to catchment. Errors in the ratings will generally be greater in those catchments where natural sections are used rather than gauging structures. Such errors are systematic within each catchment but can result is either over or under estimates of flow. Obviously, the potential errors will be greater in those catchments where it has been necessary to naturalise than in the 'natural' catchments since errors in the abstractions, releases, returns, diversions, etc. will be compounded with those in the observed flow records. In a number of catchments also, naturalisation is incomplete because of missing or inadequate data (see section 5.2.1).

Whilst every effort has been made to minimise error in the catchment rainfall estimates residual errors both in timing and magnitude will remain. In general these will vary with the network density in the vicinity of each catchment. The effects of using the MORECS potential evaporation estimates are likely to be small relative to the possible errors arising from the other inputs. The factors here will be the size of the catchment relative to the MORECS 40 km x 40 km square(s) used, the mean altitude and the mean rainfall relative to that of the square(s) and the use of monthly mean daily values.

6.3.2 Model limitations

No model can be guaranteed to simulate catchment response with absolute accuracy. All make simplifying assumptions which introduce potential sources of error. Consequently it is necessary to match the type of model used to the prime requirements, time series flow predictions in this case, to the quality and density of input data and to the time and resources available for its application.

Consideration of the quality and time interval of the input data, the requirement for the output of daily mean flows over periods of 30 plus years and of the time and resource constraints lead to the use of the HYRROM package in this case.

This package is relatively simple to use, requires catchment daily mean precipitation and potential evaporation as inputs and a reasonable period of flow record on which it can be calibrated and tested. Its basis is a simplified daily time interval version of the Institute of Hydrology lumped conceptual model suite described by Blackie and Eeles (1985). Four stores are used to simulate interception, surface runoff, soil moisture and groundwater and nine adjustable parameters control the movement of the rainfall through the system to emerge as water use or streamflow.

It is assumed that the input is rainfall (no provision for snow) and that all input emerges as streamflow or water use (no provision for sub-surface groundwater flow). Both of these limitations may have some effect on the catchments, though these are likely to be small in terms of groundwater and intermittent in terms of snowfall in the South West Region.

The model is not vegetation specific but assumes that no change occurs and that transpiration continues throughout the year, controlled only by potential evaporation and soil moisture availability. Significant changes in vegetation type (e.g. afforestation) in the prediction period will result in errors.

The limitation within the HYRROM model which has the most obvious effect in this application is the simple apportionment of 'effective' rainfall, i.e. rainfall after interception loss, between soil moisture recharge and the surface runoff store. This apportionment is controlled by a single parameter which optimises to give the best fit mean value. This results in underestimation of surface runoff when large storms occur in very wet conditions and, incidentally, an overestimate of surface runoff in very dry conditions. The former effect is most noticeable and has been commented on in section 6.1. It results in the seemingly large departures at high flows in all of the flow duration curves in appendix 2 but examination of the volume distributions over the flow ranges and of the cumulative volume comparisons suggests that it has only a marginal effect on flow prediction.

7. CONCLUSIONS

The methods adopted in carrying out this contract have resulted in the production of synthetic time series records of up to 50 years of daily mean flow for 21 catchments, reservoirs and intakes.

For 14 of these, the records were extended by fitting a streamflow model to the existing gauged or naturalised data and then applying the model to the available rainfall and evaporation record. The length of record extension possible was determined by the availability of rainfall data. The periods covered are summarised in Table 7. For one catchment (the Warleggan to Trengoffe) no extension was possible since the rainfall record was shorter than the existing flow record. The Tamar to Gunnislake was not modelled because difficulties encountered in assembling a catchment rainfall record prior to 1956 meant that no record extension could be achieved.

For the remaining seven sites where no streamflow record was available, synthetic naturalised daily mean flows were produced by area proportional estimates. These records will, inevitably, be of lower quality than those produced by modelling techniques but they at least give a reasonable estimate of what the naturalised flows might have been at these sites.

For three of the sites requested originally it has not proved possible to produce synthetic flows of reasonable quality. These are the Kennal to Ponsanooth, the Kennal Vale Intake and the Stithians Inflow. Initial attempts to model the Kennal to Ponsanooth, after naturalising by using the Kennal Vale abstraction record, were unsuccessful. Examination of the record relative to catchment rainfall (see appendix 2) revealed that the flows were considerable underestimates. This was considered to be due to exports from Stithians Reservoir for which no records were available. Since the estimation of the synthetic naturalised daily mean flows for Kennal Vale and Stithians were to be based on the 'Ponsanooth' model output, all three sites were affected.

The naturalisation of flow records is only as good as the quality of the observed records and the details made available of abstraction, releases and diversions. In a number of cases the effects of sewage returns, industrial releases, mine drainage and agricultural activities had to be ignored since insufficient data existed for which to develop flow corrections.

In using the HYRROM model package as the method of simulation it was recognised that some loss in accuracy would result. Since no model can guarantee to simulate flows with total accuracy, the particular deficiencies of the HYRROM package were considered to be acceptable when set against the advantages of ease of application and the limited requirement for input data which accorded well with the data it would be possible to acquire within the timescale and resource framework of the project.

The results presented suggest that this decision was reasonable. Simulated flows are generally within the uncertainty envelope of the observed or naturalised flows in the split record test periods, except for extreme high flow events. The errors introduced by this limitation in the model must be considered in conjunction with the uncertainties associated with the gauging of extreme events. Their overall effect on volume prediction is small and should not unduly effect the use of the synthetic records in water resource modelling

Table 7. Summary of naturalised and synthetic daily mean flows produced

	FLOW RECORDS			
	DATA AVAILABLE		SYNTHETIC RECORDS	
CATCHMENT	GAUGED	NATURALISED	MODEL	PROPORTIONAL
Fowey to Restormel	1961-89	1962-89	1941-89	-
Withey Brook to Bastreet	1973-89	1975-89	1944-89	-
Lynher to Pillaton Mill	1963-89	1975-89	1944-89	-
Fowey to Trekievesteps	1957-59*	1962-67	1962-89	-
St Neot to Craigshill Wood(n)	1971-80	-	1975-89	-
Warleggan to Trengoffe(n)	1969-89*	-	-	-
Delank to Delank	1967-89	1978-89	1961-89	-
Camel to Denby	1964-89	1966-89	1942-89	-
Seaton to Trebrownbridge(n)	1969-89*	-	1961-89	-
Tiddy to Tideford(N)	1969-89	-	1957-80	-
Gannel to Gwills	1969-89	-	1939-89	-
Fal to Tregony	1978-89	-	1952-89	-
Kenwyn to Truro(n)	1968-89	-	1939-88	-
Kennal to Ponsanooth	1968-89	see text		
Trenear	-	-	-	1952-89
Cober to Helston	1968-89*	1974-89	1952-89	-
Hayle to St Erth	1968-89*	-	1952-89	-
Kennal Vale		see text		
Rialton	-	-	-	1939-89
Colliford	-	-	-	1975-89
Siblyback	-	-	-	1962-89
Porth	-	-	-	1939-89
Crowdy	-	-	-	1942-89
Stithians		see text		
Drift	-	-	-	1952-89
Tamar to Gunnislake	1956-89	-	-	-

(n) indicates natural catchment * indicates gaps in the record

8. FUTURE WORK

At the time of completion of this contract data were not available to extend the naturalisation of flow records and the production of modelling predictions to cover 1990. This should be carried out as soon as the rainfall, flow and abstraction data can be assembled.

It may be considered desirable to produce more detailed models for a selection of the more important catchments, in water resources terms, within the South West area covered by the Colliford Scheme. This could be achieved through the application of more flexible versions of the IH lumped conceptual model than that embedded in the HYRROM package. The production of such models would require the assembly of more detailed information on land use, soils, geology and water resource manipulation within the catchments than were necessary or available for the present exercise. Nevertheless, such a project would provide greater insights into the response and yield characteristics of the catchments modelled and add to the overall efficiency of the Colliford Project.

A more detailed approach to the estimation of reservoir inflows than that used in this exercise would help to improve the accuracy of these estimates and hence the knowledge of the resource available in the reservoir. One such approach would be to derive a time series of inflows from the catchment to the reservoir using an expression of the form.

$$Q(\text{catchment})_t = V_t - V_{t-1} + \text{releases}_t + \text{spill}_t + \text{exports}_t - \text{imports}_t + A_t\,(EO_t - P_t)$$

where V_t = reservoir content on day t
A_t = reservoir surface area on day t
EO = Penman open water evaporation
P = Rainfall on the reservoir

With this flow time series and rainfall and Penman ET estimates for the catchment (i.e., excluding the reservoir) it would be possible to fit a model to these inputs. This model could then be used in the above expression to compute daily V values.

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APPENDIX 1 NOTATIONS USED IN REPORT

Q_G - GAUGED FLOW

Q_N - NATURALISED FLOW

Q_M - MODELLED (PREDICTED) FLOW

APPENDIX 2

Notes on modelling and record extension at individual sites.

A2.1 Gauging stations

A2.2 Intakes

A2.3 Reservoir inflows

A 2.1 GAUGING STATIONS

A. Fowey at Restormel (048011) Area 169.1 km^2

Compound Crump Weir

Flows considerably modified by abstractions and reservoir operations at Siblyback and Colliford.

Naturalised flow series computed, as described in section 5.2.1, for the period 1961-89. The compounding of the uncertainties in the observed flows, the Restormel abstractions, the Trekievesteps modelled flow and the Colliford releases means that this time series record must be treated with some caution.

The model was optimised on this naturalised flow are over the period 3/71 - 12/75.

Comparison of the model predicted and naturalised flows for the period 1962-89, excluding 1968, 1969 and 1983 - 85 when there were gaps in the data, is summarised in the following tables and diagrams.

The cumulative volume prediction over the period is within 3% of the naturalised total although errors as high as 10% occur in individual years. The comparisons of volume and time distribution over the flow range indicate that the model tends to underestimate at low flows, overestimate in the mid range and underestimate the extreme peaks. This tendency is also apparent in the flow duration curve (1972-82) and in the sample time series plot of 1988.

The model has been used to extend the record to cover the period from 1941.

FOWEY AT RESTORMEL

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1962	Q	11.25	6.64	5.14	4.39	3.22	1.93	1.61	1.91	2.89	3.20	5.92	6.05	4.50		
	PQ	11.70	7.04	4.35	4.01	2.58	1.21	1.13	1.93	1.78	2.33	6.53	6.08		4.21	
	ER	0.45	0.40	-0.79	-0.38	-0.63	-0.72	-0.48	0.02	-1.10	-0.87	0.61	0.03			-0.29
1963	Q	5.28	7.23	9.30	7.71	4.03	2.44	3.27	3.37	4.07	2.91	13.95	6.09	5.78		
	PQ	4.06	6.19	8.71	6.85	3.31	1.90	2.64	3.79	4.49	3.82	14.21	6.45		5.52	
	ER	-1.21	-1.04	-0.59	-0.86	-0.72	-0.54	-0.63	0.42	0.43	0.91	0.25	0.36			-0.26
1964	Q	3.18	3.41	7.09	4.34	3.32	2.81	2.29	1.69	1.48	3.43	4.02	6.17	3.61		
	PQ	2.73	3.58	6.40	4.56	3.32	2.86	2.67	1.42	1.27	4.53	5.05	7.59		3.84	
	ER	-0.45	0.18	-0.69	0.21	0.00	0.05	0.38	-0.26	-0.22	1.10	1.03	1.42			0.23
1965	Q	13.27	3.75	3.82	3.16	3.09	2.31	4.70	4.84	6.51	4.85	7.06	21.00	6.57		
	PQ	13.75	3.78	4.22	2.74	3.17	2.41	5.95	5.88	7.07	4.46	6.33	17.78		6.50	
	ER	0.48	0.03	0.40	-0.42	0.08	0.10	1.25	1.05	0.56	-0.39	-0.73	-3.22			-0.07
1966	Q	11.95	15.96	6.63	7.32	5.50	2.69	1.81	4.43	2.72	6.21	5.10	9.59	6.61		
	PQ	10.98	12.18	6.13	7.70	4.62	1.88	1.29	5.07	2.69	6.96	5.14	10.74		6.25	
	ER	-0.97	-3.78	-0.50	0.39	-0.88	-0.81	-0.52	0.64	-0.03	0.75	0.04	1.15			-0.35
1967	Q	10.63	9.80	6.75	3.51	3.96	2.76	2.00	2.02	4.62	11.09	14.76	7.50	6.59		
	PQ	9.39	9.08	6.97	3.29	3.54	2.19	1.81	2.00	4.71	12.05	12.86	7.72		6.28	
	ER	-1.24	-0.72	0.21	-0.22	-0.43	-0.58	-0.19	-0.02	0.09	0.97	-1.90	0.22			-0.31
1970	Q	13.84	13.03	6.30	4.51	3.11	1.69	1.61	3.15	3.79	2.22	9.35	6.82	5.73		
	PQ	13.20	13.97	6.09	4.45	2.48	1.24	1.73	3.59	4.69	2.16	11.19	7.61		5.98	
	ER	-0.64	0.94	-0.21	-0.06	-0.63	-0.45	0.12	0.44	0.90	-0.03	1.85	0.79			0.24
1971	Q	10.05	6.87	5.24	2.80	1.61	2.10	1.56	2.65	1.49	2.29	5.85	8.45	4.24		
	PQ	10.04	7.10	5.02	2.32	1.06	2.17	1.26	2.85	0.92	2.11	6.12	9.28		4.18	
	ER	-0.01	0.23	-0.23	-0.49	-0.55	0.07	-0.30	0.20	-0.58	-0.17	0.28	0.83			-0.06
1972	Q	10.93	12.31	8.58	4.96	5.89	5.87	4.23	2.80	1.99	1.70	7.33	13.56	6.67		
	PQ	9.76	11.63	6.82	4.75	5.16	4.55	3.45	2.42	1.44	1.54	6.53	13.57		5.96	
	ER	-1.17	-0.68	-1.76	-0.21	-0.73	-1.32	-0.77	-0.38	-0.54	-0.17	-0.80	0.01			-0.71
1973	Q	9.11	7.63	4.45	2.78	2.51	1.80	1.38	2.68	2.29	3.55	3.84	9.58	4.29		
	PQ	8.60	7.79	3.75	2.41	2.06	1.36	1.38	2.77	2.52	3.98	4.06	10.23		4.23	
	ER	-0.51	0.16	-0.70	-0.37	-0.46	-0.44	0.00	0.09	0.23	0.43	0.22	0.65			-0.06
1974	Q	17.60	22.63	5.74	2.40	3.12	1.55	1.35	2.35	10.68	9.91	10.17	9.15	7.95		
	PQ	17.19	20.32	6.08	1.80	3.03	1.03	1.29	3.14	12.02	10.53	10.37	8.85		7.89	
	ER	-0.41	-2.31	0.34	-0.60	-0.09	-0.51	-0.05	0.78	1.34	0.63	0.21	-0.30			-0.07
1975	Q	11.38	7.28	4.62	3.76	2.36	1.19	1.57	1.17	2.05	2.47	4.83	5.94	4.04		
	PQ	10.75	7.10	4.47	3.69	1.83	0.80	2.20	1.51	2.07	1.83	5.33	5.46		3.90	
	ER	-0.63	-0.18	-0.16	-0.07	-0.53	-0.39	0.63	0.34	0.02	-0.64	0.49	-0.49			-0.14
1976	Q	4.30	6.76	6.60	3.05	1.74	1.12	0.78	0.49	1.64	9.57	5.95	10.01	4.34		
	PQ	4.15	6.93	6.66	2.67	1.31	0.77	0.48	0.33	3.30	6.57	5.23	9.80		4.01	
	ER	-0.15	0.17	0.06	-0.38	-0.43	-0.35	-0.30	-0.16	1.66	-3.00	-0.72	-0.21			-0.32
1977	Q	9.99	12.85	7.57	4.48	3.17	1.92	1.16	1.17	1.13	1.48	5.49	9.16	4.92		
	PQ	9.68	12.45	7.10	3.79	2.70	1.46	0.91	1.72	1.13	1.52	6.32	9.67		4.83	
	ER	-0.31	-0.41	-0.47	-0.70	-0.47	-0.46	-0.25	0.54	0.01	0.04	0.83	0.51			-0.09

FOWEY AT RESTORMEL

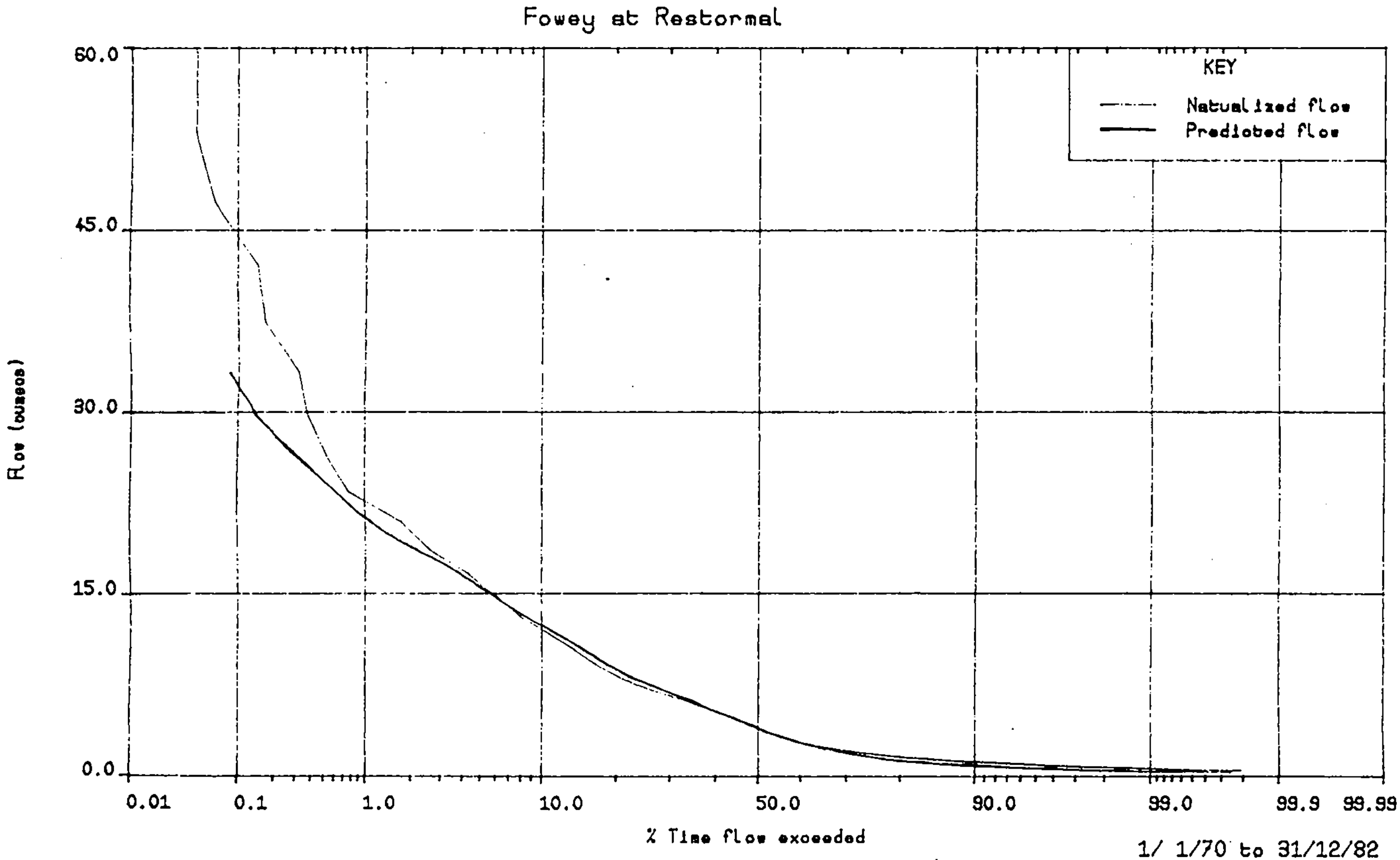
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1978	Q	9.09	11.58	10.56	6.57	2.35	1.45	2.00	1.82	1.06	0.87	1.40	9.91	4.86		
	PQ	9.04	12.21	10.72	6.25	1.93	1.42	2.38	1.59	0.70	0.61	1.52	11.14		4.93	
	ER	-0.05	0.62	0.16	-0.32	-0.41	-0.03	0.38	-0.23	-0.36	-0.26	0.13	1.24			0.07
1979	Q	7.31	9.50	9.26	5.91	4.00	3.54	1.64	2.43	1.83	3.11	6.84	14.75	5.83		
	PQ	8.35	9.52	9.46	5.85	3.93	3.14	1.38	3.09	1.60	3.95	7.13	12.54		5.81	
	ER	1.04	0.02	0.20	-0.06	-0.07	-0.40	-0.27	0.66	-0.22	0.85	0.30	-2.21			-0.01
1980	Q	8.23	12.01	6.38	4.85	1.76	2.25	2.41	2.19	5.18	8.56	7.95	8.81	5.86		
	PQ	9.05	12.10	6.08	4.24	1.25	2.81	2.32	2.06	5.62	9.53	8.02	8.29		5.92	
	ER	0.82	0.09	-0.30	-0.61	-0.51	0.56	-0.09	-0.12	0.44	0.96	0.07	-0.52			0.07
1981	Q	6.85	5.51	12.59	3.95	5.38	5.43	2.25	1.35	2.99	12.53	6.56	13.46	6.60		
	PQ	6.54	5.51	11.86	3.46	5.57	5.46	2.05	1.07	3.97	12.44	6.44	12.72		6.45	
	ER	-0.31	0.00	-0.73	-0.48	0.19	0.03	-0.20	-0.28	0.98	-0.08	-0.12	-0.74			-0.15
1982	Q	9.55	6.86	11.32	3.32	1.59	1.96	1.89	1.52	1.78	9.39	16.31	13.17	6.56		
	PQ	9.61	6.64	10.68	2.86	1.22	2.77	1.86	1.47	1.89	9.47	14.37	13.05		6.33	
	ER	0.06	-0.22	-0.64	-0.47	-0.37	0.81	-0.03	-0.06	0.11	0.08	-1.95	-0.12			-0.23
1986	Q	12.44	4.85	4.25	5.30	5.52	4.72	3.35	7.21	4.64	3.68	13.52	14.22	6.99		
	PQ	12.71	4.02	3.94	4.55	4.44	4.61	3.33	7.59	4.59	3.75	13.58	14.20		6.80	
	ER	0.26	-0.84	-0.31	-0.75	-1.08	-0.11	-0.02	0.38	-0.05	0.07	0.06	-0.02			-0.20
1987	Q	6.50	5.78	6.46	7.00	2.31	2.70	3.36	1.91	1.68	9.25	8.77	5.93	5.13		
	PQ	5.87	5.35	5.80	6.19	1.66	2.18	3.07	1.27	1.31	9.95	9.23	5.86		4.81	
	ER	-0.63	-0.43	-0.66	-0.81	-0.64	-0.52	-0.29	-0.64	-0.37	0.69	0.46	-0.07			-0.33
1988	Q	13.99	12.59	7.35	5.57	3.45	1.87	3.50	3.42	4.75	8.91	3.74	5.60	6.22		
	PQ	13.21	12.59	7.00	5.11	3.13	1.24	3.52	3.05	4.57	9.15	3.67	5.56		5.97	
	ER	-0.78	-0.01	-0.35	-0.46	-0.33	-0.63	0.02	-0.36	-0.18	0.24	-0.06	-0.04			-0.25
1989	Q	4.16	6.95	10.33	4.64	2.37	1.44	0.94	1.02	1.24	2.13	6.55	8.67	4.19		
	PQ	4.32	6.80	10.40	4.05	1.64	0.81	0.54	0.94	1.81	2.64	3.93	7.42		3.76	
	ER	0.16	-0.15	0.07	-0.59	-0.73	-0.64	-0.39	-0.07	0.57	0.51	-2.63	-1.25			-0.43
MEAN	Q	9.60	9.21	7.23	4.62	3.28	2.50	2.20	2.50	3.15	5.36	7.62	9.72	5.57		
	PQ	9.33	8.86	6.90	4.24	2.82	2.19	2.12	2.63	3.31	5.47	7.53	9.64		5.41	
	ER	-0.27	-0.34	-0.33	-0.38	-0.45	-0.32	-0.09	0.13	0.16	0.11	-0.09	-0.09			-0.16
S.D.	Q	3.57	4.45	2.39	1.51	1.30	1.27	1.05	1.47	2.23	3.63	3.84	3.79	1.17		
	PQ	3.56	4.02	2.35	1.54	1.30	1.28	1.22	1.70	2.57	3.74	3.61	3.21		1.14	

FOWEY AT RESTORMEL

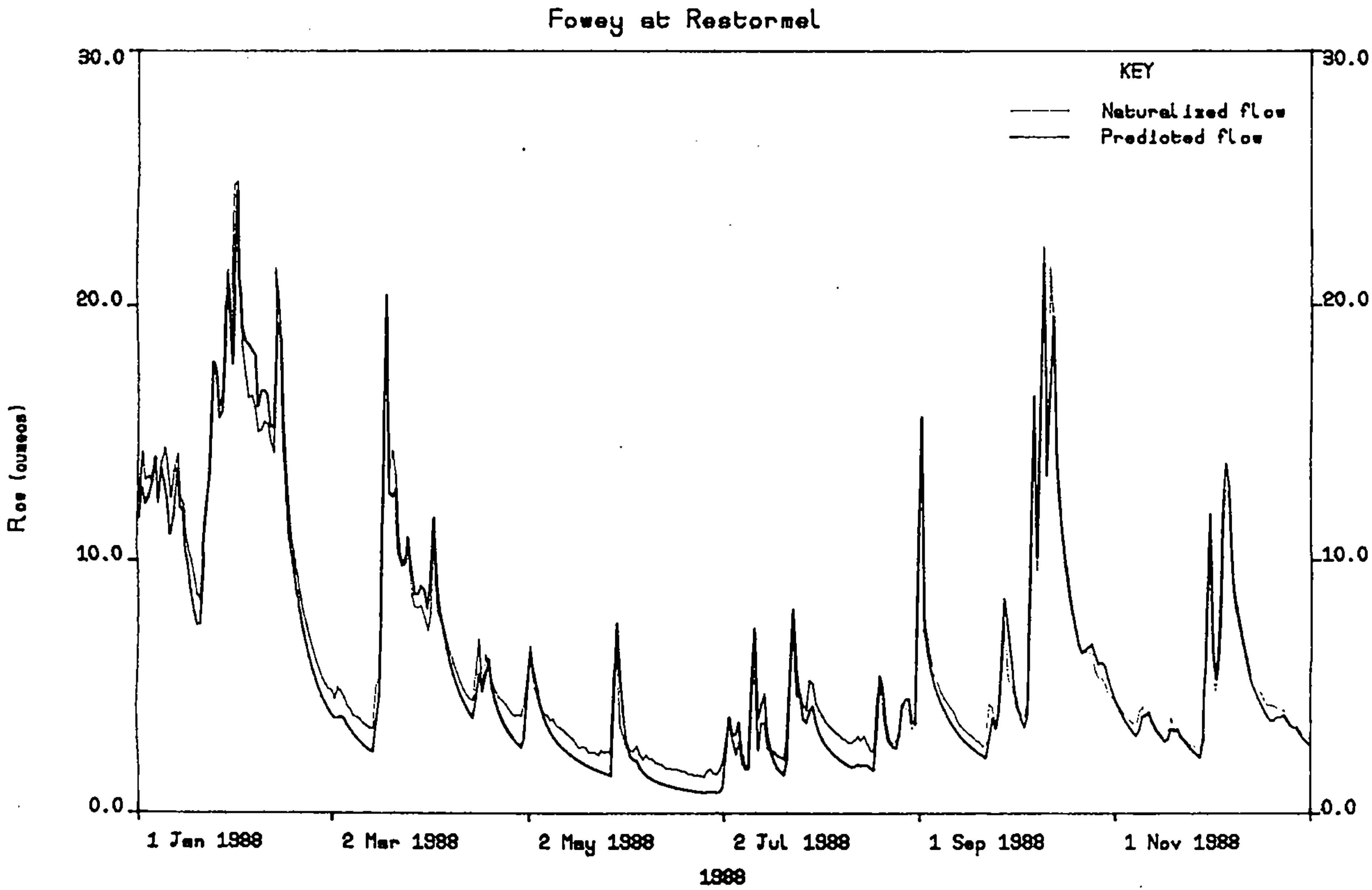
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 2.9168 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	5676.8	12.14	12.14	3111	37.04	37.04	5205.7	11.46	11.46	3332	39.67	39.67
2	10365.5	22.16	34.30	2454	29.21	66.25	9005.8	19.83	31.29	2138	25.45	65.12
3	9719.1	20.78	55.08	1364	16.24	82.49	9242.1	20.35	51.64	1287	15.32	80.44
4	6066.1	12.97	68.05	600	7.14	89.63	7044.6	15.51	67.15	699	8.32	88.76
5	4721.4	10.09	78.14	365	4.35	93.98	5638.4	12.41	79.56	437	5.20	93.96
6	3549.3	7.59	85.73	223	2.65	96.63	4324.7	9.52	89.08	272	3.24	97.20
7	2304.6	4.93	90.65	123	1.46	98.10	2524.7	5.56	94.64	134	1.60	98.80
8	1698.5	3.63	94.29	78	0.93	99.02	1123.2	2.47	97.12	52	0.62	99.42
9	734.9	1.57	95.86	30	0.36	99.38	759.2	1.67	98.79	31	0.37	99.79
10	405.3	0.87	96.72	15	0.18	99.56	190.6	0.42	99.21	7	0.08	99.87
11	183.0	0.39	97.11	6	0.07	99.63	150.7	0.33	99.54	5	0.06	99.93
12	337.0	0.72	97.84	10	0.12	99.75	167.4	0.37	99.91	5	0.06	99.99
13	145.0	0.31	98.15	4	0.05	99.80	35.5	0.08	99.99	1	0.01	100.00
14	117.2	0.25	98.40	3	0.04	99.83	0.0	0.00	99.99	0	0.00	100.00
15	84.6	0.18	98.58	2	0.02	99.86	0.0	0.00	99.99	0	0.00	100.00
16	178.5	0.38	98.96	4	0.05	99.90	0.0	0.00	99.99	0	0.00	100.00
17	141.4	0.30	99.26	3	0.04	99.94	0.0	0.00	99.99	0	0.00	100.00
18	49.8	0.11	99.37	1	0.01	99.95	0.0	0.00	99.99	0	0.00	100.00
19	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
20	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
21	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
22	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
23	130.6	0.28	99.65	2	0.02	99.98	0.0	0.00	99.99	0	0.00	100.00
24	0.0	0.00	99.65	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
25	0.0	0.00	99.65	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
26	73.8	0.16	99.80	1	0.01	99.99	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.80	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.80	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.80	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
30	84.6	0.18	99.98	1	0.01	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	46774.0			8400			45419.1			8400		



Fowey at Restormal
Flow (cumecs)
60.0
45.0
30.0
15.0
0.0
KEY
Natualized flow
Predicted flow
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/70 to 31/12/82


Fowey at Restormel
KEY
Naturalized flow
Predicted flow
Flow (cumecs)
30.0
20.0
10.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

B. Withey Brook at Bastreet (47013) Area 16.2 km^2

Compound Crump Weir

Flows considerably modified by abstractions and diversions into the catchment from Siblyback.

Naturalised flow series computed, as described in section 5.2.1, from the period 1975-1989.

Model optimised on the period 4/80 - 12/86.

Comparison of model predicted and observed flows for the period 1975-89 is summarised in the following tables and diagrams.

The cumulative volume prediction over the period is within 3% of the naturalised flow. Overall there is a tendency to underestimate, partly because of the normal underestimation of the extreme peaks but also because of underestimation of the low flows in certain periods, as illustrated in the 1988 time series plot. This may be due in part to the uncertainties associated with the abstraction and diversion data used in naturalising.

The discrepancy is also evident in the tabulated comparison of volume and time distribution over the flow range and in the flow duration curve. The slope of the later is unusual over the low flow range.

The model has been used to produce a synthetic flow record from 1944.

WITHEY BROOK AT BASTREET

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1975	Q	1.61	0.76	0.59	0.47	0.29	0.18	0.25	0.23	0.43	0.38	0.61	0.70	0.54		
	PQ	1.37	0.84	0.46	0.36	0.18	0.07	0.26	0.13	0.30	0.24	0.57	0.60		0.45	
	ER	-0.24	0.07	-0.13	-0.11	-0.11	-0.11	0.00	-0.10	-0.13	-0.14	-0.04	-0.10			-0.10
1976	Q	0.52	0.69	0.69	0.42	0.19	0.16	0.15	0.11	0.18	1.26	0.80	1.14	0.53		
	PQ	0.50	0.75	0.63	0.26	0.15	0.09	0.04	0.02	0.36	0.92	0.70	1.11		0.46	
	ER	-0.03	0.07	-0.06	-0.15	-0.04	-0.07	-0.12	-0.08	0.19	-0.34	-0.10	-0.04			-0.07
1977	Q	1.12	1.50	0.92	0.58	0.42	0.23	0.16	0.17	0.15	0.21	0.72	0.99	0.59		
	PQ	1.13	1.47	0.81	0.45	0.33	0.17	0.11	0.17	0.13	0.24	0.86	1.00		0.57	
	ER	0.01	-0.03	-0.11	-0.13	-0.09	-0.06	-0.06	0.00	-0.02	0.03	0.13	0.01			-0.03
1978	Q	1.04	1.19	1.23	0.75	0.29	0.20	0.23	0.23	0.18	0.20	0.22	1.21	0.58		
	PQ	1.08	1.19	1.21	0.64	0.18	0.14	0.26	0.22	0.08	0.07	0.25	1.28		0.55	
	ER	0.04	0.00	-0.01	-0.11	-0.11	-0.06	0.03	-0.02	-0.10	-0.13	0.02	0.06			-0.03
1979	Q	0.88	1.07	1.14	0.67	0.45	0.40	0.22	0.27	0.20	0.38	0.83	1.35	0.65		
	PQ	0.96	0.89	1.14	0.64	0.42	0.31	0.14	0.30	0.18	0.40	0.82	1.58		0.65	
	ER	0.08	-0.18	0.00	-0.03	-0.03	-0.09	-0.07	0.03	-0.02	0.02	0.00	0.24			0.00
1980	Q	0.89	1.31	0.69	0.50	0.21	0.28	0.29	0.27	0.60	0.97	1.02	1.00	0.67		
	PQ	1.12	1.38	0.76	0.43	0.13	0.34	0.22	0.24	0.61	1.01	0.99	1.04		0.69	
	ER	0.24	0.07	0.07	-0.07	-0.09	0.05	-0.07	-0.03	0.00	0.04	-0.03	0.04			0.02
1981	Q	0.80	0.65	1.48	0.46	0.69	0.58	0.27	0.20	0.48	1.57	0.76	1.38	0.78		
	PQ	0.86	0.70	1.49	0.43	0.71	0.55	0.23	0.11	0.58	1.51	0.79	1.32		0.77	
	ER	0.06	0.05	0.00	-0.04	0.02	-0.03	-0.04	-0.09	0.10	-0.05	0.03	-0.06			-0.01
1982	Q	0.93	0.75	1.25	0.39	0.19	0.24	0.21	0.17	0.26	1.07	1.56	1.46	0.71		
	PQ	1.04	0.76	1.26	0.36	0.12	0.29	0.14	0.16	0.26	1.03	1.46	1.52		0.70	
	ER	0.11	0.01	0.01	-0.03	-0.07	0.05	-0.07	-0.01	0.01	-0.05	-0.10	0.06			-0.01
1983	Q	1.50	0.61	0.42	0.57	0.75	0.29	0.14	0.15	0.14	0.38	0.32	1.04	0.53		
	PQ	1.65	0.66	0.44	0.50	0.69	0.23	0.09	0.05	0.29	0.31	0.22	1.10		0.52	
	ER	0.16	0.05	0.02	-0.07	-0.05	-0.06	-0.05	-0.10	0.15	-0.06	-0.10	0.06			-0.01
1984	Q	1.51	1.20	0.42	0.29	0.18	0.18	0.09	0.08	0.12	0.62	1.34	1.20	0.60		
	PQ	1.78	1.38	0.44	0.25	0.16	0.08	0.13	0.09	0.28	0.67	1.33	1.26		0.65	
	ER	0.26	0.17	0.02	-0.04	-0.02	-0.10	0.04	0.01	0.15	0.05	-0.01	0.06			0.05
1985	Q	0.89	0.76	0.52	0.97	0.29	0.36	0.26	0.36	0.54	0.47	0.43	1.14	0.62		
	PQ	0.86	0.73	0.58	0.90	0.26	0.37	0.25	0.36	0.50	0.43	0.46	1.08		0.61	
	ER	-0.03	-0.03	0.07	-0.07	-0.03	0.02	-0.02	0.00	-0.04	-0.04	0.03	-0.06			-0.02
1986	Q	1.38	0.49	0.46	0.55	0.62	0.44	0.31	0.94	0.48	0.50	1.88	1.68	0.81		
	PQ	1.45	0.44	0.54	0.53	0.55	0.41	0.31	0.79	0.50	0.57	1.62	1.64		0.78	
	ER	0.07	-0.05	0.08	-0.01	-0.07	-0.03	0.00	-0.15	0.03	0.07	-0.26	-0.04			-0.03
1987	Q	0.67	0.62	0.72	0.74	0.23	0.25	0.24	0.20	0.21	1.19	0.89	0.66	0.55		
	PQ	0.67	0.64	0.68	0.63	0.18	0.28	0.20	0.09	0.14	1.16	0.86	0.71		0.52	
	ER	0.00	0.02	-0.04	-0.11	-0.05	0.02	-0.04	-0.12	-0.08	-0.03	-0.04	0.05			-0.04
1988	Q	1.65	1.21	0.70	0.54	0.32	0.20	0.33	0.43	0.55	1.12	0.43	0.60	0.67		
	PQ	1.56	1.30	0.70	0.49	0.32	0.11	0.42	0.41	0.54	1.05	0.43	0.63		0.66	
	ER	-0.09	0.08	0.01	-0.05	0.00	-0.09	0.09	-0.02	-0.01	-0.07	0.00	0.03			-0.01

WITHEY BROOK AT BASTREET

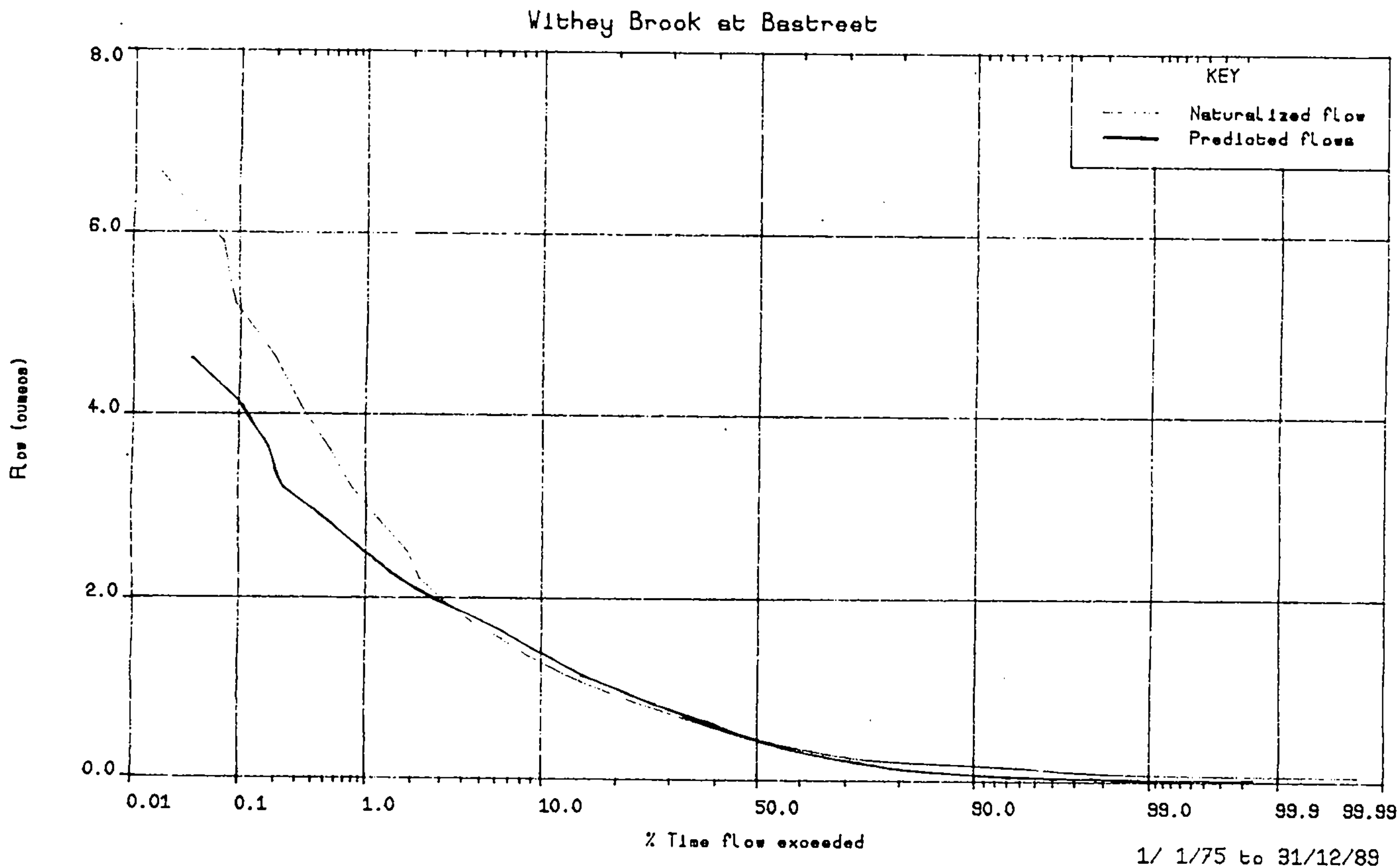
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1989	Q	0.45	0.92	1.24	0.51	0.26	0.16	0.10	0.10	0.14	0.32	0.87	0.86	0.49		
	PQ	0.52	0.84	1.28	0.47	0.17	0.09	0.05	0.11	0.26	0.38	0.74	0.93		0.48	
	ER	0.07	-0.08	0.04	-0.04	-0.08	-0.07	-0.04	0.01	0.12	0.05	-0.13	0.06			-0.01
MEAN	Q	1.06	0.92	0.83	0.56	0.36	0.28	0.22	0.29	0.31	0.71	0.85	1.09	0.62		
	PQ	1.10	0.93	0.83	0.49	0.30	0.23	0.19	0.25	0.33	0.67	0.81	1.12		0.60	
	ER	0.05	0.01	0.00	-0.07	-0.06	-0.04	-0.03	-0.04	0.02	-0.04	-0.04	0.02			-0.02
S.D.	Q	0.39	0.31	0.35	0.17	0.19	0.12	0.07	0.26	0.18	0.44	0.46	0.31	0.09		
	PQ	0.40	0.32	0.35	0.17	0.20	0.14	0.10	0.25	0.17	0.42	0.41	0.32		0.11	

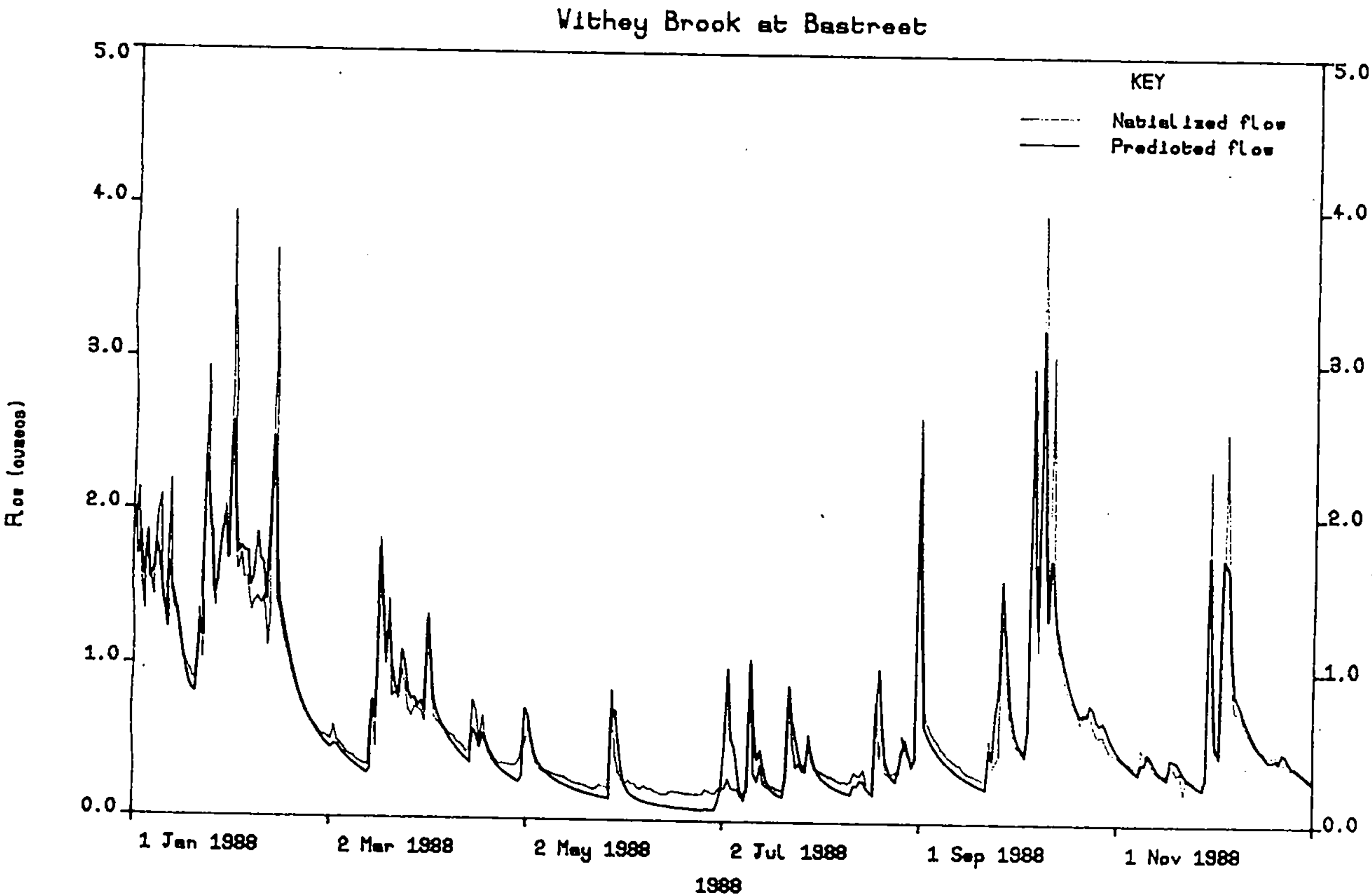
WITHEY BROOK AT BASTREET

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.2297 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	246.6	7.24	7.24	1466	26.76	26.76	193.6	5.85	5.85	1724	31.47	31.47
2	448.5	13.16	20.40	1343	24.51	51.27	392.0	11.85	17.71	1161	21.19	52.66
3	527.6	15.48	35.88	929	16.96	68.22	423.2	12.80	30.50	750	13.69	66.34
4	521.7	15.31	51.19	656	11.97	80.20	477.4	14.43	44.94	599	10.93	77.28
5	375.4	11.02	62.21	368	6.72	86.91	411.6	12.44	57.38	402	7.34	84.61
6	323.3	9.49	71.70	257	4.69	91.60	349.3	10.56	67.94	278	5.07	89.69
7	219.4	6.44	78.14	148	2.70	94.31	295.6	8.94	76.88	199	3.63	93.32
8	165.4	4.85	82.99	97	1.77	96.08	239.4	7.24	84.12	139	2.54	95.86
9	124.2	3.64	86.63	64	1.17	97.24	184.2	5.57	89.69	95	1.73	97.59
10	64.0	1.88	88.51	30	0.55	97.79	105.6	3.19	92.88	49	0.89	98.49
11	47.9	1.41	89.92	20	0.37	98.16	76.0	2.30	95.18	32	0.58	99.07
12	65.7	1.93	91.85	25	0.46	98.61	42.1	1.27	96.45	16	0.29	99.36
13	54.3	1.59	93.44	19	0.35	98.96	40.1	1.21	97.66	14	0.26	99.62
14	43.6	1.28	94.72	14	0.26	99.22	24.8	0.75	98.42	8	0.15	99.76
15	19.9	0.58	95.30	6	0.11	99.32	6.5	0.20	98.61	2	0.04	99.80
16	28.1	0.83	96.13	8	0.15	99.47	7.2	0.22	98.83	2	0.04	99.84
17	26.3	0.77	96.90	7	0.13	99.60	11.3	0.34	99.17	3	0.05	99.89
18	15.8	0.46	97.37	4	0.07	99.67	0.0	0.00	99.17	0	0.00	99.89
19	21.1	0.62	97.99	5	0.09	99.76	12.6	0.38	99.55	3	0.05	99.95
20	9.0	0.26	98.25	2	0.04	99.80	4.6	0.14	99.69	1	0.02	99.96
21	23.6	0.69	98.94	5	0.09	99.89	0.0	0.00	99.69	0	0.00	99.96
22	5.0	0.15	99.09	1	0.02	99.91	5.0	0.15	99.84	1	0.02	99.98
23	0.0	0.00	99.09	0	0.00	99.91	5.1	0.15	99.99	1	0.02	100.00
24	0.0	0.00	99.09	0	0.00	99.91	0.0	0.00	99.99	0	0.00	100.00
25	5.6	0.17	99.25	1	0.02	99.93	0.0	0.00	99.99	0	0.00	100.00
26	6.0	0.18	99.43	1	0.02	99.95	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.43	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
28	12.6	0.37	99.80	2	0.04	99.98	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.80	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
30	6.7	0.20	99.99	1	0.02	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	3407.5			5479			3307.4			5479		


Withey Brook at Bastreet
KEY
Naturalized flow
Predicted flows
Flow (cumecs)
8.0
6.0
4.0
2.0
0.0
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/75 to 31/12/89


Withey Brook at Bastreet
KEY
Natialized flow
Predicted flow
Flow (cusecs)
0.0
1.0
2.0
3.0
4.0
5.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

C. Lynher at Pillaton Mill (047004) Area 135.5 km^2

Velocity area station

Flows modified by abstractions at Bastreet and diversions from Siblyback.

Flows naturalised for the period 1975-89 (see 5.2C).

Model optimised on the period 4/80 - 12/86.

Comparison of the model predicted and observed flows for the period 1975-89 is summarised in the following tables and diagrams.

The cumulative flow prediction over the period is within 4% of the naturalised flow total, despite considerable month to month and year to year fluctuations in the volume comparison and a reasonably consistent underestimation of the naturalised flow from 1986 onwards. The 1988 time series plot suggests that this results from a poor (underestimated) low flow prediction as well as the normal failure to predict the extreme peaks. It is uncertain to what extent this is a comment on the model, on the observed flow or on the quality of the diversion and abstraction data used to naturalise the flow. The volume and time distributions also indicate the underestimation of low flows, overestimation in the mid range and underestimation of the extreme peaks.

Despite these disparities the model has been used to extend the record to cover the period from 1944 till 1975.

LYNHER AT PILLATON MILL

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1975	Q	11.02	5.44	3.24	2.55	1.69	0.89	1.01	0.78	1.36	1.94	3.87	4.91	3.22		
	PQ	9.70	5.20	3.03	2.51	1.25	0.51	1.67	0.91	1.58	1.25	3.78	4.39		2.97	
	ER	-1.32	-0.23	-0.21	-0.04	-0.43	-0.38	0.66	0.13	0.22	-0.69	-0.09	-0.53			-0.25
1976	Q	2.36	5.09	5.57	2.02	0.98	0.70	0.51	0.36	0.90	9.00	5.10	8.48	3.43		
	PQ	2.57	4.87	4.84	1.60	0.84	0.49	0.29	0.26	1.97	5.65	4.68	8.61		3.06	
	ER	0.21	-0.22	-0.73	-0.42	-0.14	-0.20	-0.22	-0.10	1.07	-3.35	-0.42	0.14			-0.37
1977	Q	8.30	11.92	5.84	3.14	2.36	1.28	0.75	0.73	0.72	1.14	5.16	7.23	4.00		
	PQ	8.05	11.52	5.60	3.02	2.27	1.15	0.60	1.32	0.69	1.34	6.61	7.07		4.05	
	ER	-0.25	-0.40	-0.24	-0.12	-0.09	-0.13	-0.16	0.59	-0.02	0.20	1.45	-0.16			0.06
1978	Q	7.49	8.50	8.91	4.41	1.51	0.92	0.98	1.05	0.60	0.52	0.91	9.07	3.72		
	PQ	7.74	8.79	8.72	4.04	1.02	0.76	1.39	0.88	0.33	0.36	1.34	9.88		3.75	
	ER	0.25	0.30	-0.19	-0.37	-0.50	-0.17	0.42	-0.18	-0.26	-0.16	0.43	0.81			0.03
1979	Q	5.33	7.77	7.88	4.09	2.41	2.25	1.07	1.23	0.90	1.83	4.75	12.86	4.35		
	PQ	6.22	6.94	7.60	4.01	2.40	2.00	0.87	2.03	0.91	2.66	5.91	12.27		4.48	
	ER	0.89	-0.84	-0.28	-0.08	-0.01	-0.25	-0.20	0.80	0.01	0.84	1.16	-0.59			0.13
1980	Q	6.79	10.39	4.56	3.54	1.15	1.31	1.32	1.34	3.66	6.72	6.84	6.96	4.52		
	PQ	6.87	10.12	4.74	3.12	0.74	1.99	1.03	1.53	4.27	7.49	6.50	6.76		4.57	
	ER	0.08	-0.27	0.18	-0.42	-0.40	0.68	-0.29	0.18	0.61	0.77	-0.34	-0.19			0.05
1981	Q	5.40	4.06	11.62	2.77	4.84	4.00	1.40	0.83	2.21	10.09	4.95	10.20	5.22		
	PQ	5.21	4.16	11.35	2.19	4.83	3.82	1.23	0.62	3.14	11.02	4.85	10.21		5.25	
	ER	-0.19	0.10	-0.27	-0.58	0.00	-0.17	-0.18	-0.21	0.94	0.93	-0.09	0.02			0.02
1982	Q	6.99	5.42	10.08	2.36	1.12	1.21	1.22	0.92	1.40	8.26	11.17	11.05	5.11		
	PQ	6.92	4.91	9.60	1.74	0.69	1.79	0.85	0.83	1.51	7.85	10.57	10.47		4.82	
	ER	-0.07	-0.51	-0.49	-0.62	-0.43	0.58	-0.36	-0.08	0.11	-0.42	-0.60	-0.58			-0.29
1983	Q	10.46	4.44	2.27	3.62	5.75	2.03	0.88	0.58	0.85	2.17	1.87	8.97	3.67		
	PQ	9.82	4.29	2.47	3.55	5.42	1.45	0.57	0.35	1.88	1.74	1.02	8.27		3.41	
	ER	-0.64	-0.15	0.19	-0.07	-0.33	-0.58	-0.30	-0.23	1.03	-0.43	-0.85	-0.70			-0.26
1984	Q	13.16	8.74	2.89	1.98	1.07	0.78	0.50	0.50	0.77	4.29	10.06	8.37	4.41		
	PQ	12.87	8.49	2.40	1.52	0.88	0.55	0.61	0.76	1.63	4.37	10.77	8.28		4.41	
	ER	-0.29	-0.25	-0.49	-0.46	-0.19	-0.24	0.11	0.26	0.86	0.07	0.71	-0.09			0.00
1985	Q	6.60	5.46	3.57	8.02	1.74	1.77	1.39	5.00	3.36	2.59	2.88	8.52	4.24		
	PQ	5.60	4.80	3.81	6.82	1.34	1.93	1.22	5.43	2.98	2.54	2.93	8.48		3.99	
	ER	-1.00	-0.65	0.24	-1.20	-0.40	0.16	-0.17	0.43	-0.38	-0.06	0.05	-0.04			-0.25
1986	Q	10.23	3.14	3.40	4.46	4.50	2.76	1.77	6.12	3.17	3.09	13.04	11.87	5.65		
	PQ	10.34	2.34	3.09	3.81	3.51	2.70	1.86	6.25	3.41	3.31	12.74	11.18		5.40	
	ER	0.11	-0.80	-0.31	-0.65	-0.98	-0.06	0.10	0.13	0.24	0.23	-0.30	-0.69			-0.24
1987	Q	4.69	4.62	5.63	6.06	1.70	1.87	1.28	0.91	0.93	7.86	6.84	5.30	3.97		
	PQ	3.89	3.72	4.77	4.97	0.95	1.66	1.04	0.38	0.80	8.77	6.73	4.71		3.53	
	ER	-0.80	-0.89	-0.86	-1.09	-0.75	-0.20	-0.24	-0.53	-0.13	0.91	-0.12	-0.59			-0.44
1988	Q	12.76	10.62	4.97	4.04	2.27	1.27	2.29	2.55	3.96	7.59	2.60	4.57	4.95		
	PQ	11.56	10.23	4.71	3.32	1.84	0.77	2.62	2.38	3.81	7.74	2.27	4.41		4.63	
	ER	-1.19	-0.39	-0.26	-0.72	-0.44	-0.50	0.34	-0.17	-0.14	0.15	-0.33	-0.16			-0.32

LYNHER AT PILLATON MILL

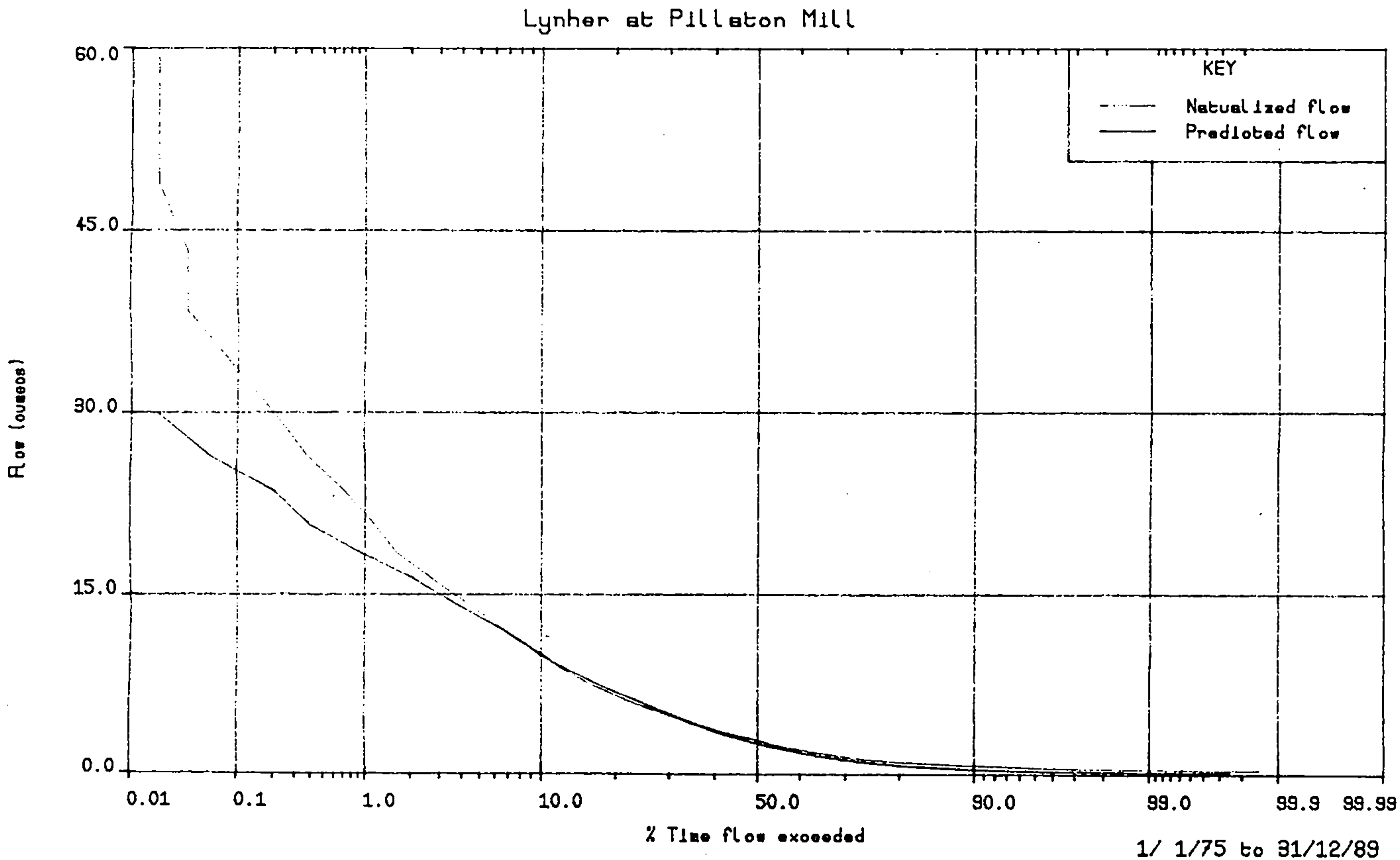
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1989	Q	3.28	6.88	9.35	3.14	1.74	0.98	0.57	0.50	0.83	2.06	6.58	8.30	3.67		
	PQ	3.30	6.27	9.53	2.75	1.06	0.51	0.34	0.73	1.46	2.20	4.05	7.61		3.30	
	ER	0.02	-0.61	0.18	-0.39	-0.68	-0.47	-0.23	0.23	0.63	0.14	-2.53	-0.70			-0.36
MEAN	Q	7.66	6.83	5.99	3.75	2.32	1.60	1.13	1.56	1.71	4.61	5.78	8.44	4.27		
	PQ	7.38	6.44	5.75	3.27	1.94	1.47	1.08	1.64	2.03	4.55	5.65	8.17		4.11	
	ER	-0.28	-0.39	-0.24	-0.48	-0.39	-0.13	-0.05	0.08	0.32	-0.06	-0.13	-0.27			-0.17
S.D.	Q	3.29	2.69	2.91	1.60	1.49	0.89	0.49	1.72	1.22	3.26	3.45	2.43	0.71		
	PQ	3.05	2.76	2.89	1.40	1.51	0.95	0.63	1.81	1.22	3.29	3.48	2.43		0.77	

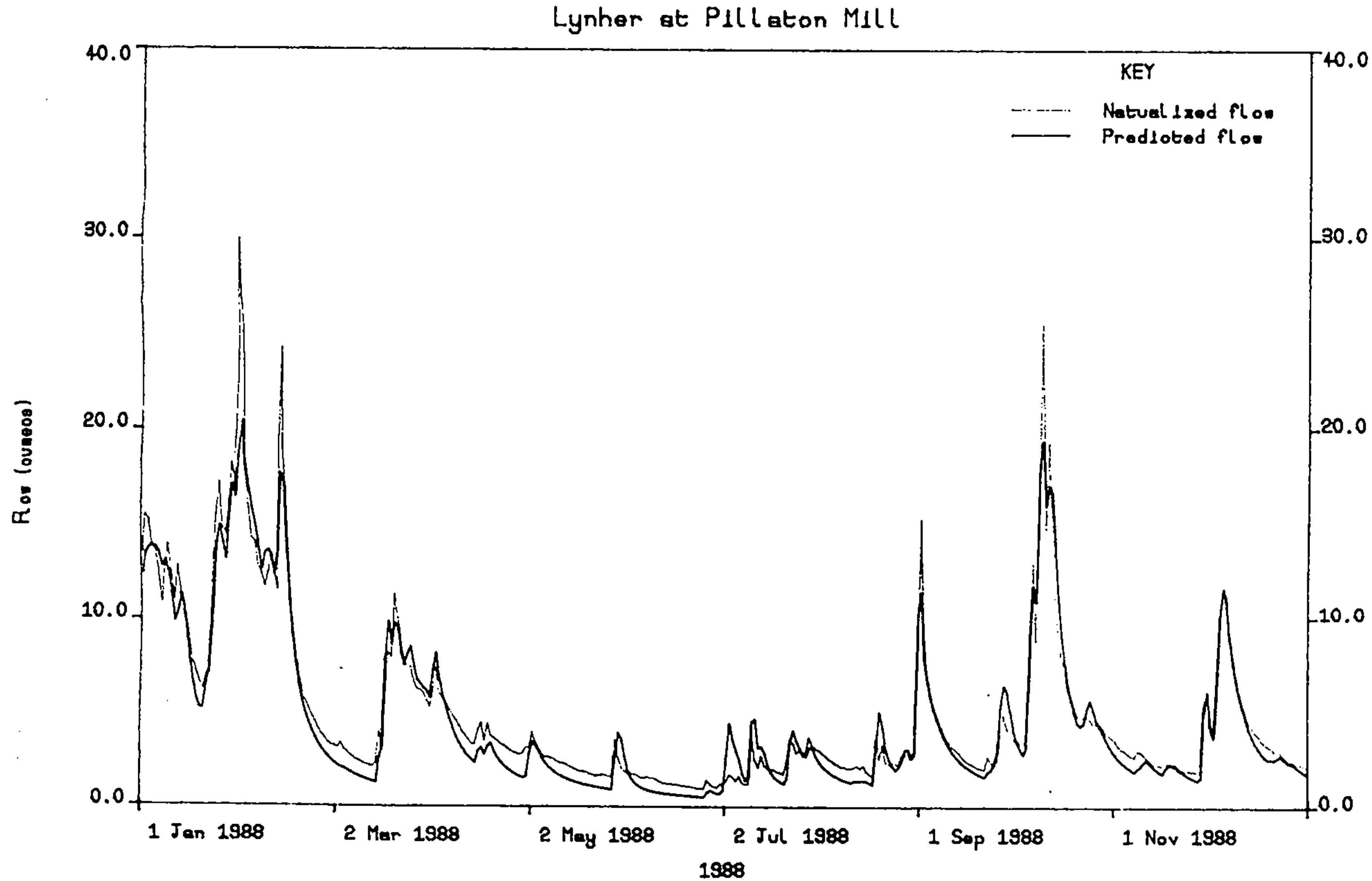
LYNHER AT PILLATON MILL

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 2.1498 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	2632.6	11.24	11.24	2307	42.11	42.11	2392.7	10.63	10.63	2440	44.53	44.53
2	4127.5	17.62	28.86	1309	23.89	66.00	3584.5	15.92	26.55	1155	21.08	65.61
3	3916.9	16.72	45.59	745	13.60	79.59	3557.8	15.80	42.35	674	12.30	77.92
4	3004.8	12.83	58.42	404	7.37	86.97	3381.7	15.02	57.37	454	8.29	86.20
5	2349.7	10.03	68.45	245	4.47	91.44	2555.0	11.35	68.72	268	4.89	91.09
6	1849.7	7.90	76.35	158	2.88	94.32	2316.2	10.29	79.01	197	3.60	94.69
7	1425.7	6.09	82.43	103	1.88	96.20	1697.8	7.54	86.55	122	2.23	96.92
8	1406.8	6.01	88.44	88	1.61	97.81	1482.3	6.58	93.13	92	1.68	98.59
9	833.4	3.56	92.00	46	0.84	98.65	803.3	3.57	96.70	44	0.80	99.40
10	386.1	1.65	93.65	19	0.35	99.00	344.1	1.53	98.23	17	0.31	99.71
11	404.4	1.73	95.37	18	0.33	99.32	111.5	0.50	98.72	5	0.09	99.80
12	319.7	1.37	96.74	13	0.24	99.56	145.3	0.65	99.37	6	0.11	99.91
13	241.0	1.03	97.77	9	0.16	99.73	52.4	0.23	99.60	2	0.04	99.95
14	147.7	0.63	98.40	5	0.09	99.82	57.9	0.26	99.86	2	0.04	99.98
15	94.1	0.40	98.80	3	0.05	99.87	31.4	0.14	100.00	1	0.02	100.00
16	64.9	0.28	99.08	2	0.04	99.91	0.0	0.00	100.00	0	0.00	100.00
17	71.5	0.31	99.38	2	0.04	99.95	0.0	0.00	100.00	0	0.00	100.00
18	37.9	0.16	99.54	1	0.02	99.96	0.0	0.00	100.00	0	0.00	100.00
19	0.0	0.00	99.54	0	0.00	99.96	0.0	0.00	100.00	0	0.00	100.00
20	0.0	0.00	99.54	0	0.00	99.96	0.0	0.00	100.00	0	0.00	100.00
21	44.0	0.19	99.73	1	0.02	99.98	0.0	0.00	100.00	0	0.00	100.00
22	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
23	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
24	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
25	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
26	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
27	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
28	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.73	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
30	62.3	0.27	100.00	1	0.02	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	23421.2			5479			22514.2			5479		


Lynher at Pillaton Mill
KEY
Natualized flow
Predicted flow
Flow (cusecs)
60.0
45.0
30.0
15.0
0.0
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/75 to 31/12/89


Lynher at Pillaton Mill
KEY
Natualized flow
Predicted flow
Flow (cumecs)
40.0
30.0
20.0
10.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

D. Fowey to Trekievesteps (048001) Area 36.8 km^2

Broad Crested Weir to 1967 then Compound Crump Weir.

Flows considerably modified by abstractions and reservoir operations at Siblyback.

Naturalised flow series computed, as described in section 5.2.1, for the period 1962-67.

Model optimised on the period 6/62 - 4/64. (Because of gaps elsewhere in rainfall record.

Comparison of model predicted and naturalised flows for the period 1963-66, excluding 1964, is summarised in the following tables and diagrams.

The cumulative volume over this short period is not particularly good at 11% below the naturalised flow.

Volume and time distribution over the flow range indicate a tendency to underpredict at low flows and at extreme high flows and to over predict in the mid range.

This is further illustrated in the flow duration curve and in the sample time series plot for 1966.

Despite these deficiencies, which are due in part to the model constraints but also arise from uncertainties in the data used in producing the naturalised record, the model has been used to extend the flow record from 1968-89.

FOWEY AT TREKIVESTEPS

MONTHLY FLOW, PREDICTED FLOW AND ERROR

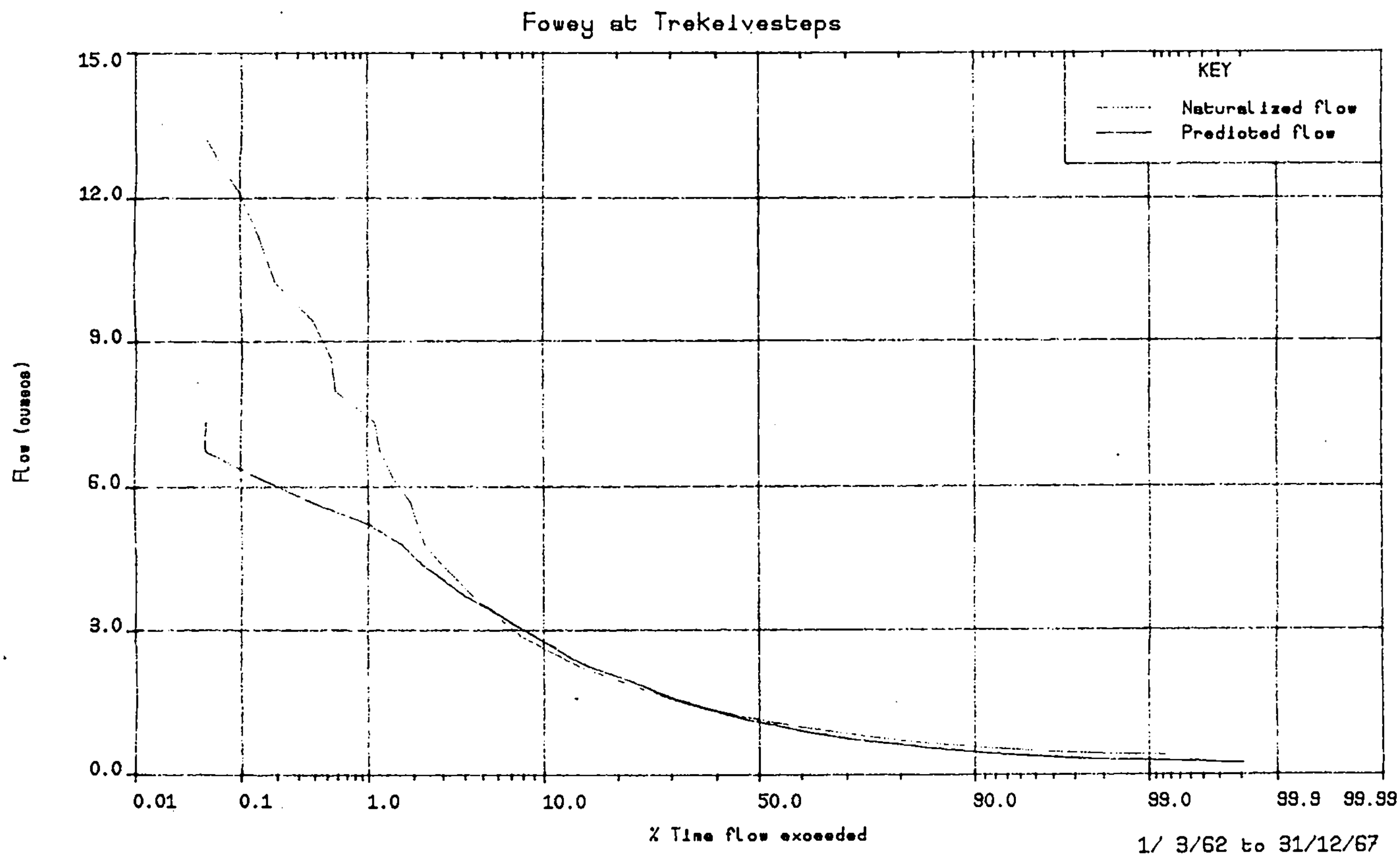
YEAR		MONTH												MEANS		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1963	Q	1.14	2.01	2.32	1.93	1.31	0.76	0.97	1.10	1.33	1.08	3.56	1.66	1.59		
	PQ	1.00	1.35	2.07	1.77	0.98	0.57	0.82	0.98	1.25	1.08	3.13	1.89		1.40	
	ER	-0.14	-0.66	-0.26	-0.16	-0.33	-0.18	-0.15	-0.12	-0.08	0.00	-0.43	0.23			-0.19
1965	Q	0.90	1.00	1.70	1.35	0.00	0.87	0.79	0.55	0.51	1.29	1.59	2.19	1.06		
	PQ	0.89	0.96	1.40	1.20	0.94	0.74	0.75	0.52	0.47	1.26	1.39	1.96		1.04	
	ER	-0.02	-0.05	-0.30	-0.15	0.94	-0.13	-0.04	-0.04	-0.03	-0.02	-0.20	-0.23			-0.02
1966	Q	3.51	1.14	1.14	0.99	0.99	0.77	1.80	1.66	1.83	1.17	1.89	4.41	1.78		
	PQ	3.20	1.28	1.21	0.84	0.91	0.71	1.31	1.37	1.83	1.28	1.73	4.21		1.66	
	ER	-0.31	0.14	0.06	-0.14	-0.09	-0.07	-0.49	-0.29	0.00	0.11	-0.16	-0.21			-0.12
MEAN	Q	1.85	1.38	1.72	1.42	0.77	0.80	1.19	1.10	1.22	1.18	2.34	2.75	1.48		
	PQ	1.70	1.19	1.56	1.27	0.94	0.68	0.96	0.96	1.18	1.21	2.08	2.69		1.37	
	ER	-0.15	-0.19	-0.17	-0.15	0.17	-0.13	-0.23	-0.15	-0.04	0.03	-0.26	-0.07			-0.11
S.D.	Q	1.44	0.55	0.59	0.48	0.68	0.06	0.54	0.55	0.67	0.10	1.06	1.46	0.37		
	PQ	1.31	0.21	0.45	0.47	0.04	0.09	0.30	0.43	0.68	0.11	0.92	1.32		0.31	

FOWEY AT TREKIVESTEPS

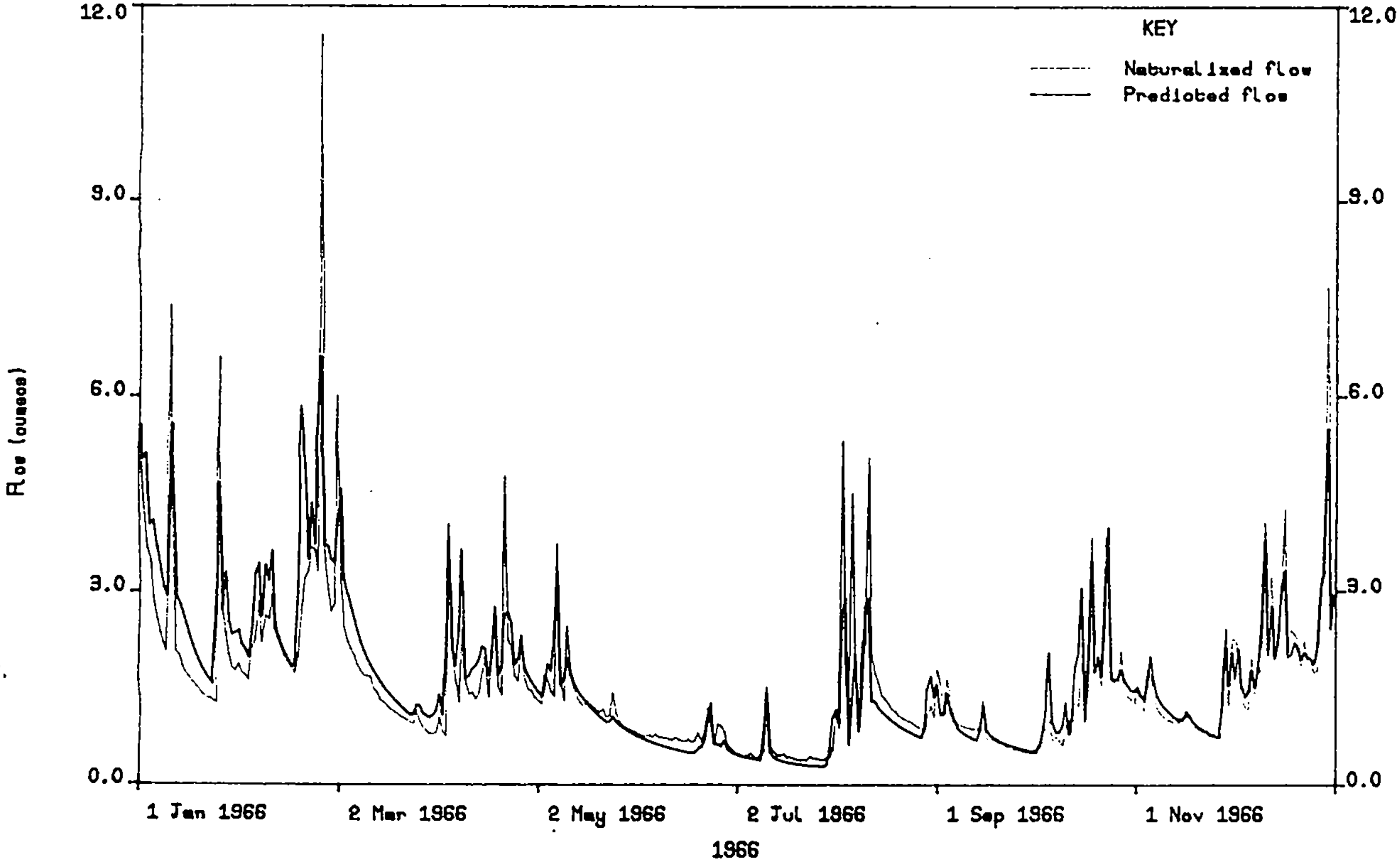
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.4405 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	9.3	0.57	0.57	54	4.93	4.93	23.6	1.57	1.57	63	5.75	5.75
2	207.8	12.82	13.40	299	27.28	32.21	244.9	16.32	17.89	362	33.03	38.78
3	355.0	21.91	35.30	330	30.11	62.32	292.3	19.48	37.37	268	24.45	63.23
4	233.6	14.42	49.72	155	14.14	76.46	239.6	15.97	53.34	158	14.42	77.65
5	178.5	11.02	60.74	90	8.21	84.67	171.9	11.45	64.79	87	7.94	85.58
6	137.6	8.49	69.22	57	5.20	89.87	108.3	7.22	72.01	45	4.11	89.69
7	79.5	4.90	74.13	28	2.55	92.43	105.9	7.06	79.07	37	3.38	93.07
8	68.5	4.23	78.36	21	1.92	94.34	79.5	5.30	84.37	24	2.19	95.26
9	48.3	2.98	81.33	13	1.19	95.53	52.0	3.47	87.83	14	1.28	96.53
10	50.0	3.09	84.42	12	1.09	96.62	58.1	3.87	91.71	14	1.28	97.81
11	37.0	2.29	86.71	8	0.73	97.35	36.7	2.45	94.16	8	0.73	98.54
12	15.0	0.93	87.63	3	0.27	97.63	35.7	2.38	96.53	7	0.64	99.18
13	10.8	0.66	88.30	2	0.18	97.81	27.9	1.86	98.39	5	0.46	99.63
14	29.4	1.81	90.11	5	0.46	98.27	17.7	1.18	99.57	3	0.27	99.91
15	12.5	0.77	90.88	2	0.18	98.45	6.4	0.42	100.00	1	0.09	100.00
16	13.6	0.84	91.71	2	0.18	98.63	0.0	0.00	100.00	0	0.00	100.00
17	22.2	1.37	93.08	3	0.27	98.90	0.0	0.00	100.00	0	0.00	100.00
18	23.3	1.44	94.52	3	0.27	99.18	0.0	0.00	100.00	0	0.00	100.00
19	0.0	0.00	94.52	0	0.00	99.18	0.0	0.00	100.00	0	0.00	100.00
20	8.5	0.52	95.05	1	0.09	99.27	0.0	0.00	100.00	0	0.00	100.00
21	27.1	1.67	96.72	3	0.27	99.54	0.0	0.00	100.00	0	0.00	100.00
22	9.5	0.59	97.30	1	0.09	99.63	0.0	0.00	100.00	0	0.00	100.00
23	9.8	0.60	97.91	1	0.09	99.73	0.0	0.00	100.00	0	0.00	100.00
24	10.2	0.63	98.54	1	0.09	99.82	0.0	0.00	100.00	0	0.00	100.00
25	10.9	0.67	99.21	1	0.09	99.91	0.0	0.00	100.00	0	0.00	100.00
26	0.0	0.00	99.21	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
27	0.0	0.00	99.21	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
28	0.0	0.00	99.21	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.21	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
30	12.8	0.79	100.00	1	0.09	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	1620.6			1096			1500.5			1096		


Fowey at Trekelvesteps
15.0
12.0
9.0
6.0
3.0
0.0
Flow (cusecs)
KEY
Naturalized flow
Predicted flow
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 3/62 to 31/12/67

Fowey at Trekelvesteps



E. St Neot to Craigs Hill Wood (48009) Area 22.7 km^2

Compound Crump Weir

Natural catchment (prior to construction of Colliford Reservoir).

Observed flows 1971-80.

Model optimised on the period 4/77 - 12/80.

Comparison of model predicted and observed flows for the period 1976 - 80 is summarised in the following tables and diagrams.

The cumulative volume prediction over the period is within 5% of the observed flow.

The comparison of volume and time distribution over the flow range is skewed because the highest daily observed flow is 2.5 times greater than the next highest value. The flow duration curves exhibit reasonable similarity, except at the extremes with a tendency for the model to underestimate at the mid to higher range.

The sample time series comparison covers the 'drought' year of 1976. Whilst agreement is reasonable over much of the year the plot demonstrates the inherent problem of the HYRROM model, discussed in 6.3.2, of overestimation of rapid response runoff in dry conditions and underestimation of the peaks in wet conditions.

Absence of rainfall data precluded flow prediction before 1975. The flow record has however been extended using the model from 1980, when gauging stopped, to 1989. Since the 'land use' of the catchment has changed considerably in the 1980s with the filling of Colliford, which now occupies over 20% of the catchment, this extended record represents the response if the reservoir had not been there rather than a 'naturalised' flow from the catchment with the reservoir.

ST. NEOT AT CRAIGSHILL WOOD

MONTHLY FLOW, PREDICTED FLOW AND ERROR

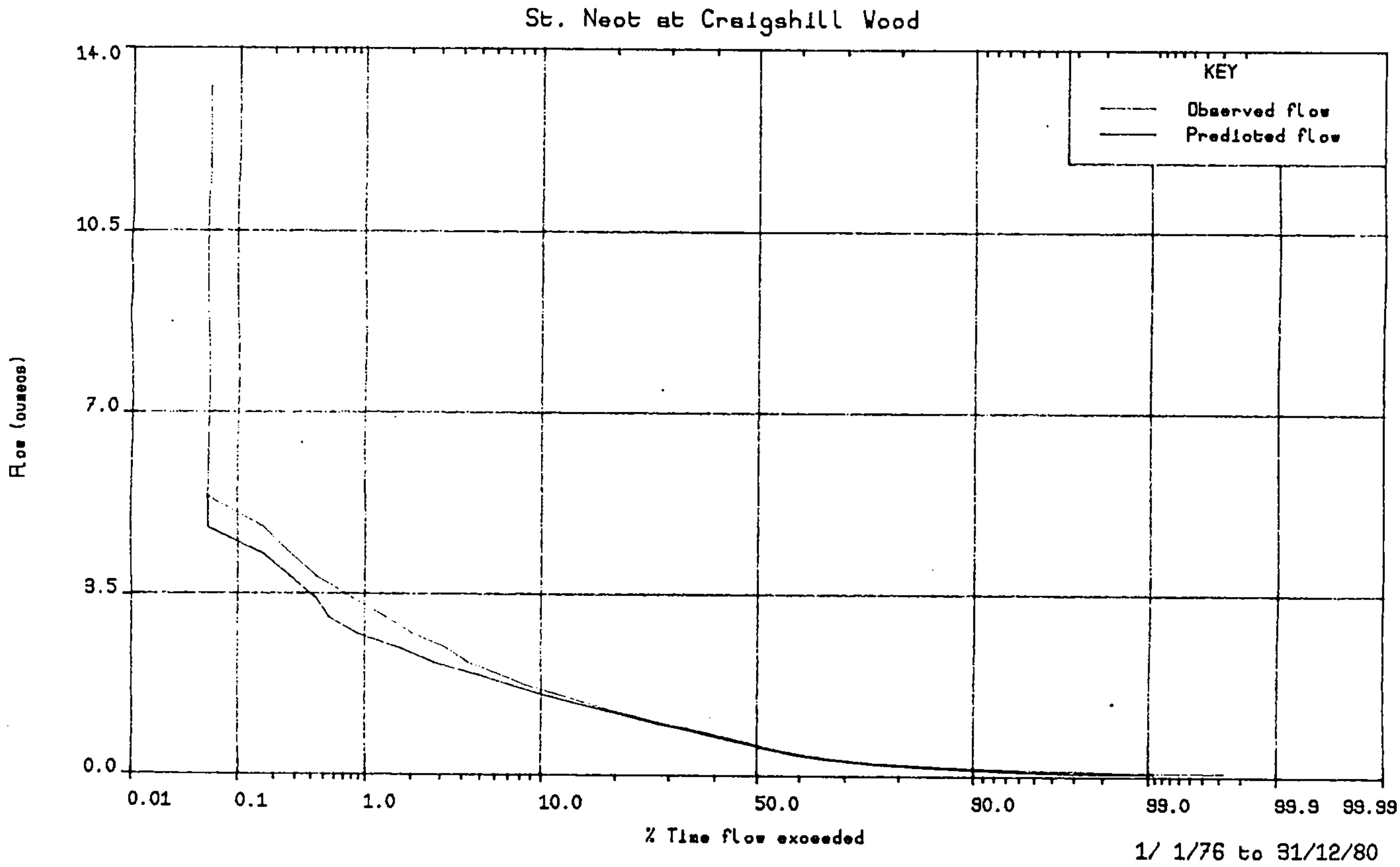
YEAR		MONTH												MEANS		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1976	Q	0.68	1.04	0.94	0.43	0.24	0.15	0.11	0.08	0.22	1.51	0.87	1.44	0.64		
	PQ	0.65	0.93	0.92	0.40	0.23	0.13	0.08	0.06	0.53	1.08	0.78	1.27		0.59	
	ER	-0.03	-0.11	-0.02	-0.03	0.00	-0.02	-0.02	-0.01	0.30	-0.43	-0.09	-0.17			-0.05
1977	Q	1.42	1.84	1.09	0.64	0.46	0.27	0.16	0.17	0.16	0.20	0.87	1.36	0.71		
	PQ	1.27	1.65	1.01	0.60	0.43	0.26	0.16	0.29	0.26	0.30	0.85	1.35		0.70	
	ER	-0.15	-0.18	-0.08	-0.04	-0.03	-0.01	0.00	0.12	0.10	0.10	-0.03	-0.01			-0.02
1978	Q	1.37	1.72	1.55	0.96	0.35	0.21	0.33	0.29	0.18	0.15	0.22	1.57	0.74		
	PQ	1.27	1.68	1.49	0.94	0.33	0.26	0.42	0.33	0.15	0.13	0.25	1.59		0.73	
	ER	-0.10	-0.04	-0.06	-0.02	-0.02	0.05	0.09	0.04	-0.03	-0.02	0.03	0.02			0.00
1979	Q	1.10	1.40	1.41	0.87	0.63	0.54	0.24	0.44	0.31	0.56	1.13	2.18	0.90		
	PQ	1.25	1.30	1.31	0.85	0.63	0.47	0.24	0.47	0.29	0.62	0.98	1.67		0.84	
	ER	0.14	-0.10	-0.11	-0.01	0.00	-0.07	0.00	0.02	-0.02	0.06	-0.15	-0.51			-0.06
1980	Q	1.15	1.76	0.92	0.68	0.26	0.35	0.39	0.35	0.81	1.33	1.29	1.32	0.88		
	PQ	1.26	1.61	0.87	0.60	0.21	0.49	0.41	0.35	0.80	1.24	1.06	1.12		0.83	
	ER	0.11	-0.15	-0.05	-0.08	-0.05	0.15	0.02	0.00	-0.01	-0.09	-0.23	-0.20			-0.05
MEAN	Q	1.15	1.55	1.18	0.71	0.39	0.30	0.25	0.27	0.34	0.75	0.88	1.57	0.77		
	PQ	1.14	1.43	1.12	0.68	0.37	0.32	0.26	0.30	0.41	0.68	0.79	1.40		0.74	
	ER	-0.01	-0.12	-0.06	-0.04	-0.02	0.02	0.02	0.03	0.07	-0.08	-0.09	-0.17			-0.04
S.D.	Q	0.29	0.33	0.28	0.21	0.16	0.15	0.12	0.15	0.27	0.64	0.41	0.35	0.11		
	PQ	0.27	0.32	0.27	0.22	0.17	0.15	0.15	0.15	0.26	0.48	0.32	0.23		0.10	

ST. NEOT AT CRAIGSHILL WOOD

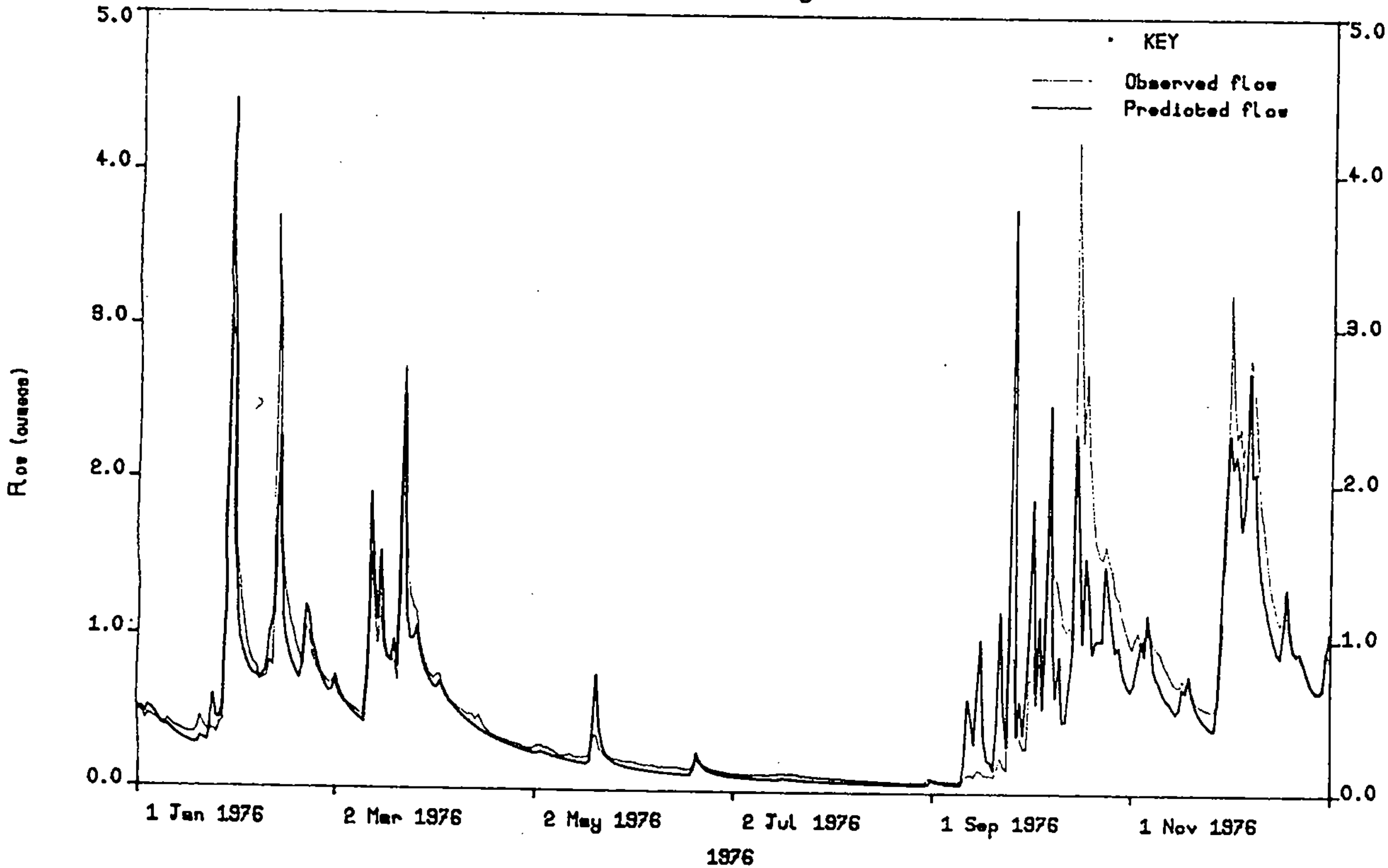
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.4569 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	193.5	13.67	13.67	806	44.12	44.12	181.8	13.48	13.48	781	42.75	42.75
2	296.6	20.95	34.61	430	23.54	67.65	309.1	22.91	36.39	460	25.18	67.93
3	345.6	24.41	59.02	311	17.02	84.67	367.1	27.21	63.61	329	18.01	85.93
4	227.5	16.07	75.09	144	7.88	92.56	224.3	16.63	80.24	143	7.83	93.76
5	136.1	9.61	84.70	67	3.67	96.22	149.5	11.08	91.32	74	4.05	97.81
6	83.4	5.89	90.59	33	1.81	98.03	62.7	4.65	95.97	25	1.37	99.18
7	50.3	3.55	94.14	17	0.93	98.96	17.2	1.28	97.24	6	0.33	99.51
8	30.8	2.17	96.31	9	0.49	99.45	10.3	0.77	98.01	3	0.16	99.67
9	15.4	1.09	97.40	4	0.22	99.67	3.8	0.28	98.29	1	0.05	99.73
10	8.6	0.60	98.00	2	0.11	99.78	12.8	0.95	99.24	3	0.16	99.89
11	9.8	0.69	98.69	2	0.11	99.89	4.6	0.34	99.58	1	0.05	99.95
12	5.2	0.37	99.06	1	0.05	99.95	0.0	0.00	99.58	0	0.00	99.95
13	0.0	0.00	99.06	0	0.00	99.95	5.7	0.42	100.00	1	0.05	100.00
14	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
15	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
16	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
17	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
18	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
19	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
20	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
21	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
22	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
23	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
24	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
25	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
26	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
27	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
28	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.06	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
30	13.3	0.94	100.00	1	0.05	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	1416.0			1827			1348.9			1827		


St. Neot at Craigshill Wood
14.0
10.5
7.0
3.5
0.0
Flow (cumecs)
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
KEY
Observed flow
Predicted flow
1/ 1/76 to 31/12/80

St.Neot at Craigshill Wood



F. <u>Warleggan to Trengoffe</u> (48004) Area 25.3 km^2

Compound Crump Weir

Natural catchment, flow record from 1969-1989.

The model was optimised over the period 1985-89.

Since no rainfall data prior to 1974 could be acquired it was not possible to use the model to extend the flow record for this catchment.

G. Delank to Delank (49003) Area 21.7 km^2

Compound Crump Weir.

Flows have been naturalised for the period 1978-89 using the tabulated abstraction data.

Model optimised on the period 4/80 - 12/86.

Comparison of model predicted and naturalised flows for the period 1979-89 is summarised in the following tables and diagrams.

The cumulative volume prediction over the period is within 0.4% of the naturalised total and the difference does not exceed 6% in any of the years.

The volume and time distributions over the flow range, and the flow duration curve, demonstrate a slight tendency to underestimate the low flows and overestimate in the mid range as well as the expected underestimation of the extreme peaks. This is further demonstrated in the time series comparison for 1988. Overall however these trends tend to cancel out within each year. It is not clear whether these departures are comment on the model, on the observed flow or on the abstraction data.

The model has been used to extend the flow record to cover the period from 1961. No rainfall data were available to extend further.

DE LANK AT DE LANK

MONTHLY FLOW, PREDICTED FLOW AND ERROR

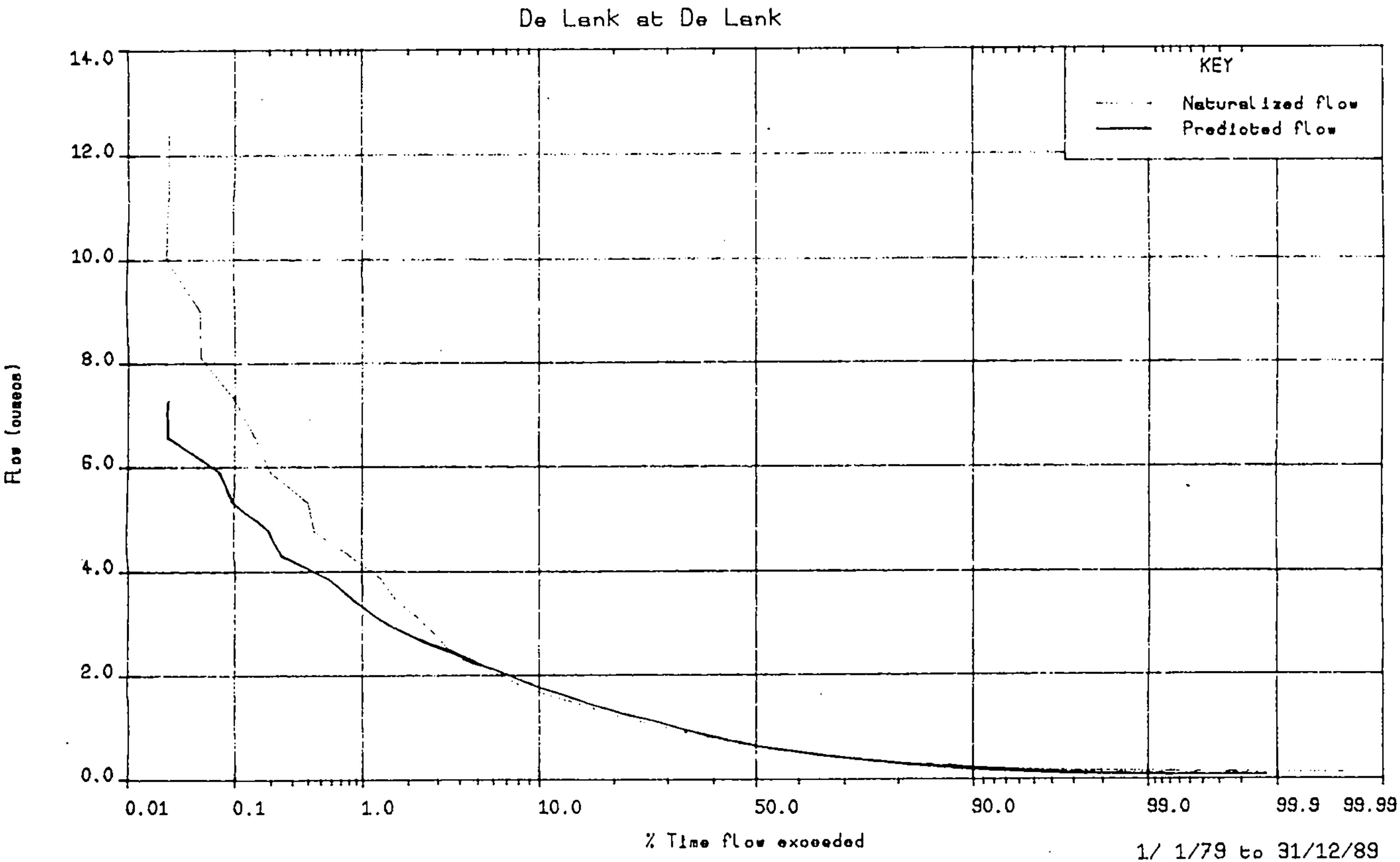
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1979	Q	1.13	1.41	1.45	0.80	0.70	0.59	0.28	0.50	0.42	0.72	1.22	1.90	0.92		
	PQ	1.16	1.15	1.39	0.76	0.62	0.54	0.28	0.65	0.44	0.68	1.05	1.76		0.87	
	ER	0.03	-0.26	-0.06	-0.04	-0.08	-0.05	0.00	0.16	0.03	-0.03	-0.17	-0.15			-0.05
1980	Q	1.04	1.58	0.93	0.60	0.24	0.48	0.65	0.42	0.80	1.37	1.26	1.35	0.89		
	PQ	1.27	1.69	0.98	0.68	0.22	0.63	0.68	0.42	0.98	1.36	1.14	1.27		0.94	
	ER	0.24	0.11	0.05	0.09	-0.03	0.15	0.03	0.00	0.18	-0.01	-0.11	-0.08			0.05
1981	Q	1.05	0.89	2.01	0.54	1.02	0.79	0.46	0.27	0.68	2.05	0.98	1.81	1.05		
	PQ	0.98	0.89	1.84	0.54	0.95	0.90	0.46	0.29	0.89	1.93	0.92	1.88		1.04	
	ER	-0.07	-0.01	-0.17	0.00	-0.07	0.11	0.00	0.01	0.21	-0.11	-0.05	0.07			-0.01
1982	Q	1.24	0.94	1.54	0.44	0.23	0.36	0.36	0.27	0.39	1.44	1.94	1.71	0.90		
	PQ	1.34	0.97	1.41	0.41	0.18	0.50	0.41	0.31	0.46	1.43	1.99	1.63		0.92	
	ER	0.09	0.04	-0.13	-0.03	-0.05	0.14	0.06	0.05	0.07	-0.01	0.05	-0.08			0.02
1983	Q	1.90	0.72	0.74	0.74	1.00	0.38	0.19	0.17	0.20	0.50	0.50	1.43	0.71		
	PQ	1.78	0.71	0.72	0.67	0.84	0.30	0.15	0.10	0.37	0.56	0.41	1.34		0.67	
	ER	-0.12	0.00	-0.02	-0.07	-0.16	-0.09	-0.04	-0.08	0.17	0.05	-0.08	-0.09			-0.04
1984	Q	1.86	1.37	0.58	0.41	0.26	0.19	0.16	0.15	0.23	0.76	1.61	1.67	0.77		
	PQ	1.84	1.37	0.65	0.39	0.29	0.17	0.10	0.17	0.48	0.72	1.55	1.72		0.79	
	ER	-0.02	-0.01	0.07	-0.02	0.03	-0.02	-0.06	0.02	0.25	-0.04	-0.06	0.05			0.02
1985	Q	1.27	0.92	0.71	1.25	0.41	0.54	0.38	1.00	0.76	0.69	0.48	1.25	0.81		
	PQ	1.17	0.85	0.76	1.01	0.38	0.64	0.39	1.00	0.79	0.71	0.56	1.23		0.79	
	ER	-0.11	-0.07	0.05	-0.24	-0.03	0.10	0.01	0.00	0.03	0.02	0.08	-0.02			-0.01
1986	Q	1.59	0.58	0.61	0.75	0.82	0.64	0.53	1.15	0.58	0.72	2.05	1.87	0.99		
	PQ	1.73	0.55	0.62	0.64	0.68	0.74	0.62	1.15	0.61	0.78	2.10	2.05		1.03	
	ER	0.14	-0.03	0.01	-0.10	-0.15	0.10	0.09	0.00	0.03	0.06	0.05	0.18			0.03
1987	Q	0.78	0.86	0.90	0.90	0.36	0.55	0.52	0.30	0.25	1.58	1.25	0.85	0.76		
	PQ	0.81	0.83	0.84	0.82	0.28	0.59	0.57	0.24	0.28	1.67	1.38	0.84		0.76	
	ER	0.03	-0.03	-0.06	-0.08	-0.08	0.04	0.05	-0.06	0.02	0.09	0.14	-0.01			0.00
1988	Q	2.05	1.30	1.06	0.67	0.42	0.29	0.60	0.70	0.80	1.37	0.68	0.81	0.90		
	PQ	1.81	1.47	1.17	0.67	0.43	0.25	0.62	0.65	0.67	1.49	0.77	0.92		0.91	
	ER	-0.24	0.17	0.11	0.00	0.00	-0.04	0.02	-0.06	-0.13	0.12	0.09	0.11			0.01
1989	Q	0.68	1.18	1.35	0.58	0.33	0.21	0.19	0.19	0.39	0.60	1.27	1.15	0.67		
	PQ	0.73	1.12	1.32	0.61	0.27	0.15	0.12	0.29	0.58	0.66	1.27	1.22		0.70	
	ER	0.10	-0.05	-0.02	0.03	-0.06	-0.07	-0.07	0.10	0.19	0.06	0.00	0.08			0.02
MEAN	Q	1.33	1.07	1.08	0.70	0.53	0.46	0.39	0.47	0.50	1.07	1.20	1.44	0.85		
	PQ	1.33	1.05	1.07	0.56	0.47	0.49	0.40	0.48	0.60	1.09	1.20	1.44		0.86	
	ER	0.01	-0.01	-0.02	-0.04	-0.06	0.03	0.01	0.01	0.10	0.02	-0.01	0.00			0.00
S.D.	Q	0.46	0.32	0.45	0.24	0.30	0.19	0.17	0.34	0.23	0.51	0.53	0.39	0.12		
	PQ	0.40	0.34	0.39	0.18	0.27	0.25	0.21	0.34	0.22	0.49	0.54	0.39		0.13	

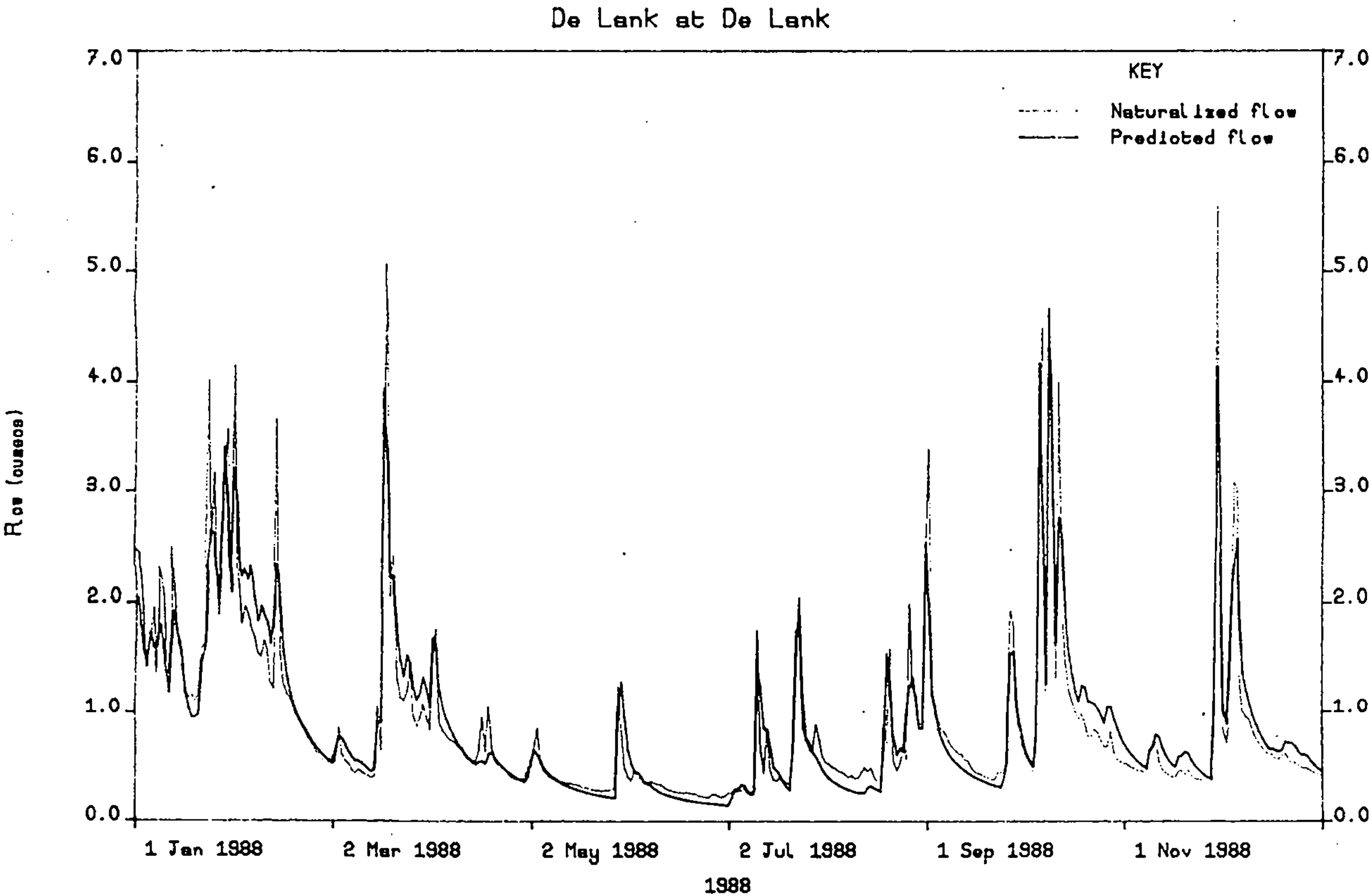
DE LANK AT DE LANK

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.4272 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	364.6	10.65	10.65	1307	32.53	32.53	327.4	9.52	9.52	1299	32.33	32.33
2	796.7	23.26	33.91	1298	32.30	64.83	739.9	21.52	31.04	1194	29.72	62.05
3	724.2	21.14	55.05	689	17.15	81.98	725.1	21.09	52.12	688	17.12	79.17
4	486.4	14.20	69.25	329	8.19	90.17	570.1	16.58	68.70	386	9.61	88.78
5	330.0	9.64	78.89	174	4.33	94.50	416.7	12.12	80.82	218	5.43	94.20
6	205.4	6.00	84.89	88	2.19	96.69	264.1	7.68	88.50	113	2.81	97.01
7	91.8	2.68	87.57	33	0.82	97.51	170.5	4.96	93.45	62	1.54	98.56
8	92.6	2.70	90.27	29	0.72	98.23	73.6	2.14	95.59	23	0.57	99.13
9	64.5	1.88	92.15	18	0.45	98.68	40.4	1.17	96.77	11	0.27	99.40
10	77.8	2.27	94.43	19	0.47	99.15	56.0	1.63	98.40	14	0.35	99.75
11	62.3	1.82	96.24	14	0.35	99.50	9.2	0.27	98.67	2	0.05	99.80
12	19.7	0.57	96.82	4	0.10	99.60	9.7	0.28	98.95	2	0.05	99.85
13	16.3	0.48	97.29	3	0.07	99.68	10.4	0.30	99.25	2	0.05	99.90
14	28.7	0.84	98.13	5	0.12	99.80	5.6	0.16	99.41	1	0.02	99.93
15	0.0	0.00	98.13	0	0.00	99.80	12.2	0.35	99.77	2	0.05	99.98
16	19.9	0.58	98.71	3	0.07	99.88	0.0	0.00	99.77	0	0.00	99.98
17	7.0	0.20	98.91	1	0.02	99.90	0.0	0.00	99.77	0	0.00	99.98
18	0.0	0.00	98.91	0	0.00	99.90	0.0	0.00	99.77	0	0.00	99.98
19	15.5	0.45	99.37	2	0.05	99.95	7.8	0.23	99.99	1	0.02	100.00
20	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
21	0.0	0.00	99.37	0	0.00	99.95	0.0	0.00	99.99	0	0.00	100.00
22	9.1	0.27	99.63	1	0.02	99.98	0.0	0.00	99.99	0	0.00	100.00
23	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
24	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
25	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
26	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.63	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
30	12.4	0.36	99.99	1	0.02	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	3424.8			4018			3438.8			4018		


De Lank at De Lank
KEY
Naturalized flow
Predicted flow
Flow (cumecs)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/79 to 31/12/89


De Lank at De Lank
KEY
Naturalized flow
Predicted flow
Flow (cumecs)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

H. Camel to Denby (49001) Area 208.8 km^2

Velocity–area station

Flows affected by Delank abstractions and by sewage inputs from Bodmin.

No data on the sewage inputs were available.

A naturalised record for the period 1965-89 was produced by using the tabulated abstraction data at Delank and the observed flows at Denby.

Model optimised on the period 4/80 - 12/86.

Comparison of the model predicted and naturalised flows for the period 1966-89 is summarised in the following tables and diagrams.

Whilst the cumulative volume prediction over the period is within 2% of the naturalised flow the summary table shows a marked tendency to underpredict in the latter part of the data run. This is demonstrated in the 1988 time series plot which indicates underprediction of low flows as well at the expected underprediction of the extreme peaks. Have the returns from Bodmin increased significantly in recent years?

The comparisons of volume and time distribution over the flow range are distorted by the observed max daily mean flow of 114 cumecs (the next highest value being 64.8 cumecs).

The flow duration curve indicates underestimation at low flows, slight overestimation in the mid range and the normal underestimation at the extremes (<1% of time).

The model has been used to extend the flow record to cover the period from 1941.

CAMEL AT DENBY

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		MONTH JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	PFLOW	ER
1966	Q	11.48	14.16	6.89	7.66	4.99	2.39	1.90	4.60	2.26	6.58	5.30	10.80	6.55		
	PQ	11.21	13.02	6.30	8.00	4.54	2.06	1.42	6.05	2.78	8.28	5.95	10.62		6.66	
	ER	-0.28	-1.14	-0.60	0.34	-0.45	-0.33	-0.48	1.45	0.52	1.70	0.65	-0.18			0.11
1967	Q	9.83	9.83	8.15	4.13	4.43	2.66	1.60	1.60	4.56	12.04	13.83	8.69	6.76		
	PQ	8.83	8.49	6.98	3.33	3.44	2.06	1.35	1.45	4.50	13.31	12.95	8.39		6.24	
	ER	-1.00	-1.34	-1.16	-0.81	-0.99	-0.60	-0.25	-0.14	-0.07	1.27	-0.88	-0.31			-0.52
1968	Q	10.08	5.02	2.91	2.40	3.76	3.84	5.43	1.87	1.83	3.43	4.70	10.84	4.69		
	PQ	9.31	5.27	2.81	2.53	4.00	3.95	6.59	1.69	2.54	3.94	5.78	11.01		4.96	
	ER	-0.77	0.25	-0.10	0.13	0.24	0.10	1.17	-0.17	0.71	0.50	1.07	0.18			0.27
1969	Q	13.29	7.62	6.39	3.00	3.96	2.48	2.11	1.46	1.38	1.08	6.05	9.07	4.82		
	PQ	12.60	7.00	5.43	2.83	4.38	3.05	3.09	1.78	2.09	1.19	8.80	10.25		5.20	
	ER	-0.69	-0.63	-0.96	-0.16	0.42	0.57	0.98	0.32	0.71	0.11	2.76	1.19			0.39
1970	Q	13.82	13.33	5.71	3.73	2.32	0.97	1.06	3.61	3.31	1.50	12.89	8.56	5.85		
	PQ	12.54	13.05	5.71	4.13	2.43	1.46	1.71	4.13	5.18	2.19	15.04	8.25		6.26	
	ER	-1.28	-0.29	0.01	0.40	0.11	0.48	0.65	0.52	1.87	0.69	2.15	-0.31			0.41
1971	Q	12.42	7.84	5.95	2.29	1.05	1.75	0.92	1.85	0.89	1.15	5.73	8.34	4.17		
	PQ	12.11	8.26	6.43	2.71	1.10	2.80	1.76	2.40	0.78	2.11	7.29	10.48		4.84	
	ER	-0.31	0.42	0.48	0.42	0.05	1.06	0.84	0.54	-0.11	0.96	1.56	2.14			0.67
1972	Q	11.80	14.46	8.29	4.58	4.96	5.56	4.30	2.83	1.63	1.60	8.31	15.70	6.98		
	PQ	11.53	14.28	7.60	4.66	4.55	5.05	4.25	3.20	1.54	1.80	8.39	15.97		6.88	
	ER	-0.27	-0.18	-0.69	0.08	-0.41	-0.50	-0.05	0.37	-0.08	0.19	0.08	0.27			-0.10
1973	Q	10.94	8.71	4.82	2.86	2.23	1.50	1.37	3.45	2.35	3.38	4.56	10.60	4.72		
	PQ	10.82	9.02	4.30	2.38	1.86	1.20	1.47	3.72	2.78	4.59	4.91	11.25		4.85	
	ER	-0.13	0.30	-0.53	-0.49	-0.37	-0.30	0.10	0.27	0.43	1.21	0.35	0.65			0.12
1974	Q	19.69	21.03	5.66	2.18	2.15	1.02	0.90	2.07	12.00	12.07	11.60	9.77	8.26		
	PQ	19.21	20.56	6.36	1.76	1.83	0.58	1.23	2.80	12.31	11.72	11.88	9.54		8.23	
	ER	-0.48	-0.47	0.69	-0.42	-0.32	-0.44	0.33	0.72	0.30	-0.34	0.28	-0.23			-0.03
1975	Q	11.59	6.55	4.97	4.86	2.62	1.30	1.27	1.44	2.40	2.80	5.46	6.64	4.32		
	PQ	11.72	6.87	5.32	4.65	1.92	0.79	2.15	2.06	2.36	1.78	5.89	6.46		4.32	
	ER	0.12	0.32	0.35	-0.21	-0.70	-0.51	0.89	0.62	-0.04	-1.02	0.43	-0.18			0.00
1976	Q	4.92	6.97	6.97	3.34	1.67	1.04	0.67	0.49	1.43	7.79	6.09	11.24	4.39		
	PQ	4.39	7.22	7.19	2.85	1.16	0.74	0.43	0.32	3.48	5.20	4.36	11.42		4.06	
	ER	-0.53	0.25	0.21	-0.49	-0.52	-0.31	-0.24	-0.17	2.04	-2.60	-1.73	0.19			-0.33
1977	Q	10.51	12.78	7.68	4.33	3.70	2.19	1.14	1.24	1.21	1.46	6.36	9.49	5.13		
	PQ	10.84	13.07	7.76	3.97	3.16	1.50	0.88	1.92	1.00	1.35	7.17	10.06		5.18	
	ER	0.34	0.29	0.08	-0.35	-0.54	-0.69	-0.26	0.68	-0.21	-0.11	0.81	0.58			0.05
1978	Q	10.01	13.40	11.12	6.55	2.32	1.57	2.89	2.38	1.47	0.96	1.45	10.57	5.35		
	PQ	9.96	13.96	11.09	5.98	1.57	1.29	2.80	1.77	0.70	0.52	1.44	12.70		5.28	
	ER	-0.05	0.55	-0.03	-0.57	-0.75	-0.28	-0.09	-0.61	-0.77	-0.44	-0.01	2.13			-0.08
1979	Q	8.01	10.29	10.58	6.27	4.23	3.86	1.78	2.65	2.17	3.69	7.40	15.33	6.34		
	PQ	9.09	10.54	10.75	6.17	4.11	3.61	1.51	2.55	1.71	4.59	8.36	13.79		6.38	
	ER	1.08	0.25	0.18	-0.10	-0.12	-0.25	-0.27	-0.10	-0.45	0.91	0.96	-1.54			0.04

CAMEL AT DENBY

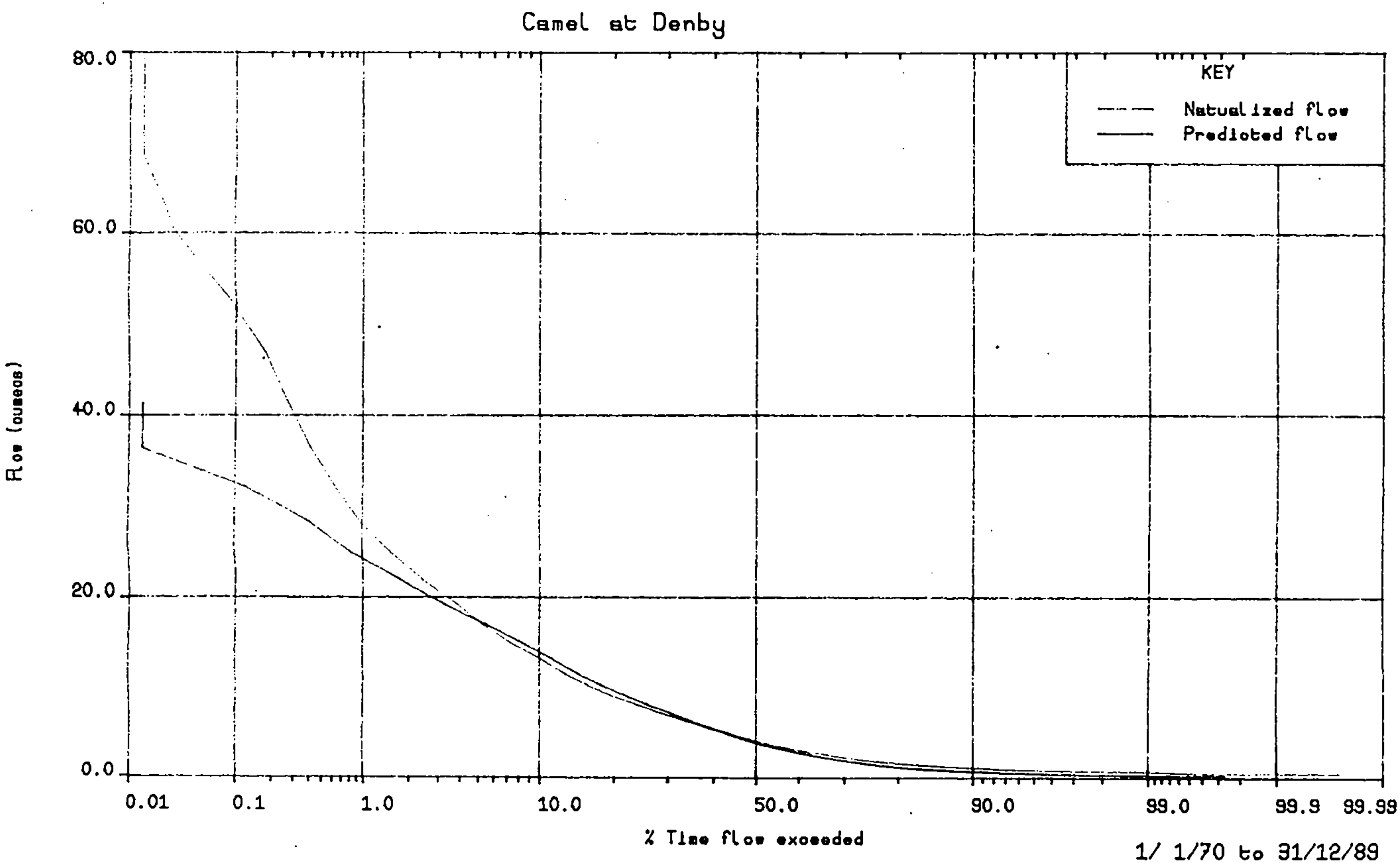
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1980	Q	9.36	13.99	6.81	5.69	1.94	2.52	3.69	2.47	6.11	9.46	9.66	9.73	6.76		
	PQ	10.10	13.77	6.77	5.32	1.21	3.26	3.01	1.75	6.21	11.03	8.98	9.02		6.67	
	ER	0.75	-0.22	-0.04	-0.38	-0.73	0.74	-0.68	-0.72	0.10	1.56	-0.68	-0.71			-0.08
1981	Q	7.15	5.99	16.50	4.37	6.25	5.30	2.67	1.70	3.56	16.73	7.53	17.27	7.96		
	PQ	6.72	5.90	14.83	3.60	6.60	5.43	2.31	1.20	4.88	16.28	6.93	15.37		7.54	
	ER	-0.43	-0.09	-1.67	-0.77	0.35	0.13	-0.37	-0.49	1.33	-0.45	-0.60	-1.89			-0.42
1982	Q	11.03	7.48	12.74	3.46	1.75	1.93	1.92	1.47	1.89	10.62	18.08	14.74	7.27		
	PQ	10.76	7.08	11.55	2.56	1.12	2.77	1.71	1.43	2.25	11.56	17.10	13.30		6.94	
	ER	-0.26	-0.40	-1.19	-0.89	-0.63	0.84	-0.21	-0.04	0.36	0.94	-0.98	-1.43			-0.33
1983	Q	14.35	5.48	4.44	5.61	8.58	3.08	1.32	0.90	1.08	2.36	2.53	9.92	4.99		
	PQ	12.37	4.62	4.00	5.70	7.99	2.09	0.85	0.50	2.11	2.63	1.53	8.21		4.40	
	ER	-1.99	-0.86	-0.44	0.08	-0.59	-0.99	-0.47	-0.40	1.04	0.27	-1.00	-1.70			-0.59
1984	Q	13.90	10.68	4.17	2.90	1.77	1.13	0.83	0.80	1.15	3.23	11.68	12.80	5.40		
	PQ	13.64	10.28	3.64	2.44	1.78	0.90	0.48	0.94	2.54	3.54	13.08	13.10		5.51	
	ER	-0.26	-0.39	-0.53	-0.47	0.02	-0.23	-0.35	0.14	1.39	0.31	1.40	0.30			0.11
1985	Q	9.27	7.52	4.96	9.48	2.81	2.38	1.74	5.16	4.74	4.45	3.15	9.14	5.39		
	PQ	8.41	6.62	5.35	8.76	1.99	2.83	1.60	6.01	4.65	4.85	3.48	9.40		5.32	
	ER	-0.86	-0.91	0.39	-0.72	-0.82	0.45	-0.14	0.85	-0.09	0.40	0.33	0.25			-0.07
1986	Q	13.84	5.31	3.75	5.63	5.55	4.98	3.73	7.95	4.83	4.00	17.89	16.23	7.82		
	PQ	14.04	3.98	3.60	5.01	4.55	4.97	3.77	7.94	4.48	4.22	16.25	15.72		7.40	
	ER	0.21	-1.33	-0.15	-0.62	-0.99	0.00	0.04	-0.01	-0.35	0.21	-1.64	-0.51			-0.42
1987	Q	6.62	5.70	6.63	7.93	2.57	2.79	3.38	2.06	1.61	12.51	10.84	6.22	5.74		
	PQ	5.74	5.41	6.12	6.97	1.59	2.01	2.78	1.07	1.17	12.74	11.11	6.03		5.22	
	ER	-0.86	-0.30	-0.50	-0.97	-0.97	-0.79	-0.60	-1.00	-0.44	0.23	0.27	-0.19			-0.51
1988	Q	16.62	13.45	8.81	5.56	2.95	1.94	3.12	3.21	5.10	11.53	4.57	7.22	7.00		
	PQ	14.92	13.39	8.73	5.19	2.88	1.03	3.87	3.62	4.85	10.93	4.08	6.66		6.67	
	ER	-1.70	-0.06	-0.08	-0.37	-0.07	-0.91	0.76	0.41	-0.25	-0.60	-0.49	-0.56			-0.33
1989	Q	5.10	9.15	11.40	4.73	2.52	1.59	1.02	0.89	1.67	3.09	8.26	10.14	4.94		
	PQ	4.84	7.88	10.83	3.97	1.51	0.82	0.50	1.03	2.39	2.83	4.29	9.81		4.21	
	ER	-0.26	-1.27	-0.57	-0.76	-1.01	-0.77	-0.52	0.14	0.72	-0.26	-3.97	-0.34			-0.73
MEAN	Q	11.07	9.86	7.35	4.73	3.38	2.49	2.12	2.42	2.94	5.73	8.08	10.79	5.90		
	PQ	10.65	9.56	7.06	4.39	2.97	2.34	2.15	2.56	3.30	5.96	8.13	10.70		5.80	
	ER	-0.41	-0.30	-0.28	-0.34	-0.41	-0.15	0.03	0.13	0.36	0.24	0.05	-0.09			-0.10
S.D.	Q	3.46	3.99	3.21	1.90	1.75	1.34	1.26	1.66	2.44	4.64	4.45	3.04	1.23		
	PQ	3.31	4.05	2.95	1.86	1.82	1.45	1.44	1.89	2.46	4.68	4.42	2.82		1.16	

CAMEL AT DENBY

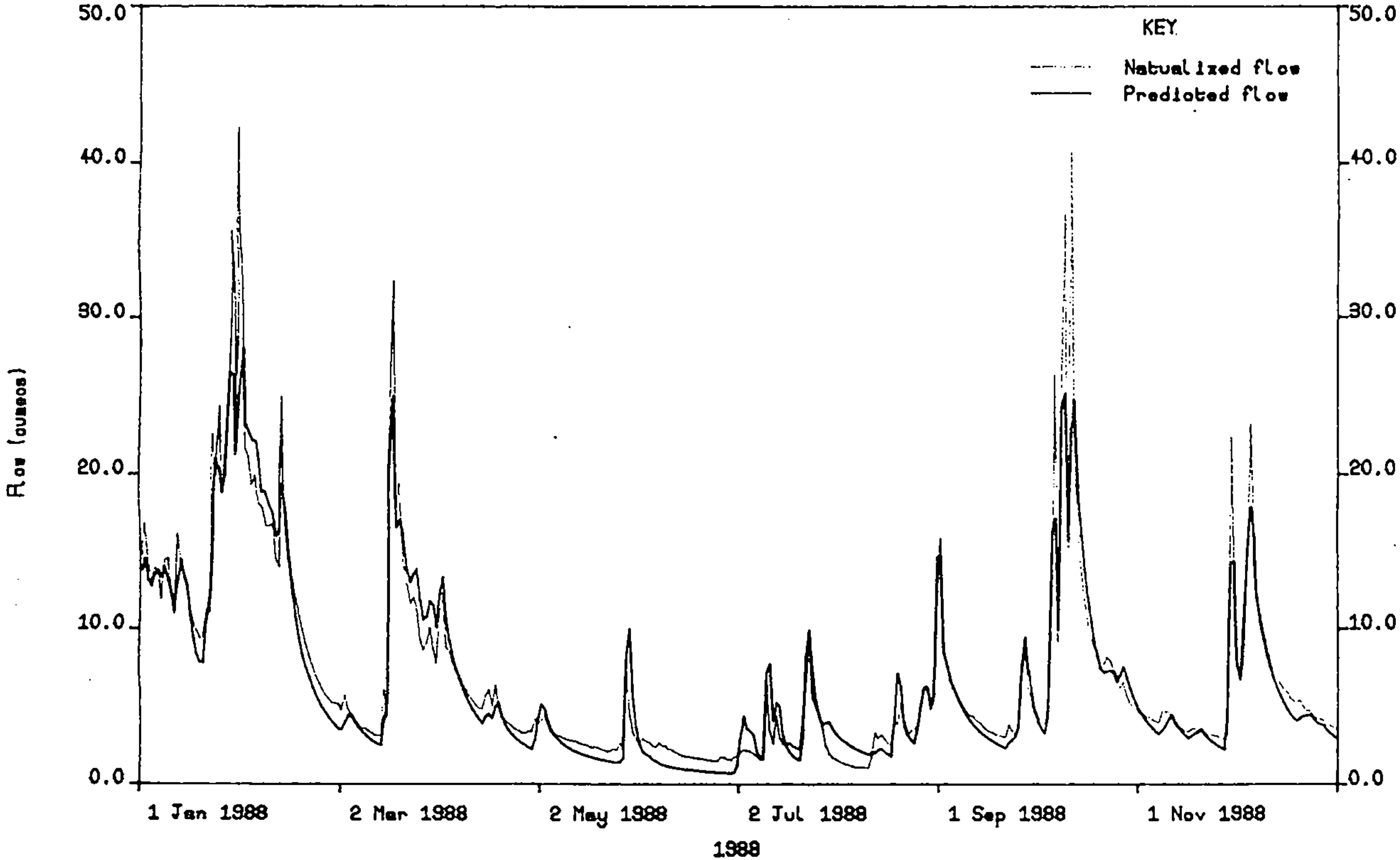
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 3.9303 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	8823.3	17.06	17.06	4300	49.05	49.05	7932.0	15.60	15.60	4371	49.86	49.86
2	13249.2	25.62	42.68	2329	26.57	75.62	11821.1	23.24	38.84	2064	23.55	73.41
3	10215.6	19.75	62.44	1071	12.22	87.84	10884.9	21.40	60.24	1129	12.88	86.29
4	7106.8	13.74	76.18	524	5.98	93.82	8305.7	16.33	76.57	611	6.97	93.26
5	4069.6	7.87	84.05	233	2.66	96.47	6020.1	11.84	88.41	344	3.92	97.18
6	3461.1	6.69	90.74	162	1.85	98.32	3220.5	6.33	94.74	151	1.72	98.90
7	1548.6	2.99	93.73	61	0.70	99.02	1333.2	2.62	97.36	53	0.60	99.51
8	876.5	1.69	95.43	30	0.34	99.36	824.8	1.62	98.98	28	0.32	99.83
9	592.8	1.15	96.58	18	0.21	99.57	431.5	0.85	99.83	13	0.15	99.98
10	409.5	0.79	97.37	11	0.13	99.69	35.5	0.07	99.90	1	0.01	99.99
11	368.0	0.71	98.08	9	0.10	99.79	42.3	0.08	99.98	1	0.01	100.00
12	225.1	0.44	98.51	5	0.06	99.85	0.0	0.00	99.98	0	0.00	100.00
13	198.4	0.38	98.90	4	0.05	99.90	0.0	0.00	99.98	0	0.00	100.00
14	266.0	0.51	99.41	5	0.06	99.95	0.0	0.00	99.98	0	0.00	100.00
15	56.0	0.11	99.52	1	0.01	99.97	0.0	0.00	99.98	0	0.00	100.00
16	59.5	0.12	99.64	1	0.01	99.98	0.0	0.00	99.98	0	0.00	100.00
17	64.8	0.13	99.76	1	0.01	99.99	0.0	0.00	99.98	0	0.00	100.00
18	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
19	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
20	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
21	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
22	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
23	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
24	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
25	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
26	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
27	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
28	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
29	0.0	0.00	99.76	0	0.00	99.99	0.0	0.00	99.98	0	0.00	100.00
30	114.0	0.22	99.98	1	0.01	100.00	0.0	0.00	99.98	0	0.00	100.00
TOTALS	51714.4			8766			50861.0			8766		


Camel at Denby
KEY
Natualized flow
Predicted flow
80.0
60.0
40.0
20.0
0.0
Flow (cusecs)
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/70 to 31/12/89

Camel at Denby



I. Seaton to Trebrownbridge (048010) Area 38.1 km^2

Natural catchment, Compound Crump Weir.

Observed flows 1969-89.

Model optimised on period 1980-86.

Comparison of the model predicted and observed flows for the period 1973-89 is summarised in the following tables and diagrams.

Summarised separately is the period 1970-72.

The cumulative volume prediction over the 1973-89 period is within 1% of the observed flow. By contrast when the model was run on the 1970-72 period it produced a cumulative overestimate of 28%. Double mass plots of flow on rain and intercomparison of both flow and rain with the adjacent Tiddy catchment indicated that the observed flow in the Seaton over 1970-72 was considerably underestimated.

For the 1973-89 period the volume and time distributions over the flow range are in reasonable agreement apart for the normal problem of underestimation at the very high flows.

The record has been extended using the model to cover the period from 1961. In view of the comments above it is recommended that the synthetic record be used in place of the observed record from 1969 to 1972.

SEATON AT TROWBROWNBRIDGE

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		MONTH												MEANS		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1970	Q	2.15	2.75	1.62	0.82	0.57	0.41	0.35	0.34	0.34	0.29	0.71	1.24	0.95		
	PQ	2.90	3.17	1.31	0.87	0.62	0.31	0.30	0.74	1.12	0.51	2.00	1.58		1.27	
	ER	0.74	0.42	-0.31	0.05	0.06	-0.10	-0.05	0.40	0.79	0.22	1.29	0.34			0.32
1971	Q	1.68	1.79	0.94	0.71	0.49	0.39	0.29	0.29	0.22	0.22	0.30	0.59	0.65		
	PQ	2.02	1.58	0.94	0.52	0.29	0.37	0.24	0.55	0.26	0.38	0.81	1.86		0.82	
	ER	0.35	-0.21	0.00	-0.20	-0.21	-0.02	-0.05	0.27	0.03	0.16	0.51	1.27			0.16
1972	Q	1.05	2.29	1.87	0.81	0.57	0.67	0.57	0.42	0.30	0.27	1.30	2.76	1.07		
	PQ	1.95	2.24	1.72	1.19	1.48	1.38	0.73	0.49	0.32	0.29	1.51	2.95		1.35	
	ER	0.90	-0.05	-0.15	0.38	0.91	0.71	0.16	0.07	0.01	0.02	0.20	0.19			0.28
MEAN	Q	1.63	2.28	1.48	0.78	0.54	0.49	0.40	0.35	0.29	0.26	0.77	1.53	0.89		
	PQ	2.29	2.33	1.32	0.86	0.80	0.69	0.42	0.59	0.57	0.39	1.44	2.13		1.15	
	ER	0.66	0.05	-0.15	0.08	0.26	0.20	0.02	0.25	0.28	0.13	0.67	0.60			0.25
S.D.	Q	0.55	0.48	0.48	0.06	0.04	0.16	0.15	0.06	0.06	0.04	0.50	1.11	0.22		
	PQ	0.52	0.80	0.39	0.34	0.62	0.60	0.27	0.13	0.48	0.11	0.60	0.72		0.29	

SEATON AT TROWBROWNBRIDGE

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.1862 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	0.0	0.00	0.00	0	0.00	0.00	3.0	0.24	0.24	17	1.55	1.55
2	98.5	10.07	10.07	346	31.57	31.57	65.1	5.18	5.42	243	22.17	23.72
3	97.1	9.92	19.99	211	19.25	50.82	65.3	5.19	10.61	143	13.05	36.77
4	84.6	8.64	28.63	129	11.77	62.59	60.9	4.85	15.46	95	8.67	45.44
5	52.7	5.39	34.02	63	5.75	68.34	63.9	5.08	20.53	76	6.93	52.37
6	44.3	4.52	38.54	43	3.92	72.26	85.8	6.82	27.35	83	7.57	59.95
7	82.9	8.47	47.02	68	6.20	78.47	104.1	8.28	35.63	86	7.85	67.79
8	68.3	6.98	54.00	49	4.47	82.94	85.3	6.78	42.41	61	5.57	73.36
9	34.5	3.53	57.53	22	2.01	84.95	86.9	6.91	49.32	55	5.02	78.38
10	31.4	3.21	60.74	18	1.64	86.59	61.9	4.92	54.24	35	3.19	81.57
11	39.1	4.00	64.74	20	1.82	88.41	48.7	3.87	58.11	25	2.28	83.85
12	23.3	2.38	67.12	11	1.00	89.42	40.8	3.25	61.36	19	1.73	85.58
13	72.1	7.37	74.48	31	2.83	92.24	58.6	4.66	66.01	25	2.28	87.86
14	65.5	6.69	81.17	26	2.37	94.62	47.4	3.77	69.78	19	1.73	89.60
15	56.7	5.79	86.97	21	1.92	96.53	51.1	4.07	73.85	19	1.73	91.33
16	23.2	2.37	89.34	8	0.73	97.26	55.1	4.38	78.23	19	1.73	93.07
17	24.7	2.52	91.86	8	0.73	97.99	30.6	2.43	80.67	10	0.91	93.98
18	22.9	2.34	94.20	7	0.64	98.63	62.0	4.93	85.60	19	1.73	95.71
19	24.1	2.46	96.66	7	0.64	99.27	34.2	2.72	88.32	10	0.91	96.62
20	7.3	0.74	97.41	2	0.18	99.45	50.6	4.02	92.34	14	1.28	97.90
21	11.4	1.16	98.57	3	0.27	99.73	27.0	2.14	94.49	7	0.64	98.54
22	4.1	0.41	98.98	1	0.09	99.82	16.0	1.27	95.76	4	0.36	98.90
23	0.0	0.00	98.98	0	0.00	99.82	21.0	1.67	97.43	5	0.46	99.36
24	0.0	0.00	98.98	0	0.00	99.82	13.1	1.04	98.47	3	0.27	99.63
25	4.5	0.46	99.45	1	0.09	99.91	0.0	0.00	98.47	0	0.00	99.63
26	0.0	0.00	99.45	0	0.00	99.91	14.4	1.15	99.61	3	0.27	99.91
27	0.0	0.00	99.45	0	0.00	99.91	4.9	0.39	100.00	1	0.09	100.00
28	0.0	0.00	99.45	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.45	0	0.00	99.91	0.0	0.00	100.00	0	0.00	100.00
30	5.4	0.55	100.00	1	0.09	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	978.5			1096			1257.6			1096		

SEATON AT TROWBROWNBRIDGE

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		MONTH												MEANS		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1973	Q	1.44	1.32	0.87	0.54	0.51	0.38	0.28	0.32	0.27	0.52	0.48	1.43	0.69		
	PQ	1.55	1.40	0.75	0.53	0.55	0.41	0.28	0.53	0.45	0.80	0.72	1.74		0.81	
	ER	0.11	0.08	-0.12	0.00	0.04	0.02	0.00	0.21	0.18	0.28	0.24	0.30			0.11
1974	Q	2.69	3.89	1.20	0.68	0.68	0.41	0.30	0.37	1.58	1.70	1.90	1.82	1.42		
	PQ	2.85	3.93	1.39	0.49	0.56	0.27	0.25	0.57	1.98	1.99	2.05	1.75		1.49	
	ER	0.16	0.04	0.19	-0.19	-0.12	-0.14	-0.05	0.19	0.40	0.29	0.15	-0.07			0.07
1975	Q	2.40	1.76	0.90	0.69	0.54	0.33	0.32	0.27	0.33	0.41	0.77	1.12	0.82		
	PQ	2.16	1.78	0.85	0.66	0.47	0.24	0.37	0.22	0.37	0.49	0.91	1.09		0.80	
	ER	-0.23	0.02	-0.04	-0.03	-0.08	-0.09	0.05	-0.05	0.04	0.08	0.14	-0.04			-0.02
1976	Q	0.58	1.22	1.59	0.78	0.40	0.27	0.20	0.15	0.37	1.72	1.36	2.02	0.89		
	PQ	0.59	1.16	1.38	0.69	0.33	0.19	0.13	0.11	0.36	1.24	1.28	1.87		0.78	
	ER	0.01	-0.06	-0.22	-0.08	-0.07	-0.08	-0.08	-0.04	-0.01	-0.48	-0.08	-0.15			-0.11
1977	Q	1.87	2.89	1.68	0.99	0.68	0.43	0.28	0.28	0.25	0.26	0.94	1.74	1.01		
	PQ	1.78	2.77	1.60	0.88	0.59	0.32	0.20	0.29	0.22	0.32	1.17	1.77		0.98	
	ER	-0.08	-0.12	-0.08	-0.11	-0.09	-0.10	-0.09	0.01	-0.04	0.06	0.23	0.03			-0.03
1978	Q	1.90	2.40	2.25	1.37	0.54	0.34	0.31	0.26	0.19	0.17	0.23	1.64	0.96		
	PQ	1.76	2.27	2.29	1.27	0.46	0.29	0.33	0.26	0.15	0.12	0.26	1.72		0.93	
	ER	-0.14	-0.13	0.04	-0.10	-0.08	-0.04	0.02	0.00	-0.04	-0.04	0.03	0.08			-0.03
1979	Q	1.51	2.18	1.78	1.27	0.68	0.62	0.35	0.39	0.30	0.47	1.16	2.68	1.11		
	PQ	1.76	1.99	1.69	1.15	0.67	0.56	0.33	0.52	0.35	0.67	1.29	2.37		1.11	
	ER	0.25	-0.19	-0.09	-0.11	-0.01	-0.05	-0.02	0.13	0.06	0.20	0.13	-0.31			0.00
1980	Q	1.79	2.71	1.32	1.07	0.43	0.38	0.30	0.36	0.71	1.47	1.63	1.74	1.15		
	PQ	1.90	2.50	1.35	0.98	0.35	0.42	0.29	0.38	0.85	1.69	1.53	1.62		1.15	
	ER	0.10	-0.20	0.03	-0.09	-0.09	0.04	-0.01	0.02	0.15	0.22	-0.10	-0.11			0.00
1981	Q	1.46	1.12	2.71	1.00	1.02	1.16	0.48	0.28	0.43	1.79	1.25	2.37	1.26		
	PQ	1.39	1.06	2.30	0.85	0.96	1.04	0.43	0.22	0.52	1.93	1.33	2.10		1.18	
	ER	-0.08	-0.05	-0.41	-0.15	-0.05	-0.12	-0.05	-0.06	0.08	0.14	0.07	-0.27			-0.08
1982	Q	1.95	1.27	2.41	0.77	0.41	0.41	0.38	0.31	0.37	1.66	2.48	2.69	1.26		
	PQ	2.00	1.19	2.26	0.73	0.34	0.47	0.45	0.42	0.45	1.88	2.46	2.67		1.28	
	ER	0.05	-0.08	-0.15	-0.04	-0.07	0.06	0.07	0.11	0.08	0.22	-0.02	-0.02			0.02
1983	Q	2.19	1.23	0.68	0.91	1.19	0.66	0.35	0.23	0.27	0.46	0.43	1.83	0.87		
	PQ	2.23	1.22	0.69	0.90	1.13	0.55	0.26	0.16	0.39	0.37	0.34	1.74		0.83	
	ER	0.04	0.00	0.01	-0.02	-0.07	-0.11	-0.08	-0.06	0.12	-0.09	-0.09	-0.09			-0.04
1984	Q	2.78	2.13	0.71	0.47	0.33	0.23	0.18	0.17	0.20	0.66	2.03	1.79	0.97		
	PQ	3.05	2.39	0.70	0.47	0.28	0.19	0.12	0.17	0.26	0.74	2.22	2.06		1.05	
	ER	0.27	0.26	-0.01	0.00	-0.05	-0.04	-0.06	0.00	0.06	0.08	0.19	0.27			0.08
1985	Q	1.60	1.57	0.88	1.85	0.58	0.41	0.31	0.82	0.77	0.52	0.57	1.74	0.96		
	PQ	1.44	1.51	0.95	1.63	0.52	0.49	0.36	1.05	0.85	0.60	0.63	1.74		0.98	
	ER	-0.17	-0.06	0.07	-0.22	-0.07	0.08	0.05	0.23	0.08	0.08	0.07	0.00			0.01
1986	Q	2.28	0.95	0.85	1.03	0.90	0.83	0.60	1.15	0.91	0.65	2.31	2.45	1.25		
	PQ	2.43	0.90	0.81	1.01	0.82	0.96	0.75	1.36	1.11	0.77	2.50	2.78		1.35	
	ER	0.15	-0.05	-0.04	-0.03	-0.08	0.13	0.15	0.21	0.20	0.13	0.19	0.32			0.11

SEATON AT TROWBROWNBRIDGE

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1987	Q	1.26	1.02	1.18	1.55	0.53	0.57	0.37	0.26	0.25	1.24	1.55	1.18	0.91		
	PQ	1.35	0.97	1.11	1.43	0.44	0.62	0.47	0.26	0.25	1.55	1.86	1.26		0.96	
	ER	0.08	-0.05	-0.07	-0.12	-0.09	0.05	0.10	0.00	0.00	0.31	0.31	0.08			0.05
1988	Q	2.53	2.58	1.20	1.04	0.59	0.36	0.43	0.48	0.77	1.46	0.70	1.04	1.09		
	PQ	2.38	2.87	1.31	1.07	0.59	0.29	0.49	0.48	0.77	1.70	0.72	1.10		1.14	
	ER	-0.15	0.29	0.11	0.03	0.01	-0.07	0.06	0.01	0.00	0.24	0.03	0.06			0.05
1989	Q	0.76	1.29	2.14	0.90	0.48	0.29	0.20	0.18	0.20	0.29	1.16	1.85	0.81		
	PQ	0.81	1.16	2.22	0.94	0.43	0.23	0.15	0.17	0.25	0.31	0.65	1.76		0.75	
	ER	0.05	-0.13	0.07	0.04	-0.04	-0.06	-0.05	-0.02	0.05	0.01	-0.51	-0.09			-0.06
MEAN	Q	1.82	1.86	1.43	0.99	0.62	0.48	0.33	0.37	0.48	0.91	1.23	1.83	1.03		
	PQ	1.85	1.83	1.39	0.92	0.56	0.44	0.33	0.42	0.56	1.01	1.29	1.83		1.03	
	ER	0.02	-0.03	-0.04	-0.07	-0.06	-0.03	0.00	0.05	0.08	0.10	0.06	0.00			0.01
S.D.	Q	0.63	0.82	0.64	0.36	0.23	0.23	0.10	0.25	0.36	0.60	0.68	0.50	0.19		
	PQ	0.65	0.85	0.59	0.32	0.23	0.25	0.16	0.33	0.45	0.65	0.72	0.47		0.22	

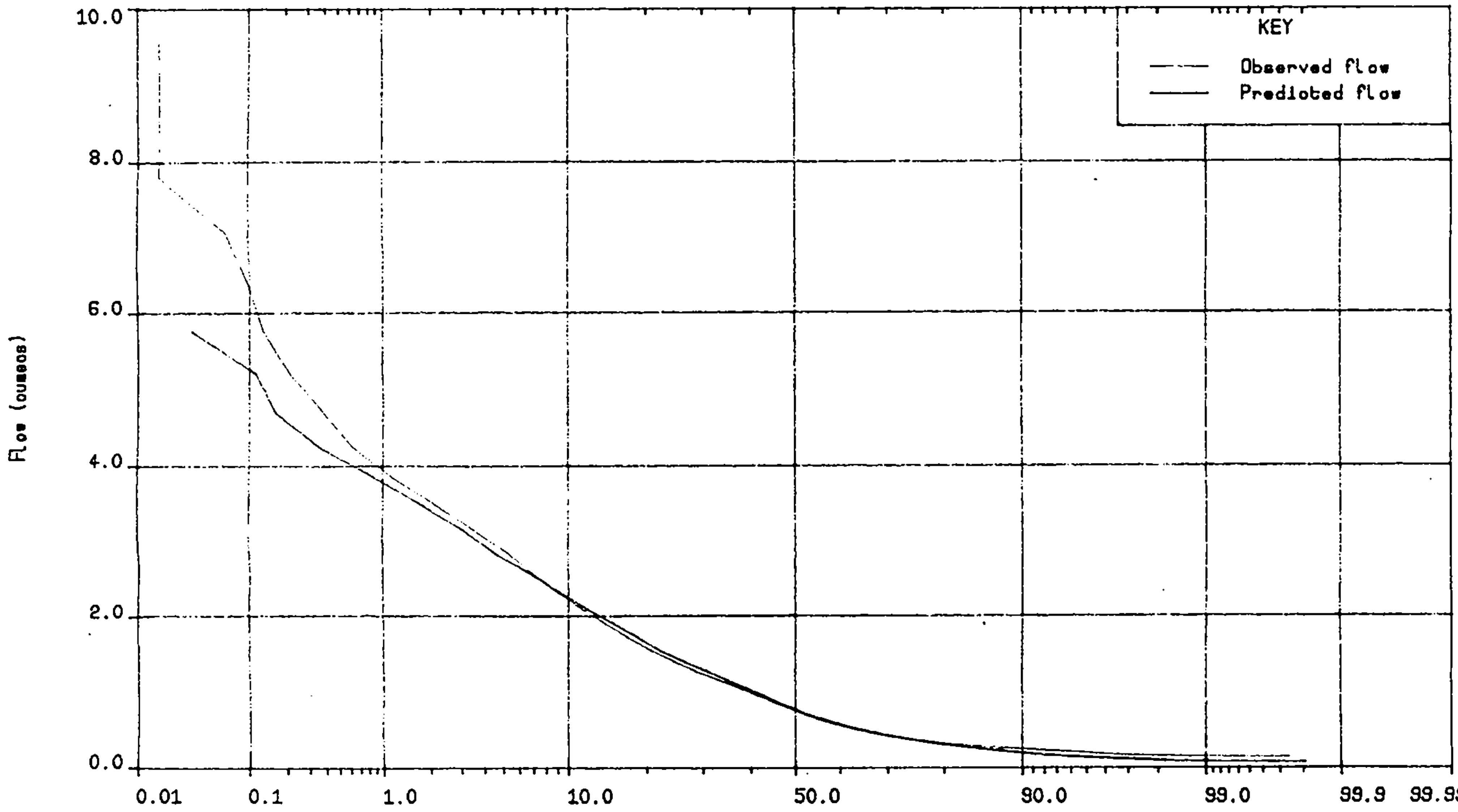
SEATON AT TROWBROWNBRIDGE

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

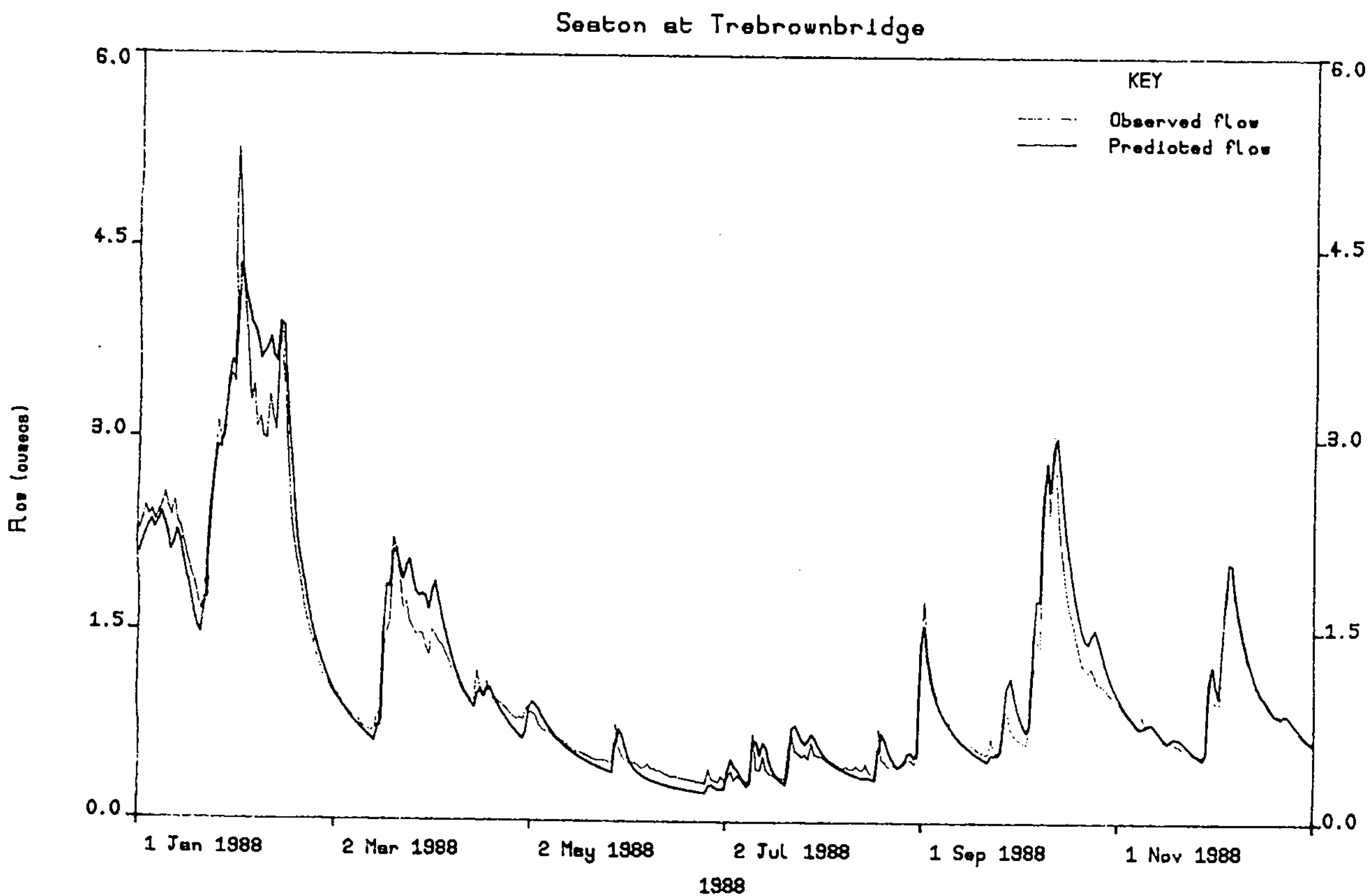
INTERVAL 0.3291 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	323.3	5.08	5.08	1320	21.26	21.26	285.2	4.44	4.44	1358	21.87	21.87
2	736.5	11.57	16.64	1551	24.98	46.24	695.2	10.83	15.28	1441	23.21	45.08
3	731.4	11.49	28.13	893	14.38	60.62	706.8	11.02	26.30	870	14.01	59.09
4	859.1	13.49	41.62	749	12.06	72.68	830.3	12.94	39.24	721	11.61	70.70
5	763.3	11.99	53.60	520	8.37	81.06	809.2	12.61	51.85	550	8.86	79.56
6	656.9	10.32	63.92	365	5.88	86.94	688.6	10.73	62.58	383	6.17	85.73
7	520.3	8.17	72.09	244	3.93	90.87	630.3	9.82	72.40	296	4.77	90.50
8	396.5	6.23	78.32	162	2.61	93.48	511.7	7.98	80.38	207	3.33	93.83
9	325.3	5.11	83.42	117	1.88	95.36	398.2	6.21	86.58	143	2.30	96.13
10	348.4	5.47	88.89	112	1.80	97.17	262.4	4.09	90.67	84	1.35	97.49
11	230.5	3.62	92.51	67	1.08	98.24	238.1	3.71	94.38	69	1.11	98.60
12	185.2	2.91	95.42	49	0.79	99.03	166.0	2.59	96.97	44	0.71	99.31
13	90.0	1.41	96.83	22	0.35	99.39	90.3	1.41	98.38	22	0.35	99.66
14	66.7	1.05	97.88	15	0.24	99.63	35.2	0.55	98.93	8	0.13	99.79
15	33.9	0.53	98.41	7	0.11	99.74	23.7	0.37	99.30	5	0.08	99.87
16	15.3	0.24	98.65	3	0.05	99.79	5.2	0.08	99.38	1	0.02	99.89
17	21.6	0.34	98.99	4	0.06	99.85	16.2	0.25	99.63	3	0.05	99.94
18	5.8	0.09	99.08	1	0.02	99.87	17.3	0.27	99.90	3	0.05	99.98
19	6.0	0.09	99.18	1	0.02	99.89	6.0	0.09	99.99	1	0.02	100.00
20	12.9	0.20	99.38	2	0.03	99.92	0.0	0.00	99.99	0	0.00	100.00
21	0.0	0.00	99.38	0	0.00	99.92	0.0	0.00	99.99	0	0.00	100.00
22	7.0	0.11	99.49	1	0.02	99.94	0.0	0.00	99.99	0	0.00	100.00
23	14.9	0.23	99.72	2	0.03	99.97	0.0	0.00	99.99	0	0.00	100.00
24	7.7	0.12	99.84	1	0.02	99.98	0.0	0.00	99.99	0	0.00	100.00
25	0.0	0.00	99.84	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
26	0.0	0.00	99.84	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.84	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.84	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.84	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
30	9.5	0.15	99.99	1	0.02	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	6368.3			6209			6416.1			6209		

Seaton at Trebrownbridge



1/ 1/73 to 31/12/89


Seaton at Trebrownbridge
KEY
Observed flow
Predicted flow
flow (cumecs)
6.0
4.5
3.0
1.5
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

J. Tiddy to Tideford (047009) Area 37.2 km^2

Natural catchment, simple Crump Weir.

Observed flows 1969-89.

Model optimised on period 1980-85.

Comparison of the model predicted and observed flows for the period 1970-80 is summarised in the following tables and diagrams.

1969 was omitted because of missing rainfall records as was the period from 1981 onwards.

The cumulative volume prediction over the period is within 0.1% of the observed flow.

The volume and time distributions over the flow range demonstrate that the good cumulative volume agreement is somewhat fortuitous. The model tends to underestimate at the very low flows, overestimate in the middle range and underestimate at the very high flows, as is demonstrated in the flow distribution table and in the flow duration curve. Despite this relatively poor performance on the fine structure of the hydrograph, the reasons for which are not fully understood at present, the summary tables show that annual totals are generally predicted to better than 10%.

The record has been extended using the model to cover the period from 1957 until records began in 1969. The daily values in this synthetic period of record must be treated with caution but the cumulative volume totals over periods of a year or longer should be acceptable.

TIDDY AT TIDEFORD

MONTHLY FLOW, PREDICTED FLOW AND ERROR

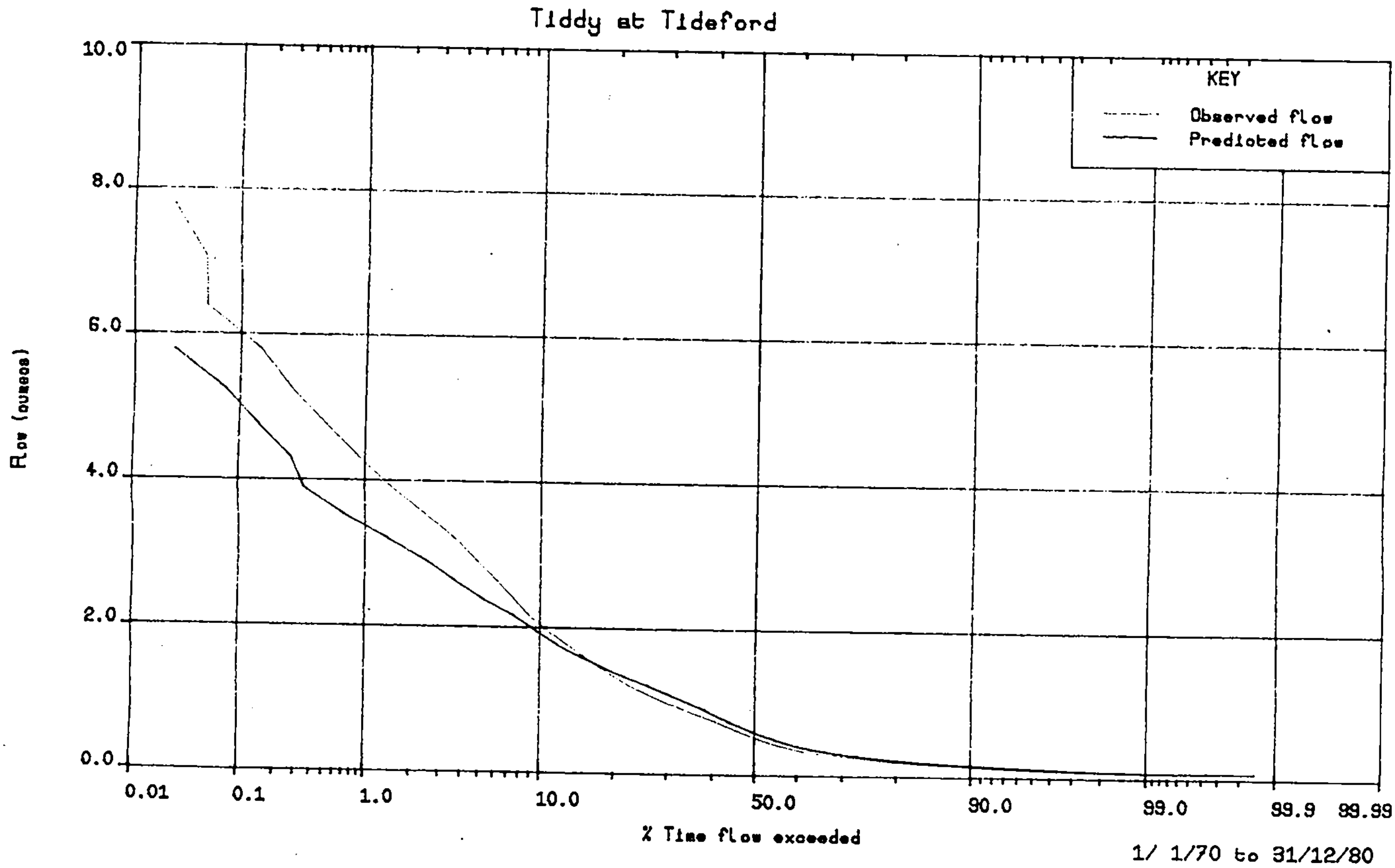
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1970	Q	2.52	2.36	0.82	0.64	0.47	0.22	0.17	0.31	0.49	0.25	1.58	1.03	0.89		
	PQ	2.16	2.42	1.13	0.78	0.49	0.25	0.24	0.44	0.54	0.33	1.40	1.34		0.95	
	ER	-0.36	0.05	0.31	0.14	0.02	0.04	0.07	0.14	0.05	0.08	-0.18	0.30			0.06
1971	Q	1.97	1.04	0.76	0.41	0.25	0.22	0.14	0.26	0.15	0.32	0.68	1.36	0.63		
	PQ	1.69	1.40	0.86	0.43	0.23	0.33	0.17	0.31	0.12	0.34	0.73	1.56		0.68	
	ER	-0.29	0.36	0.10	0.02	-0.02	0.10	0.03	0.05	-0.03	0.02	0.05	0.20			0.05
1972	Q	1.75	1.94	1.55	0.78	1.20	1.05	0.43	0.28	0.21	0.21	1.40	2.54	1.11		
	PQ	1.81	2.13	1.29	0.81	0.93	0.79	0.49	0.34	0.25	0.23	0.96	2.40		1.03	
	ER	0.06	0.20	-0.26	0.03	-0.27	-0.26	0.06	0.05	0.03	0.02	-0.44	-0.14			-0.08
1973	Q	1.22	1.07	0.66	0.43	0.46	0.33	0.23	0.25	0.18	0.47	0.40	1.42	0.59		
	PQ	1.42	1.42	0.73	0.64	0.41	0.28	0.19	0.19	0.20	0.32	0.43	1.44		0.64	
	ER	0.21	0.35	0.07	0.21	-0.05	-0.04	-0.03	-0.06	0.02	-0.15	0.02	0.02			0.04
1974	Q	2.58	3.36	1.05	0.45	0.65	0.32	0.19	0.29	1.50	1.28	1.68	1.53	1.23		
	PQ	2.59	3.55	1.12	0.41	0.45	0.21	0.18	0.31	1.53	1.58	1.69	1.65		1.26	
	ER	0.01	0.19	0.07	-0.03	-0.19	-0.11	-0.01	0.02	0.02	0.30	0.01	0.12			0.03
1975	Q	2.05	1.25	0.72	0.55	0.40	0.20	0.20	0.15	0.22	0.31	0.73	0.91	0.64		
	PQ	2.05	1.61	0.83	0.58	0.39	0.21	0.30	0.19	0.26	0.23	0.64	0.91		0.68	
	ER	0.00	0.36	0.11	0.03	-0.01	0.01	0.10	0.04	0.04	-0.08	-0.10	0.00			0.04
1976	Q	0.40	1.03	1.34	0.47	0.24	0.15	0.11	0.08	0.14	1.80	1.21	1.78	0.73		
	PQ	0.69	1.14	1.05	0.53	0.27	0.18	0.12	0.09	0.29	1.11	0.90	1.57		0.66	
	ER	0.29	0.11	-0.29	0.06	0.03	0.03	0.01	0.01	0.15	-0.69	-0.31	-0.22			-0.07
1977	Q	1.79	2.79	1.42	0.78	0.54	0.28	0.17	0.17	0.16	0.19	0.96	1.70	0.90		
	PQ	1.63	2.42	1.32	0.74	0.49	0.27	0.17	0.26	0.16	0.27	0.89	1.44		0.83	
	ER	-0.17	-0.38	-0.10	-0.04	-0.05	-0.01	0.01	0.09	0.01	0.08	-0.06	-0.26			-0.07
1978	Q	1.70	2.15	1.99	1.11	0.36	0.21	0.20	0.16	0.11	0.09	0.14	1.73	0.82		
	PQ	1.47	1.94	1.89	1.04	0.39	0.24	0.31	0.26	0.13	0.12	0.32	1.66		0.81	
	ER	-0.23	-0.20	-0.11	-0.07	0.03	0.03	0.11	0.10	0.03	0.02	0.18	-0.06			-0.01
1979	Q	1.18	1.95	1.62	1.05	0.52	0.50	0.22	0.26	0.19	0.39	1.08	2.49	0.95		
	PQ	1.54	1.42	1.52	0.94	0.52	0.41	0.22	0.52	0.28	0.57	1.09	2.15		0.93	
	ER	0.36	-0.53	-0.09	-0.11	0.00	-0.09	0.00	0.26	0.09	0.18	0.01	-0.34			-0.02
1980	Q	1.53	2.36	1.08	0.84	0.25	0.26	0.22	0.24	0.60	1.34	1.34	1.50	0.96		
	PQ	1.77	2.26	1.22	0.85	0.31	0.41	0.27	0.27	0.57	1.16	1.32	1.39		0.98	
	ER	0.24	-0.07	0.14	0.01	0.05	0.15	0.05	0.03	-0.03	-0.18	-0.02	-0.11			0.02
MEAN	Q	1.70	1.94	1.18	0.68	0.49	0.34	0.21	0.22	0.36	0.60	1.02	1.63	0.86		
	PQ	1.71	1.97	1.18	0.71	0.45	0.33	0.24	0.29	0.39	0.57	0.94	1.59		0.86	
	ER	0.01	0.04	0.00	0.02	-0.04	-0.01	0.04	0.07	0.04	-0.04	-0.08	-0.04			0.00
S.D.	Q	0.62	0.77	0.44	0.25	0.27	0.25	0.08	0.07	0.41	0.58	0.49	0.51	0.20		
	PQ	0.48	0.69	0.33	0.20	0.19	0.17	0.10	0.12	0.40	0.49	0.42	0.40		0.19	

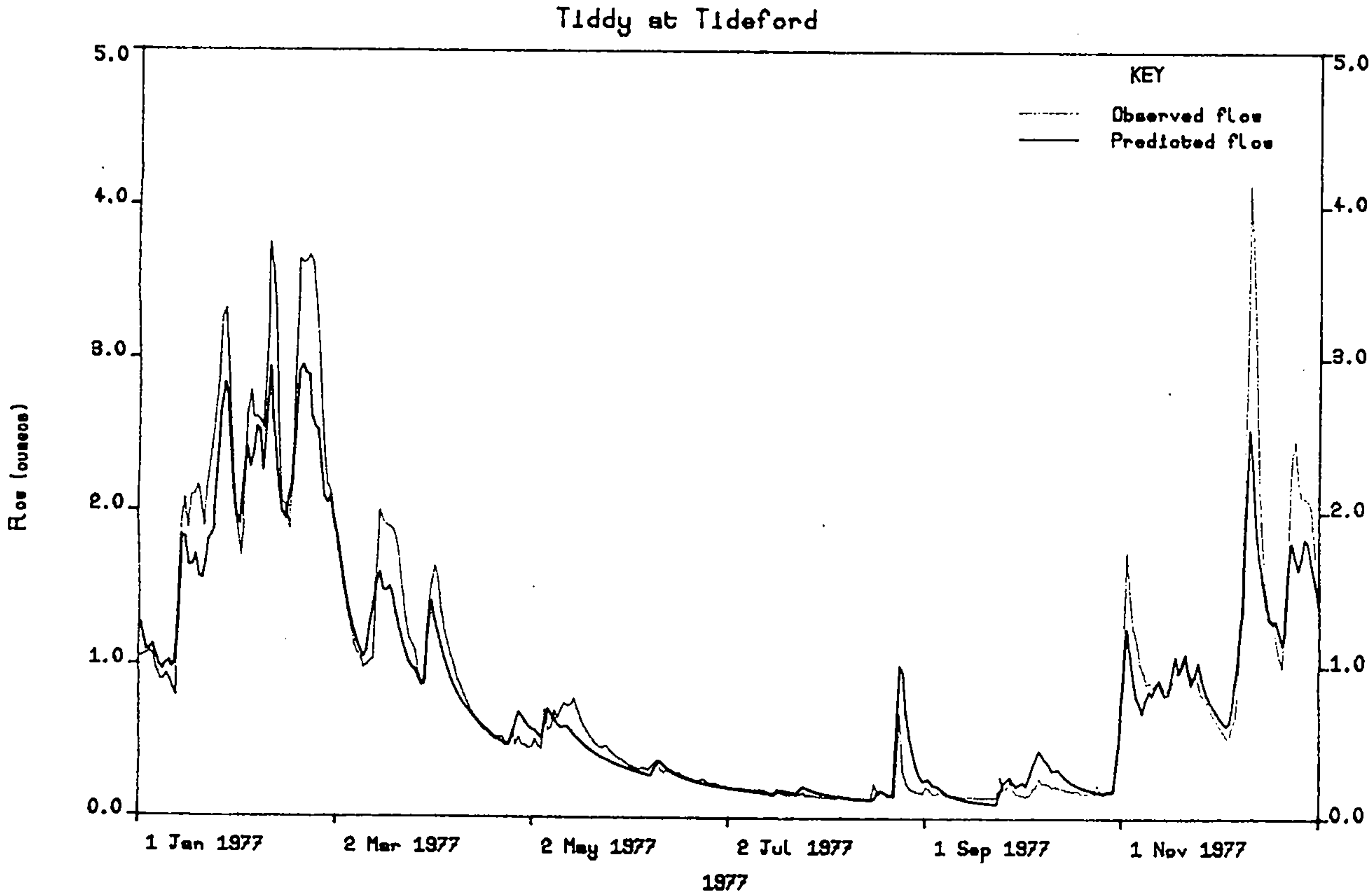
TIDDY AT TIDEFORD

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.2686 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	216.8	6.28	6.28	1225	30.49	30.49	188.2	5.46	5.46	1046	26.03	26.03
2	314.1	9.10	15.38	835	20.78	51.27	326.5	9.46	14.92	858	21.35	47.39
3	315.2	9.13	24.51	468	11.65	62.92	304.2	8.82	23.74	459	11.42	58.81
4	406.1	11.76	36.27	433	10.78	73.69	381.7	11.06	34.80	404	10.05	68.87
5	320.5	9.29	45.56	269	6.69	80.39	474.1	13.74	48.54	394	9.81	78.67
6	253.1	7.33	52.89	172	4.28	84.67	381.5	11.06	59.60	260	6.47	85.14
7	248.9	7.21	60.10	143	3.56	88.23	288.1	8.35	67.95	166	4.13	89.27
8	218.5	6.33	66.43	109	2.71	90.94	242.6	7.03	74.99	121	3.01	92.28
9	154.2	4.47	70.90	68	1.69	92.63	235.9	6.84	81.82	104	2.59	94.87
10	154.5	4.48	75.37	60	1.49	94.13	167.8	4.86	86.69	66	1.64	96.52
11	141.1	4.09	79.46	50	1.24	95.37	141.4	4.10	90.78	50	1.24	97.76
12	120.6	3.49	82.95	39	0.97	96.34	110.5	3.20	93.99	36	0.90	98.66
13	147.3	4.27	87.22	44	1.10	97.44	66.7	1.93	95.92	20	0.50	99.15
14	116.2	3.37	90.59	32	0.80	98.23	54.1	1.57	97.49	15	0.37	99.53
15	74.1	2.15	92.73	19	0.47	98.71	19.0	0.55	98.04	5	0.12	99.65
16	53.5	1.55	94.28	13	0.32	99.03	12.3	0.36	98.40	3	0.07	99.73
17	57.3	1.66	95.94	13	0.32	99.35	9.0	0.26	98.66	2	0.05	99.78
18	37.8	1.09	97.04	8	0.20	99.55	14.1	0.41	99.07	3	0.07	99.85
19	19.8	0.57	97.61	4	0.10	99.65	5.0	0.14	99.21	1	0.02	99.88
20	31.3	0.91	98.52	6	0.15	99.80	15.8	0.46	99.67	3	0.07	99.95
21	0.0	0.00	98.52	0	0.00	99.80	5.5	0.16	99.83	1	0.02	99.97
22	17.4	0.50	99.02	3	0.07	99.88	5.9	0.17	100.00	1	0.02	100.00
23	6.1	0.18	99.20	1	0.02	99.90	0.0	0.00	100.00	0	0.00	100.00
24	12.6	0.36	99.56	2	0.05	99.95	0.0	0.00	100.00	0	0.00	100.00
25	0.0	0.00	99.56	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
26	0.0	0.00	99.56	0	0.00	99.95	0.0	0.00	100.00	0	0.00	100.00
27	7.2	0.21	99.77	1	0.02	99.97	0.0	0.00	100.00	0	0.00	100.00
28	0.0	0.00	99.77	0	0.00	99.97	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.77	0	0.00	99.97	0.0	0.00	100.00	0	0.00	100.00
30	7.8	0.23	100.00	1	0.02	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	3452.0			4018			3449.9			4018		


Tiddy at Tideford
KEY
Observed flow
Predicted flow
10.0
8.0
6.0
4.0
2.0
0.0
Flow (cumecs)
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/70 to 31/12/80


Tiddy at Tideford
KEY
Observed flow
Predicted flow
Flow (cumecs)
5.0
4.0
3.0
2.0
1.0
0.0
1 Jan 1977
2 Mar 1977
2 May 1977
2 Jul 1977
1 Sep 1977
1 Nov 1977
1977

K. Gannel to Gwills (049004) Area 41.0 km^2

Simple Crump Weir (insensitive at low flows).

Some modification may occur as the result of mine drainage. In the absence of any data on this the catchment has been treated as a natural one.

Model optimised on period 4/84 - 12/89.

Comparison of the model predicted and observed flows over the period 1970 - 89 is summarised in the following tables and diagrams.

The cumulative flow prediction over the period is within 5% of the observed flow.

The volume and time distributions over the flow range are in reasonable agreement for 99% of the time and some 95% of the volume, with the expected underestimation on the extreme peaks. This is further illustrated in the flow duration curve.

Because 1988 formed part of the optimisation period the time series plot is not presented. Instead the time series plots from 1976 to 1977 are shown. The period from September 1976, the recovery from the extremely dry summer, illustrates a problem encountered in modelling a number of the catchments. Because of the structural constraint in the model, described in 6.3.2, the rapid runoff response to the first storms on the very dry catchment are overestimated. As a result the initial recharge and resulting rise in baseflow is underestimated. By mid-December the model has 'caught up' with the catchment and the fit during 1977 is very good, apart from the extreme peaks.

The flow record has been extended using the model to cover the period from 1939.

GANNEL AT GWILLIS

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		MONTH JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	PFLOW	ER
1970	Q	1.99	1.59	0.70	0.39	0.27	0.15	0.13	0.17	0.14	0.10	0.97	0.85	0.62		
	PQ	1.81	1.81	0.71	0.41	0.33	0.18	0.14	0.26	0.18	0.13	1.37	1.13		0.70	
	ER	-0.19	0.22	0.01	0.02	0.06	0.03	0.01	0.09	0.04	0.03	0.39	0.28			0.08
1971	Q	1.32	1.00	0.66	0.42	0.25	0.25	0.13	0.22	0.11	0.13	0.71	0.94	0.51		
	PQ	1.50	1.30	0.79	0.45	0.27	0.33	0.24	0.34	0.17	0.24	0.79	1.25		0.63	
	ER	0.17	0.30	0.13	0.03	0.02	0.08	0.11	0.12	0.05	0.11	0.08	0.31			0.13
1972	Q	1.55	2.27	1.23	0.39	0.30	0.57	0.26	0.22	0.15	0.18	0.91	1.83	0.82		
	PQ	1.66	2.49	1.31	0.38	0.29	0.50	0.27	0.27	0.19	0.24	1.06	2.23		0.90	
	ER	0.11	0.22	0.08	-0.01	-0.01	-0.07	0.00	0.05	0.03	0.06	0.15	0.40			0.08
1973	Q	1.44	1.19	0.67	0.34	0.26	0.16	0.14	0.17	0.13	0.26	0.32	0.99	0.50		
	PQ	1.66	1.41	0.69	0.28	0.24	0.19	0.14	0.27	0.23	0.45	0.51	1.30		0.61	
	ER	0.22	0.22	0.02	-0.06	-0.02	0.03	0.00	0.10	0.10	0.19	0.19	0.31			0.11
1974	Q	2.39	2.73	0.93	0.41	0.35	0.19	0.15	0.21	0.74	1.10	1.30	0.98	0.95		
	PQ	2.53	2.88	1.12	0.41	0.27	0.17	0.15	0.23	0.82	1.11	1.31	0.95		0.98	
	ER	0.13	0.16	0.19	0.00	-0.07	-0.02	-0.01	0.03	0.08	0.00	0.01	-0.03			0.04
1975	Q	1.39	1.06	0.77	0.65	0.36	0.18	0.15	0.25	0.30	0.34	0.72	0.98	0.59		
	PQ	1.24	1.04	0.75	0.63	0.33	0.18	0.25	0.38	0.41	0.42	0.83	1.01		0.62	
	ER	-0.15	-0.02	-0.02	-0.02	-0.03	0.00	0.10	0.12	0.10	0.08	0.11	0.02			0.02
1976	Q	0.58	0.89	1.53	0.59	0.28	0.16	0.09	0.07	0.14	0.73	0.83	1.67	0.63		
	PQ	0.61	1.03	1.50	0.69	0.27	0.16	0.11	0.09	0.34	0.56	0.36	1.35		0.59	
	ER	0.03	0.14	-0.03	0.09	0.00	0.00	0.02	0.02	0.20	-0.17	-0.47	-0.31			-0.04
1977	Q	1.67	2.01	1.28	0.63	0.44	0.36	0.20	0.27	0.19	0.82	1.03	1.73	0.88		
	PQ	1.62	2.02	1.30	0.66	0.38	0.35	0.18	0.34	0.23	0.73	1.18	1.70		0.88	
	ER	-0.05	0.01	0.01	0.03	-0.06	-0.01	-0.02	0.07	0.04	-0.10	0.15	-0.03			0.00
1978	Q	1.36	2.01	1.65	0.99	0.36	0.20	0.16	0.14	0.09	0.08	0.10	1.03	0.67		
	PQ	1.39	2.01	1.67	0.96	0.37	0.20	0.24	0.15	0.08	0.06	0.16	1.40		0.72	
	ER	0.03	-0.01	0.02	-0.04	0.01	0.00	0.08	0.01	-0.01	-0.02	0.07	0.37			0.04
1979	Q	1.08	1.72	1.49	0.97	0.46	0.35	0.19	0.21	0.16	0.47	0.77	1.70	0.79		
	PQ	1.53	1.93	1.56	1.02	0.47	0.48	0.28	0.34	0.21	0.71	0.99	1.46		0.91	
	ER	0.45	0.21	0.07	0.05	0.01	0.13	0.09	0.14	0.04	0.24	0.22	-0.24			0.12
1980	Q	1.65	2.14	0.96	0.78	0.30	0.25	0.17	0.13	0.28	0.67	0.99	0.97	0.77		
	PQ	1.69	2.21	0.99	0.83	0.30	0.29	0.15	0.09	0.37	0.89	1.03	1.08		0.82	
	ER	0.04	0.06	0.03	0.05	0.00	0.04	-0.02	-0.04	0.08	0.23	0.04	0.11			0.05
1981	Q	0.77	0.78	1.59	0.62	0.76	0.55	0.31	0.18	0.30	1.04	0.90	2.21	0.84		
	PQ	0.83	0.83	1.60	0.61	1.05	0.75	0.32	0.18	0.49	1.27	0.89	2.04		0.91	
	ER	0.07	0.04	0.01	-0.02	0.29	0.20	0.02	0.00	0.19	0.23	-0.01	-0.17			0.07
1982	Q	1.58	1.04	1.39	0.51	0.28	0.25	0.16	0.15	0.15	0.84	2.04	1.79	0.85		
	PQ	1.97	1.11	1.35	0.46	0.22	0.27	0.16	0.15	0.19	0.66	1.75	1.79		0.84	
	ER	0.39	0.07	-0.04	-0.05	-0.05	0.02	0.00	-0.01	0.03	-0.18	-0.30	0.00			-0.01
1983	Q	1.44	0.65	0.42	0.61	0.86	0.38	0.18	0.12	0.14	0.21	0.21	0.93	0.51		
	PQ	1.44	0.64	0.36	0.50	0.47	0.24	0.15	0.11	0.16	0.32	0.17	0.57		0.43	
	ER	0.01	-0.01	-0.06	-0.11	-0.39	-0.14	-0.03	-0.02	0.02	0.11	-0.03	-0.37			-0.09

GANNEL AT GWILLIS

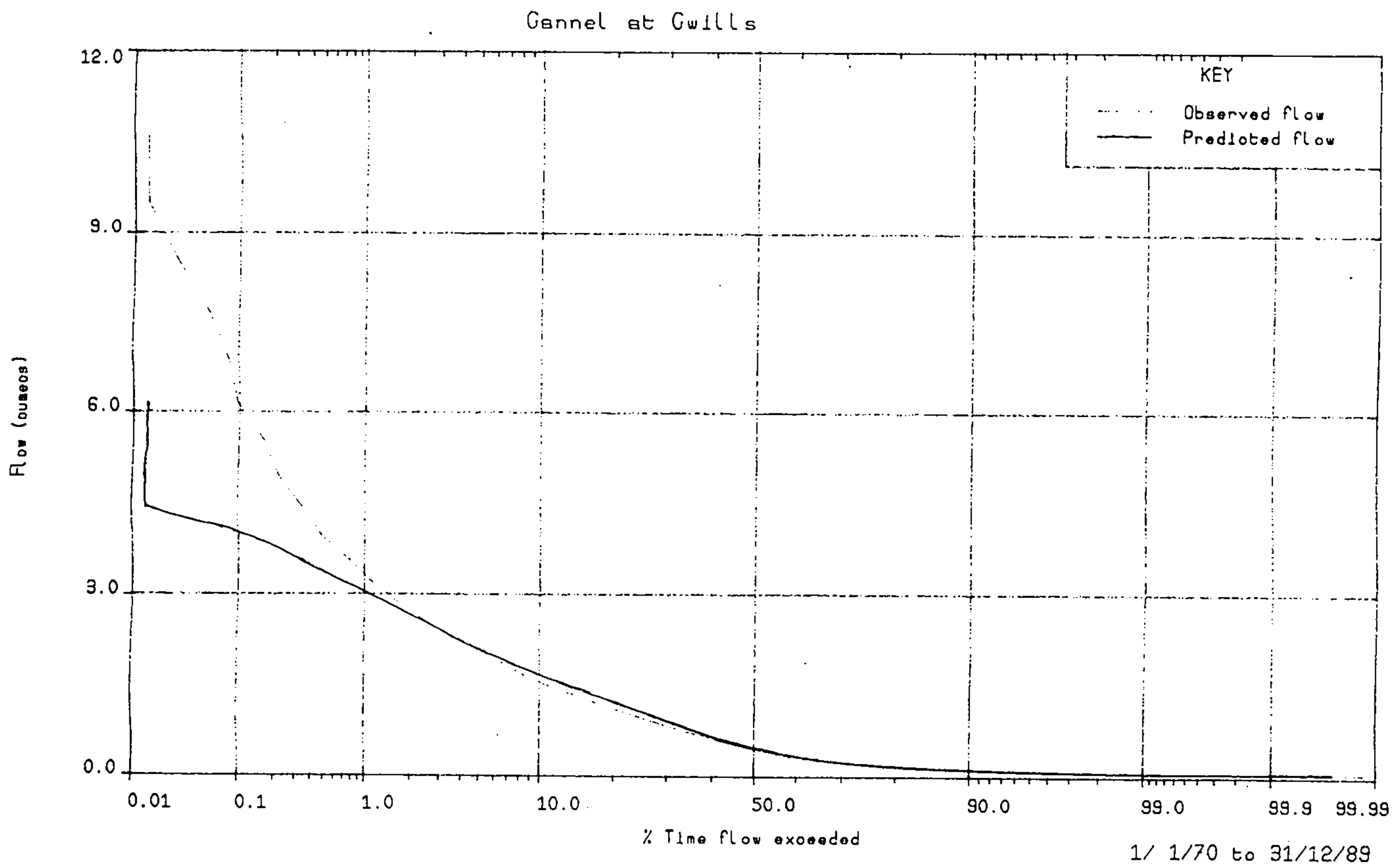
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1984	Q	1.58	1.26	0.58	0.36	0.27	0.16	0.10	0.09	0.09	0.20	0.99	1.36	0.58		
	PQ	1.36	1.38	0.67	0.39	0.25	0.14	0.15	0.13	0.23	0.29	1.30	1.60		0.65	
	ER	-0.22	0.12	0.09	0.03	-0.02	-0.02	0.05	0.05	0.13	0.09	0.31	0.23			0.07
1985	Q	1.23	1.05	0.72	1.07	0.40	0.26	0.16	0.30	0.30	0.31	0.28	0.94	0.58		
	PQ	1.06	0.85	0.71	0.85	0.38	0.28	0.16	0.31	0.33	0.29	0.25	0.81		0.52	
	ER	-0.17	-0.20	-0.01	-0.21	-0.01	0.02	-0.01	0.02	0.03	-0.02	-0.03	-0.13			-0.06
1986	Q	1.75	0.82	0.49	0.55	0.44	0.62	0.39	0.47	0.37	0.30	1.36	1.93	0.79		
	PQ	1.56	0.77	0.44	0.62	0.49	0.66	0.54	0.62	0.48	0.41	1.43	1.88		0.83	
	ER	-0.19	-0.04	-0.05	0.07	0.05	0.03	0.15	0.15	0.11	0.11	0.08	-0.06			0.03
1987	Q	0.80	0.70	0.59	1.01	0.35	0.25	0.20	0.12	0.11	0.71	1.40	0.84	0.59		
	PQ	0.84	0.63	0.56	0.64	0.26	0.23	0.20	0.09	0.09	0.84	1.52	0.93		0.57	
	ER	0.04	-0.06	-0.03	-0.37	-0.09	-0.02	-0.01	-0.03	-0.02	0.13	0.12	0.08			-0.02
1988	Q	2.05	1.72	1.15	0.81	0.37	0.22	0.38	0.29	0.30	1.16	0.58	0.98	0.83		
	PQ	1.75	2.08	1.28	0.82	0.30	0.18	0.38	0.26	0.32	1.14	0.61	1.08		0.85	
	ER	-0.30	0.37	0.13	0.01	-0.07	-0.04	0.00	-0.04	0.02	-0.02	0.03	0.10			0.01
1989	Q	0.53	0.93	1.28	0.64	0.31	0.18	0.12	0.07	0.09	0.16	0.49	1.11	0.49		
	PQ	0.67	0.88	1.36	0.62	0.30	0.17	0.12	0.09	0.26	0.34	0.33	0.70		0.49	
	ER	0.14	-0.05	0.09	-0.03	-0.01	0.00	0.00	0.02	0.17	0.19	-0.15	-0.41			0.00
MEAN	Q	1.41	1.38	1.00	0.64	0.38	0.28	0.19	0.19	0.22	0.49	0.84	1.29	0.69		
	PQ	1.43	1.46	1.04	0.61	0.36	0.30	0.22	0.23	0.29	0.56	0.89	1.31		0.72	
	ER	0.03	0.09	0.03	-0.03	-0.02	0.01	0.03	0.04	0.07	0.07	0.05	0.02			0.03
S.D.	Q	0.48	0.60	0.40	0.23	0.16	0.15	0.08	0.09	0.15	0.36	0.47	0.44	0.15		
	PQ	0.46	0.67	0.42	0.21	0.18	0.17	0.11	0.13	0.17	0.35	0.48	0.45		0.16	

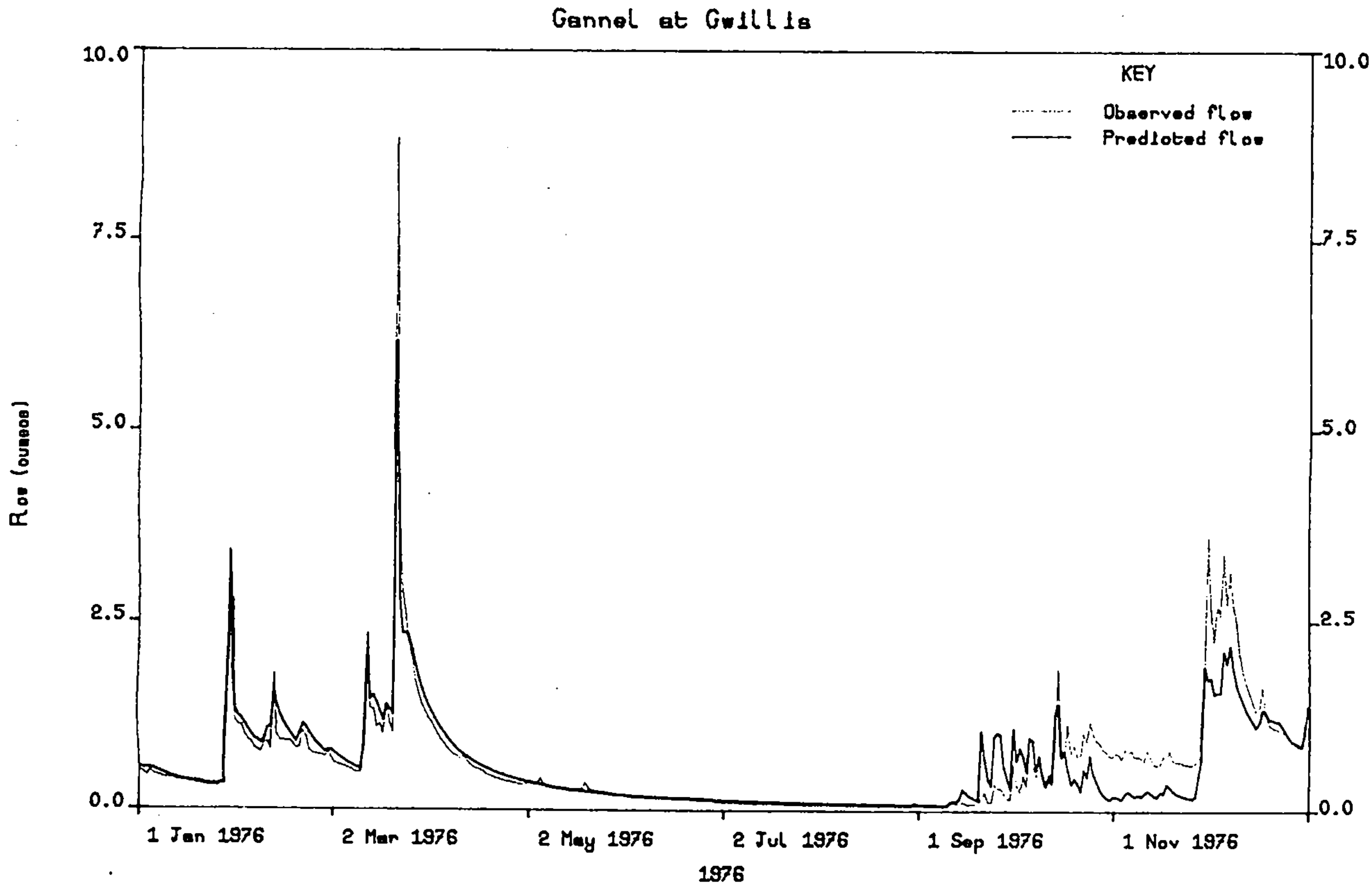
GANNEL AT GWILLIS

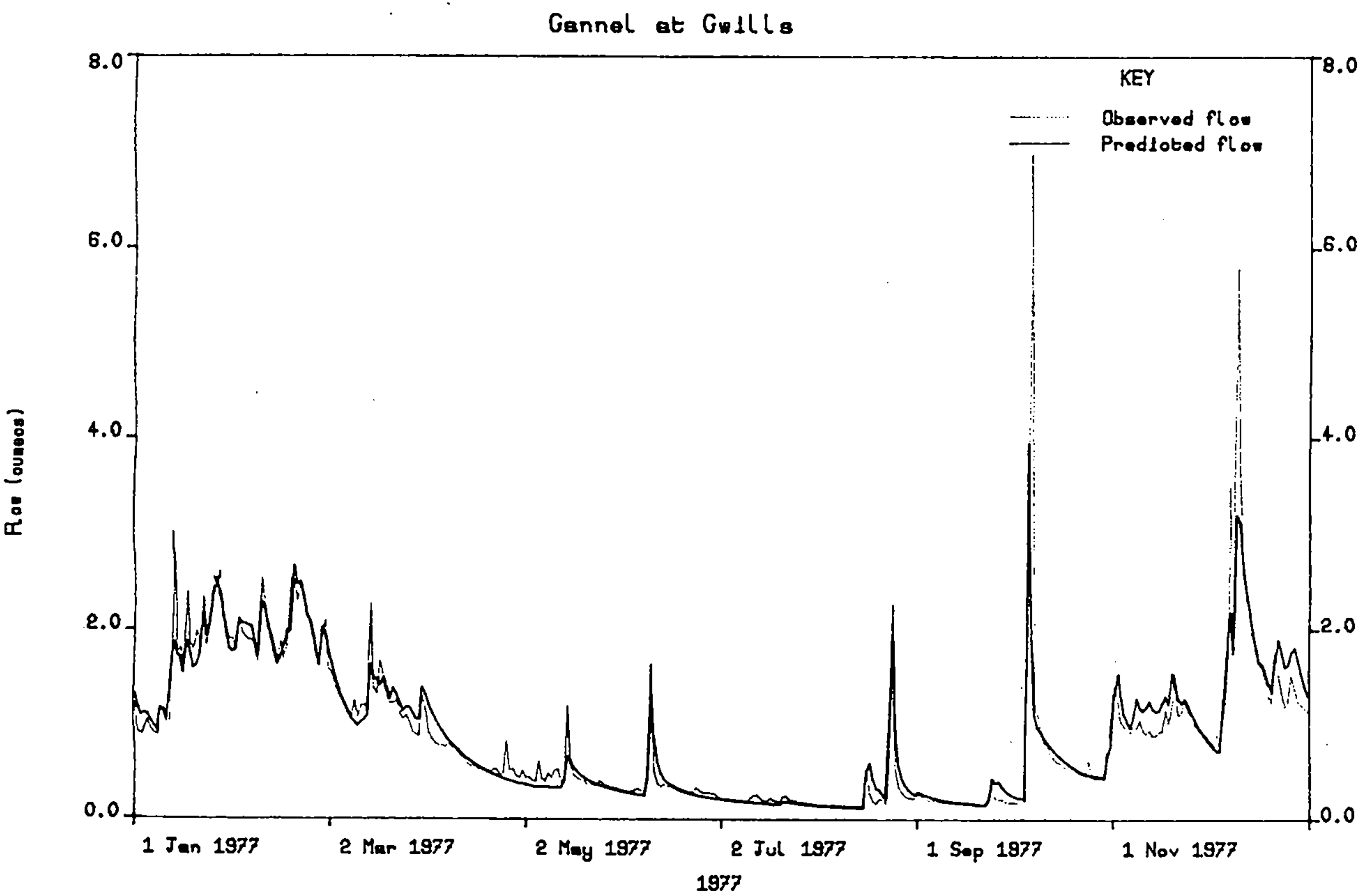
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.3655 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	635.2	12.60	12.60	3273	44.80	44.80	595.7	11.29	11.29	3054	41.81	41.81
2	829.8	16.46	29.07	1549	21.20	66.01	838.0	15.88	27.17	1593	21.81	63.61
3	911.4	18.08	47.15	1015	13.89	79.90	861.8	16.34	43.51	954	13.06	76.67
4	802.5	15.92	63.07	635	8.69	88.60	862.2	16.34	59.85	680	9.31	85.98
5	528.1	10.48	73.55	325	4.45	93.05	747.2	14.16	74.01	457	6.26	92.24
6	411.6	8.17	81.71	206	2.82	95.87	507.1	9.61	83.62	254	3.48	95.72
7	283.3	5.62	87.34	120	1.64	97.51	322.5	6.11	89.74	137	1.88	97.59
8	189.5	3.76	91.10	70	0.96	98.47	234.5	4.44	94.18	86	1.18	98.77
9	117.4	2.33	93.42	38	0.52	98.99	148.9	2.82	97.00	48	0.66	99.42
10	80.0	1.59	95.01	23	0.31	99.30	79.9	1.52	98.52	23	0.31	99.74
11	64.9	1.29	96.30	17	0.23	99.53	42.3	0.80	99.32	11	0.15	99.89
12	29.5	0.59	96.88	7	0.10	99.63	24.8	0.47	99.79	6	0.08	99.97
13	36.6	0.73	97.61	8	0.11	99.74	4.4	0.08	99.87	1	0.01	99.99
14	19.7	0.39	98.00	4	0.05	99.79	0.0	0.00	99.87	0	0.00	99.99
15	16.1	0.32	98.32	3	0.04	99.84	0.0	0.00	99.87	0	0.00	99.99
16	17.1	0.34	98.66	3	0.04	99.88	0.0	0.00	99.87	0	0.00	99.99
17	11.9	0.24	98.90	2	0.03	99.90	6.2	0.12	99.99	1	0.01	100.00
18	6.3	0.12	99.02	1	0.01	99.92	0.0	0.00	99.99	0	0.00	100.00
19	0.0	0.00	99.02	0	0.00	99.92	0.0	0.00	99.99	0	0.00	100.00
20	13.9	0.28	99.30	2	0.03	99.95	0.0	0.00	99.99	0	0.00	100.00
21	7.7	0.15	99.45	1	0.01	99.96	0.0	0.00	99.99	0	0.00	100.00
22	7.8	0.15	99.60	1	0.01	99.97	0.0	0.00	99.99	0	0.00	100.00
23	0.0	0.00	99.60	0	0.00	99.97	0.0	0.00	99.99	0	0.00	100.00
24	0.0	0.00	99.60	0	0.00	99.97	0.0	0.00	99.99	0	0.00	100.00
25	8.8	0.18	99.78	1	0.01	99.99	0.0	0.00	99.99	0	0.00	100.00
26	0.0	0.00	99.78	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.78	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.78	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.78	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
30	10.6	0.21	99.99	1	0.01	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	5040.1			7305			5276.0			7305		


Gannel at Gwills
KEY
Observed flow
Predicted flow
Flow (cumecs)
12.0
9.0
6.0
3.0
0.0
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/70 to 31/12/89


Gannel at Gwillis
Flow (cumecs)
10.0
7.5
5.0
2.5
0.0
KEY
Observed flow
Predicted flow
1 Jan 1976
2 Mar 1976
2 May 1976
2 Jul 1976
1 Sep 1976
1 Nov 1976
1976



Gannel at Gwills
KEY
Observed flow
Predicted flow
Flow (cumecs)
8.0
6.0
4.0
2.0
0.0
1 Jan 1977
2 Mar 1977
2 May 1977
2 Jul 1977
1 Sep 1977
1 Nov 1977
1977

L. Fal to Tregony (048003) Area 87.0 km^2

Velocity-area station with low flow flume.

Flows modified by industrial abstractions and returns.

In the absence of quantitative data on these, the flows have been treated as natural.

Observed flows said to the unreliable till mid 1978.

Model optimised on period 4/84 - 12/88.

Comparison of the model predicted and observed flows for the period 1979-89 is summarised in the following tables and diagrams.

Whilst the cumulative flow prediction over this period exceeds the observed flow by only 3.5% this does not give a good indication of the model performance. The tabulated monthly and annual comparisons demonstrate that volume prediction was somewhat erratic over the period, with errors in annual totals ranging from -11% in 1979 through +0.4% in 1981 to +17% in 1985. The worst monthly error of -33% occurred in December 1979 when a peak daily mean flow of 48.2 m^3s^{-1} was recorded on 27 December. If genuine, this represents a runoff of 47.9 mm/day from the catchment.

The flow duration curve demonstrates the normal pattern of underestimation of the extremes but the good overall agreement demonstrated in the 1981 time series plot makes the erratic pattern of error described above difficult to explain other than by raising queries over the rating and the extent of the effects of industrial usage.

Despite these uncertainties the model has been used to generate a synthetic daily flow series from 1952.

FAL AT TREGONY

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1979	Q	3.20	5.23	3.68	2.47	1.53	1.35	0.78	0.90	0.66	1.73	2.70	5.59	2.47		
	PQ	3.44	4.58	3.60	2.36	1.39	1.37	0.79	0.86	0.50	1.75	2.27	3.72		2.21	
	ER	0.24	-0.65	-0.09	-0.11	-0.14	0.01	0.01	-0.03	-0.16	0.02	-0.43	-1.87			-0.26
1980	Q	4.11	5.02	2.52	1.98	0.84	0.96	0.74	0.64	1.14	2.99	3.18	3.12	2.26		
	PQ	4.19	5.20	2.81	2.09	0.78	1.05	0.62	0.52	1.16	3.02	2.86	2.84		2.25	
	ER	0.08	0.17	0.29	0.11	-0.06	0.09	-0.12	-0.12	0.02	0.03	-0.32	-0.28			-0.01
1981	Q	2.25	2.19	4.36	1.79	1.79	1.54	0.94	0.65	1.19	3.45	2.22	4.84	2.28		
	PQ	2.27	2.08	3.86	1.73	2.00	1.74	0.91	0.58	1.53	3.74	2.24	4.61		2.28	
	ER	0.03	-0.11	-0.50	-0.06	0.21	0.20	-0.03	-0.07	0.34	0.29	0.02	-0.22			0.01
1982	Q	4.01	2.64	3.69	1.39	0.82	0.97	0.76	0.66	0.66	2.77	5.50	5.14	2.42		
	PQ	4.57	2.90	3.77	1.45	0.67	0.96	0.56	0.53	0.69	3.29	5.46	4.97		2.49	
	ER	0.57	0.27	0.08	0.05	-0.14	-0.01	-0.19	-0.14	0.04	0.52	-0.04	-0.17			0.07
1983	Q	3.84	1.82	1.43	1.79	2.18	1.15	0.61	0.43	0.58	0.89	0.77	2.73	1.52		
	PQ	4.07	1.99	1.36	1.86	2.54	1.15	0.57	0.35	0.78	0.82	0.55	2.72		1.56	
	ER	0.22	0.16	-0.07	0.07	0.36	0.00	-0.04	-0.08	0.20	-0.07	-0.22	-0.01			0.04
1984	Q	4.42	3.42	1.51	1.13	0.80	0.55	0.37	0.39	0.53	1.02	3.42	3.61	1.76		
	PQ	4.13	3.79	1.76	1.10	0.77	0.43	0.28	0.41	0.77	1.30	4.18	4.71		1.96	
	ER	-0.30	0.37	0.25	-0.04	-0.04	-0.12	-0.09	0.02	0.24	0.28	0.76	1.10			0.20
1985	Q	3.38	2.79	1.80	3.03	1.13	0.89	0.61	1.22	1.16	1.17	0.99	2.79	1.74		
	PQ	3.51	2.98	2.42	3.30	1.13	1.15	0.69	1.91	1.53	1.66	1.26	3.01		2.04	
	ER	0.13	0.18	0.62	0.27	0.00	0.27	0.08	0.68	0.37	0.49	0.29	0.21			0.30
1986	Q	4.71	2.10	1.61	1.60	1.35	1.48	1.14	1.67	1.15	1.12	3.99	5.32	2.27		
	PQ	4.93	2.06	1.71	1.78	1.53	1.70	1.38	2.60	1.72	1.52	4.42	5.82		2.60	
	ER	0.22	-0.05	0.09	0.18	0.18	0.22	0.24	0.93	0.57	0.40	0.43	0.49			0.33
1987	Q	2.18	1.87	1.78	2.69	1.03	0.99	0.74	0.57	0.54	2.29	3.34	2.12	1.67		
	PQ	2.67	2.35	2.19	2.63	0.91	0.80	0.81	0.53	0.44	2.87	3.69	2.73		1.88	
	ER	0.48	0.48	0.40	-0.06	-0.12	-0.19	0.08	-0.04	-0.10	0.58	0.36	0.61			0.21
1988	Q	5.81	5.30	3.12	2.25	1.23	0.77	1.33	1.08	1.19	3.60	1.52	2.19	2.44		
	PQ	5.11	5.29	3.20	2.46	1.44	0.63	1.42	1.11	1.31	2.96	1.61	2.17		2.39	
	ER	-0.70	-0.01	0.08	0.21	0.21	-0.14	0.09	0.03	0.12	-0.65	0.10	-0.02			-0.06
1989	Q	1.36	2.55	3.52	1.81	0.98	0.64	0.44	0.35	0.42	0.66	1.72	3.68	1.51		
	PQ	1.66	2.35	3.51	1.90	0.95	0.50	0.31	0.33	0.59	0.94	1.23	3.29		1.46	
	ER	0.30	-0.20	-0.01	0.09	-0.03	-0.14	-0.13	-0.02	0.17	0.28	-0.48	-0.40			-0.05
MEAN	Q	3.57	3.18	2.64	1.99	1.24	1.03	0.77	0.78	0.84	1.97	2.67	3.74	2.03		
	PQ	3.69	3.23	2.75	2.06	1.28	1.04	0.76	0.88	1.00	2.17	2.71	3.69		2.10	
	ER	0.11	0.06	0.11	0.07	0.04	0.02	-0.01	0.11	0.16	0.20	0.04	-0.05			0.07
S.D.	Q	1.28	1.37	1.07	0.57	0.44	0.33	0.28	0.41	0.32	1.09	1.41	1.28	0.39		
	PQ	1.10	1.27	0.91	0.61	0.58	0.44	0.37	0.73	0.46	1.02	1.55	1.17		0.36	

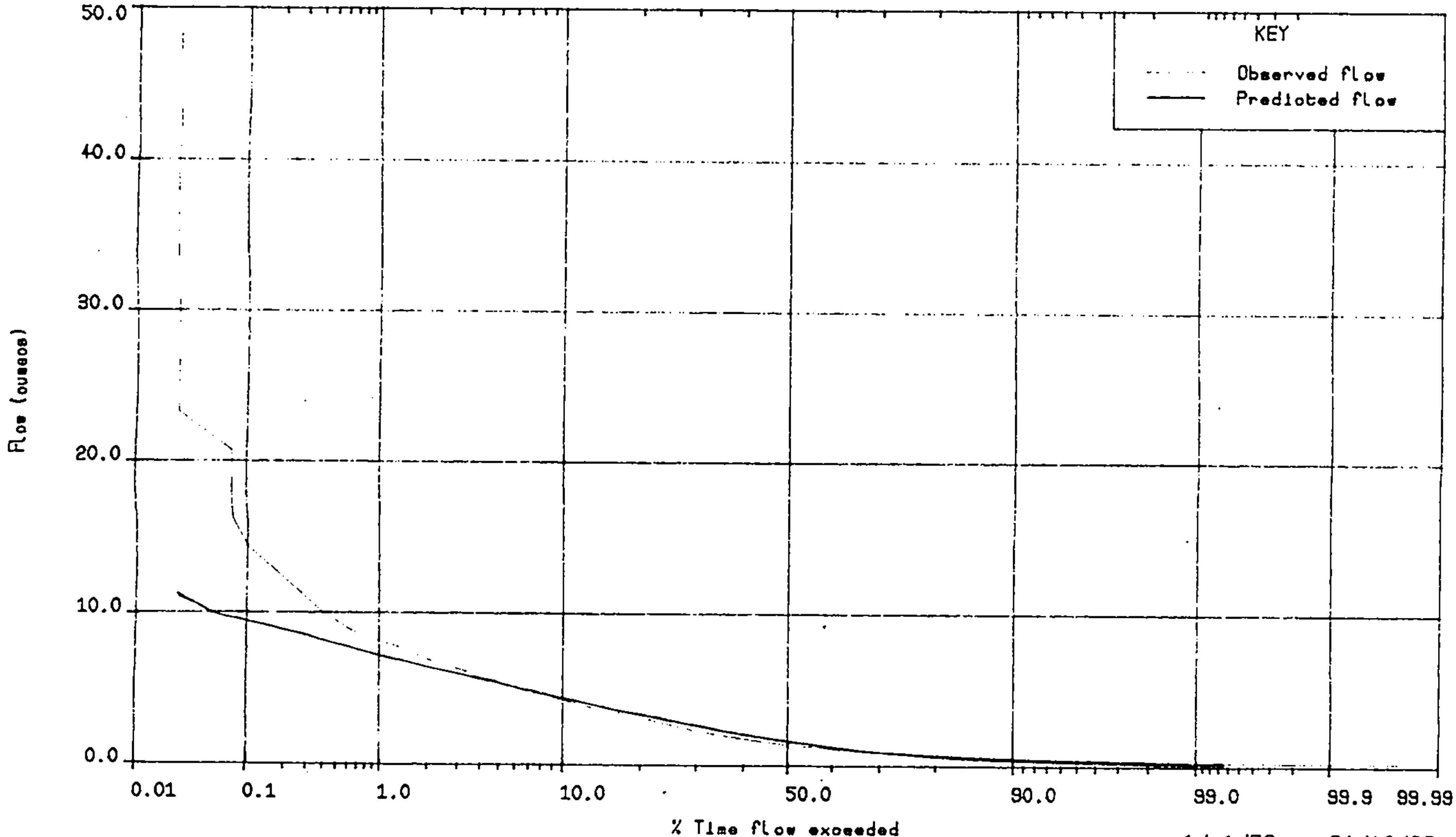
FAL AT TREGONY

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

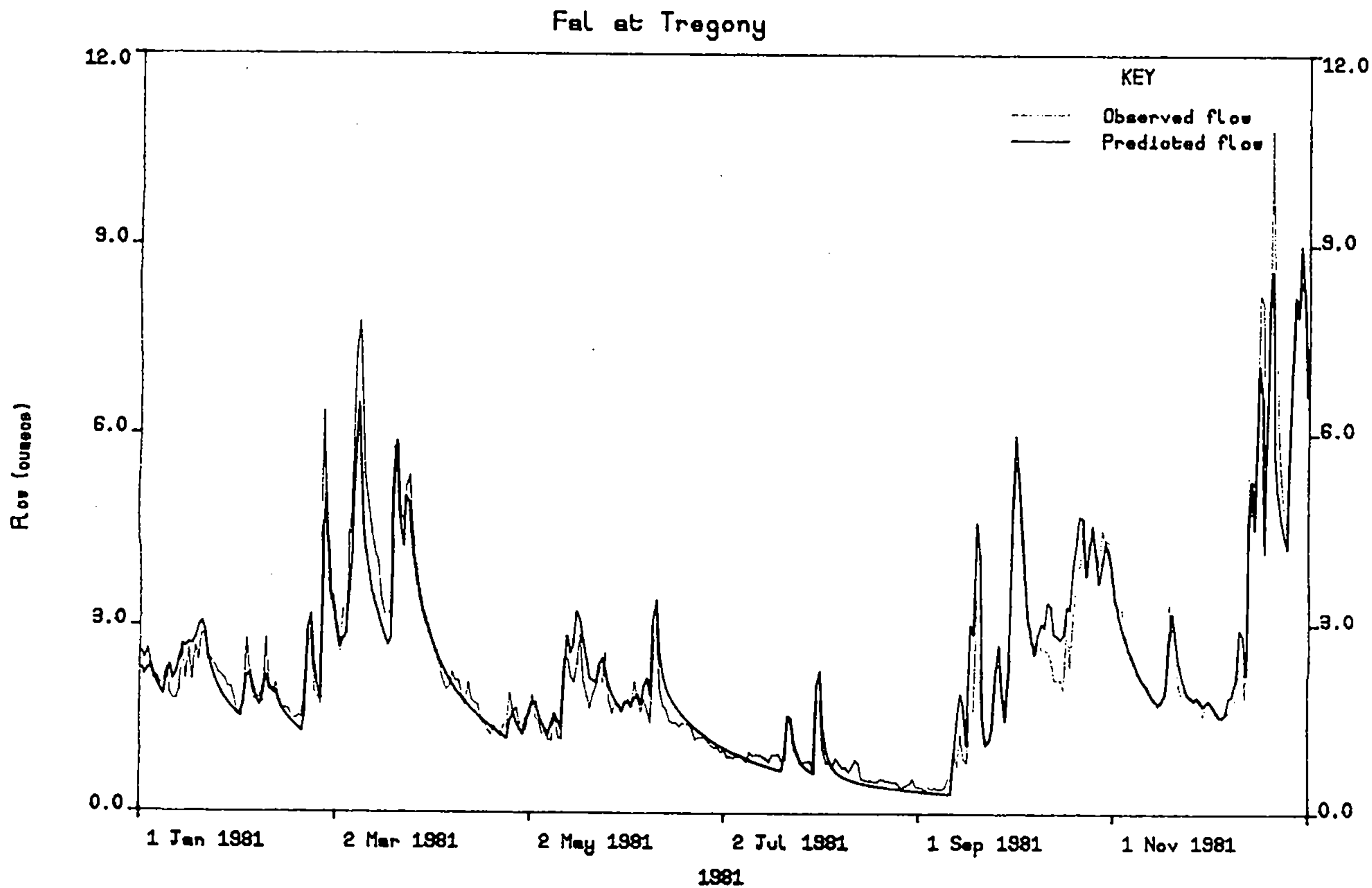
INTERVAL 1.6636 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	2142.9	26.25	26.25	2294	57.09	57.09	1682.3	19.92	19.92	2007	49.95	49.95
2	2365.6	28.98	55.24	1003	24.96	82.06	2848.2	33.72	53.64	1188	29.57	79.52
3	1835.6	22.49	77.72	461	11.47	93.53	2211.1	26.18	79.81	549	13.66	93.18
4	860.6	10.54	88.27	152	3.78	97.31	1154.2	13.66	93.48	203	5.05	98.23
5	563.3	6.90	95.17	76	1.89	99.20	412.0	4.88	98.36	56	1.39	99.63
6	135.8	1.66	96.83	15	0.37	99.58	115.9	1.37	99.73	13	0.32	99.95
7	97.5	1.19	98.03	9	0.22	99.80	10.7	0.13	99.86	1	0.02	99.98
8	12.1	0.15	98.18	1	0.02	99.83	11.8	0.14	100.00	1	0.02	100.00
9	56.4	0.69	98.87	4	0.10	99.93	0.0	0.00	100.00	0	0.00	100.00
10	0.0	0.00	98.87	0	0.00	99.93	0.0	0.00	100.00	0	0.00	100.00
11	0.0	0.00	98.87	0	0.00	99.93	0.0	0.00	100.00	0	0.00	100.00
12	0.0	0.00	98.87	0	0.00	99.93	0.0	0.00	100.00	0	0.00	100.00
13	0.0	0.00	98.87	0	0.00	99.93	0.0	0.00	100.00	0	0.00	100.00
14	43.9	0.54	99.40	2	0.05	99.98	0.0	0.00	100.00	0	0.00	100.00
15	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
16	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
17	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
18	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
19	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
20	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
21	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
22	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
23	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
24	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
25	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
26	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
27	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
28	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
29	0.0	0.00	99.40	0	0.00	99.98	0.0	0.00	100.00	0	0.00	100.00
30	48.2	0.59	100.00	1	0.02	100.00	0.0	0.00	100.00	0	0.00	100.00
TOTALS	8162.4			4018			8446.7			4018		

Fal at Tregony



1/ 1/79 to 31/12/89



Fal at Tregony
KEY
Observed flow
Predicted flow
Flow (cumecs)
12.0
9.0
6.0
3.0
0.0
1 Jan 1981
2 Mar 1981
2 May 1981
2 Jul 1981
1 Sep 1981
1 Nov 1981
1981

M. Kenwyn to Truro (048005) Area 19.1 km^2

Natural catchment, Compound Crump Weir

Observed flows 1968-89.

Model optimised on period 1980-85.

Comparison of model predicted and observed flows for the period 1969-88 is summarised in the following tables and diagrams.

1968, 71 and 73 are omitted from the comparison because of gaps in the rainfall record and therefore in the flow prediction.

The cumulative volume prediction is within 1.1% of the observed flow.

The volume and time distributions over the flow range are in close agreement up to a daily flow rate of 3.85 cumecs, which includes 98.9% of the observed flow and 99.9% of the time. Flow exceeded this level on 5 days out of 6575 and was predicted to exceed this level on 1 day.

Of these 5 high flow days 4 occurred in 1988, as did the predicted 1 day of exceptionally high flow. They are therefore shown in the 1988 time series plot included. Despite this, the cumulative volume error in 1988 was only 6% with the worst monthly error of 18% occurring in October 1991.

The record has been extended using the model to cover the period from 1939 till records began in 1968,. Assuming no radical changes in land use occurred within the catchment this synthetic record can be assumed to be of comparable quality to the observed record, except during storm events in wet catchment conditions, when the predicted flow will be underestimated.

KENWYN AT TRURO

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1969	Q	1.09	0.62	0.69	0.28	0.23	0.19	0.14	0.12	0.10	0.07	0.50	0.78	0.40		
	PQ	1.02	0.56	0.56	0.24	0.21	0.19	0.24	0.14	0.15	0.08	0.74	0.82		0.41	
	ER	-0.08	-0.06	-0.13	-0.04	-0.02	-0.01	0.10	0.02	0.05	0.01	0.23	0.04			0.01
1970	Q	1.21	1.00	0.45	0.21	0.15	0.09	0.08	0.09	0.08	0.06	0.51	0.44	0.36		
	PQ	1.09	0.90	0.37	0.19	0.13	0.07	0.05	0.11	0.07	0.04	0.44	0.41		0.32	
	ER	-0.12	-0.10	-0.07	-0.02	-0.02	-0.02	-0.03	0.02	-0.01	-0.02	-0.07	-0.02			-0.04
1972	Q	0.78	1.15	0.74	0.19	0.19	0.36	0.16	0.12	0.09	0.10	0.63	1.09	0.46		
	PQ	0.37	0.97	0.60	0.16	0.21	0.32	0.16	0.13	0.10	0.09	0.64	1.19		0.41	
	ER	-0.42	-0.19	-0.13	-0.03	0.02	-0.04	0.00	0.01	0.01	-0.01	0.02	0.10			-0.05
1974	Q	1.32	1.54	0.42	0.22	0.23	0.14	0.10	0.12	0.56	0.63	0.75	0.57	0.54		
	PQ	1.16	1.59	0.50	0.16	0.25	0.14	0.09	0.11	0.54	0.58	0.80	0.53		0.53	
	ER	-0.16	0.05	0.08	-0.07	0.02	0.00	-0.02	-0.01	-0.02	-0.05	0.06	-0.04			-0.01
1975	Q	0.82	0.57	0.37	0.30	0.18	0.09	0.07	0.12	0.18	0.21	0.48	0.56	0.33		
	PQ	0.80	0.54	0.36	0.27	0.13	0.07	0.08	0.18	0.16	0.13	0.43	0.52		0.30	
	ER	-0.02	-0.03	-0.01	-0.03	-0.05	-0.02	0.01	0.06	-0.02	-0.08	-0.04	-0.05			-0.02
1976	Q	0.28	0.52	0.71	0.27	0.13	0.07	0.04	0.03	0.09	0.58	0.52	1.02	0.36		
	PQ	0.25	0.51	0.63	0.24	0.10	0.06	0.04	0.03	0.19	0.30	0.29	0.92		0.30	
	ER	-0.03	-0.01	-0.08	-0.03	-0.03	-0.01	0.00	0.01	0.11	-0.29	-0.23	-0.10			-0.06
1977	Q	0.95	1.21	0.71	0.31	0.28	0.17	0.10	0.10	0.07	0.30	0.52	1.01	0.47		
	PQ	0.86	1.09	0.59	0.24	0.18	0.12	0.07	0.15	0.10	0.45	0.56	0.98		0.45	
	ER	-0.09	-0.12	-0.13	-0.07	-0.10	-0.05	-0.03	0.05	0.03	0.14	0.04	-0.02			-0.03
1978	Q	0.79	1.21	0.88	0.52	0.19	0.10	0.08	0.06	0.04	0.03	0.05	0.65	0.38		
	PQ	0.75	1.15	0.79	0.42	0.14	0.07	0.07	0.07	0.03	0.03	0.07	0.87		0.37	
	ER	-0.04	-0.06	-0.09	-0.10	-0.05	-0.03	-0.01	0.01	0.00	-0.01	0.02	0.22			-0.01
1979	Q	0.71	1.11	0.81	0.46	0.20	0.14	0.08	0.08	0.06	0.14	0.34	0.93	0.42		
	PQ	0.80	1.16	0.75	0.39	0.14	0.18	0.10	0.11	0.06	0.27	0.49	0.92		0.44	
	ER	0.09	0.05	-0.06	-0.07	-0.06	0.04	0.02	0.03	0.00	0.13	0.15	0.00			0.03
1980	Q	0.82	0.93	0.45	0.39	0.13	0.10	0.07	0.05	0.07	0.21	0.53	0.54	0.36		
	PQ	0.96	1.06	0.44	0.33	0.11	0.11	0.06	0.04	0.08	0.30	0.59	0.60		0.39	
	ER	0.15	0.13	-0.02	-0.06	-0.02	0.01	-0.02	-0.01	0.02	0.08	0.06	0.06			0.03
1981	Q	0.41	0.42	0.92	0.31	0.31	0.22	0.12	0.07	0.12	0.56	0.39	0.94	0.40		
	PQ	0.41	0.39	1.00	0.28	0.34	0.24	0.11	0.08	0.19	0.57	0.34	1.02		0.42	
	ER	0.01	-0.02	0.08	-0.04	0.03	0.02	-0.01	0.00	0.07	0.01	-0.05	0.08			0.02
1982	Q	0.87	0.52	0.86	0.26	0.13	0.12	0.09	0.07	0.07	0.59	1.09	1.04	0.48		
	PQ	0.92	0.52	0.87	0.23	0.10	0.17	0.10	0.09	0.08	0.81	1.14	1.08		0.51	
	ER	0.05	-0.01	0.01	-0.03	-0.03	0.04	0.01	0.01	0.01	0.21	0.04	0.04			0.03
1983	Q	0.68	0.33	0.23	0.39	0.42	0.18	0.09	0.05	0.07	0.10	0.10	0.59	0.27		
	PQ	0.67	0.31	0.21	0.32	0.29	0.13	0.07	0.05	0.09	0.13	0.09	0.46		0.23	
	ER	-0.01	-0.02	-0.02	-0.07	-0.13	-0.06	-0.02	-0.01	0.03	0.03	-0.01	-0.13			-0.03
1984	Q	0.91	0.72	0.30	0.20	0.12	0.07	0.05	0.05	0.06	0.12	0.67	0.65	0.33		
	PQ	1.06	0.76	0.29	0.23	0.12	0.07	0.05	0.07	0.11	0.21	0.88	0.73		0.38	
	ER	0.15	0.04	-0.01	0.03	0.00	0.00	0.00	0.01	0.04	0.09	0.21	0.08			0.05

KENWYN AT TRURO

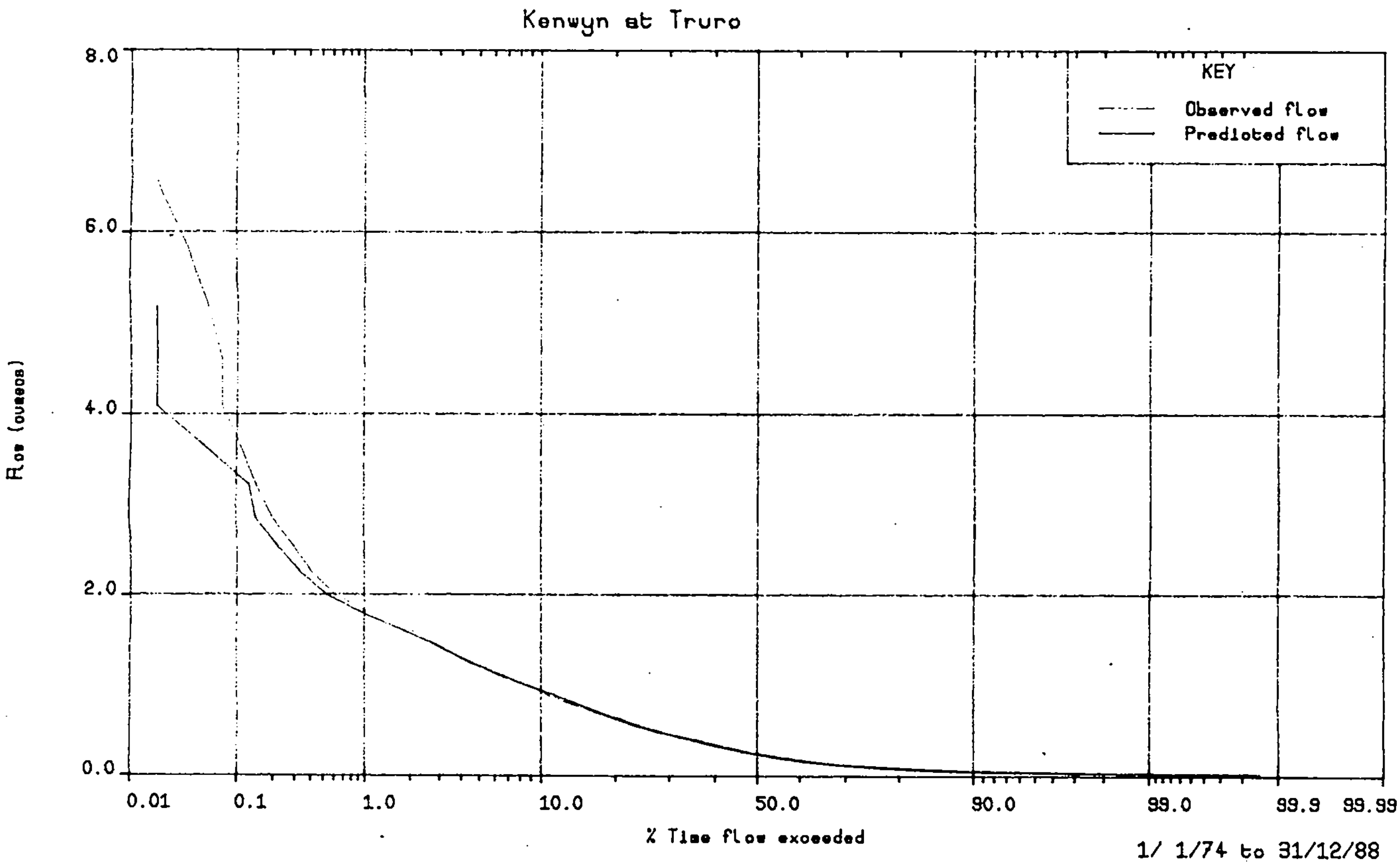
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1985	Q	0.68	0.58	0.31	0.61	0.19	0.12	0.09	0.12	0.13	0.16	0.13	0.60	0.31		
	PQ	0.66	0.53	0.37	0.55	0.15	0.14	0.08	0.20	0.19	0.25	0.17	0.74		0.33	
	ER	-0.02	-0.05	0.06	-0.06	-0.04	0.01	-0.01	0.08	0.06	0.08	0.04	0.13			0.02
1986	Q	1.02	0.44	0.25	0.33	0.23	0.18	0.13	0.18	0.17	0.15	0.87	0.99	0.41		
	PQ	1.04	0.37	0.26	0.31	0.20	0.22	0.19	0.26	0.19	0.20	0.85	1.09		0.43	
	ER	0.02	-0.06	0.02	-0.02	-0.03	0.04	0.06	0.08	0.02	0.05	-0.02	0.10			0.02
1987	Q	0.40	0.39	0.35	0.52	0.15	0.11	0.07	0.05	0.05	0.38	0.70	0.52	0.31		
	PQ	0.40	0.39	0.36	0.51	0.13	0.11	0.07	0.04	0.06	0.46	0.73	0.60		0.32	
	ER	0.01	0.00	0.00	-0.01	-0.02	0.00	0.00	-0.01	0.00	0.08	0.02	0.08			0.01
1988	Q	1.51	1.06	0.70	0.42	0.20	0.12	0.13	0.11	0.13	0.71	0.29	0.53	0.49		
	PQ	1.33	1.19	0.63	0.38	0.18	0.09	0.13	0.09	0.14	0.59	0.28	0.47		0.46	
	ER	-0.18	0.14	-0.07	-0.04	-0.02	-0.02	0.00	-0.02	0.00	-0.13	-0.01	-0.06			-0.03
MEAN	Q	0.85	0.79	0.56	0.34	0.20	0.14	0.09	0.09	0.12	0.28	0.50	0.75	0.39		
	PQ	0.81	0.78	0.53	0.30	0.17	0.14	0.10	0.11	0.14	0.30	0.53	0.77		0.39	
	ER	-0.04	-0.02	-0.03	-0.04	-0.03	-0.01	0.00	0.02	0.02	0.02	0.03	0.03			0.00
S.D.	Q	0.32	0.36	0.24	0.12	0.07	0.07	0.03	0.04	0.12	0.23	0.27	0.22	0.07		
	PQ	0.30	0.37	0.22	0.11	0.07	0.07	0.05	0.06	0.11	0.22	0.29	0.25		0.08	

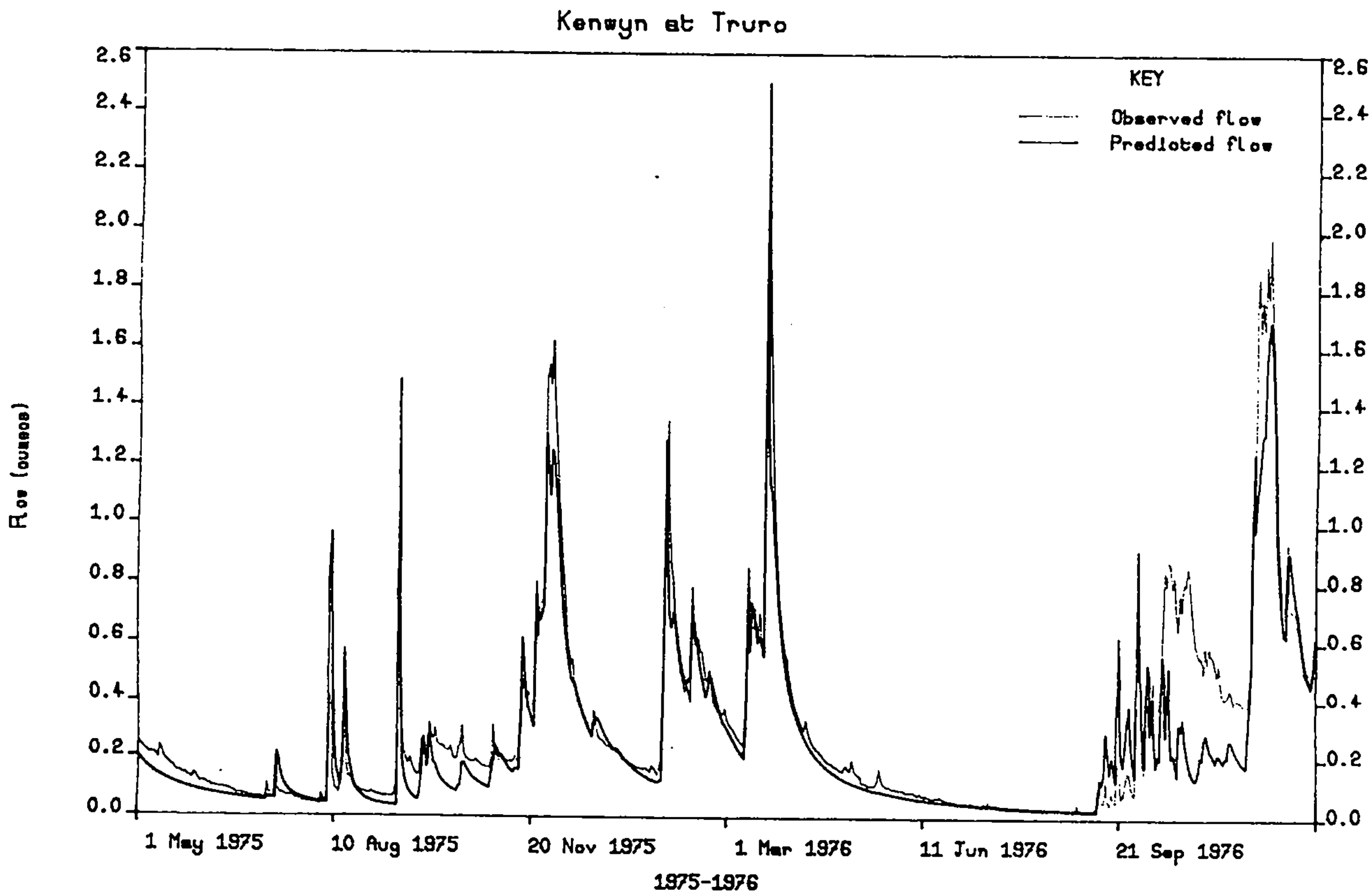
KENWYN AT TRURO

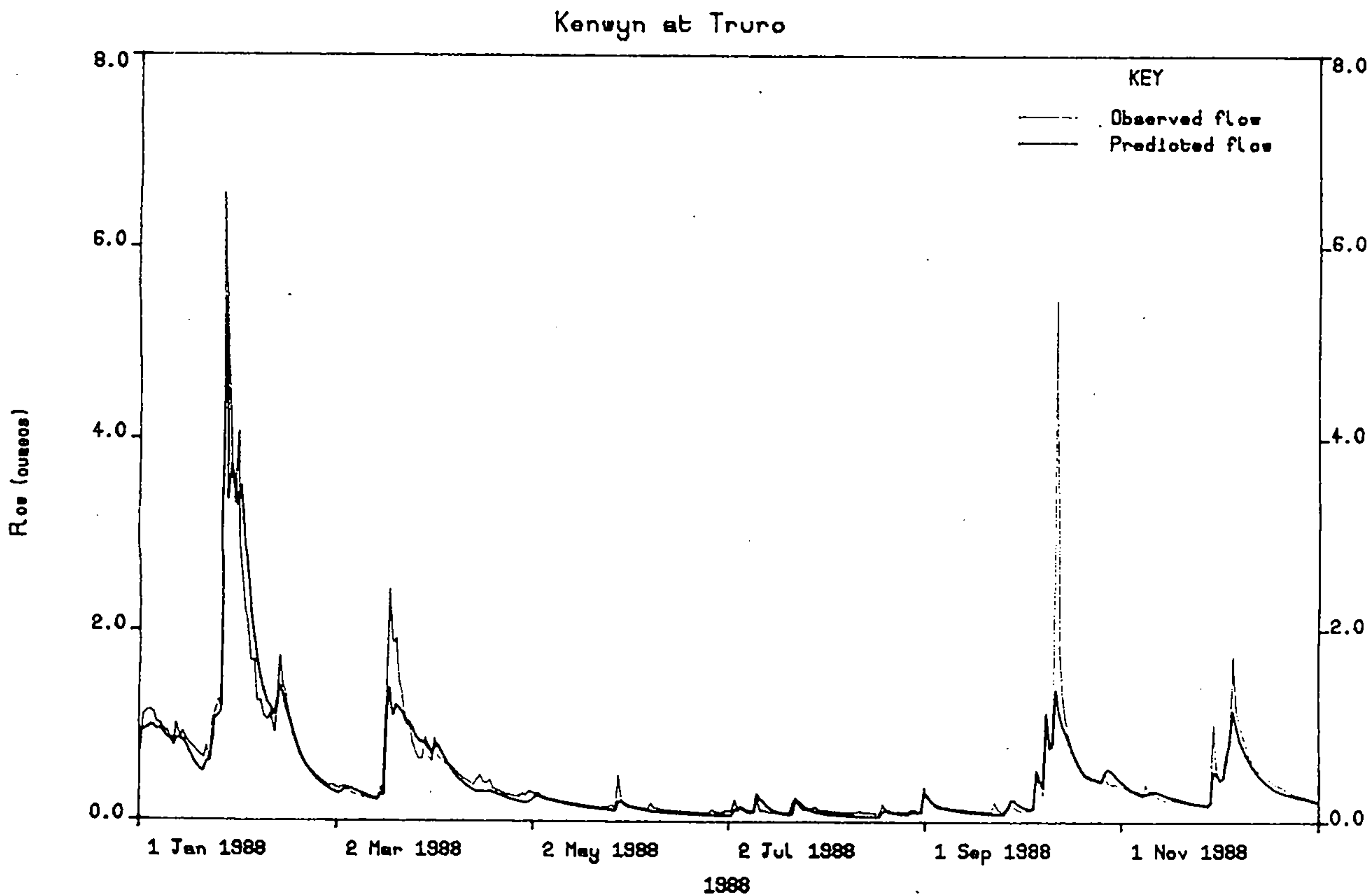
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.2266 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	355.9	13.78	13.78	3193	48.56	48.56	353.0	13.81	13.81	3234	49.19	49.19
2	453.5	17.56	31.34	1374	20.90	69.46	435.9	17.06	30.87	1329	20.21	69.40
3	465.7	18.03	49.37	840	12.78	82.24	456.6	17.87	48.74	822	12.50	81.90
4	364.6	14.12	63.48	465	7.07	89.31	361.9	14.16	62.90	460	7.00	88.90
5	283.3	10.97	74.45	280	4.26	93.57	311.2	12.18	75.07	309	4.70	93.60
6	230.7	8.93	83.38	187	2.84	96.41	239.0	9.35	84.43	194	2.95	96.55
7	134.5	5.21	88.59	92	1.40	97.81	153.8	6.02	90.45	105	1.60	98.14
8	127.9	4.95	93.54	76	1.16	98.97	111.8	4.37	94.82	66	1.00	99.15
9	55.4	2.14	95.69	29	0.44	99.41	51.8	2.03	96.85	27	0.41	99.56
10	32.1	1.24	96.93	15	0.23	99.63	21.3	0.83	97.68	10	0.15	99.71
11	14.4	0.56	97.48	6	0.09	99.73	7.2	0.28	97.96	3	0.05	99.76
12	15.6	0.61	98.09	6	0.09	99.82	15.5	0.61	98.57	6	0.09	99.85
13	2.7	0.11	98.19	1	0.02	99.83	2.8	0.11	98.68	1	0.02	99.86
14	9.2	0.36	98.55	3	0.05	99.88	3.2	0.12	98.81	1	0.02	99.88
15	3.3	0.13	98.68	1	0.02	99.89	6.7	0.26	99.07	2	0.03	99.91
16	3.5	0.13	98.81	1	0.02	99.91	7.0	0.28	99.34	2	0.03	99.94
17	3.7	0.14	98.95	1	0.02	99.92	11.1	0.43	99.78	3	0.05	99.98
18	0.0	0.00	98.95	0	0.00	99.92	0.0	0.00	99.78	0	0.00	99.98
19	4.1	0.16	99.11	1	0.02	99.94	0.0	0.00	99.78	0	0.00	99.98
20	0.0	0.00	99.11	0	0.00	99.94	0.0	0.00	99.78	0	0.00	99.98
21	0.0	0.00	99.11	0	0.00	99.94	0.0	0.00	99.78	0	0.00	99.98
22	4.8	0.19	99.30	1	0.02	99.95	0.0	0.00	99.78	0	0.00	99.98
23	0.0	0.00	99.30	0	0.00	99.95	0.0	0.00	99.78	0	0.00	99.98
24	0.0	0.00	99.30	0	0.00	99.95	0.0	0.00	99.78	0	0.00	99.98
25	5.5	0.21	99.51	1	0.02	99.97	5.5	0.21	99.99	1	0.02	100.00
26	5.8	0.23	99.74	1	0.02	99.98	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.74	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.74	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.74	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
30	6.6	0.25	99.99	1	0.02	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	2582.9			6575			2555.4			6575		


Kenwyn at Truro
KEY
Observed flow
Predicted flow
Flow (cumecs)
8.0
6.0
4.0
2.0
0.0
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% Time flow exceeded
1/ 1/74 to 31/12/88


Kenwyn at Truro
KEY
Observed flow
Predicted flow
Flow (cumecs)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
1 May 1975
10 Aug 1975
20 Nov 1975
1 Mar 1976
11 Jun 1976
21 Sep 1976
1975-1976


Kenwyn at Truro
KEY
Observed flow
Predicted flow
Flow (cumecs)
8.0
6.0
4.0
2.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

N. Kennal to Ponsanooth (048007) Area 26.6 km^2

Simple Crump Weir

The observed flows at Ponsanooth are significantly affected by direct exports from the Stithians reservoir, within its catchment, as well as by abstractions at Kennal Vale. Using data supplied for Kennal Vale abstractions the flows were 'naturalised' for the period 1975-85. This 'naturalisation' made no provision for the effects of direct exports from Stithians, data on which were not available.

Attempts to fit the model to this 'naturalised' data were unsuccessful.

Further investigation, including comparison of rainfall and the 'naturalised' flow as summarised in the following table indicated that the 'naturalised' flow was a considerable underestimate of the probable catchment response to rainfall. The mean annual water use suggested by this comparison, 720 mm, is 17% greater than potential evaporation from the catchment. The implication therefore is that the 'naturalised' flow is underestimated by some 100 - 200 mm per annum or average. This represents 2.66 - 5.32 x 10^6 cubic metres or a mean annual flow rate of 0.08 - 0.17 cumecs.

When data are obtained on the volume of direct exports from Stithians it will be interesting to compare them within this indirect estimate.

KENNEL AT PONSANOOTH

MONTHLY RAINFALL, STREAMFLOW AND PENMAN ET

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS RAIN	RDAYS	FLOW	ET	R-Q
1975	R	217.8	42.6	94.0	88.8	36.0	6.9	103.4	170.2	125.5	74.8	214.1	48.9	1223.0	281	545.3	659.0	677.7
	RD	31	20	24	24	17	13	19	25	24	26	30	28					
	Q	123.6	73.8	46.3	38.7	28.7	15.2	14.7	21.6	19.3	22.8	71.7	69.0					
	ET	22.0	17.9	40.9	57.0	92.4	109.5	96.4	82.8	59.4	39.4	25.8	15.5					
	R-Q	94.2	-31.2	47.7	50.1	7.3	-8.3	88.7	148.6	106.2	52.0	142.4	-20.1					
1976	R	96.8	83.6	150.0	22.1	55.3	15.3	32.6	13.0	174.2	239.6	139.3	166.2	1188.0	268	484.0	666.0	704.0
	RD	27	28	22	11	23	19	19	9	23	30	29	28					
	Q	28.2	54.0	74.9	36.7	20.0	10.1	7.7	6.0	9.6	60.8	65.3	110.6					
	ET	22.6	20.0	36.3	61.5	81.3	92.2	96.7	115.0	58.5	40.6	23.9	17.3					
	R-Q	68.6	29.6	75.1	-14.6	35.3	5.2	24.9	7.0	164.6	178.8	74.0	55.6					
1977	R	187.6	235.4	111.9	74.1	82.7	66.3	77.5	154.0	69.5	155.0	161.1	211.8	1586.9	295	752.0	637.4	834.9
	RD	30	27	29	26	20	22	17	21	13	31	28	31					
	Q	98.8	163.0	87.4	42.9	36.7	21.9	14.7	19.5	24.4	57.7	70.8	114.0					
	ET	20.1	23.2	41.8	60.3	95.8	66.9	95.8	85.3	52.2	45.3	32.4	18.3					
	R-Q	88.8	72.4	24.5	31.2	46.0	44.4	62.8	134.5	45.1	97.3	90.3	97.8					
1978	R	182.6	207.3	200.8	69.2	23.0	54.6	99.5	33.9	34.2	21.1	93.8	314.2	1334.2	270	608.7	601.1	725.5
	RD	30	26	28	17	12	21	20	19	19	25	26	27					
	Q	85.0	143.9	142.7	75.6	24.1	13.2	11.4	9.7	7.2	6.7	8.6	80.3					
	ET	23.3	19.6	39.7	55.2	88.3	83.1	72.5	73.5	60.3	37.5	25.8	22.3					
	R-Q	97.6	63.4	58.1	-6.6	-1.1	41.4	88.1	24.2	27.0	14.4	85.2	233.9					
1979	R	148.8	196.2	182.4	69.4	103.9	62.6	51.7	107.0	69.2	169.3	118.2	246.2	1524.9	296	756.4	580.4	768.5
	RD	22	23	30	25	27	19	18	25	22	30	27	28					
	Q	105.4	154.4	121.8	61.8	27.1	19.2	13.3	15.6	13.1	44.3	77.7	102.8					
	ET	19.2	17.6	42.2	53.1	79.7	70.2	86.2	75.3	51.0	36.9	26.4	22.6					
	R-Q	43.4	41.8	60.6	7.6	76.8	43.4	38.4	91.4	56.1	125.0	40.5	143.4					
1980	R	141.5	186.2	145.7	26.9	49.6	110.5	53.1	65.6	101.8	169.2	166.8	134.4	1351.3	283	631.8	505.1	719.5
	RD	24	25	27	10	15	27	24	27	26	28	22	28					
	Q	98.1	139.5	68.0	48.9	19.5	15.0	11.6	9.9	12.4	50.1	80.5	78.3					
	ET	18.6	21.5	38.4	57.8	93.4	80.2	79.5	65.6	57.2	43.6	26.6	22.8					
	R-Q	43.4	46.7	77.7	-22.0	30.1	95.5	41.5	55.7	89.4	119.1	86.3	56.1					
1981	R	89.2	129.6	239.7	46.5	151.9	71.1	72.1	4.8	182.4	189.8	58.8	224.1	1460.0	278	648.0	578.0	812.0
	RD	29	20	29	19	30	19	26	2	26	31	21	26					
	Q	56.5	45.0	135.2	43.8	40.9	44.1	19.8	12.5	15.9	80.5	55.0	98.8					
	ET	18.9	19.9	38.1	51.3	68.5	70.5	80.0	31.5	63.6	42.5	25.2	18.0					
	R-Q	32.7	84.6	104.5	2.7	111.0	27.0	52.3	-7.7	166.5	109.3	3.8	125.3					
1982	R	132.7	100.8	156.8	34.6	46.9	163.6	45.8	94.1	75.9	222.8	203.9	192.9	1470.8	230	723.0	618.0	747.8
	RD	25	17	19	7	15	18	12	19	17	27	27	27					
	Q	106.9	52.7	117.3	37.4	18.4	19.8	18.7	14.2	13.6	85.4	115.4	123.2					
	ET	17.7	20.4	46.8	62.1	85.3	80.1	79.0	80.0	53.7	40.0	31.8	21.1					
	R-Q	25.8	48.1	39.5	-2.8	28.5	143.8	27.1	79.9	62.3	137.4	88.5	69.7					

KENNEL AT PONSANOOTH

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	RAIN	RDAYS	FLOW	ET
1983	R	149.8	51.2	76.9	139.3	99.0	35.0	29.6	21.9	139.4	98.3	73.9	152.0	1066.3			
	RD	26	17	22	23	25	14	11	10	24	23	13	22		230		
	Q	99.2	43.2	35.6	53.5	44.6	22.7	13.3	10.0	14.2	27.5	25.6	77.0			466.5	
	ET	23.9	26.0	36.0	60.3	84.0	81.3	112.8	93.3	62.7	44.9	21.0	21.1				667.4
	R-Q	50.6	8.0	41.3	85.8	54.4	12.3	16.3	11.9	125.2	70.8	48.3	75.0	R-Q 599.8			
1984	R	240.1	73.8	76.3	11.2	80.5	8.6	54.1	52.5	138.2	130.2	195.1	140.0	1200.6			
	RD	28	14	15	10	8	9	14	8	25	27	25	24		207		
	Q	131.4	80.9	33.6	26.3	17.6	10.2	6.6	6.0	7.3	21.3	87.4	87.8			516.4	
	ET	26.3	23.2	32.5	49.2	74.0	67.7	101.2	71.1	57.1	37.9	20.6	17.2				578.0
	R-Q	108.7	-7.1	42.7	-15.1	62.9	-1.6	47.5	46.5	130.9	108.9	107.7	52.2	R-Q 684.2			
1985	R	144.1	64.7	137.4	91.1	68.6	98.1	54.0	170.7	53.8	70.9	87.7	196.1	1237.2			
	RD	22	14	25	18	15	14	17	30	14	11	20	26		226		
	Q	99.0	83.5	45.1	86.5	24.5	17.9	14.1	38.1	37.0	36.7	24.8	88.5			595.7	
	ET	14.6	20.7	39.4	58.5	82.8	76.8	80.9	70.7	45.0	35.3	24.9	18.6				568.2
	R-Q	45.1	-18.8	92.3	4.6	44.1	80.2	39.9	132.6	16.8	34.2	62.9	107.6	R-Q 641.5			
MEAN	R	157.4	124.7	142.9	61.2	72.5	63.0	61.2	80.7	105.8	140.1	137.5	184.3	1331.2			
	RD	26	21	24	17	18	17	17	17	21	26	24	26		260		
	Q	93.8	94.0	82.5	50.2	27.5	19.0	13.3	14.8	15.8	44.9	62.1	93.7			611.6	
	ET	20.7	20.9	39.3	56.9	84.1	79.9	89.2	61.3	56.4	40.4	25.9	19.5				614.4
	R-Q	63.5	30.7	60.4	11.0	45.0	43.9	47.9	65.9	90.0	95.2	75.5	90.6	R-Q 719.6			
S.D.	R	46.4	69.7	51.7	37.7	36.7	47.9	24.4	62.7	49.5	68.0	54.8	68.9	163.6			
	RD	3	5	4	6	6	4	4	9	4	5	4	2		31		
	Q	29.1	46.8	40.9	18.1	9.4	9.4	4.0	9.2	8.7	25.0	31.4	17.5			102.9	
	ET	3.3	2.5	3.8	4.3	8.3	12.5	12.2	13.6	5.5	3.4	3.7	2.5				37.7
	R-Q	29.2	38.2	24.6	32.5	31.5	46.4	23.8	55.5	52.8	48.3	36.6	64.6	SD R-Q 69.8			

O. Cober at Trenear   Area 19.0 km^2

Gauging station installed 1987, no rainfall data. The short record and the absence of rainfall data meant that it was not possible to model this tributary of the Cober.

A relatively crude estimate of synthetic flows was produced by applying an area proportional factor of 0.474 to the synthetic flows obtained for the Cober at Helston for the period from 1952.

P. Cober to Helston (048006) Area 40.1 km^2

Velocity-area station

Flows naturalised 1974-89 (see 5.2 P).

Model optimised on period 4/82 - 12/84.

Comparison of the model predicted and naturalised flows for the period 1974-88 is summarised in the following tables and diagrams.

1981 and 1982 are omitted from the comparison because of gaps in the flow record.

The cumulative flow prediction over the period is within 3% of the naturalised flow. The tabulated monthly comparisons show particularly poor agreement in the latter half of 1975, with the annual total underpredicted by 31%. It is understood that major modifications to the rated cross section were undertaken in this period, suggesting that the observed flows may be in doubt and therefore also the naturalised flows.

The tabulated volume and time distributions over the flow range demonstrate only limited agreement within the flow range as well as the expected disagreement at the extremes.

Considering the uncertainties arising from the rating of the section and from the data used in naturalising, the broad agreement demonstrated in the 1988 time series plot suggests that the use of the model is unlikely to introduce radical errors in the extension of an already uncertain record.

The record has been extended to cover the period from 1952 till records began.

COBER AT HELSTON

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEANS FLOW	MEANS PFLOW	MEANS ER
1974	Q	2.06	3.10	1.29	0.67	0.54	0.41	0.36	0.41	1.26	1.50	2.16	1.53	1.26		
	PQ	1.82	2.80	1.41	0.56	0.44	0.32	0.29	0.39	1.26	1.37	1.85	1.47		1.15	
	ER	-0.24	-0.30	0.12	-0.11	-0.10	-0.09	-0.06	-0.02	0.00	-0.13	-0.31	-0.06			-0.11
1975	Q	1.89	1.56	0.99	0.89	0.66	0.52	0.74	0.95	0.75	1.03	1.81	2.06	1.15		
	PQ	1.85	1.63	1.04	0.82	0.48	0.26	0.25	0.29	0.26	0.42	1.27	1.60		0.84	
	ER	-0.04	0.07	0.05	-0.07	-0.18	-0.26	-0.50	-0.66	-0.49	-0.60	-0.54	-0.46			-0.31
1976	Q	0.71	1.17	1.86	0.96	0.48	0.21	0.25	0.11	0.23	0.93	1.20	2.31	0.87		
	PQ	0.67	1.10	1.46	0.86	0.38	0.22	0.15	0.11	0.31	0.56	0.98	2.15		0.75	
	ER	-0.05	-0.07	-0.40	-0.10	-0.10	0.01	-0.10	0.00	0.08	-0.37	-0.22	-0.16			-0.12
1977	Q	1.95	2.84	1.68	0.83	0.65	0.45	0.34	0.57	0.45	0.96	1.12	2.20	1.16		
	PQ	1.92	2.55	1.67	0.93	0.72	0.40	0.27	0.49	0.69	1.10	1.34	2.01		1.17	
	ER	-0.03	-0.29	-0.01	0.10	0.07	-0.05	-0.07	-0.08	0.24	0.13	0.22	-0.20			0.00
1978	Q	1.67	3.36	2.65	1.45	0.56	0.33	0.26	0.21	0.17	0.15	0.18	1.11	0.99		
	PQ	1.61	2.59	2.38	1.47	0.59	0.29	0.24	0.16	0.11	0.08	0.15	1.50		0.92	
	ER	-0.06	-0.77	-0.28	0.02	0.03	-0.04	-0.03	-0.05	-0.06	-0.06	-0.04	0.39			-0.07
1979	Q	2.57	4.04	2.20	1.35	0.63	0.42	0.28	0.32	0.26	0.70	1.49	2.34	1.37		
	PQ	2.28	3.28	2.24	1.38	0.62	0.48	0.34	0.41	0.39	1.03	1.67	1.80		1.31	
	ER	-0.29	-0.76	0.04	0.04	-0.01	0.06	0.07	0.09	0.13	0.33	0.17	-0.54			-0.05
1980	Q	2.15	3.09	1.27	1.01	0.45	0.36	0.24	0.21	0.27	0.76	1.65	1.45	1.07		
	PQ	2.26	2.70	1.51	1.09	0.42	0.32	0.20	0.15	0.30	1.11	1.77	1.62		1.12	
	ER	0.11	-0.39	0.24	0.09	-0.03	-0.04	-0.04	-0.06	0.03	0.35	0.12	0.17			0.05
1983	Q	1.95	1.07	0.78	0.96	1.01	0.58	0.34	0.19	0.25	0.41	0.44	1.19	0.76		
	PQ	1.94	1.11	0.79	1.06	0.99	0.51	0.27	0.17	0.25	0.28	0.27	1.14		0.73	
	ER	0.00	0.04	0.01	0.10	-0.02	-0.07	-0.07	-0.02	0.00	-0.13	-0.17	-0.04			-0.03
1984	Q	2.57	1.81	0.69	0.47	0.36	0.21	0.13	0.12	0.15	0.30	1.66	1.64	0.84		
	PQ	2.22	1.89	0.74	0.62	0.35	0.20	0.14	0.14	0.19	0.42	1.67	1.99		0.88	
	ER	-0.35	0.08	0.05	0.15	-0.01	-0.01	0.01	0.02	0.04	0.12	0.01	0.35			0.04
1985	Q	1.79	1.66	0.93	1.33	0.58	0.38	0.24	0.54	0.65	0.64	0.55	1.53	0.90		
	PQ	1.69	1.71	1.11	1.36	0.53	0.41	0.31	0.80	0.84	0.74	0.48	1.36		0.94	
	ER	-0.09	0.05	0.18	0.03	-0.05	0.03	0.08	0.26	0.18	0.10	-0.07	-0.17			0.04
1986	Q	2.43	1.22	0.94	1.16	0.78	0.60	0.44	0.48	0.44	0.46	2.07	2.55	1.13		
	PQ	2.44	1.25	0.89	1.09	0.73	0.61	0.53	0.70	0.60	0.55	2.00	2.71		1.18	
	ER	0.01	0.03	-0.05	-0.07	-0.04	0.01	0.09	0.22	0.16	0.09	-0.08	0.16			0.04
1987	Q	1.42	1.08	1.03	1.46	0.61	0.60	0.46	0.31	0.31	1.00	1.60	1.43	0.94		
	PQ	1.59	1.02	1.06	1.44	0.51	0.68	0.51	0.28	0.26	1.32	1.92	1.65		1.02	
	ER	0.18	-0.06	0.03	-0.01	-0.10	0.08	0.05	-0.04	-0.05	0.32	0.32	0.22			0.08
1988	Q	3.00	2.89	1.36	1.19	0.73	0.47	0.50	0.42	0.58	1.30	0.83	1.17	1.20		
	PQ	2.65	3.02	1.51	1.38	0.75	0.39	0.50	0.46	0.67	1.51	0.89	1.24		1.24	
	ER	-0.36	0.13	0.14	0.19	0.03	-0.08	-0.01	0.04	0.08	0.21	0.06	0.07			0.04
MEAN	Q	2.01	2.22	1.36	1.06	0.62	0.43	0.35	0.37	0.44	0.78	1.29	1.73	1.05		
	PQ	1.92	2.05	1.37	1.08	0.58	0.39	0.31	0.35	0.47	0.81	1.25	1.71		1.02	
	ER	-0.09	-0.17	0.01	0.03	-0.04	-0.03	-0.04	-0.02	0.03	0.03	-0.04	-0.02			-0.03

COBER AT HELSTON

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
S.D.	Q	0.58	1.03	0.59	0.30	0.16	0.13	0.16	0.23	0.31	0.39	0.63	0.50	0.18		
	PQ	0.50	0.81	0.51	0.31	0.18	0.15	0.13	0.22	0.32	0.46	0.64	0.42		0.19	

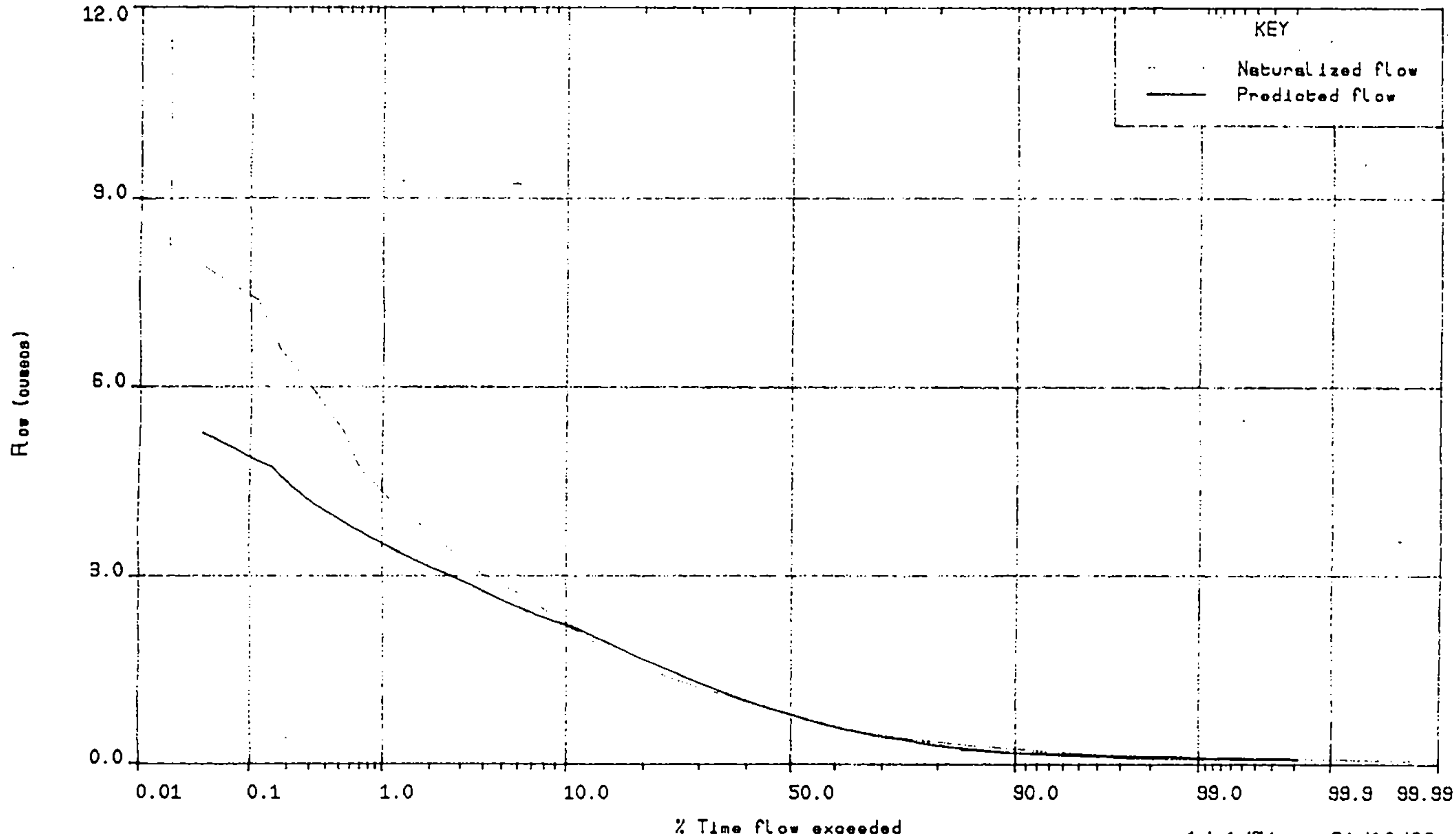
COBER AT HELSTON

DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

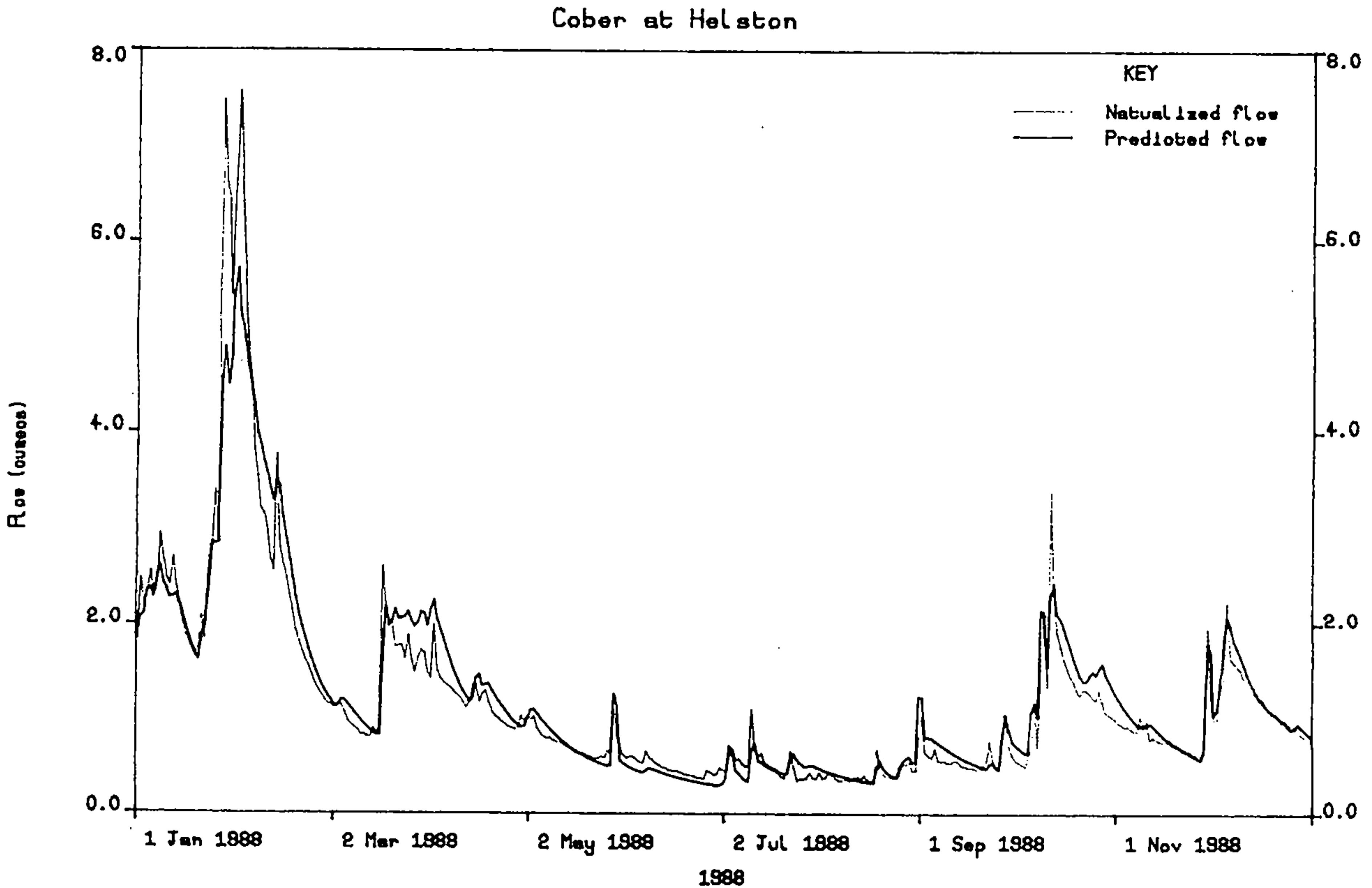
INTERVAL 0.3959 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	299.0	6.00	6.00	1159	24.41	24.41	295.8	6.11	6.11	1278	26.91	26.91
2	699.1	14.02	20.02	1235	26.01	50.41	645.4	13.33	19.45	1120	23.58	50.49
3	852.4	17.10	37.12	863	18.17	68.58	726.7	15.01	34.46	741	15.60	66.10
4	757.1	15.18	52.30	556	11.71	80.29	736.2	15.21	49.67	538	11.33	77.43
5	570.8	11.45	63.75	324	6.82	87.11	728.2	15.04	64.72	410	8.63	86.06
6	445.2	8.93	72.68	206	4.34	91.45	713.4	14.74	79.46	328	6.91	92.97
7	366.8	7.36	80.04	143	3.01	94.46	409.3	8.46	87.91	160	3.37	96.34
8	285.3	5.72	85.76	97	2.04	96.50	264.3	5.46	93.37	89	1.87	98.21
9	201.7	4.04	89.80	60	1.26	97.77	133.0	2.75	96.12	40	0.84	99.05
10	116.6	2.34	92.14	31	0.65	98.42	78.1	1.61	97.74	21	0.44	99.49
11	99.5	2.00	94.14	24	0.51	98.93	41.1	0.85	98.59	10	0.21	99.71
12	68.9	1.38	95.52	15	0.32	99.24	27.2	0.56	99.15	6	0.13	99.83
13	35.0	0.70	96.22	7	0.15	99.39	24.6	0.51	99.66	5	0.11	99.94
14	37.7	0.76	96.98	7	0.15	99.54	10.7	0.22	99.88	2	0.04	99.98
15	34.8	0.70	97.67	6	0.13	99.66	5.7	0.12	99.99	1	0.02	100.00
16	12.4	0.25	97.92	2	0.04	99.71	0.0	0.00	99.99	0	0.00	100.00
17	32.5	0.65	98.57	5	0.11	99.81	0.0	0.00	99.99	0	0.00	100.00
18	6.8	0.14	98.71	1	0.02	99.83	0.0	0.00	99.99	0	0.00	100.00
19	29.3	0.59	99.30	4	0.08	99.92	0.0	0.00	99.99	0	0.00	100.00
20	15.2	0.30	99.60	2	0.04	99.96	0.0	0.00	99.99	0	0.00	100.00
21	8.1	0.16	99.76	1	0.02	99.98	0.0	0.00	99.99	0	0.00	100.00
22	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
23	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
24	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
25	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
26	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
28	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.76	0	0.00	99.98	0.0	0.00	99.99	0	0.00	100.00
30	11.5	0.23	99.99	1	0.02	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	4985.9			4749			4840.0			4749		

Cober at Helston



1/ 1/74 to 31/12/88



Cober at Helston
KEY
Natualized flow
Predicted flow
Flow (cusecs)
8.0
6.0
4.0
2.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

Q. Hayle at St. Erth (49002) Area 48.9 km^2

Compound Crump Weir

Flows are known to be affected by mine drainage.

No data on drainage were available so the catchment has been treated as a natural one.

Model optimised on the period 4/80 - 12/86.

Comparison of the model predicted and observed flows over the period 1969-89 is summarised in the following tables and diagrams.

The cumulative flow prediction over the period is within 4% of the observed flow. There is a general tendency to underpredict.

The observed and predicted volume and time distributions over the flow range are generally similar except at the extremes. The model predicts a significantly greater % of volume and of time at flows lower than 0.25 cumecs than is observed and underestimates on the extreme peaks. The disagreement at very low flows may be a comment on the effect of mine drainage on the observed flows. The pattern is illustrated in the 1988 time series plot.

The model has been used to extent the flow record to cover the period from 1952.

HAYLE AT ST. ERTH

MONTHLY FLOW, PREDICTED FLOW AND ERROR

YEAR		MONTH												MEANS		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1969	Q	2.64	1.79	2.08	1.10	0.73	0.56	0.40	0.34	0.30	0.23	0.67	1.29	1.01		
	PQ	2.53	1.89	1.74	0.93	0.67	0.48	0.39	0.35	0.26	0.17	1.10	1.63		1.01	
	ER	-0.11	0.10	-0.33	-0.16	-0.06	-0.09	-0.01	0.02	-0.04	-0.06	0.43	0.34			0.00
1970	Q	2.15	2.75	1.62	0.82	0.57	0.41	0.35	0.34	0.34	0.29	0.71	1.24	0.95		
	PQ	2.14	2.64	1.54	0.77	0.52	0.33	0.26	0.27	0.32	0.23	0.80	1.24		0.91	
	ER	-0.02	-0.11	-0.08	-0.05	-0.04	-0.07	-0.09	-0.06	-0.02	-0.06	0.08	0.00			-0.04
1971	Q	1.68	1.79	0.94	0.71	0.49	0.39	0.29	0.29	0.22	0.22	0.30	0.59	0.65		
	PQ	1.56	1.64	1.02	0.71	0.40	0.31	0.23	0.28	0.16	0.15	0.33	0.77		0.62	
	ER	-0.12	-0.15	0.08	0.00	-0.09	-0.08	-0.07	-0.01	-0.07	-0.07	0.03	0.18			-0.03
1972	Q	1.05	2.29	1.87	0.81	0.57	0.67	0.57	0.42	0.33	0.29	0.88	2.47	1.02		
	PQ	1.23	2.45	1.91	0.83	0.71	0.80	0.53	0.36	0.27	0.22	0.91	2.50		1.06	
	ER	0.18	0.16	0.04	0.02	0.14	0.13	-0.04	-0.06	-0.05	-0.08	0.03	0.03			0.04
1973	Q	1.66	1.66	1.26	0.65	0.48	0.35	0.28	0.26	0.25	0.56	0.50	0.99	0.74		
	PQ	1.76	1.66	1.12	0.51	0.37	0.27	0.20	0.21	0.18	0.46	0.39	1.11		0.68	
	ER	0.10	-0.01	-0.15	-0.14	-0.10	-0.08	-0.08	-0.05	-0.07	-0.09	-0.12	0.12			-0.05
1974	Q	2.25	3.43	1.67	0.89	0.54	0.38	0.31	0.32	0.74	1.14	1.81	1.65	1.25		
	PQ	2.27	3.47	1.81	0.77	0.45	0.31	0.26	0.26	0.93	1.24	1.85	1.63		1.25	
	ER	0.02	0.04	0.14	-0.13	-0.09	-0.07	-0.05	-0.06	0.19	0.10	0.05	-0.03			0.01
1975	Q	1.93	1.87	1.22	0.92	0.72	0.46	0.34	0.31	0.28	0.31	0.78	1.50	0.88		
	PQ	1.84	1.86	1.28	0.94	0.58	0.34	0.29	0.31	0.26	0.21	0.57	1.16		0.80	
	ER	-0.09	-0.01	0.06	0.03	-0.14	-0.12	-0.05	0.00	-0.03	-0.10	-0.21	-0.34			-0.08
1976	Q	0.75	0.86	1.37	1.02	0.53	0.34	0.24	0.17	0.21	0.58	0.86	1.98	0.74		
	PQ	0.62	0.93	1.21	0.91	0.45	0.29	0.21	0.16	0.24	0.44	0.29	1.44		0.60	
	ER	-0.13	0.07	-0.16	-0.11	-0.07	-0.05	-0.03	-0.01	0.03	-0.14	-0.58	-0.54			-0.14
1977	Q	1.92	2.73	1.88	0.95	0.68	0.51	0.37	0.37	0.34	0.65	0.95	2.03	1.11		
	PQ	1.77	2.52	1.84	0.90	0.69	0.45	0.30	0.36	0.32	0.75	1.23	2.08		1.09	
	ER	-0.14	-0.21	-0.04	-0.04	0.01	-0.07	-0.08	-0.01	-0.02	0.10	0.28	0.04			-0.01
1978	Q	1.64	2.58	2.50	1.64	0.70	0.42	0.32	0.26	0.20	0.18	0.18	0.50	0.92		
	PQ	1.77	2.47	2.61	1.65	0.66	0.37	0.27	0.23	0.16	0.12	0.12	0.56		0.91	
	ER	0.13	-0.10	0.11	0.01	-0.04	-0.05	-0.05	-0.03	-0.05	-0.06	-0.06	0.06			-0.01
1979	Q	1.72	2.75	1.89	1.45	0.77	0.47	0.32	0.29	0.23	0.36	0.87	1.66	1.05		
	PQ	1.39	2.66	2.12	1.55	0.66	0.42	0.28	0.27	0.18	0.49	1.22	1.74		1.07	
	ER	-0.32	-0.09	0.23	0.10	-0.11	-0.05	-0.04	-0.02	-0.06	0.14	0.35	0.08			0.02
1980	Q	2.10	2.77	1.47	1.20	0.64	0.43	0.31	0.24	0.23	0.42	1.13	1.36	1.02		
	PQ	2.48	2.91	1.71	1.22	0.53	0.36	0.24	0.17	0.17	0.52	1.18	1.52		1.08	
	ER	0.38	0.14	0.24	0.02	-0.11	-0.06	-0.07	-0.07	-0.06	0.10	0.05	0.15			0.06
1981	Q	1.17	1.03	2.34	1.31	0.82	0.86	0.57	0.36	0.34	0.92	1.10	2.08	1.08		
	PQ	1.31	1.04	2.20	1.19	0.94	0.91	0.51	0.31	0.37	0.99	1.02	2.03		1.07	
	ER	0.14	0.01	-0.13	-0.11	0.13	0.06	-0.06	-0.05	0.03	0.08	-0.08	-0.06			0.00
1982	Q	2.42	1.37	2.36	1.20	0.63	0.48	0.37	0.30	0.27	0.85	2.30	2.52	1.26		
	PQ	2.40	1.41	2.34	1.13	0.53	0.44	0.29	0.20	0.18	1.05	2.25	2.56		1.23	
	ER	-0.02	0.04	-0.02	-0.06	-0.11	-0.04	-0.08	-0.10	-0.09	0.20	-0.05	0.05			-0.02

HAYLE AT ST. ERTH

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	FLOW	PFLOW	ER
1983	Q	2.20	1.31	0.85	1.17	1.46	0.86	0.49	0.30	0.30	0.33	0.33	1.09	0.89		
	PQ	2.22	1.32	0.80	1.21	1.37	0.67	0.37	0.25	0.29	0.31	0.19	0.95		0.83	
	ER	0.02	0.01	-0.06	0.04	-0.09	-0.19	-0.12	-0.06	0.00	-0.02	-0.14	-0.14			-0.06
1984	Q	2.49	2.15	0.93	0.59	0.44	0.37	0.24	0.20	0.19	0.25	0.88	1.54	0.85		
	PQ	2.27	2.31	0.97	0.68	0.42	0.28	0.19	0.17	0.17	0.29	0.96	1.70		0.86	
	ER	-0.22	0.17	0.04	0.09	-0.03	-0.10	-0.05	-0.03	-0.02	0.04	0.08	0.16			0.01
1985	Q	1.88	2.16	1.14	1.63	0.79	0.49	0.35	0.42	0.48	0.45	0.42	1.42	0.96		
	PQ	1.79	2.00	1.28	1.59	0.68	0.43	0.29	0.59	0.69	0.55	0.43	1.37		0.97	
	ER	-0.09	-0.16	0.13	-0.04	-0.11	-0.05	-0.06	0.17	0.22	0.10	0.01	-0.05			0.01
1986	Q	2.53	1.52	0.95	1.31	0.91	0.63	0.44	0.41	0.37	0.37	1.48	2.58	1.12		
	PQ	2.42	1.40	0.88	1.14	0.69	0.51	0.40	0.41	0.39	0.36	1.44	2.44		1.04	
	ER	-0.11	-0.12	-0.07	-0.17	-0.22	-0.11	-0.04	0.00	0.02	-0.01	-0.04	-0.15			-0.08
1987	Q	1.80	1.34	1.15	1.64	0.75	0.57	0.38	0.29	0.27	0.77	1.55	1.44	0.99		
	PQ	1.70	1.10	0.94	1.31	0.58	0.47	0.34	0.22	0.18	0.74	1.48	1.49		0.88	
	ER	-0.10	-0.25	-0.21	-0.33	-0.17	-0.10	-0.04	-0.06	-0.09	-0.02	-0.07	0.04			-0.12
1988	Q	3.01	3.29	1.53	1.39	0.82	0.56	0.49	0.40	0.45	1.18	0.86	1.26	1.27		
	PQ	2.42	3.23	1.62	1.31	0.72	0.42	0.37	0.28	0.40	1.14	0.82	1.12		1.15	
	ER	-0.59	-0.06	0.08	-0.08	-0.10	-0.15	-0.12	-0.13	-0.05	-0.04	-0.04	-0.14			-0.12
1989	Q	0.96	1.10	2.18	1.23	0.71	0.43	0.30	0.23	0.25	0.27	0.72	1.59	0.83		
	PQ	0.90	0.95	2.04	1.15	0.61	0.35	0.24	0.19	0.23	0.24	0.34	0.66		0.66	
	ER	-0.06	-0.15	-0.14	-0.07	-0.10	-0.07	-0.06	-0.05	-0.02	-0.04	-0.38	-0.92			-0.17
MEAN	Q	1.90	2.03	1.58	1.12	0.70	0.51	0.37	0.31	0.31	0.51	0.92	1.56	0.98		
	PQ	1.85	1.99	1.57	1.07	0.63	0.44	0.31	0.28	0.30	0.51	0.90	1.51		0.94	
	ER	-0.05	-0.03	-0.01	-0.06	-0.07	-0.07	-0.06	-0.03	-0.01	0.00	-0.02	-0.05			-0.04
S.D.	Q	0.58	0.75	0.52	0.32	0.22	0.15	0.10	0.07	0.12	0.30	0.52	0.57	0.17		
	PQ	0.54	0.76	0.53	0.31	0.22	0.17	0.09	0.10	0.19	0.35	0.57	0.58		0.19	

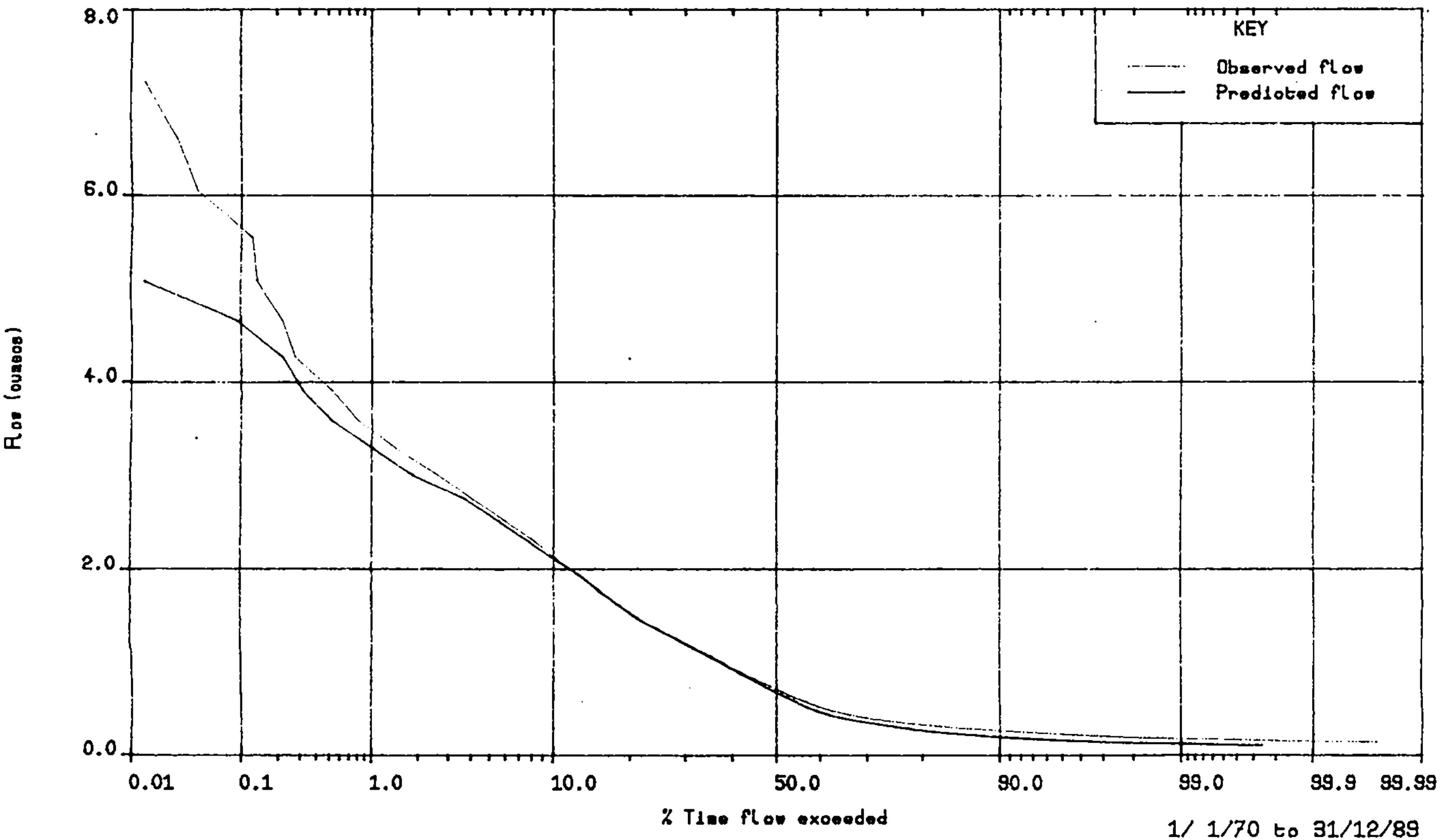
HAYLE AT ST. ERTH

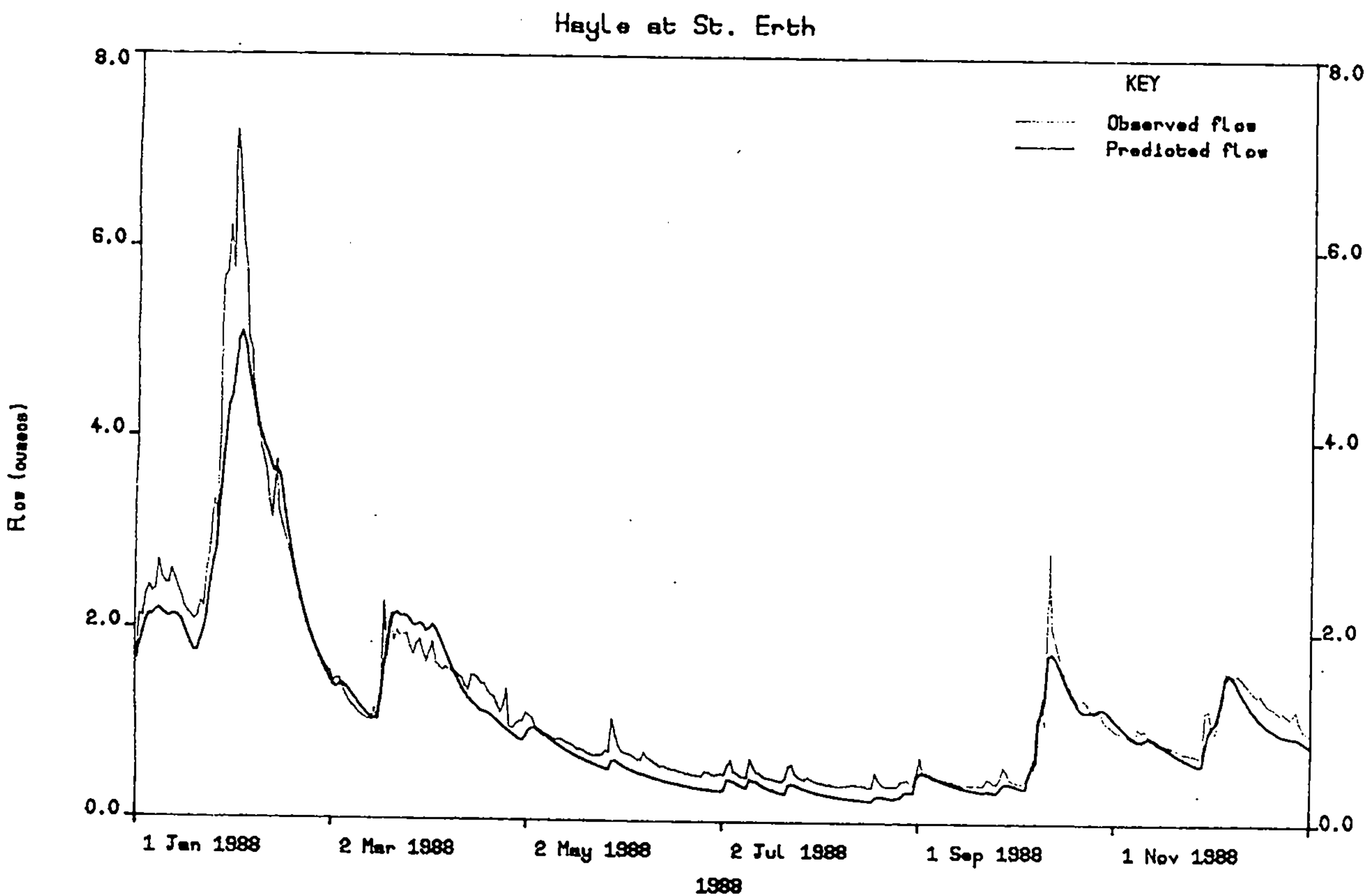
DISTRIBUTIONS OF DAILY FLOW AND PREDICTED FLOW

INTERVAL 0.2489 CUMECS

	FLOW						PREDICTED FLOW					
INTERVAL	CUMECS	%	CUM %	DAILY	%	CUM %	CUMECS	%	CUM %	DAILY	%	CUM %
1	126.1	1.68	1.68	598	7.80	7.80	237.9	3.29	3.29	1266	16.51	16.51
2	838.5	11.15	12.83	2360	30.77	38.57	681.7	9.44	12.74	1926	25.11	41.62
3	612.7	8.15	20.98	1002	13.06	51.63	542.3	7.51	20.25	877	11.43	53.05
4	739.7	9.84	30.82	854	11.13	62.76	636.1	8.81	29.06	732	9.54	62.59
5	733.1	9.75	40.57	656	8.55	71.32	754.6	10.45	39.51	678	8.84	71.43
6	748.7	9.96	50.53	549	7.16	78.47	758.1	10.50	50.01	555	7.24	78.67
7	633.3	8.42	58.95	393	5.12	83.60	645.7	8.94	58.95	399	5.20	83.87
8	587.9	7.82	66.77	317	4.13	87.73	580.2	8.04	66.99	311	4.05	87.93
9	525.6	6.99	73.76	250	3.26	90.99	584.9	8.10	75.09	278	3.62	91.55
10	483.0	6.42	80.19	205	2.67	93.66	508.0	7.04	82.13	215	2.80	94.35
11	450.6	5.99	86.18	173	2.26	95.92	380.4	5.27	87.39	146	1.90	96.26
12	302.9	4.03	90.21	106	1.38	97.30	394.6	5.46	92.86	138	1.80	98.06
13	267.8	3.56	93.77	86	1.12	98.42	195.0	2.70	95.56	63	0.82	98.88
14	156.7	2.08	95.86	47	0.61	99.04	127.3	1.76	97.32	38	0.50	99.37
15	107.7	1.43	97.29	30	0.39	99.43	68.0	0.94	98.26	19	0.25	99.62
16	38.6	0.51	97.80	10	0.13	99.56	30.8	0.43	98.69	8	0.10	99.73
17	53.4	0.71	98.51	13	0.17	99.73	16.3	0.23	98.92	4	0.05	99.78
18	21.8	0.29	98.80	5	0.07	99.79	34.8	0.48	99.40	8	0.10	99.88
19	4.7	0.06	98.86	1	0.01	99.80	23.2	0.32	99.72	5	0.07	99.95
20	19.4	0.26	99.12	4	0.05	99.86	9.8	0.14	99.85	2	0.03	99.97
21	10.2	0.14	99.26	2	0.03	99.88	10.1	0.14	99.99	2	0.03	100.00
22	0.0	0.00	99.26	0	0.00	99.88	0.0	0.00	99.99	0	0.00	100.00
23	11.4	0.15	99.41	2	0.03	99.91	0.0	0.00	99.99	0	0.00	100.00
24	11.5	0.15	99.56	2	0.03	99.93	0.0	0.00	99.99	0	0.00	100.00
25	18.2	0.24	99.81	3	0.04	99.97	0.0	0.00	99.99	0	0.00	100.00
26	0.0	0.00	99.81	0	0.00	99.97	0.0	0.00	99.99	0	0.00	100.00
27	0.0	0.00	99.81	0	0.00	99.97	0.0	0.00	99.99	0	0.00	100.00
28	6.9	0.09	99.90	1	0.01	99.99	0.0	0.00	99.99	0	0.00	100.00
29	0.0	0.00	99.90	0	0.00	99.99	0.0	0.00	99.99	0	0.00	100.00
30	7.2	0.10	99.99	1	0.01	100.00	0.0	0.00	99.99	0	0.00	100.00
TOTALS	7517.9			7670			7220.2			7670		

Hayle at St. Erth





Hayle at St. Erth
KEY
Observed flow
Predicted flow
Flow (cumecs)
8.0
6.0
4.0
2.0
0.0
1 Jan 1988
2 Mar 1988
2 May 1988
2 Jul 1988
1 Sep 1988
1 Nov 1988
1988

A2.2 INTAKES

Kennal Vale

See comment on Kennal to Ponsanooth under N in A2.1.

Rialton

In the absence of observed flows for this site, on which the model could be fitted, a synthetic flow record has been estimated for the period 1939-89 by area proportional multiplication of the model predicted record for the adjacent Gannel catchment. The ratio of the respective areas has been taken as 0.646.

The assumptions involved in this approach, that the rainfall and catchment response characteristics are identical, must inevitably lead to the synthetic record being regarded with caution.

A2.3 RESERVOIR INFLOWS

A. Colliford

With no natural or naturalised flow for the site it was not possible to model the inflows. A synthetic time series flow record has been produced by area proportional multiplication of the model predicted record for Craig's Hill Wood for the period 1975-89 (see A2.1, E). The multiplication factor is 0.53. As noted in the comment on the St. Neot to Craig's Hill Wood, this synthetic record must be treated with caution, since it simulates the flows expected at this site in the absence of the reservoir. Since some 40% of the catchment is now open water rather than vegetation, the evaporation losses will be higher and these synthetic flows will therefore overestimate the actual water available to contribute to flow.

B. Siblyback

A synthetic time series of daily mean flow from1962-89 has been derived for this site using areal proportional estimation (multiplication factor, 0.22) on the model predicted flows for the Fowey at Trekievesteps (see A2.1, D). As with Colliford this may represent an overestimate of the inflow but the area of the catchment occupied by the reservoir in this case is only 7% so the effect should be less marked.

C. Stithians

See comment on Kennal to Ponsanooth under N in A2.1.

D. Porth

No rainfall or natural flow records were available from which to derive a model from the Porth catchment flows. Consequently an estimated time series was produced by area proportional estimation from the adjacent Gannel catchment to Gwills (see A2.1, K) for the period 1939-89. The multiplication factor used was 0.60. This approach assumes identical rainfall and runoff response in the two catchments.

E. Drift

As with Porth, no flow records were available from which a model could be derived. However a rainfall record was estimated for the catchment for the period from 1961 using the Penzance rainfall. Consequently a synthetic flow record was estimated for the period 1952 to 1989 by assuming that the catchment response characteristics were identical to those of the Hayle catchment to St. Erth. The factor applied to the St. Erth record was derived as follows

$$\text{Est flow at Drift} = \frac{\text{Area of Drift catchment}}{\text{Area of Hayle catchment}} \cdot \frac{\text{Drift rainfall}}{\text{Hayle rainfall}} \cdot \text{model est flow at St. Erth}$$

$$= \frac{19.0}{48.9} \cdot 0.986 \cdot \text{flow at St. Erth}$$

Obviously this can only be regarded as a crude estimate, but in the absence of any other information it provides a first guess of the probable flows.

F. Crowdy

In the absence of flow or rainfall records an estimated time series flow record was obtained by proportional area multiplication of the model predicted record for 1942-89 for the Camel (see A2.1, H), of which the Crowdy catchment is one of the headwater areas. The multiplication factor applied was 0.020.

A2.4 OTHER

Tamar to Gunnislake

The contract called for an extended synthetic flow record for the Tamar to Gunnislake. Flow records from Gunnislake are available from 1956. In the absence of any data on abstractions, ratings, etc. this has been taken as an essentially natural record. Before modelling the catchment, rainfall availability was investigated and it was found that no satisfactory catchment record could be assembled prior to 1956. Consequently modelling of the catchment was abandoned since no record extension could be achieved.

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