NRA-ANGLIAN 287 4) 90/32 a more NRA GOGWS LOUSE/THET COMTROL RULES DHERAM JULY 1990 National Rivers Authority Anglian Region

GROUNDWATER DEVELOPMENT SCHEME

LITTLE OUSE AND THET CATCHMENT

CONTROL RULES

1. Introduction

There are 27 abstraction wells available for the support of river flows in the basin.

A full investigation and precise formulation of a set of control rules could become the subject of a long and complex study.

In practice, in 1989, believed to be the only year in which the wells have been used to alleviate the efects of low flows, quite simple rules were applied with apparent success.

2. Order of Priority

The wells have been listed in an order of priority based on a subjective evaluation of several criteria.

These criteria are listed in Table 1.

At several sites, the criteria are in conflict. In such cases, a reasonable balance has been sought.

The resulting order of priority is given in Table 2.

The Wells fall into 3 lists, named A, B and C.

Wells higher in each list should be switched on before wells lower down, and List A should take priority over List B.

List A = Wells in R. Thet basin which have good yields and few derogation problems.

It should be noted that there were complaints in 1989 that pumping at Wk. No. 65 (=5A) was causing a local pond to dry up. If this is accepted, this well should be moved down the list, possibly into List C.

There was a complaint about the iron content in water from Wk. No. 58 (=9A) causing deposition problems in the Roudham Brook. This needs further investigation.

List B = Wells in upper Lt Ouse basin which only make a compact group when wells to the north in List A are already pumping. On their own, they would probably merely transfer base flow from the Thet to the Lt. Ouse.

List C = Wells not far from Wetland sites, where abstraction may cause derogation.

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3. Further Criteria

Other considerations could have been brought in, especially differences in net gain, electricity costs and chemical quality, but data may not be easily available. There is scope for these to be given further study.

Experience in the Rhee basin suggests that it is difficult to quantify net gains from individual wells and that net gains which appear high at a monitoring site close to the recharge point can be severely depleted by losses occurring farther downstream.

On the other hand, costs of a unit volume of water calculated from power consumption and electricity tariffs are known to vary widely and these should be further investigated and given due weight in the priority listing.

The quality of water produced at each site should also be reviewed to find out whether this should form a further parameter to be considered in the order of precedence.

4. Mode of Operation

There are at present two possible modes of operation which can be named according to their main objective as the 'Constant River Flow' mode and the 'Constant Net Gain' mode.

The first was applied during the testing of the Pilot Area well field in 1971, and in the Rhee in 1986. The second was applied in the Lt. Ouse during the drought of 1989.

Obviously the two objectives can be combined in various ways, especially in a large basin such as the Lt. Ouse. For example, there could be a requirement to maintain a flow of not less than 300 1/s at Bridgham AND a net gain at Abbey Heath of 200 1/s.

4.1 Constant River Flow

This places a priority on local needs in the river. It is assumed that if flow can be maintained above a certain level, its quality and environmental features can be preserved.

Although a constant flow is the ideal objective, in order to give a reasonable time in which to respond to varying conditions, an upper and a lower limit should be set.

Even so, this method of operation requires telemetry and remote control of pumps if it is to be reasonably successful.

4.2 Constant Net Gain

This places priority on needs at the downstream end of the system.

For example, in 1989 it was decided that more water was needed in the Lt. Ouse at Hockwold for diversion into the Cut Off Channel to support the abstraction at Blackdyke which feeds rivers in Essex.

The amount required was known and the appropriate number of pumps were selected to give this gain. Only when more water was required at Hockwold were more pumps prepared for switch-on.

This method of operation relies far less on telemetry and remote control.

Nevertheless, regular monitoring of flows is required as the drought proceeds, and the information must be plotted on some form of control chart to make sure that net gain is being maintained.

For this purpose, a Control Area is usually designated which is close enough to the pumped area to have similar conditions of rainfall, geology etc, but is nevertheless unaffected by the support activity.

Hydrological observations in the Control Area are used to predict undisturbed flow in the maintained river. This flow is often called "Natural Flow" for short, but it reflects longstanding abstractions and returns and is not the same as "Naturalised Flow".

The difference between the actual flow measured in the river and the natural flow is defined as "Net Gain".

In 1989, pumping took place only in the R. Thet basin and not in the Lt. Ouse basin upstream of Knettishall.

Prior investigation had shown that the record at Knettishall gauging station could be used to predict natural flow at Melford and Abbey Heath. Control charts were constructed and Figs. 1-3 give an example of their use.

As soon as the well field upstream of Knettishall is brought into use during the course of any future drought, these charts cannot be used as a control, and other unaffected sites must be found.

5. Target Flows

In a report in 1990, it was recommended that a Cessation Flow should be included as a condition in the new licences being granted for Public Supply abstractions close to the river, and upper and lower limits to the flow were proposed at Melford and Abbey Heath. It was later decided not to use these values as a condition to be imposed on the licensee, but to accept them as targets to be aimed for by the NRA.

Criteria used in setting the targets were return periods of low flows and the shape of the flow duration curve at each monitoring point.

Since then a criterion based on one-fifth of the mean flow (1/5 QM) has been suggested. Because of differing rates of recession, the 1/5 QM value does not occur simultaneously at the various control points and its use could result in some unbalanced pumping of part of the aquifer.

Values are given in Table 3.

Bridgham has been included because it is a sensitive control point.

6. Monitoring of Groundwater Levels

In past use of the well field, because of innate difficulties in understanding groundwater behaviour, detailed measurements have been made in all surrounding observation boreholes.

For example in 1989, it was proposed to use 15 abstraction wells in the Thet basin. The number of observation bores required to monitor the effects of this was 37, and accordingly, the reading frequency was increased at these sites from about once per month to about twice per month.

Although this would still be counted as good practice, staff resources are not currently available to carry out an analysis of the extra data. The increased frequency can therefore are regarded as non-essential.

On the other hand, where it is known that there are very sensitive locations or complaints may be expected, more frequent monitoring should be attempted e.g. pond at Waterways Farm, East Harling (TL 990 867) and the Breckland Meres.

For the purpose of reference, a schedule of all observation bores in the vicinity of each abstraction well is included as Table 4.

7. Past History of Scheme

The Groundwater Development Scheme was promoted under a Parliamentary Order in 1977 for which printed maps were prepared and are still available.

For the record, all sites have been listed in Tables 5 and 6 to give the current status of each site and the basin in which each operates.

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8. Recommendations

Pumping should take place using wells based on the given order of priority.

Before the onset of a drought condition, a decision should be made on whether to operate to a Constant River Flow criterion or a Constant Net Gain criterion.

As the drought proceeds, the choice between these two methods should be kept under review.

If a Constant River Flow is chosen, the values listed in Table 3 should be used.

If a Constant Net Gain is required, monitoring should take place according to control correlations which should be prepared from flows occurring in previous years and up-dated from data collected in the 3-4 months prior to the onset of pumping. Examples are given in Figs. 1-3.

Background monitoring of groundwater levels should continue at monthly intervals. At sensitive locations monitoring should be more frequent.

Control sites should be established for all parts of the well field. The area upstream of Knettishall is in particular need of attention.

The quality of groundwater produced at each site, especially the iron content, should be reviewed.

In any future operation of the scheme, careful records should be kept of electricity consumption and resultant charges.

D HESLAM

4 July 1990

DHREPGROU/MS

TABLE 1

CRITERIA FOR DECIDING ORDER

OF PRIORITY FOR SWITCHING ON

ABSTRACTION WELLS

HIGHER PRIORITY	LOWER PRIORITY
Well has high yield	Well has low yield
Pipeline outfall close to lower reach of river i.e. close to Thetford	Pipeline outfall far upstream i.e. remote from Thetford. (More chances of obstruction to flow and channel losses)
Well sited far from stream whereby base-flow interception will be delayed and net gain high	Well sited close to stream where loss of base-flow may be expected, and net gain will be low
Well discharges to Main River	Well discharges to I.D.B. or other small drain (More field checking required to ensure channel is not obstructed)
Abstraction not known to cause derogation	Abstraction likely to cause some effect on neighbourhood
Well is remote from wetland S.S.S.I's, especially the Meres	Well is closer to the Meres. N.B. It was agreed that the 5 wells closest to the Meres would be pumped last.
Part of well field in use at any time forms a compact unit with a linked area of drawdown, drawing on stored groundwater	Wells in use are scattered over area, leading to groundwater transfer across boundaries

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LIST A

BIVER SOPPORT WELLS IN THE THET CATCHEEPT. In Order Of Priority For Switch - On.

G.D.S WOBES NO.	G.W.P.S. No.	STATION NO.	N.G.R	AVERAGE OUTP TCHD L/S		CHARNEL Idh Biparia	BEMARIS I	
ł	-	TL 88/48	TL 889 828		38.9 -			
3	- 71	TL 98/136	TL 961 837		93.1 -		· ·	
59 69	78 18	TL 98/134 TH 08/78	TL 969 855 TH 011 859		47.5 -		-	
64	BA	TL 98/103	TL 988 894				-	
65	58	TL 98/131	TL 988 867				-	
61	104	TL 98/105	TL 974 883			YRS -	•	
58	94	TL 98/104	TL 964 872			TES -	•	
66	11 4 124	TL 99/89	TL 994 912			 • PC	-	
62 50	134	TL 99/90 TL 99/91	TL 981 918 TL 971 905			TBS - TBS -	·	
10	-	TH 03/91	TH 051 871			TES -		
11	-	TH 08/90	TH 071 856			TES -	-	
8	-	TH 09/119	TH 021 917			TES -	-	
12	-	TH 09/120	TH 084 910	9.600 1		YES YES		
TOTAL				85_338 9		**		
				8 ≤ 3 1 8 97	7.7			
	LIST B	:=						
la Order Of	RIVER SUPPO	ORT WELLS IN	LITTLE ODSE	CATCENENT				
	G.W.P.S. NO.	STATION No.	N.G.R	AVERAGE OUTPUTCHD		CBANBBL EDB RIPARIA	BBYABES	
4	\$	TL 98/112 TL 98/111	TL 972 830 TL 985 818		22.2 - 34.7 -		-	
5 5	\$	TE 08/117	TE 001 820		92.5 -		-	
9	\$	TH 08/85	TH 025 836		50.0 -		•	
TOTAL				17.228 1	99.4			
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In Order Of		 WELLS COULD or Switch On.) AFFECT WETL	AND SITES.				
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	NO.	BO.	N.G.B	AVERAGE OUTPU TCND L/S		CEANNEL IDB RIPARIA	BEMARKS I	
68	21	TY 08/79	TH 002 854	3.629	42.0 -		1.1 In from B. Barling Fen	
	38	TH 98/100	TL 986 842		43.0 -		0.6 Km from H. Harling Fen	
	64	TH 08/81	TH 002 884	4.346	50.3 T	IBS -	0.5 Is from B. Harling Fen	
	164 174	TL 99/93	TL 963 921			IBS -	6.7 Im from Bingmere \$\$\$	
	110	TL 99/94 TL 99/92	TL 951 915 TL 951 901			IS -	5.4 In from Ringmere \$\$\$	•
55	158		1912 11.1			IBS -	4.6 In from Ringmere \$\$\$	
55 56	15A 14A			1 728	20.0 ¥	HS	L L IR Trop Findnara III	
55 56 54		TL 98/106 TL 99/95			20.0 Y 53.5 Y	115 -	4.9 In from Ringmere 335 4.0 In from Bingmere 333	
55 56 54	148	TL 98/106	TL 949. 885	4.622			- 20.5VA	

TABLE 3

LT. OUSE AND THET - TARGET FLOWS IN L/S

	CONT	ROL GAUGIN	G STATION	
	Abbey Heath	Melford	County Bridge	Bridgham
Upper limit	1200	470	125	380
Lower limit	1035	374	56	300
Single target based on 1/5 QM	800	405	100	320

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		T WELLS		1-5-63	1.2.2.2.1		
GWDS No.	GWPS No.	STATION	GWDEN.	CUPS	STATION	KEMARKS	
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		4	16	4D	TL 98/11		
				145	TL 98 27		
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		1		50	TL98/12		
	<u> </u>			146	TL98/35		
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69	<u> 1A</u>	TM 08 78		101	TN 08/7	Asjacent I	
				248	TM08/G		
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			+	131	TL98/13		
	1				16 10/24		
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61	10A	TL 98/105	-	_110	TL98/5	ASjacent	
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				<u>8</u> B	TL 98/14		
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OBSER RIVEZ	VATION SUPPOR	SCHEDUL	E IN THE	€T - (L	157 A contd)
ABSTRA	CTION	WELL	OBSERV			REMARKS.
GWDSN.	G.W.P.S. N.	No.	GWDS No.	GWP5 No	STATION No.	
58	٩Å	TL98/104		109	TL98/22	Abjacent. Recorder
		· ;		95	TL98/15	
ಎಎ	A	TL99/89		F11	71 99/19	Asjacent
				GB	TMO9/94	
				ц	TM09 98	
<u> </u>	12 A	TL99/90	· · · · · · · · · · · · · · · · · · ·	112	TL99/20	Adjacent
60	<u>13 A</u>	TL99/91		113	TL 99/21	Adjacent
10		TM08/91	83		TM08/104	ASjacent
				133	TM08/11	· · · · · · · · · · · · · · · · · · ·
		••••••	: 	134	TM08 12	
		TM08/90	86		TM08 /103	ASjacent
8		TM09/119	81		TA109/138	FlSjacent
			-	130	TM09/2	
2		-TM09/120	87		TM09/139	<u>HSjacent</u>
		<u> </u>			TM09/1	······
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		T WELLS		OUSE	(LIST B)	i	4	
ABSTRAC	TION WE	ELL	OBSERV	ATION	BORE			
GINDE No.	GWP5 No	STATION No.	GWDS.Nb.	GWPS No.	STATION		REMARKS	
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				142	TL98/G		10. V	
				144	TL98/26		<u> </u>	
			74		TL98/148		Phi f	
5		TL98/111	76	 :	TL98/150		ASjacent.	
		<u>.</u>		143	TL98/25		J	
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ى		TM08/117			TM08/112		HSjacent	
				: 141	TM08/17		· · · · · · · · · · · · · · · · · · ·	
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٩		TM08 85	82	-	TM08/108		Adjacent	
				139	TM08/3			
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OBSERVATION SCHEDULE IN THET (LIST C - Could affect wetland sites) RIVER SUPPORT WELLS WELL ABSTRACTION BORE OBSERVATION GWPS STATION GWDSM No STATION GWDS No. REMARKS No NO NO TM08/79 ASjacent କ୍ଷ TM08/8 2 A 102 TL98/19 <u>ASjacent</u> TL98/100 <u>6</u>3 ЗA 103 TL98/9 B TL98/10 2 B TL98/30 <u>ASjacent</u> GA TM08/81 67 106 TL98 34 136 Jange Board EZZ TL 98/164 TL98 165 - Jauge Board EZ3 135 TM08/13 TABLE 4

RVER SUTTERT WELLS IN THET (LIST C - Cull field Mire: With malt be purpled in guen sequence) ABSTERACTION WELL GWTS SUTTER GWTS MAC MARE GWTS MAC MARE MAC MARE	OBSERVATION SCHEDUL			
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$\begin{array}{c c c c c c c c c c c c c c c c c c c $	GWPS STATION	EWPS	STATION	REMARKS
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120 TL98/35 152 TL98/36 158 TL98/37 125 TL98/37 125 TL98/37 125 TL99/37 125 TL99/37 128 TL99/25 55 17 A. TL99/94 117 TL99/25 55 17 A. TL99/94 117 TL99/25 55 17 A. TL99/94 117 TL99/25 56 17 A. TL99/94 123 TL99/26 123 TL99/26 123 TL99/26 24 TL99/26 17 B TL99/28 17 B TL99/28 5c 15 A 15 TL99/28 16 TL99/28 748LE - T48LE -		119	TL98/23	V .
$\frac{152 \text{ TL98/3c}}{158 \text{ TL98/37}}$ $\frac{152 \text{ TL99/37}}{128 \text{ TL99/37}}$ $\frac{128 \text{ TL99/37}}{128 \text{ TL99/25}}$ $\frac{128 \text{ TL99/25}}{128 \text{ TL99/25}}$ $\frac{17 \text{ A} \text{ TL99/94}}{117 \text{ TL99/23}}$ $\frac{100 \text{ TL88/9}}{128 \text{ TL99/23}}$ $\frac{100 \text{ TL88/9}}{128 \text{ TL99/6}}$ $\frac{24 \text{ TL99/10}}{128 \text{ TL99/16}}$ $\frac{24 \text{ TL99/16}}{178 \text{ TL99/168}}$ $\frac{5c \text{ 15 A \text{ TL99/92}}{115 \text{ TL99/168}}$ $\frac{115 \text{ TL99/128}}{115 \text{ TL99/28}}$ $\frac{115 \text{ TL99/28}}{115 \text{ TL99/28}}$ $\frac{115 \text{ TL99/28}}{158 \text{ TL99/28}}$		157	TL98/29	Recorder
158 TL98/37		120	TL98/33	
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123 TL99/G 24 TL99/10 16 B TL99/15 17 B TL99/163 5c 15 A TL99/92 115 TL99/28 All the above bores, plus:- 115 TL99/28 Abjacent		160		
$\frac{24}{168} \frac{7L99}{15}$ $\frac{178}{178} \frac{7L99}{168}$ $\frac{56}{15A} \frac{7L99}{92}$ $\frac{7115}{115} \frac{7L99}{28} \frac{711}{78} \frac{115}{7L99} \frac{711}{28} \frac{115}{748} \frac{748}{748} \frac{115}{748} \frac{115}{78} \frac{115}{7$		123		
$\frac{16 \text{ B}}{17 \text{ B}} \frac{\text{TL99}/15}{\text{TL99}/16\text{A}}$ $\frac{17 \text{ B}}{17 \text{ B}} \frac{\text{TL99}/16\text{B}}{\text{TL99}/16\text{B}}$ $\frac{56 \text{ 15 A}}{115 \text{ TL99}/28} \frac{\text{All the above bores, plus:-}}{\text{Hbjacent}}$ $\frac{115 \text{ TL99}/28}{115 \text{ TL99}/28} \frac{\text{Hbjacent}}{\text{Hbjacent}}$			1	
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$\frac{17 \text{ B} \text{ TL99/IGB}}{\frac{56}{15 \text{ A} \text{ TL99/92}}} = \frac{115 \text{ TL99/1GB}}{\frac{115}{15 \text{ TL99/28}}} = \frac{115 \text{ TL99/28}}{\frac{748 \text{ LE-1}}{15 \text{ TL99/28}}}$				
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	EVATION SCHEDULE SUPPORT IN THET		.)	
ABSTR GWDS No.	ACTION WELL GWPS STATION NO. NO	OBSER VATION GWDS No No	U BORE	REMARKS
54	14A TL98/10G	11A 105	TL98/32 TL98/16	All bores on previous sheet, plus:- Albjacent
			· ·	
<u>53</u>	18 <u>A TL99/95</u>		TL99/29 TL99/18	All the above bores, plus:-
		· · · · · · · · · · · · · · · · · · ·		
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	S WELLS U.S.		C	Not incl in Pr	- /
G.D.5. No.	PILOT SCH REF . DA No NO DR	ILLING STATU	SIN 1989 MELF	U.S. LT OUSE U.S. COUNTY BR.	SAPISTON U.S. RECTORY
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3	TL98/136 H	19 82 Availabl	e for R.S. V		
4	TL98/112 Ju	ıl 82 ,		. /	
5	TL98/111 H	1g 83		÷ 🗸	
ى _	TM08/117 N	00 83	· · ·	· · · · ·	
7		- Not de	illed	✓	
8	TM09/119 0	ct 81 · Availab	le foi R.5. V		
q	TM 08/85 M	ar 85	<u> </u>	v	<u>. į</u>
10	TM08/91 0	ct 82	<u> </u>		
11	TM08/90 D	ec 81	·· · ·		
12	TM09/120'T	lec 82	<u>"/</u>		
13	TL 97/137 N	lay 83 Offered 1	5 C.W.C.	J	
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15	TL98/110 J	ul 83 Offered	t CWC	/	
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G.D.S WELLS U.S. OF THETFORD (Incl. in Pilot Area)

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G.D.J. No	PILOT SCH. REF No. No.	DATE OF DRILLING	STATUS	10 1989				
. 53	18 A TL99/95	Aug 68	Available	for River	Support			_
54	14 A TL98/100	Jun 68		11				
55	17 A TL 99/9-	Jules		l 		•		
56	15 A TL99/92	Sep 68		. n				
57	16 A TL99/93	Sep G8		1				
58	9 A TL98/104	May 68		4	•			
59	7 A	Jun 68						
60	13 A TL99/91	Aug 68	i	: ₁₁				
61	10 A TL98/10	5 JUIG8	1					
<u> </u>	12 A TL99/9.	o Jul 68		1 	.		4	
63	3A TL98/100	Apr 68	:	т. "н			1	
64	. 8A TL98/10	3 Jul 68	1	: "				
65	5A TL98/10	Apr 68		"				
66	11 A TL99/80	a Jun 68	<u>.</u>					
67	GA TM08/8	May 68		11				
68	2A TM08/7	Apr 68		4			ا ا	
69	1A TM08/7	8 68		<u>н</u>			1	
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NB	4A TM08/8	0: 1968	- Handed	over for F.V	1.5 in 1973			
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38 FIG. I 30.0 11:0 FOR Conclusion:- Target was met except on 3 occasions. HEATH 5-day median values plotted. © Daka prior to pumping. A Daka during pumping Target Net Gain = 230 Lls 320 CHART Example of use in 1989. ABBEY 0 300 CONTROL 0 2 ---- --26.2 ALE 240 0 1.01= 200 1120 < ÷ HLO W 120 00 170 A 120 -11

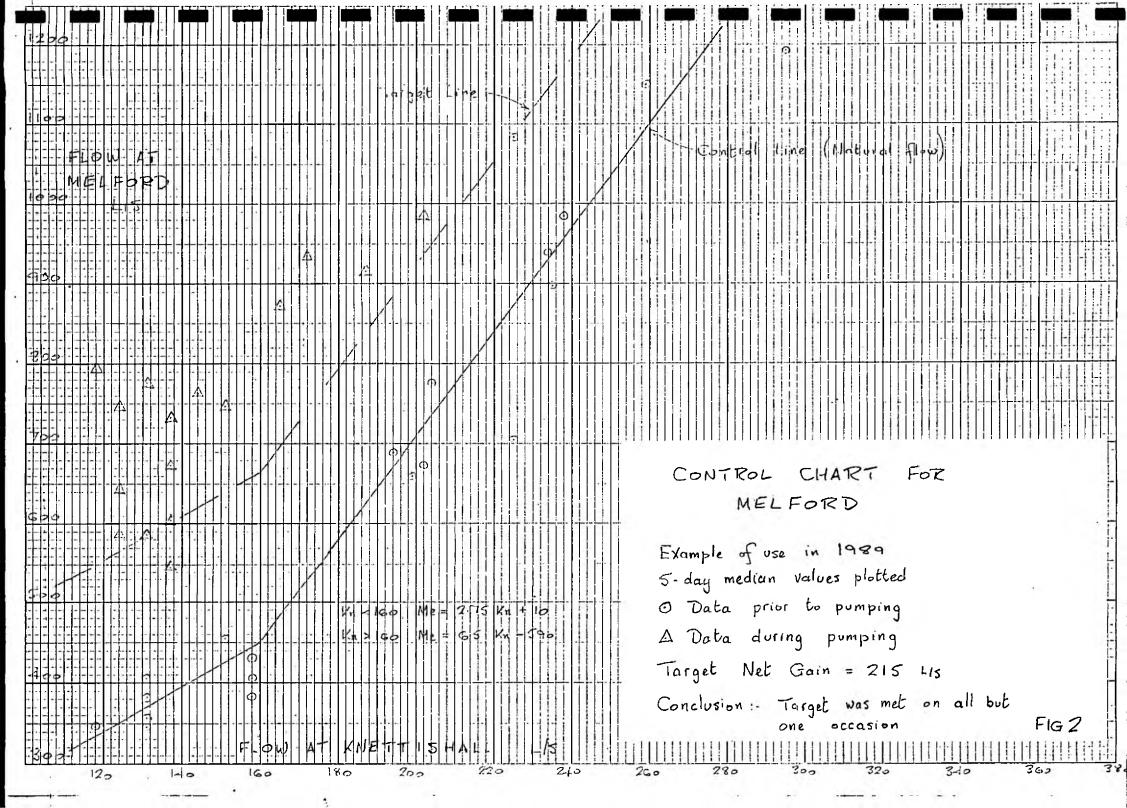


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