NRA Southern Box 6

NATIONAL RIVERS AUTHORITY

SOUTHERN REGION

REGIONAL WATER RESOURCE REVIEW

Thursday 5th October 1995

ARUNDEL STAKIS HOTEL

NATIONAL RIVERS AUTHORITY - SOUTHERN REGION

Regional Water Resources Review

Thursday 5th October, Arundel Stakis Hotel

A G E N D A

9.00 am	Welcome and Introduction	PWH
	SESSION I - GROUNDWATER	(Chair GDW)
9.15 am	Licensing the Chichester Chalk	SHV
9.35 am	Medway Tunnel	BT
9.55 am	Groundwater Protection Zone Modelling	PJS
10.15 am	Medway Catchment Licensing	RH
	COFFEE 10.35 - 10.50 AM	
	SESSION II - HYDROMETRY	(Chair GAB)
10.50 am	Barcombe Flow Measurement and Ardingly/Ouse Operation.	JLH
11.10 am	HER in Sussex	NGH
11.30 am	WAMS Data Cleaning	JP
11.50 am	The Drought of 1995: a Kent Perspective	SCO
12.10 am	Waiting for WAMS - the alternatives.	SCF
	LUNCH 12.30 - 2 PM	
	SESSION III - WATER RESOURCE MANAGEMENT	(Chair JE)
2.00 pm	Water Level Management Schemes in Sussex.	SMT
2.20 pm	Hardham Scheme	SMT
2.40 pm	Darent Action Plan	IGGH
3.00 pm	Demand Management	DAH
	SESSION IV - FORWARD LOOK	(Chair PWH)
3.20 pm	Water Resources in Envage - Key Issues.	
	• WRB Views. • Discussion	
4.00 pm	Tea and departure.	

DISTRIBUTION

(1) Attendees

Region

Peter Herbertson
Geoff Burrow
John Ellis
Scott Ferguson
Paul Shaw
David Howarth

Kent Area

Graham Warren
Brigit Thorne
Steven Oakes
Rob Harding
Ian Hogg

Sussex Area

Simon Taylor
Simon Vipond
John Headey
Nigel Hepworth

Hampshire Area

Rod Murchie
Joe Pearce

(2) For Information

Malcolm West - Regional Technical Manager
David Jordan - Area Manager Kent
Peter Midgley - Area Manager Sussex
Mike Beard - Area Manager Hampshire

SESSION

I

GROUNDWATER

WATER RESOURCES SEMINAR 5 OCTOBER 1995 - SESSION 1 NOTES

Licensing the Chichester Chalk - Simon Vipond

Licence applications by Southern Water and Portsmouth Water represented a 20% increase in abstraction from the aquifer unit. With groundwater flow from west to east there was a threat to Swanbourne Lake and the associated SSSI as well as to the Wildlife and Wetlands Trust ponds. A lengthy pumping test was analysed by Southern Science for Southern Water and by NRA and its consultants. In addition a groundwater model of the chalk block was developed by Halcrow for NRA to include simulation of water levels in the lake at nil and varying rates of abstraction.

A key stage of the project was the agreement of the model calibration by all parties although some questions were inevitably raised over its accuracy. All the applications were finally refused: Slindon and Tortington on the grounds of need, net yields of nearby sources, environmental impact and derogation; Aldingbourne on the additional grounds of derogation of flows in rifes rising in the South Downs. English Nature objected to the applications but offered no quantified evidence in support.

Tortington was offered to NRA as an observation borehole - in contrast Portsmouth Water withdrew their application but will re-apply for Aldingbourne, probably involving a public inquiry, in the light of recent nitrate problems in nearby sources .

Medway Tunnel - Bridget Thorn

A cut and cover tunnel to take the railway under the Medway was constructed with a casting basin adjacent to the river de-watered by 16 well points with a predicted combined discharge of 250l/s. The basin was to be flooded to float completed tunnel sections into the river. In the event the discharge was 400l/s and drawdowns of 3m were found at a radius of 1.5km after additional monitoring was insisted upon by NRA. The chalk was obviously highly fissured and chloride monitoring showed that 66% of the pumped discharge was fresh water rather than marine. After 6 months' pumping licences were within the zone of influence although no derogation was claimed, and some nearby structures were beginning to move.

The major risk to NRA interests was the possibility of large volumes of saline water filling the dewatered void when the basin was flooded leading to long-term contamination of the aquifer. In the event although some movement of salt water was detected the aquifer was in fact flushed out by the pumping and was in effect cleaner than before the operations.

There was continual conflict with the contractor's consultants over the cost of monitoring but this was over-ridden by the NRA's duty to protect licences and the aquifer itself. It was felt essential to be firm with the contractors from the outset and to appoint a single NRA contact for the life of the project so that a stable working relationship could be established. Lessons were learnt from residence and transit times of contaminants in chalk which could be developed into a research project on coastal sources, and it was important to keep licence holders informed of events which could have an impact on their interests.

Groundwater Protection Zone Modelling - Paul Shaw

The aquifer is zoned to protect major sources into 50 day (bacterial decay), 400 day (hydrogeological year) and total catchment areas based on particle tracking. The models combine manual and analytical methods and take account of catchment irregularities. Average aquifer constants and abstraction volumes were used for steady-state modelling and it was difficult to cater for extreme events.

Target water levels and flow velocities were used and Modflow was favoured over Flowpath for ease of use and flexibility. Although much modelling has been carried out by consultants it was felt important to keep these skills available in-house for project supervision and other resources work.

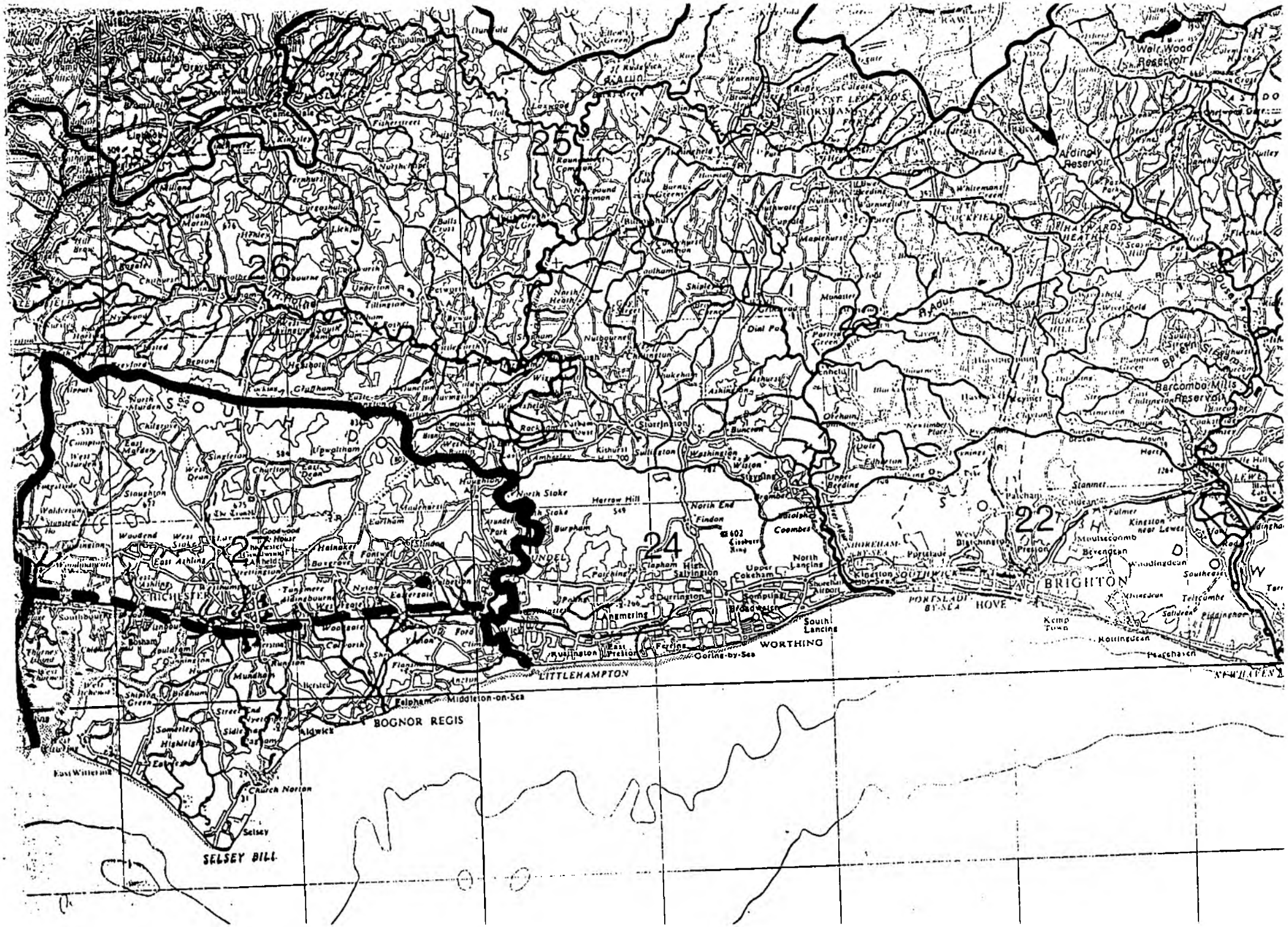
Medway Catchment Licensing - Rob Harding

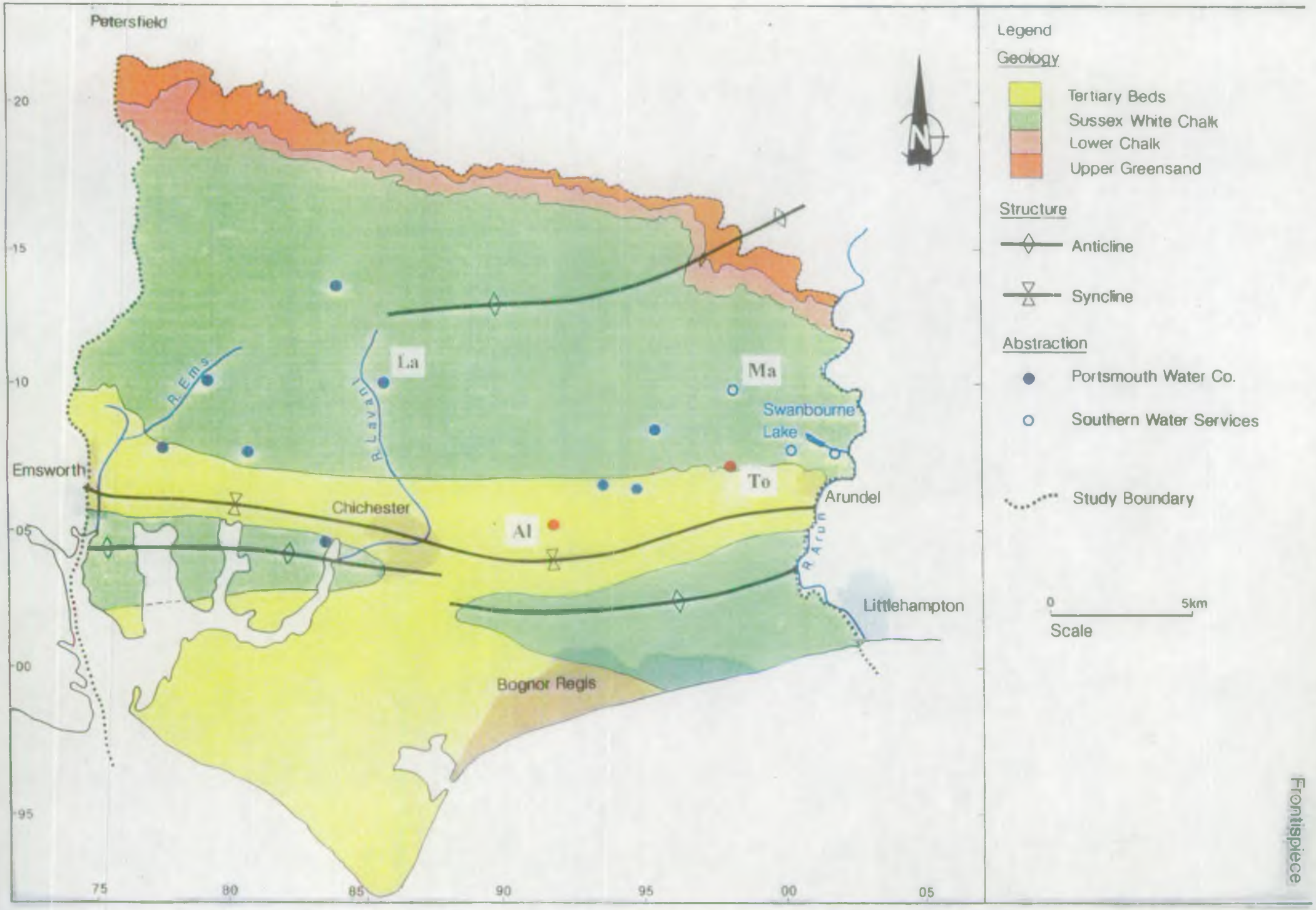
The Medway Condition is a prescribed flow gauged at Teston applying to 110 licences within the catchment. It has been progressively stepped up as more of the resource has been allocated, but a Southern Water licence has recently had its flow condition raised as part of an agreement to provide compensation flows. This relaxation in effect derogates all other licences with the Medway Condition and they will all have to be varied pro rata. Most of the licences are used every year and there is little likelihood of revocation. The flow characteristics of the river are such that no licence-holder will suffer any real reduction in the number of days when abstraction is allowed, but some political difficulties arise when reconciling an apparently reduced standard of river flow protection with a continuing presumption against further groundwater abstraction from the catchment.

Chichester Chalk Licensing

By

SIMON VIPOND


Weir Wood Reservoir
Ardingly Reservoir
Barcombe Mills Reservoir
25
26
23
24
22
27
SOUTH
Dial Post
Storrington
Washington
Wiston
Steyning
Bramber
North Stoke
Harrow Hill
North End
Findon
Clapham
Salvington
Durrington
Upper Cokeham
North Lancing
Shoreham Airport
Kingston by Sea
SOUTHWICK
PORTSLADE-BY-SEA
HOVE
BRIGHTON
Kingston near Lewes
Rottingdean
Peacehaven
Telscombe
Saltdean
Ferring
Goring-by-Sea
WORTHING
South Lancing
Rustington
East Preston
Littlehampton
Middleton-on-Sea
BOGNOR REGIS
Aldwick
Felpham
Selsey
SELSEY BILL
Church Norton
East Wittering
CHICHESTER
Bosham
Funtington
Mundham
Hunston
Sidlesham
Somerley
Highleigh
Earnley
Bognor
Arundel
Burpham
Ford
Climping
Yapton
Walberton
Eastergate
Westergate
Barnham
Aldingbourne
Tangmere
Boxgrove
Halnaker
Goodwood House
Fontwell
Slindon
Eartham
Madehurst
Stoughton
Compton
West Marden
East Marden
Chilgrove
Charlton
East Dean
West Dean
Lavant
Singleton
Cocking
Midhurst
Easebourne
Lodsworth
Petworth
Tillington
Upperton
Fernhurst
Haslemere
Hindhead
Grayshott
Liphook
Liss
Liss Forest
Bramshott
Lindford
Bordon
Selborne
Alton
Ropley
Medstead
Four Marks
Froxfield
Steep
Petersfield
Rogate
Harting
Chichester
Bognor Regis
Littlehampton
Worthing
Brighton
Lewes
Newhaven



Frontispiece

P2 Spring - 23rd November 1990

Photo 1

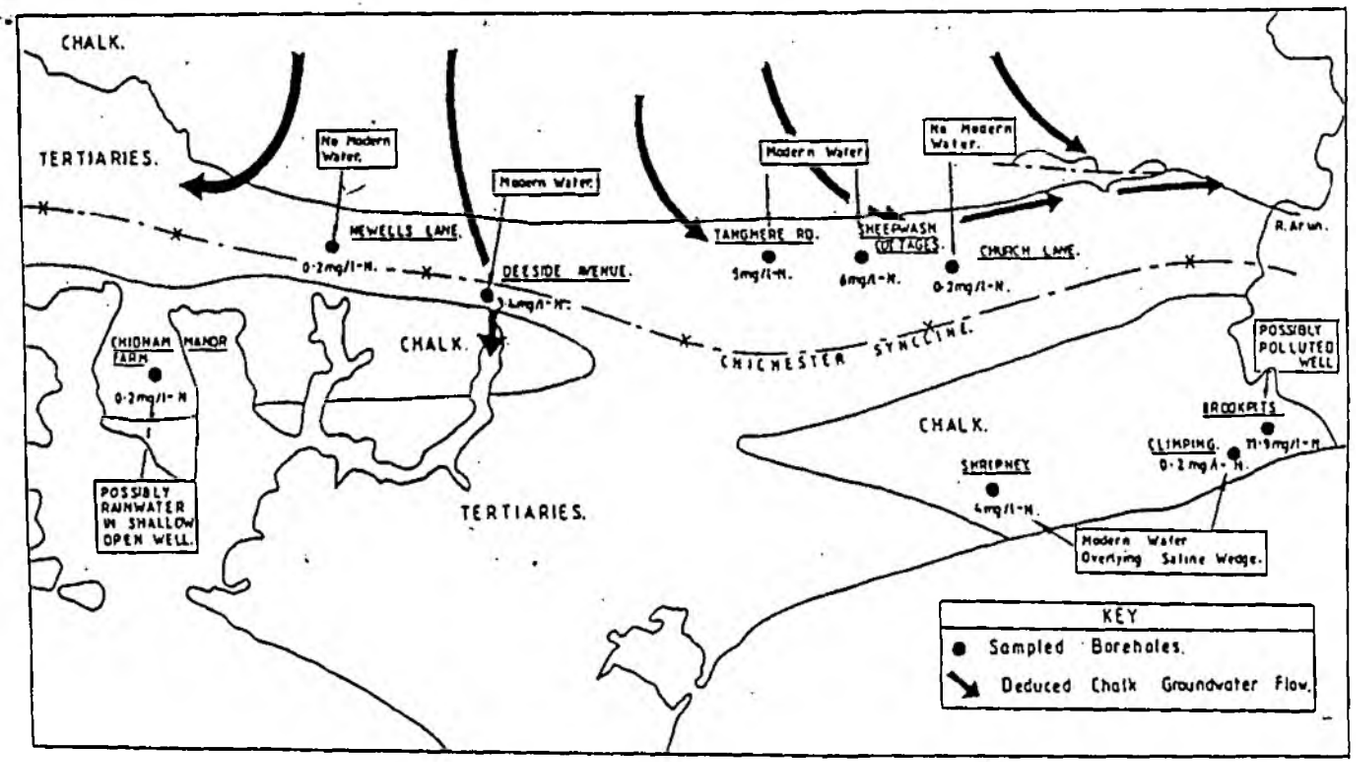
P2 Spring - 15th November 1990

Photo 2

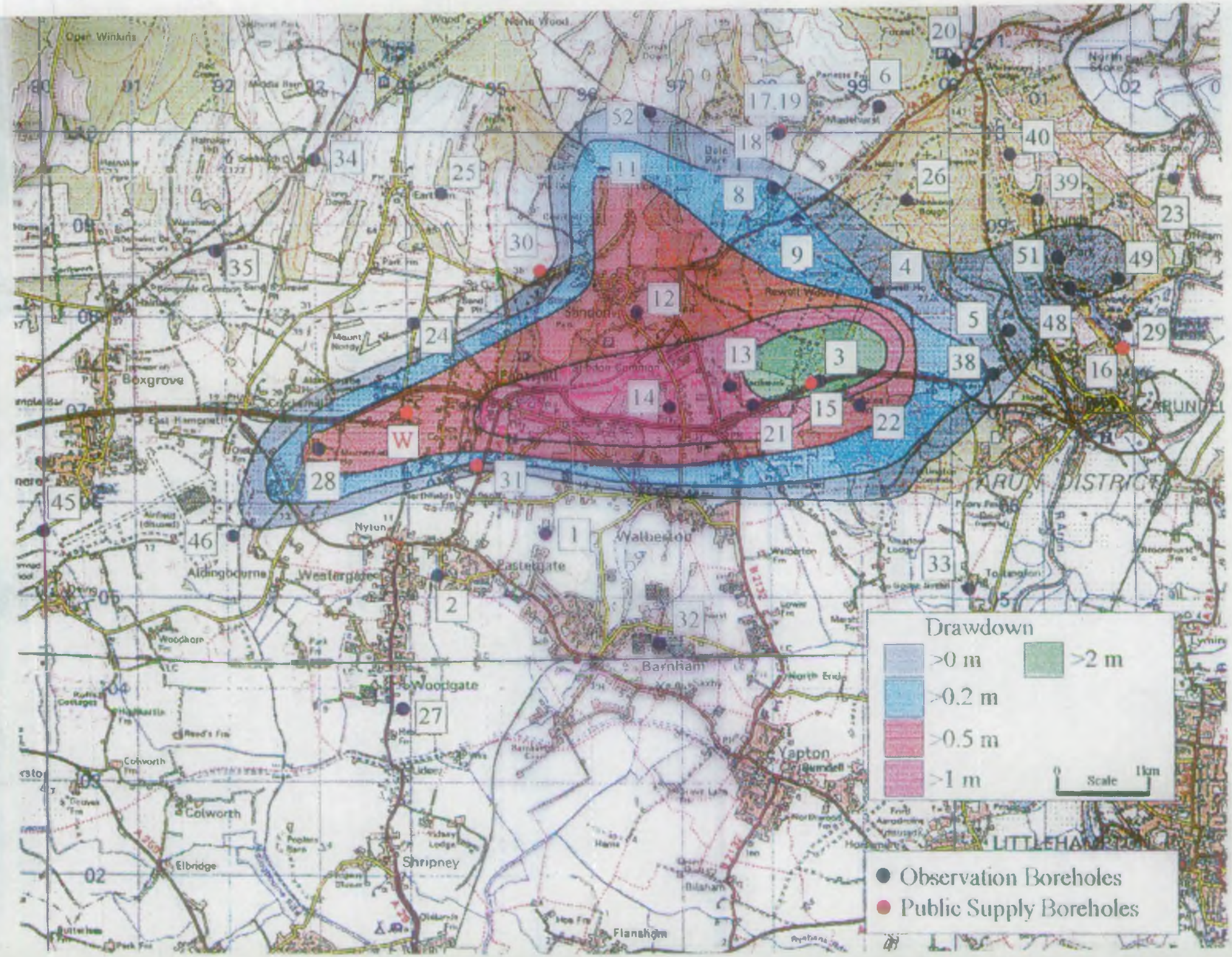
PHOTOGRAPHS OF LAKE DURING LOW LEVEL PERIOD LATE 1990

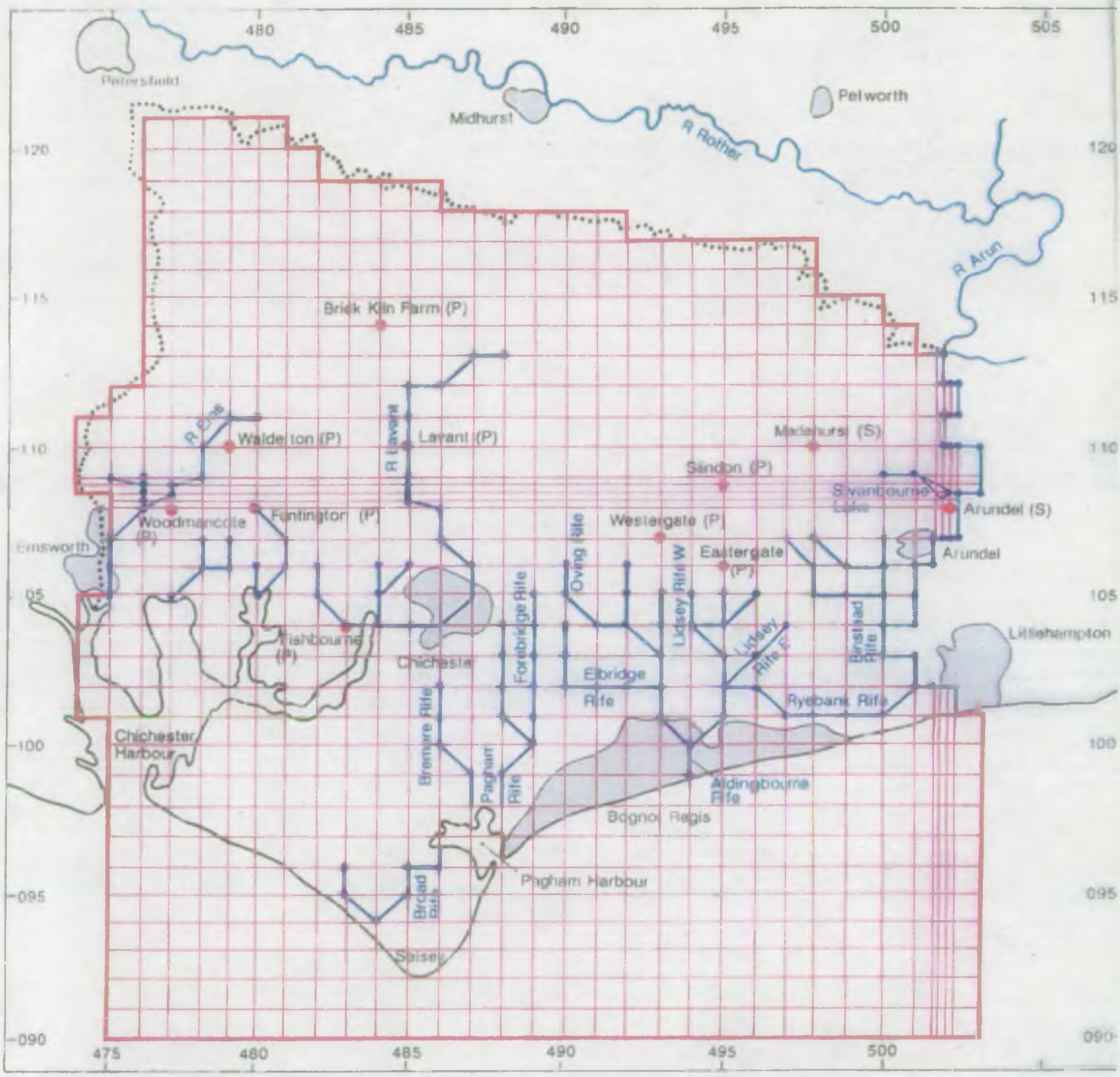
Figure 3.3

Sheet 1 of 2



Summary of Nitrate Sampling Results and Deduced Chalk Groundwater Flows


Drawdown
>0 m
>0.2 m
>0.5 m
>1 m
>2 m
0
Scale
1km
Observation Boreholes
Public Supply Boreholes
Boxgrove
Aldingbourne
Westergate
Nyton
Walberton
Eastergate
Barnham
Woodgate
Yapton
Colworth
Elbridge
Shripney
Flansham
Sindon
Rewell Wood
Madehurst
Arundel
ARUN DISTRICT
LITTLEHAMPTON
W



KEY:

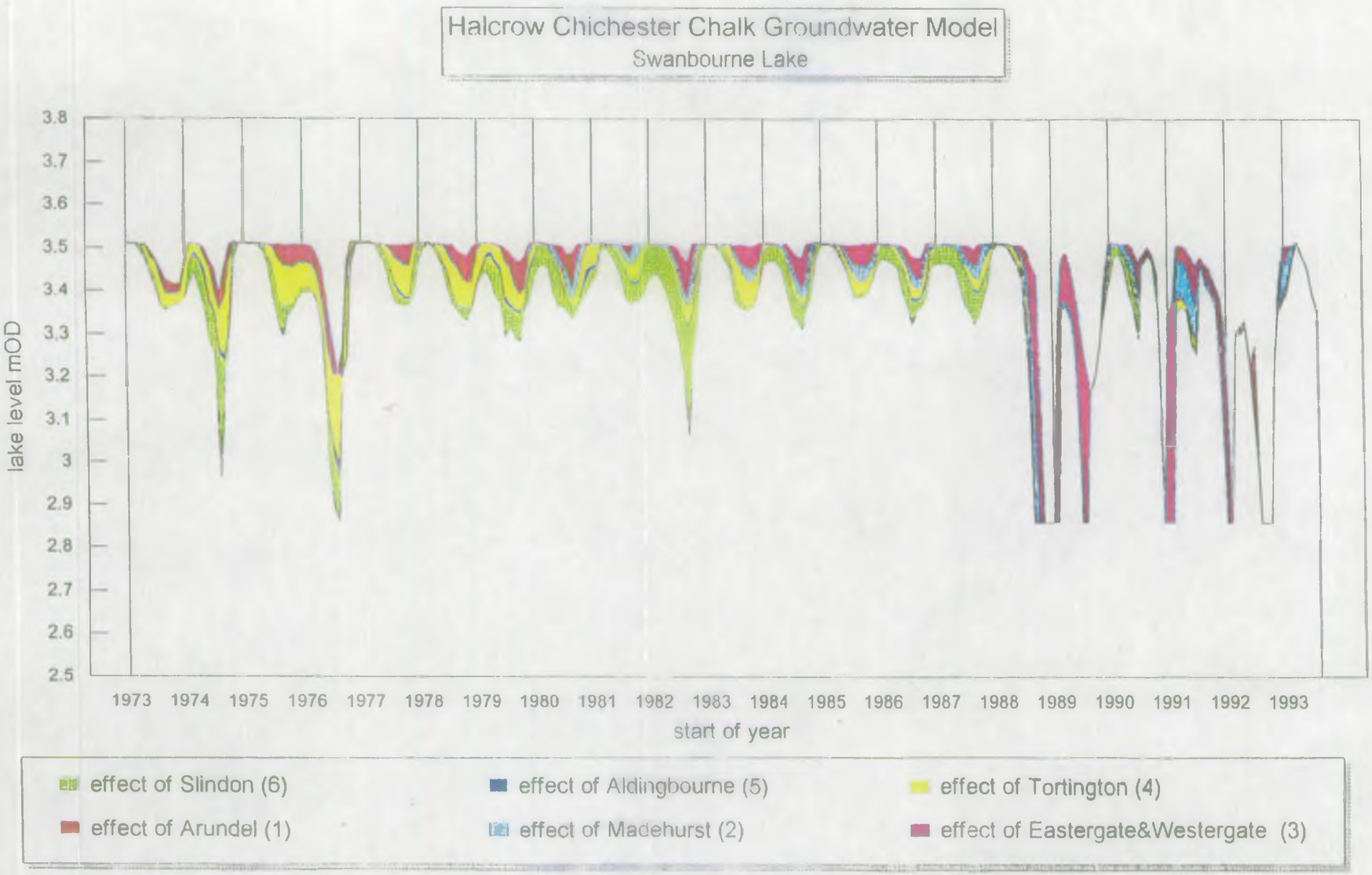
- Existing and Proposed Public Supply Sources
- Boundary to Chalk Block
- Model River Node
- Model Boundary
- S Southern Water Services Source
- P Portsmouth Water Company Source

Note:

Major mesh interval = 1km

Minor mesh interval = 0.25km

PROPOSED FINITE DIFFERENCE MODEL MESH



set1: Starting from baseline 1 (historical) cumulatively remove (order) historical abstractions, then add Tortington, Slindon and Aldingbourne

GROUNDS FOR REFUSAL

TORTINGTON [SOUTHERN WATER]

1. NEED.
2. REPRESENTATIONS (EN AND SWT).
3. THE "SYNTHETIC YIELD" OF MADEHURST.
4. EQUAL IMPACT UPON SWANBOURNE LAKE [cmp MADEHURST].
5. POTENTIAL DEROGATION OF PARK BOTTOM.

ALDINGBOURNE [PORTSMOUTH WATER]

1. NEED.
2. INSUFFICIENT DEMAND MANAGEMENT.
3. FAILURE TO CONSIDER OTHER OPTIONS.
4. SOURCE OUTPUT ?
5. LOCAL ENVIRONMENTAL IMPACT (RIFE FLOWS).
6. REMOTE ENVIRONMENTAL IMPACT (ARUNDEL PARK SSSI).

Medway Tunnel

By

BRIGIT THORNE

RESOURCE IMPLICATION OF THE CONSTRUCTION OF THE MEDWAY TUNNEL

The initial input by the Resources Section of the NRA, Southern Region was during the drawing up of the Medway Tunnel Act which was passes in 1990. The design of the tunnel is on the principle of "cut and cover". In doing this the chalk aquifer under the Medway Estuary will be exposed. Thus protective provisions were accepted.

NO 1

An additional provision stated that the NRA would be given 56 days notice of any works which would be carried out.

In Autumn 1992, the contract to build the Medway Tunnel was awarded to Tarmac/HBM by KCC who were acting as wardens for the promotor, Rochester Bridge Trust. The contact was on a "design/build" status. The proposed method of construction was to build 3 concrete tunnel sections in a casting basin on the east bank of R. Medway. Once these and the cut in the river were completed, the casting basin is to be flooded and the tunnel sections floated out into the cut channel.

NO 2 (a) Autumn '93

The plans for this were submitted to NRA for approval. As dewatering is an exempt abstraction ,(Section 29(2) of Water Resources Act 1991), the resources section of the NRA would primarily be interested in the protection of the aquifer not the loss of resource. If, however, the dewatering derogated against any persons right to abstract then the NRA would be asked to be an advisor to the Secretary of State if a civil action arose between the abstractor and the contractor.

In January 1993, the design criteria for the dewatering of the casting basin and the west bank approach were submitted to NRA. From these, two problems could arise.

1) would it be possible for the contractor to lower the water table to an average of -11.00m OD(N) within the basin <u>without</u>
   - causing irreparable damage to the resources of the area
   - causing derogation to licensed abstraction

2) during the flooding stage of the programme, would the contractor be able to prevent saline water "backfilling" into the drained area.?

NRA requested that a hydrogeological study be carried out.

The first stage of this was to establish a monitoring programme. This includes :-

a) weekly water levels from 26 piezometers within the construction site plus 4 specially drilled observation holes outside the site.

b) full geophysical logging and full chemical analysis of the water of each well on its construction.

c) Weekly chloride levels of the water being pumped from
   8 wells within the casting basin
   4 outer observation holes.
   2 wells on the west bank

d) three-monthly full chemical analysis of the water from the above mentioned holes.

During the initial stage of pumping, it was obvious that the lowering of the water levels on the east bank could not be achieved with the original 16 wells. 24 more wells had to be introduced. The discharge of water into the Medway was raised from the anticipated 250 l/sec to 600 l/sec.

Alarm bells were raised by the water levels we were recording at Brompton Black Lion which is possitioned approximately 1km SSE of the dewatering.

No 4

Within the duty of NRA to protect the licensed abstracters, additional monitoring of groundwater levels and water quality away from the construction site was initiated. This is being carried out by NRA staff and the consultants for KCC (Travers Morgan).

The changes in chloride concentrations of the pumped water show that a large quantity of fresh water was being drawn from the south east of the basin.

NO 5

Initial calculations show that upto 115 l/sec (10 megalitres/day) of fresh water are being abstracted from the aquifer.

By November 1993, the levels around the casting basin had stablised. There were times when the pumps were only just coping as it was a wet autumn and recharge was having some effect in raising the groundwater levels to the south. The regional effect was

No 6

The next major concern to NRA was how would the aquifer

respond when the basin was flooded so that the immersed tubes could be floated out into the Medway. Also at this time the chalk acifer below the Medway would be exposed as it was cut away to allow the tubes to be set.
An additional hydrogeological study was carried out by the consultants for the contractor. Initially it was very poor and after rather protracted discussions between them and NRA (P shaw & myself) we agreed that the wells around the casting basin would have to continue pumping and so act like scavenger wells. The contractor was asked to maintain water levels of -3.0m OD(N) at the edge of the basin. The intention of this was to ensure that the fresh water component continued to move northwards towards the basin

NO 7

Also if there was severe migration of chlorides to the SE we would have asked the contractor to build a second rim of scavenger wells.

In Oct/Nov 1994, the casting basin was sealed from the Medway again and after the largest fish rescue NRA had ever carried out in Kent, the second stage of dewatering began. As they built the approach ramp, the NRA requested that the wells should be pumped and not decommisioned until the groundwater levels in the monitoring wells around the basin were at least -1.0m.

Once again this was to maintain a northerly flow of water. This has now been achieved and on 20th September 1995, all wells have been switched off. The regional Groundwater levels are now.

No 8

The effects of the pumping on the aquifer are

a) it appears to have been cleaned No 9
No 9a

However we will still continue to monitor and at the present time are in discussions with the contractor on how long this should be.

What have we learnt from this experience.

1. **early monitoring and understanding of the aquifer is** essential. This helps to persuade the contractor why we are making such extra burdens and costs upon him. For example without persuasion , he would not have wanted to run the 24 pumps for the 2 months whilst the basin was flooded at a cost of approx £500/day.

2. Rigorous analysis of the data received so that contingency plans can be made.

MEDWAY TUNNEL ACT 1990

; SECTION 37

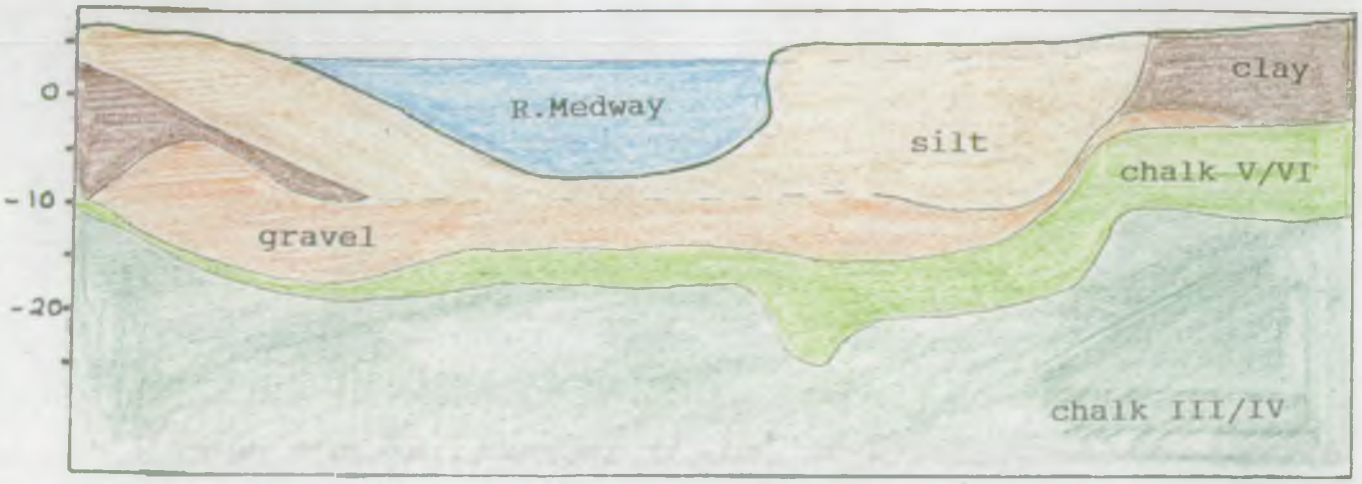
PROTECTIVE PROVISION FOR NATIONAL RIVERS AUTHORITY

(2) (*a*) In the design and construction of the tunnel the Wardens shall have regard to the matters mentioned in paragraph (3) (*a*) below and, in consultation with the rivers authority, shall so design and construct the tunnel as to ensure by all reasonably practicable means that saline or other contaminating intrusion into water resources in underground strata does not occur by reason of such construction;

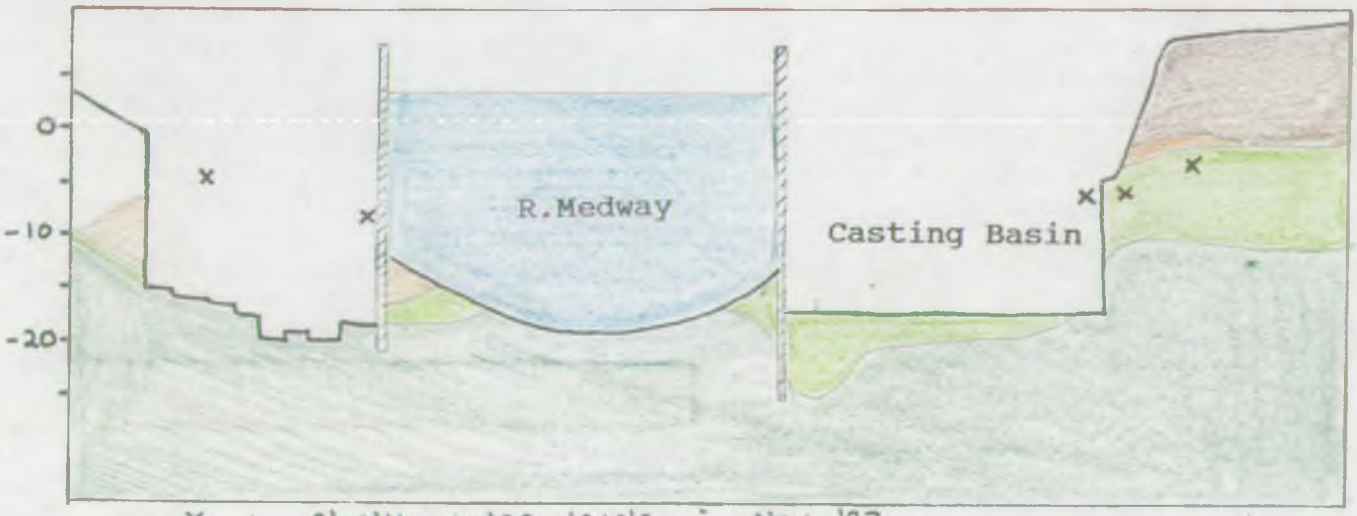
(3) (*a*) The matters to which the rivers authority may have regard in considering the said plans relate to the avoidance or (if avoidance is not reasonably practicable) the minimising of contamination of water resources in underground strata (within the meanings given to those two expressions in the Water Resources Act 1963) by reason of construction of the tunnel; and in approving the said plans the rivers authority may require the taking of such measures in or in connection with the construction of the tunnel, whether as to methods of working, additional or protective works or otherwise, as appear to the rivers authority to be reasonably required for such avoidance or minimising of contamination;

(4) (*a*) For the purpose of monitoring and recording the levels and quality of water in underground strata in the vicinity of the tunnel, the Wardens shall provide and maintain in a reasonably sufficient number of positions approved by the rivers authority such apparatus for the continuous monitoring of those water levels and quality of water as may be so approved and shall permit the rivers authority to have access at all reasonable times to the apparatus and to all records deriving from the apparatus;

ORIGINAL CROSS SECTION

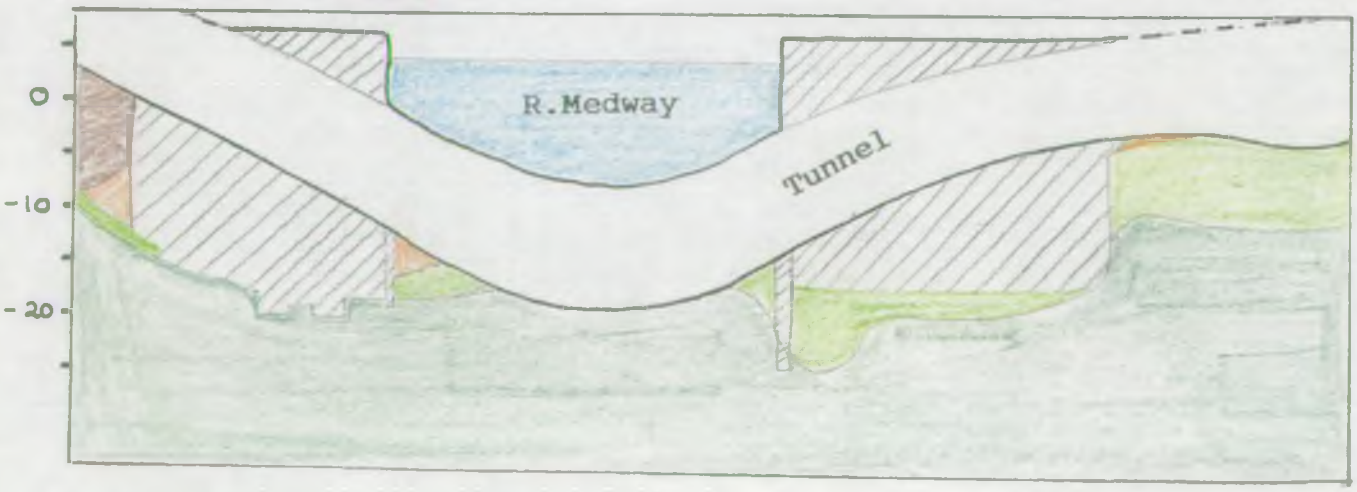


MAXIMUM EXCAVATIONS : SUMMER 1995

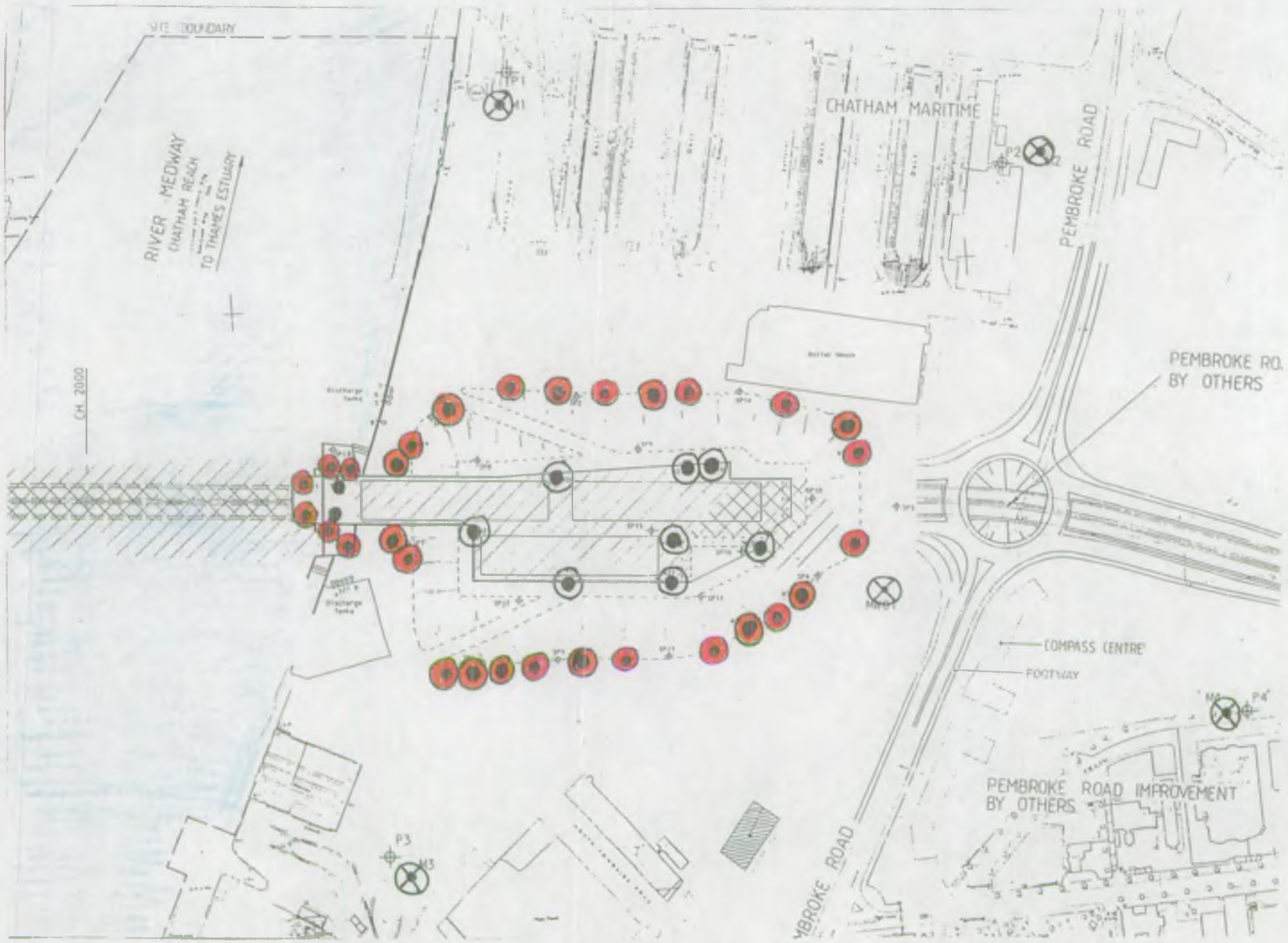


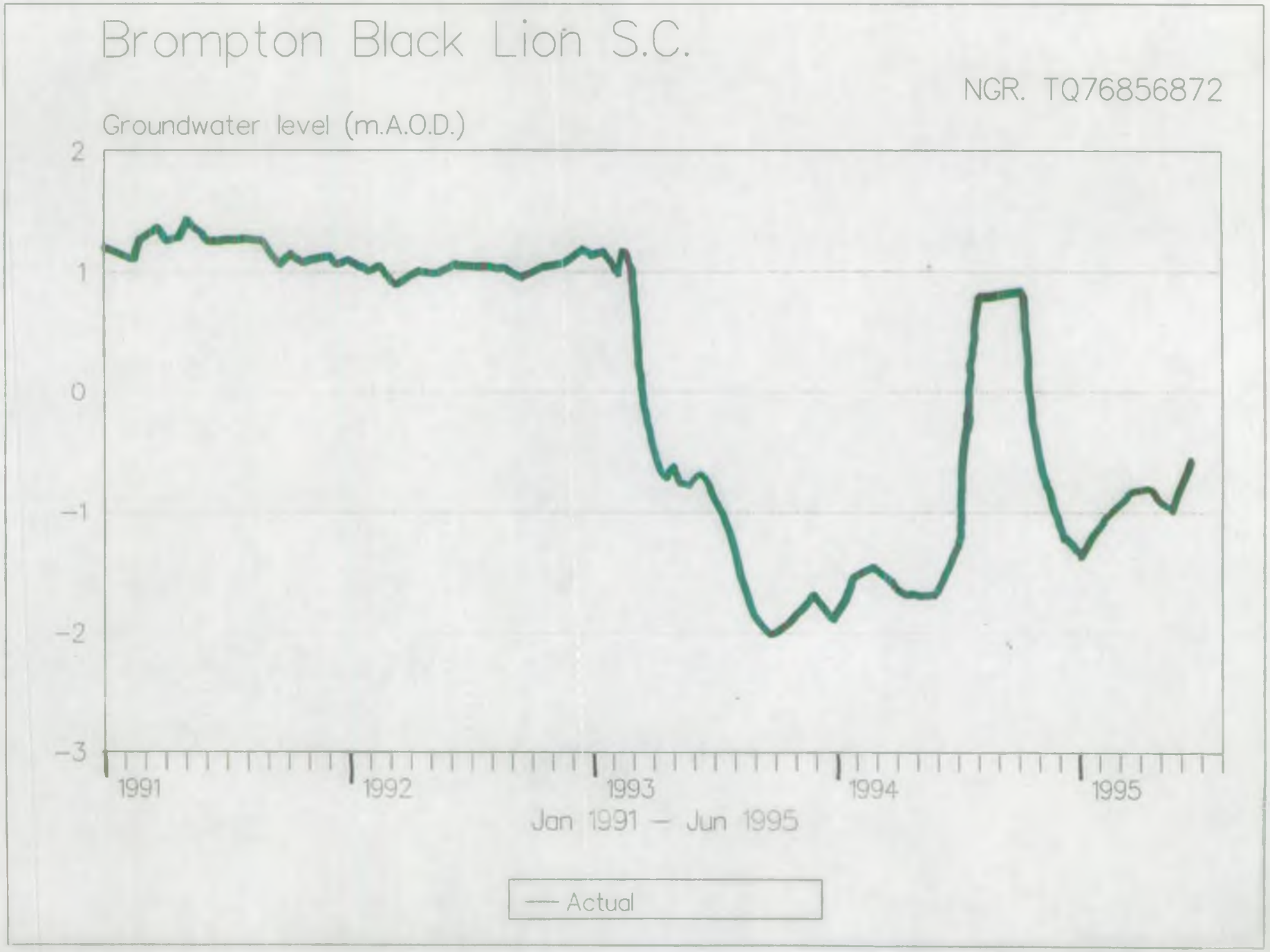
X : Chalk water levels in Nov '93

FINAL CROSS SECTION



EASTSIDE ; POSITION OF DEWATERING WELLS

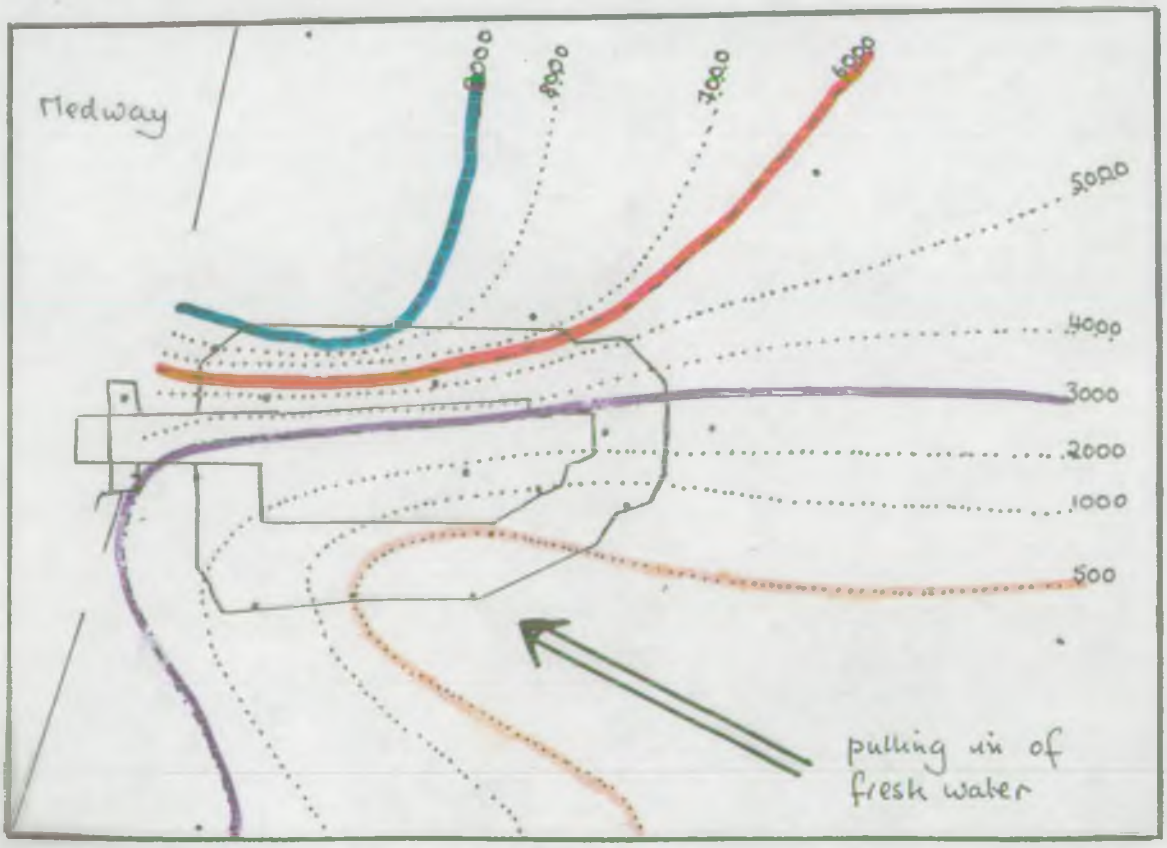



Brompton Black Lion S.C.
NGR. TQ76856872
Groundwater level (m.A.O.D.)
2
1
0
-1
-2
-3
1991
1992
1993
1994
1995
Jan 1991 – Jun 1995
Actual

CHLORIDE CONCENTRATIONS (mg/l) OF GROUNDWATER

14th February 1993

4th November 1993



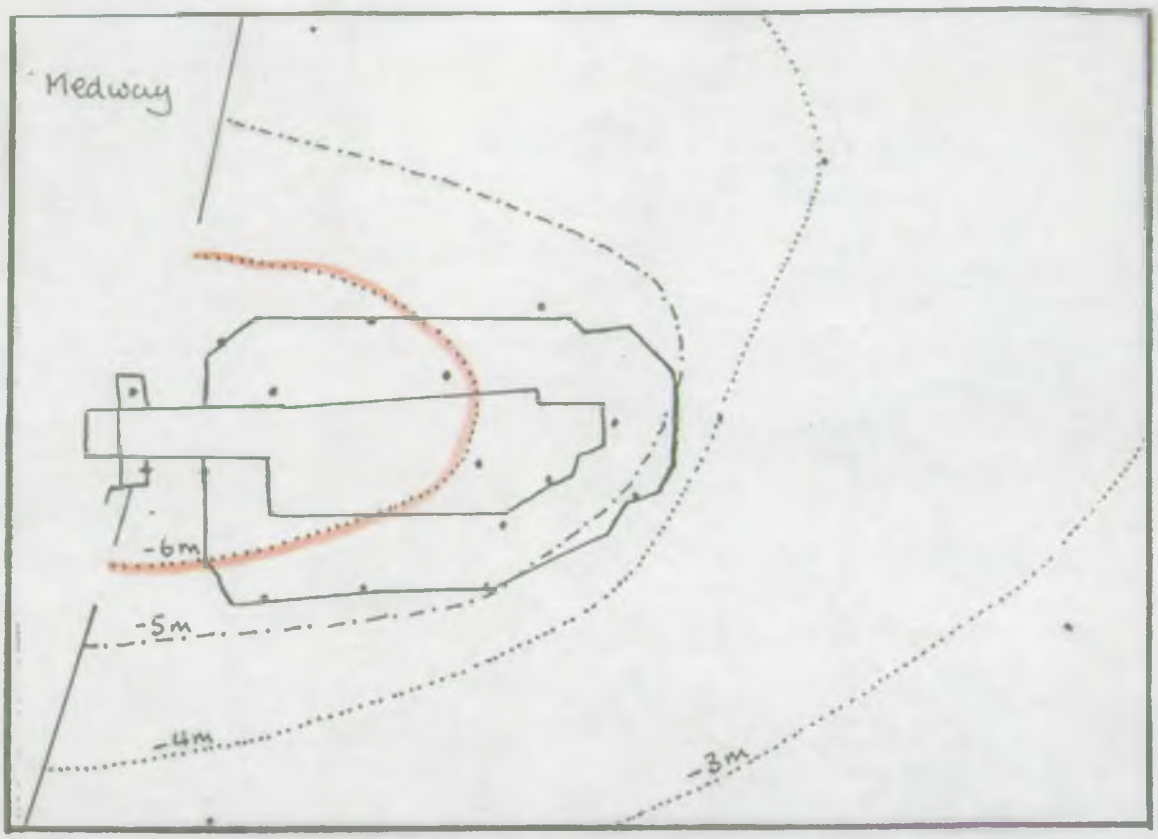
REGIONAL GROUNDWATER LEVELS ; 24th Sept 1993

★ - Licenced Abstractors

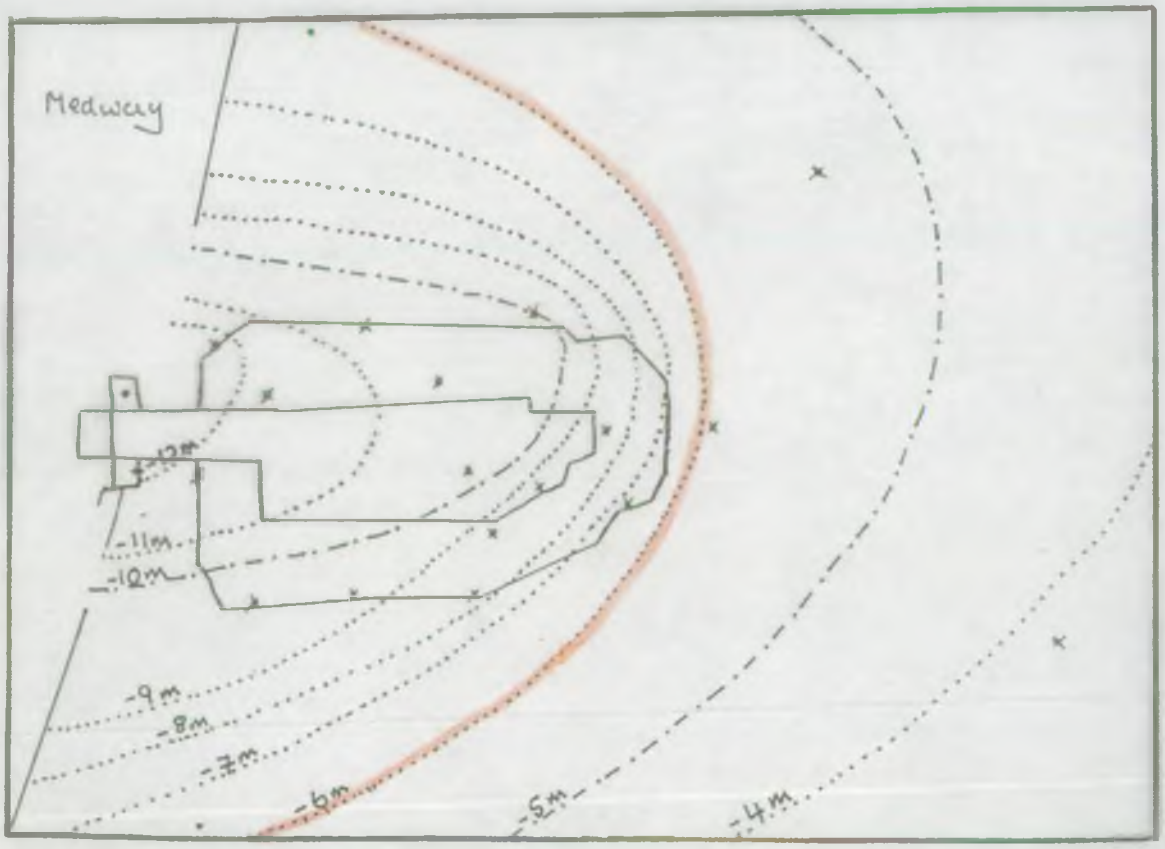
▲ - Southern Water Pumping Stations

● - Piezometers and wells

29th March 1993



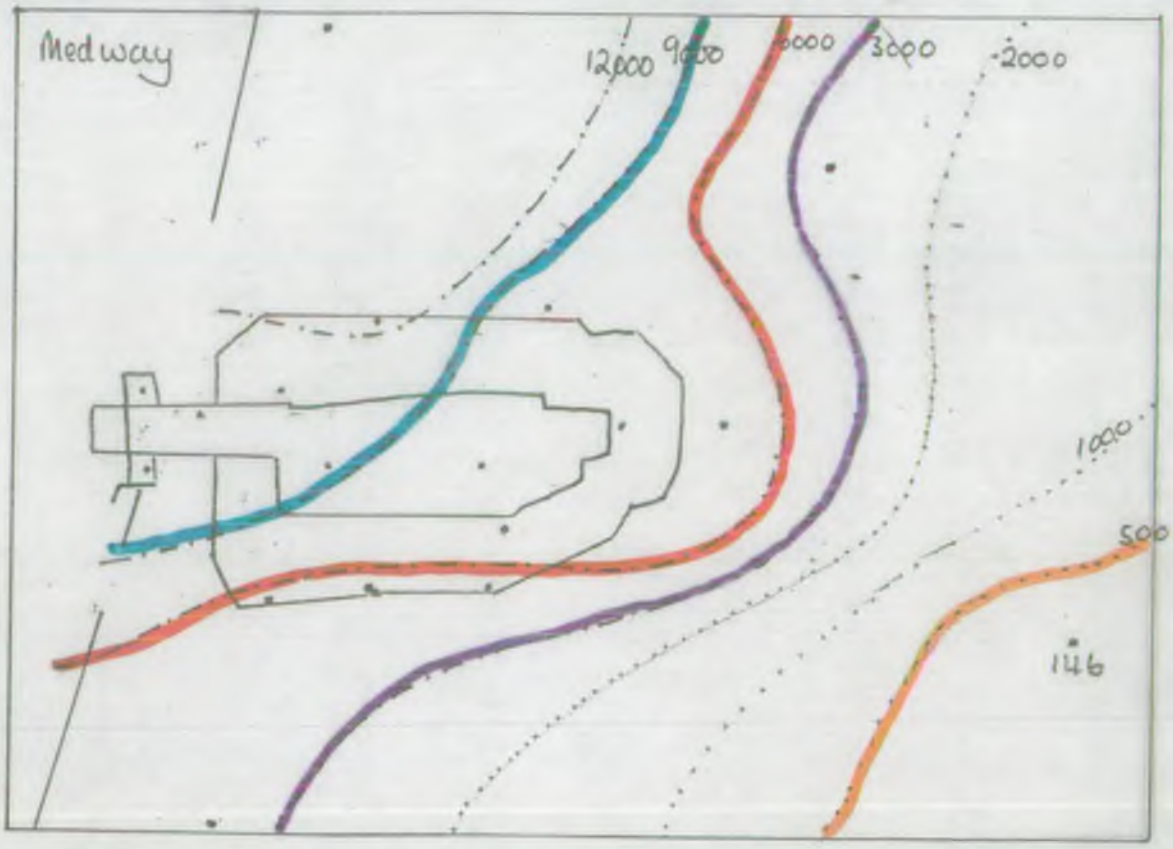
2nd November 1993



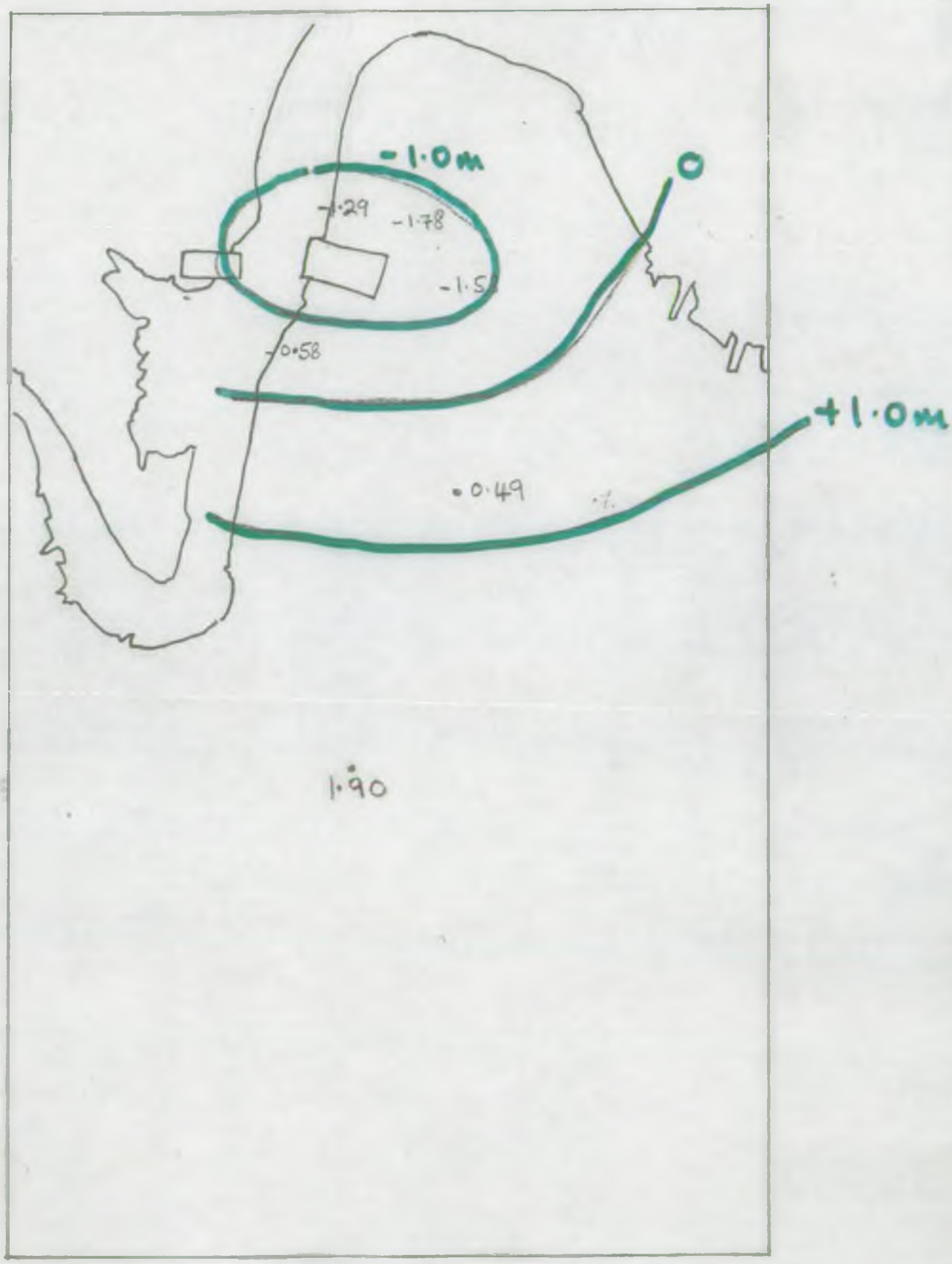
CHLORIDE CONCENTRATIONS OF GROUNDWATER (mg/l)

10th June 1994

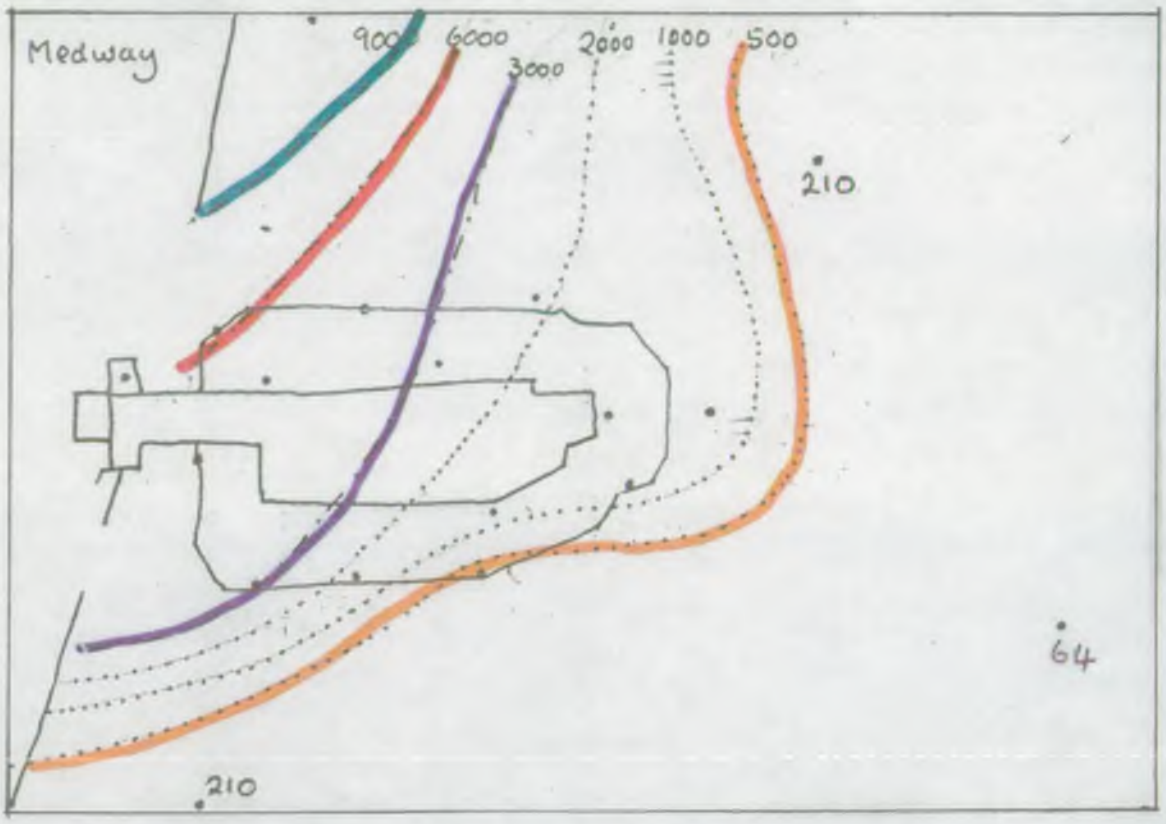
12th August 1994

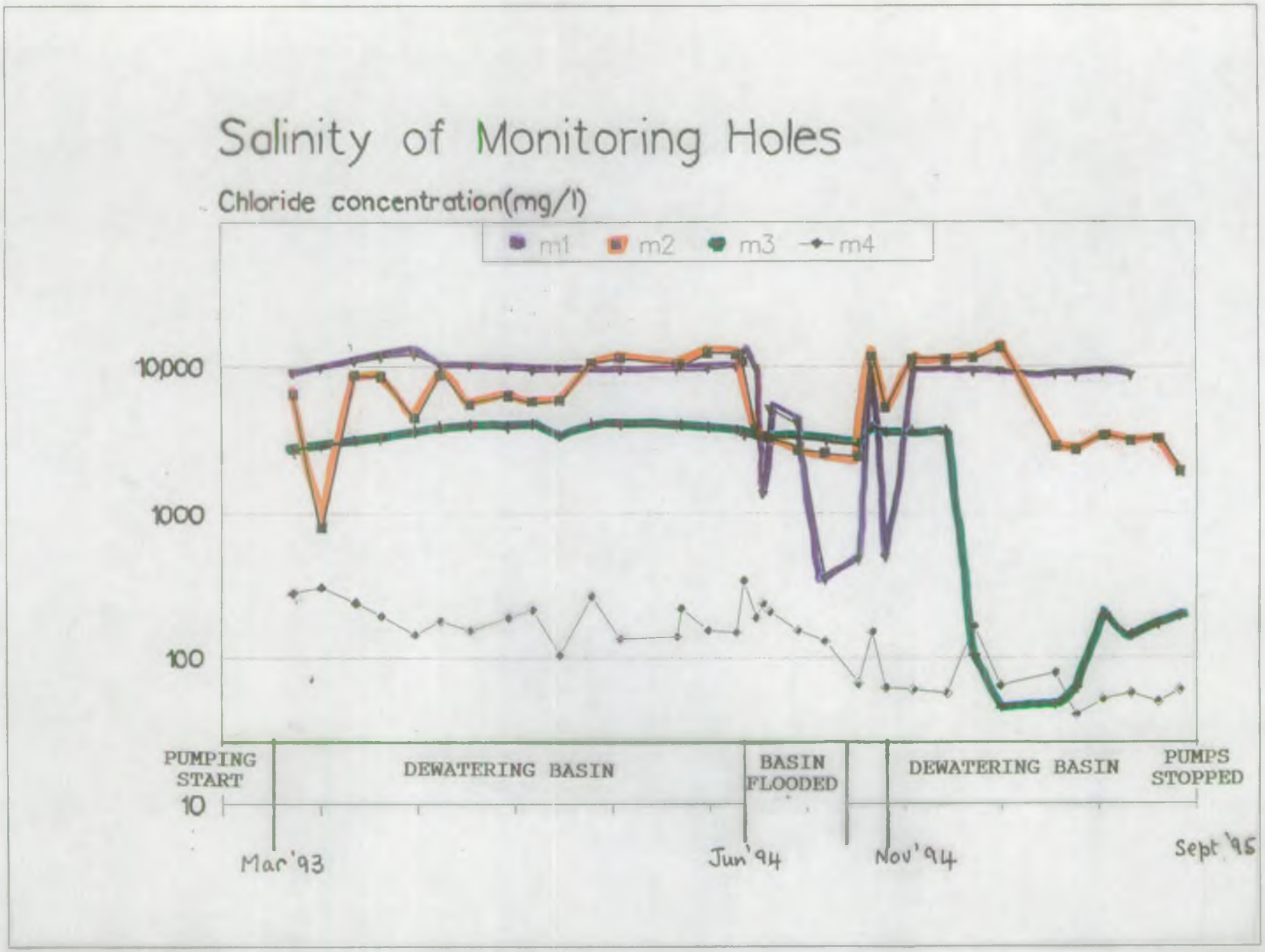


Sept '95



15th September 1995




Salinity of Monitoring Holes
Chloride concentration(mg/l)
m1
m2
m3
m4
10,000
1000
100
10
PUMPING START
DEWATERING BASIN
BASIN FLOODED
DEWATERING BASIN
PUMPS STOPPED
Mar'93
Jun'94
Nov'94
Sept'95

Groundwater Protection Zone Modelling

By

PAUL SHAW

GROUNDWATER PROTECTION ZONE MODELLING

Requirements

- Groundwater Protection Policy
- National Project
- Update Southern region APP
- Rather than give maximum protection to ALL useable groundwater the NRA (and predecessors) have defined ZONES with different levels of protection.
- The highest levels of protection are applied around the major public supply sources in the vulnerable aquifers.
- Some zones are designated Nitrate Sensitive Areas

What are GPZs?

- **Areas surrounding the well head based on 50 day, 400 day and total catchment areas.**

- **Zone boundaries are defined by the 50 and 400 day isochrones and the total catchment draining to a given source.**

- **Isochrones are based on backward tracking from the source along pathlines.**

- **Advection only.**

- **The protection zones are DYNAMIC, reflecting the current behaviour of the aquifer. Updating will be required.**

Methods for GPZ delineation

- **Manual**
- **Analytical**
- **Modelling**

Why use models?

- **Groundwater flow models are the only approach which can integrate all of the above factors which affect the shape of GPZs.**

Which models could be used?

- NRA-GC review
- FLOWPATH and MODFLOW/MODPATH
- Both used in Southern Region but preference given to use of MODFLOW/MODPATH
- These are used in steady-state mode to model advective flow

Advantages of using MODFLOW

- Once learnt it is almost as quick
- It is a route to more complex modelling if needed
- The code is accessible
- While post processing is not available without special add-ons the outputs are accessible for plotting etc.
- Large arrays can be handled
- Can be used either as a K or a T model
- Can include multiple layers
- Can model confined aquifer areas

GPZ modelling programme

- Coverage based on aquifer "blocks"
- First pass modelling was insufficient for most of the Region.
- Try to progress priority sites first (e.g. CTRL).
- In-house groundwater team and contracted work
- Consultation procedures
- Progress to date on models for North Kent Chalk, Chichester Chalk, Thanet Chalk, Eastbourne Chalk, Medway LGS.
- Special methods have been developed to cope with complex aquifer geometry and high density of abstractions for some models.

Modelling procedures

- Data collation, SERs
- Conceptual model
- Target piezometry
- Model set-up
- Flow model calibration
- Particle tracking (actual and licensed abstractions)
- Manual amendment
- Consultation
- Mapping

Key assumptions

- Calibration based on average abstractions
- Prediction based on licensed abstractions
- A steady-state target piezometry
- Average recharge
- Effective thickness for Chalk aquifer

Factors affecting size of GPZs

- Permeability
- Dynamic porosity
- Hydraulic gradient
- Boundary conditions
- Recharge
- Thickness
- Product of thickness and porosity

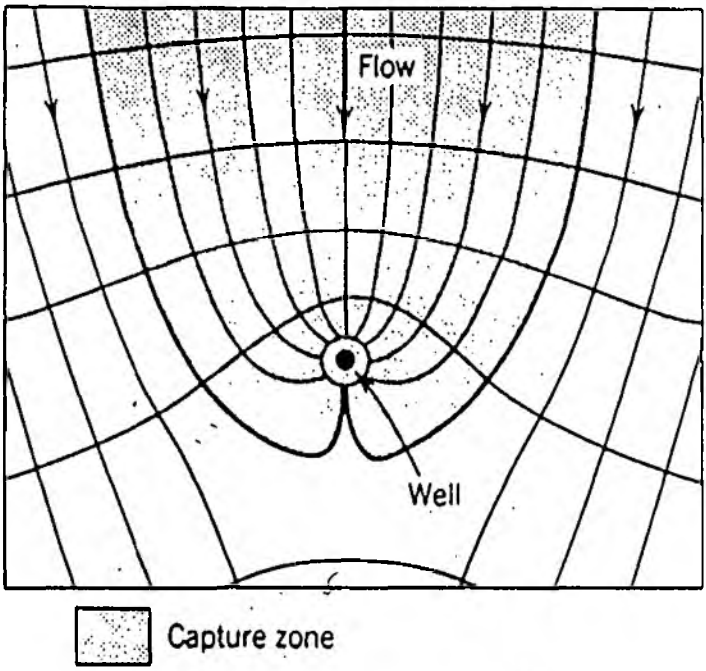
An example: Chichester Chalk

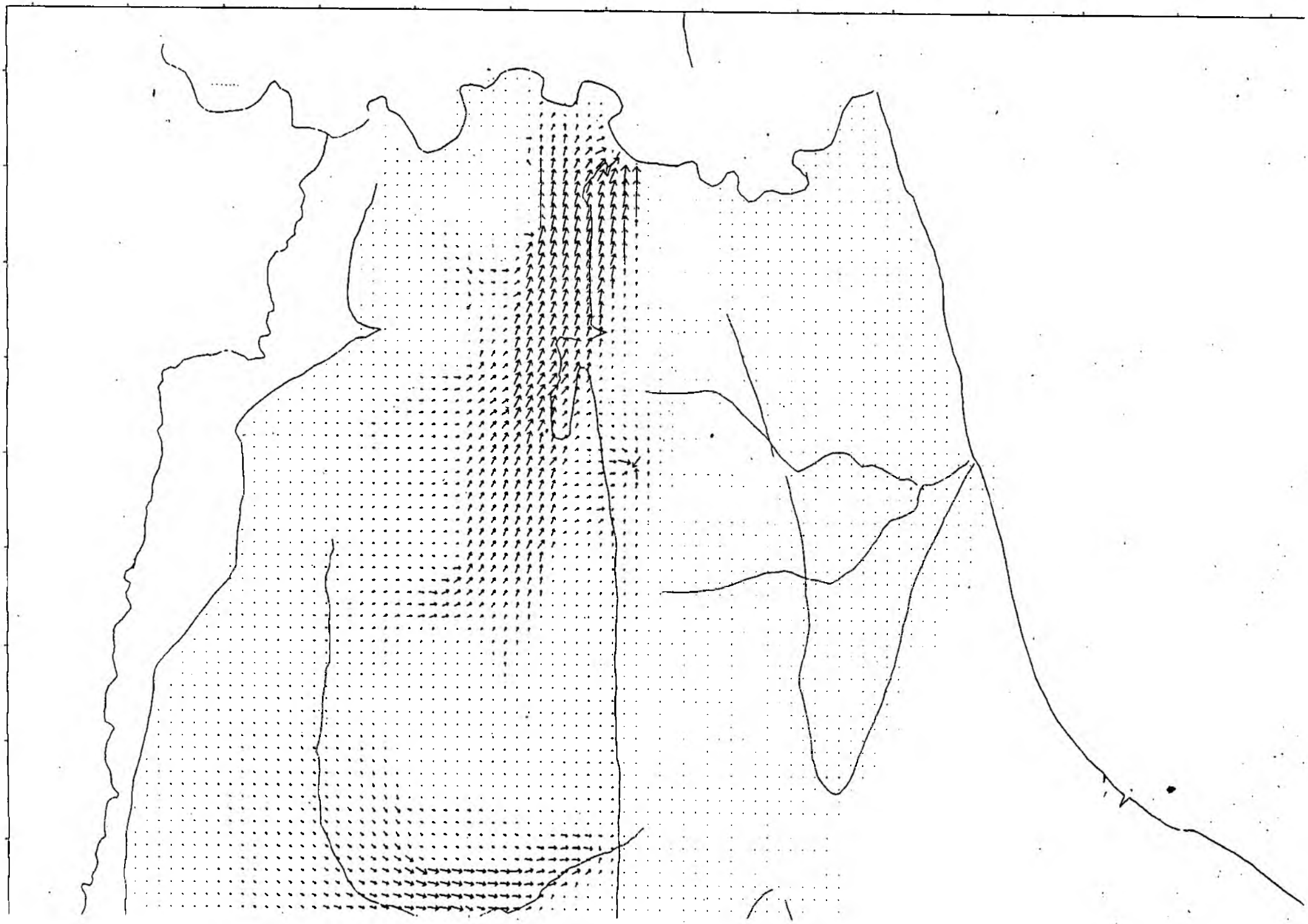
- **Grid and boundaries**
- **Recharge**
- **Aquifer parameters**
- **Spider plots**

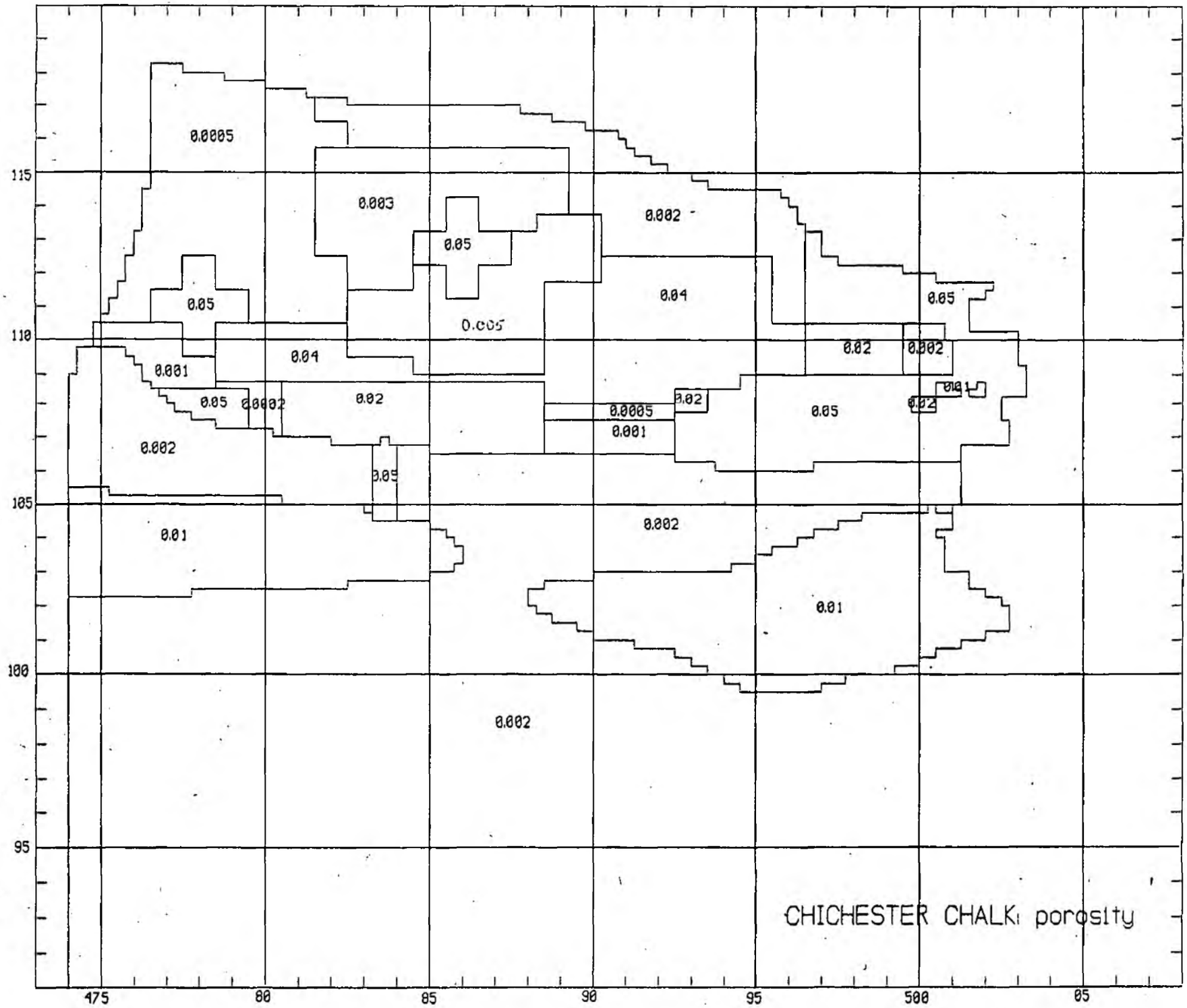
Some issues:

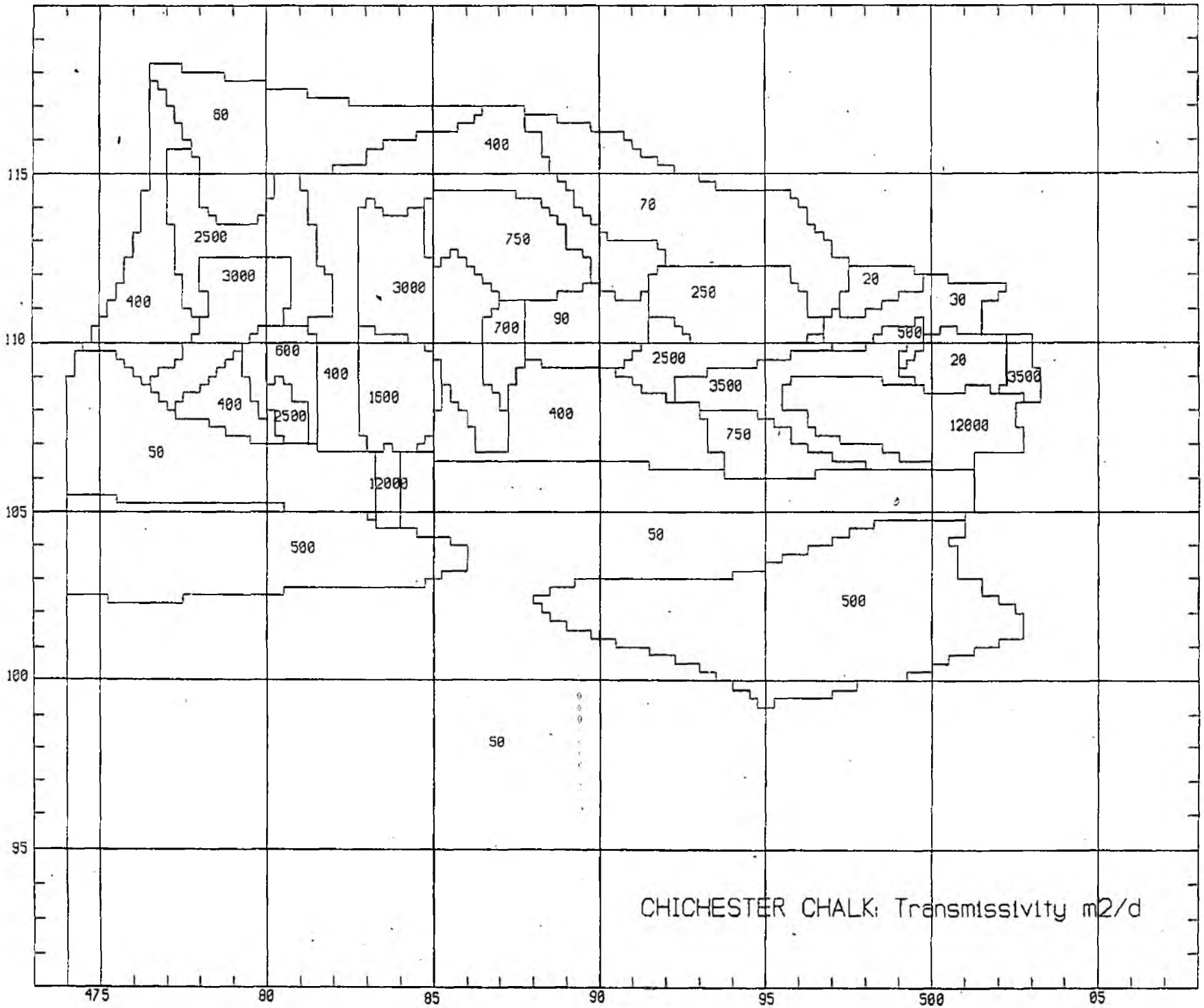
- **A different approach is needed for steady state modelling**
- **Chalk dry valleys**
- **High T zones/ karstic features**
- **Recharge distribution in relation to cover**
- **Effective thickness**
- **Rivers**
- **Seasonally changing conditions**
- **Porosity and Effective Thickness are important and, especially for the Chalk, need to be considered together not in isolation.**

Figure 19.8
The effects of pumping superimposed on a regional flow system creates a capture zone (modified from Gorelick, 1987).
Reprinted by permission of Solving Ground Water Problems with Models.. Copyright © 1987. All rights reserved.


Flow
Well
Capture zone




0.0005
0.003
0.05
0.002
0.05
0.04
0.05
0.05
0.04
0.02
0.002
0.001
0.05
0.0002
0.02
0.0005
0.001
0.02
0.05
0.02
0.001
0.002
0.05
0.01
0.002
0.01
0.002
115
110
105
100
95
475
80
85
90
95
500
05
CHICHESTER CHALK: porosity


CHICHESTER CHALK: Transmissivity m2/d
115
110
105
100
95
475
80
85
90
95
500
05
60
400
2500
3000
400
3000
750
70
250
20
30
700
90
500
600
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1500
2500
400
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3500
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3500
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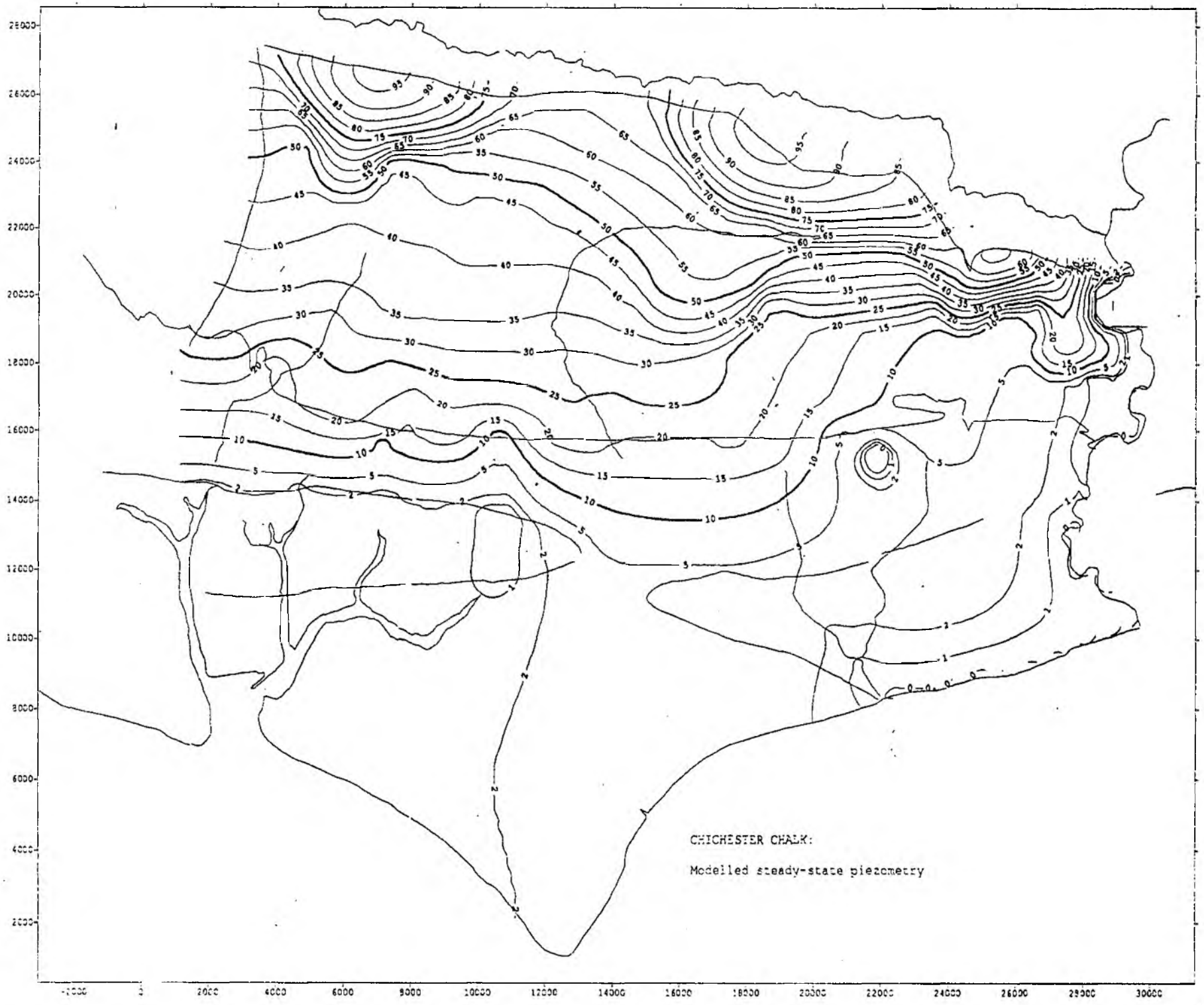
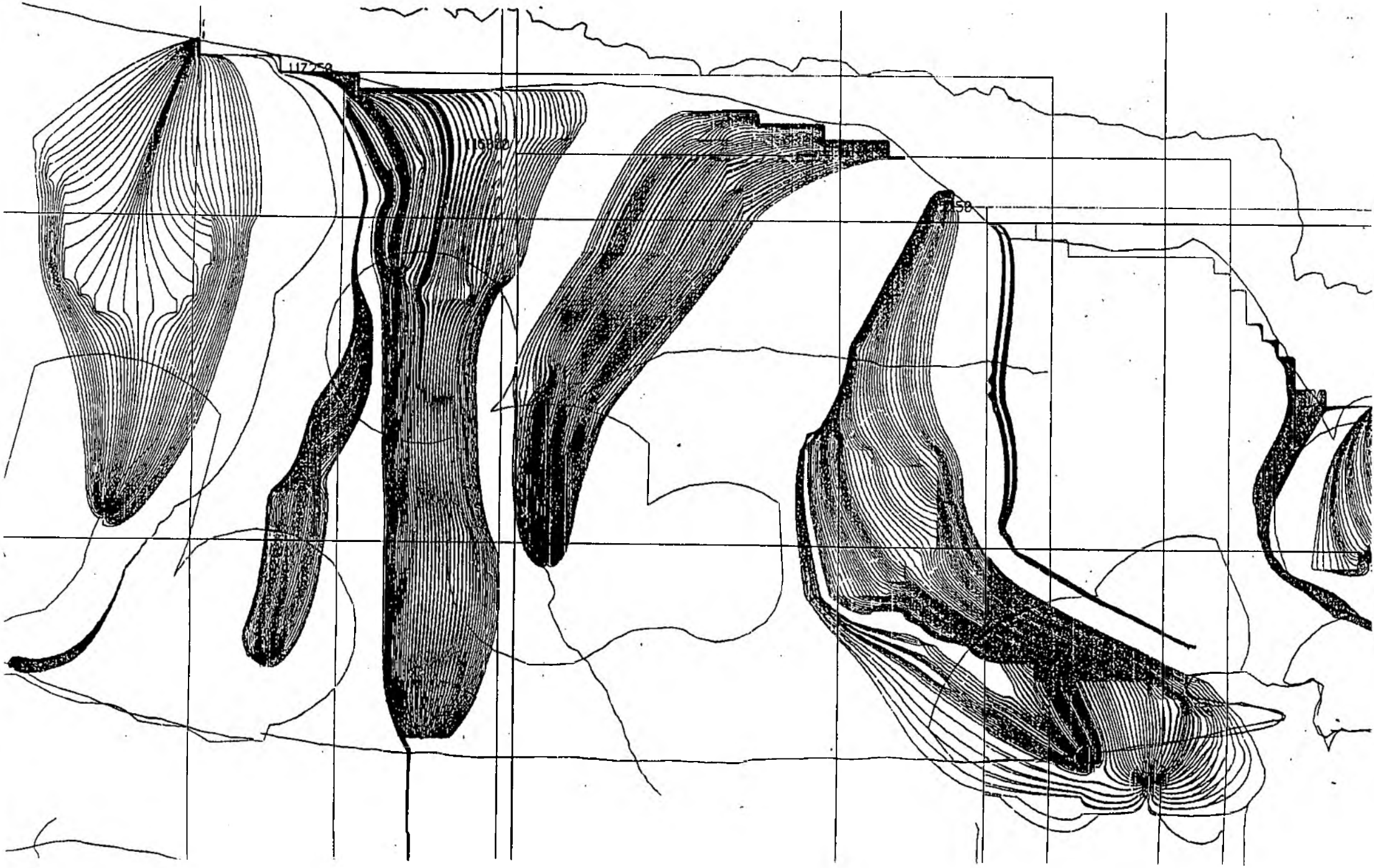
2500
750
12000
50
12000
500
50
500
50


CHICHESTER CHALK:
Modelled steady-state piezometry


117258
116822
7158

Medway Catchment Licensing

By

ROB HARDING

Medway Variations

What ?

- Reduction of licence holders prescribed flow condition under Section 52 of the Water Resources Act 1991
- Since 1966 all licences issued in the Medway system have a prescribed flow tied to Teston - "Medway Condition". 110 licences
- Condition was progressively stepped up

Where?

- Resource Areas 2,3,4,5 and 6

Why ?

- Consequence of Licence No. 2/114 issued in April 1992 to SWS
- Included a condition reducing their Medway Condition from 352 to 275 Ml/d (= 77 Ml/d)
- Placed existing rights at a disadvantage - derogation !
- Have to reduce Medway Conditions on existing licences to be fair and consistent

When ?

- Medway Condition would only be reduced when Yalding pipeline operational. Now !

How ?

- List of all rights in Medway system (LOR's, tied licences and other protected rights)
- Compiled 1:100,000 map
- Totalled Medway licenced abstraction
- Calculated abilities to abstract. Restricted in most summers
- Looked at effects of reducing Medway Condition on:
    - tied licences
    - groundwater abstractors
    - "sensitive" abstractors ie, LOR's downstream of tied licences
    - Public water supply licences
    - the river

Conclusions

- Condition makes little difference in practice because all enforced together
- 890 Ml/d cut offs - no difference
- 500 Ml/d cut offs - significant change
- Medway Conditions appropriate at the time
- No groundwater, LOR's, protected rights or PWS will be adversely affected

Recommendation

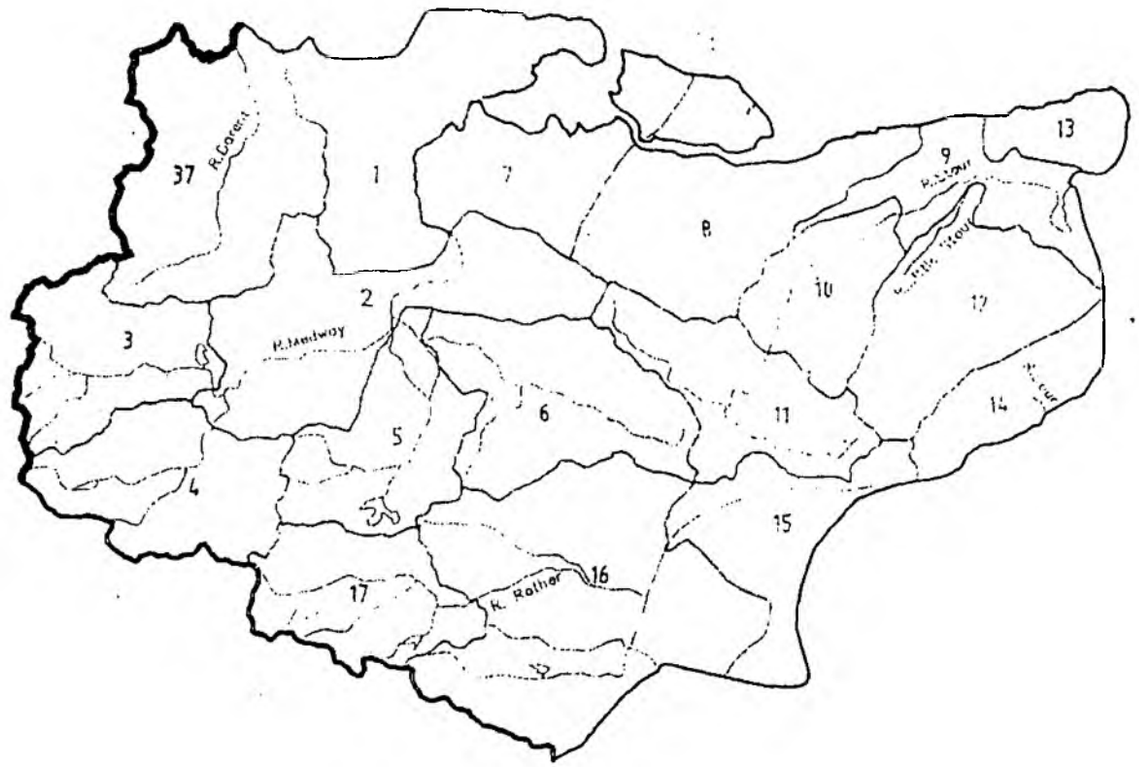
- All Medway Conditions are reduced by 77 Ml/d

To do

- Write to all interested parties
- Advertise proposal
- Assess representations
- Amend 110 licences
- Issue

KENT RESOURCE AREAS

RESOURCE AREA	NAME
1.	Medway Estuary
2.	Middle Medway
3.	River Eden
4.	Upper Medway
5.	River Teise
6.	River Beult



Appendix I

	Summary Table of Max and Min Abstraction in Each Area in Ml/d					
Area	All ~~Areas~~ Licences		Licenses of Right		Other Licenses	
	Max Monthly Take	Min Monthly Take	Max monthly Take	Min Monthly Take	Max Monthly Take	Min Monthly Take
2	169.16	159.71	17.5	11.09	159.65	148.27
3	284.34	10.03	2.91	1.01	281.43	9.12
4	255.4	248.53	0.12	0.09	254.43	247.6
5	448.09	437.61	15.38	2.25	437.81	431.66
6	26.43	11.34	7.45	1.41	22.36	7.3
2 (revised)	18.46	11.88	7.57	3.15	10.89	8.73
All	790.14	515.68	31.94	10.02	775.2	483.33

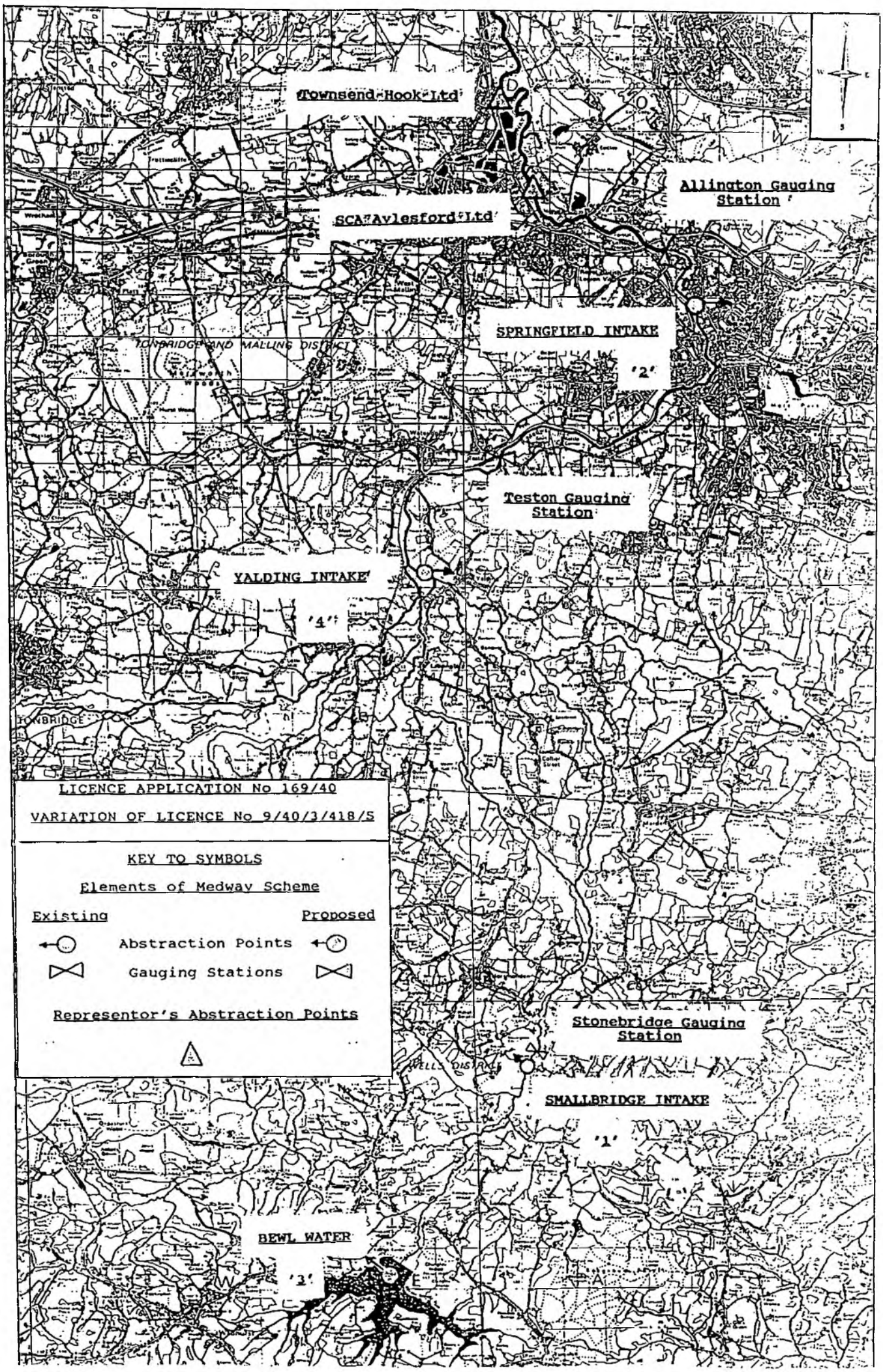
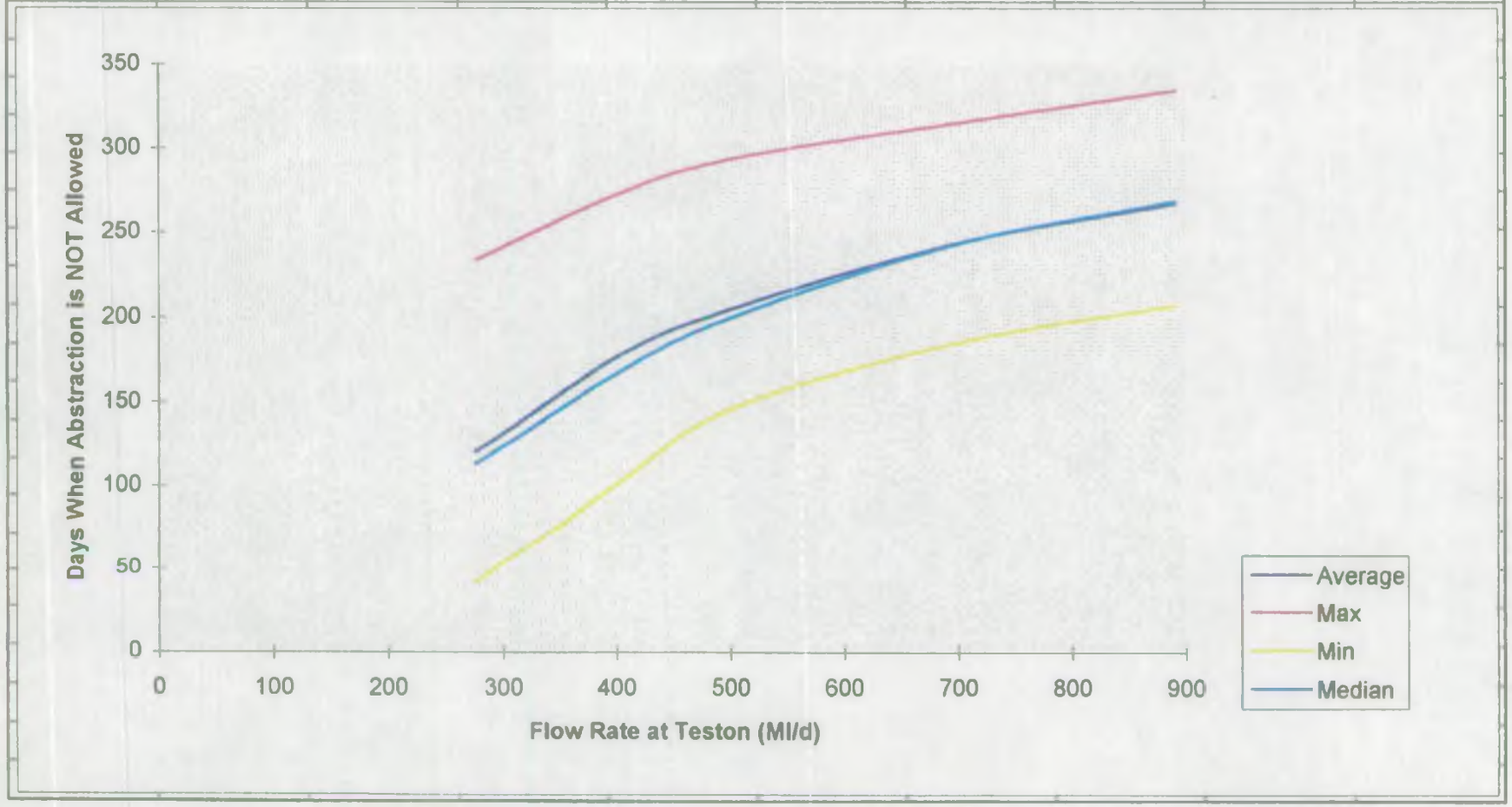

Townsend Hook Ltd
Allington Gauging Station
SCA Aylesford Ltd
SPRINGFIELD INTAKE
'2'
TONBRIDGE AND MALLING DISTRICT
Teston Gauging Station
YALDING INTAKE
'4'
TONBRIDGE
LICENCE APPLICATION No 169/40
VARIATION OF LICENCE No 9/40/3/418/S
KEY TO SYMBOLS
Elements of Medway Scheme
Existing
Proposed
Abstraction Points
Gauging Stations
Representor's Abstraction Points
Stonebridge Gauging Station
WELLS DISTRICT
SMALLBRIDGE INTAKE
'1'
BEWL WATER
'3'

Fig 2

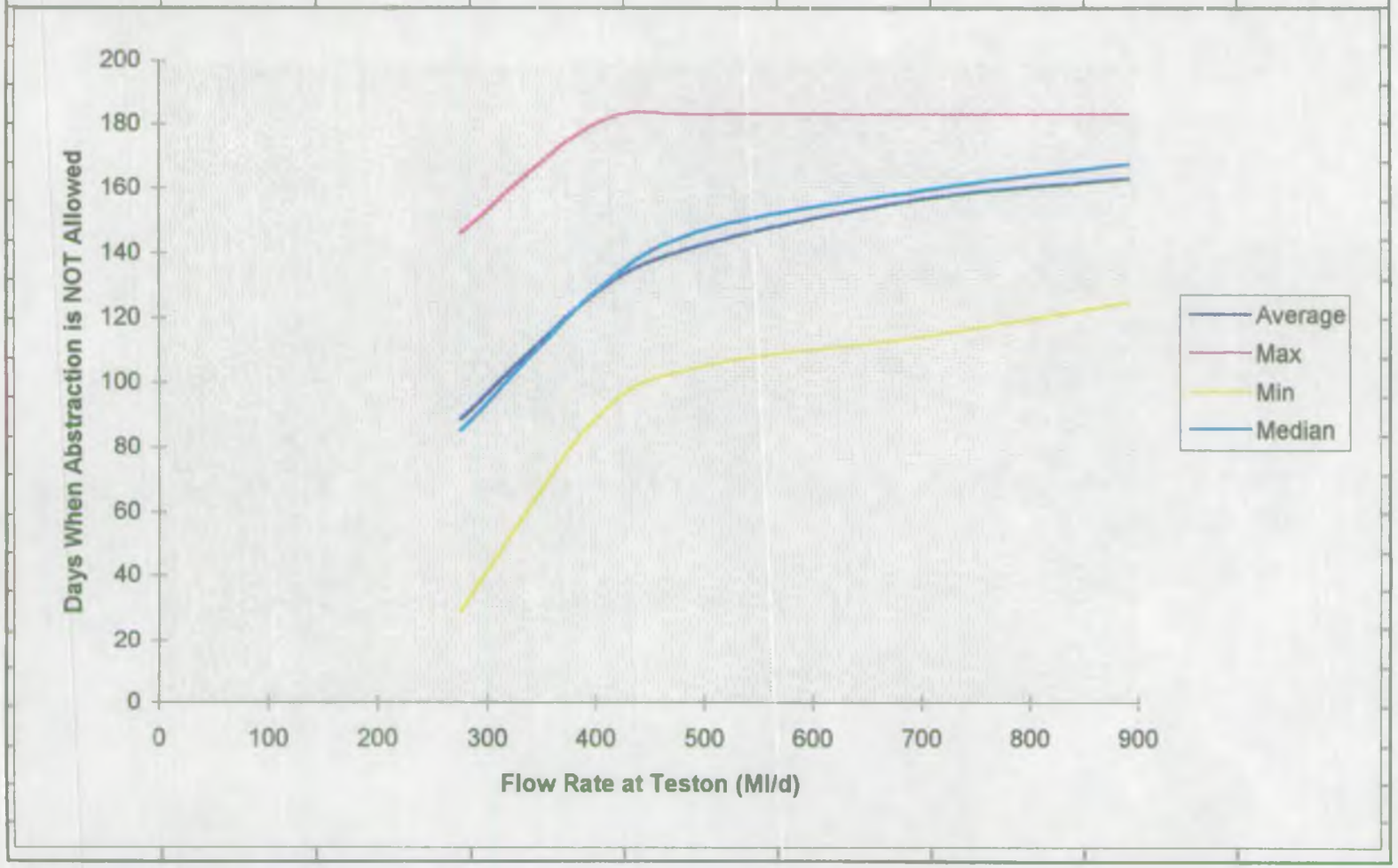
Industrial Graph

		275	400	500	700	890			
Average		120.3548	176.5161	204.8387	243.3226	266.8387			
Max		233	272	293	315	334			
Min		41	101	146	185	207			
Median		113	167	200	243	268			



SI Graph

		275	400	500	700	890		
Average		88.6129	127.3226	142.5484	156.6452	162.8387		
Max		146	180	183	183	183		
Min		29	89	105	114	125		
Median		85	128	147	159	167		



SESSION

II

HYDROMETRY

NOTES OF REGIONAL WATER RESOURCES REVIEW
5 OCTOBER 1995
ARUNDEL STAKIS HOTEL

SESSION II - HYDROMETRY

1. **Barcombe Flow Measurement and Ardingly/Ouse Operation - John Headey**

   * Ardingly releases take longer than SEW think to get to Barcombe FGS.

   * There are a number of channels and 4 gauging points at the FGS.

   * Sussex have installed an ultrasonic gauge d/s of roadbridge at cost of £40K. Flow records from this, compared to the historical station, show we have grossly over measured the flow.

   * Hampshire have experienced problems with ultrasonics and electro-magnetics with the depth measurement in particular.

   * Sussex are not looking at ultrasonic covering a wide range - ie there are inaccuracies at high flows.

   * Current meter gaugings have been carried out. The results are encouraging being close to ultrasonic gaugings.

   Main Conclusion:

   If we measure more accurately, it places us in a difficult position to re-visit historical data.

2. **Hydrometric Efficiency Review in Sussex - Nigel Hepworth**

   * Work started in July by implementing sub projects, eg site audits, training.

   Main Points:

   * **Gauging Station Classification**

     - Data quality assurance
     - Gaugings at structures are available but sparse, almost negligible historical practice in Sussex
     - 600 man days of gauging may be needed
     - will require a 'culture change'

* **Site Maintenance Contracts**

  - Grass cutting
  - Weir crest cleaning etc. Are we right to put it out to contract?

  The aim and plausible result is to save technician time for better things.

* **Standards and Best Practices**

  - Rainfall data collection
  - Current meter gauging
  - GW Measurement

  Rainfall questionnaire reveals inconsistencies.

Main Conclusions:

* Will involve a major impact on routine activities by project work. However, greater work should result in more confidence in data.

* Have to strike a balance between an intensive gauging programme and constructing an accurate gauging station.

* PWH questioned the need to current meter to establish accuracy of properly designed hydraulic gauging structures, eg trapezoidal, weirs, flumes etc. ST said it needs to be done because very few 'pure' structures exist.

* It is not to be taken lightly because of workload involved.

3. **WAMS Data Cleaning - Joe Pearce**

WAMS is not going to deliver what was originally promised.

Data cleaning project was set up to:

- reference data
- enable functionality from Day 1
- address missing/additional data

Basic errors have been spotted from data cleaning exercise, eg wrong rating table being used on ICL, NGRs, names of gauging stations.

Two NRA regions have achieved BS accreditation for data handling, eg hydrometric records.

4. The Drought of 1995: A Kent Perspective

- In 1995 there has been a deficiency in rainfall. The Scotney Castle record shows April 1995 as the second lowest in history. April 1976 was the lowest.
- But for the high winter recharge maintaining spring flows, the gauged flows for the rest of year at Teston (Medway) were on par with 1976.
- Groundwater levels were maintained a little above the long term mean.
- Darent flows were maintained all summer.

Main Conclusions:

* We need to consider the intensity and duration of a drought.
* IOH report said that as a result of climatic change more short, extreme events would be experienced. It proved to be the case this year.
* PR of droughts could be improved within NRA and Region.

5. Waiting for WAMS - the alternatives - Scott Ferguson

* Most data processing is done on the ICL, currently spend £600K/year.
* WAMS is currently in a state of limbo.

Alternatives :-

i) Continue with current system.
ii) Bespoke software, designed around Southern's needs - high IS resource is needed.
iii) Implement IOH software (Hydata) - has serious limitations.
iv) Implement South West system of WIMS with Hydrology front end - high IS requirements.
v) Implement Hydrolog and Rainark

Hydrologic can't provide: audit trails, data archive security, archive fragmentation and management, rainfall, QA, search facilities and there is a loss of some site reference details.

Main Conclusions:

* Biggest challenge to Region is the management of the system. Tools are available.

* At the moment the system adopted is dependant on WAMS.

* It is important to step back when creating a business case and not assume existing staff will take on additional work.

* Transition from Hydrolog to WAMS should be relatively easy. Experience gained from Hydrolog will not be lost.

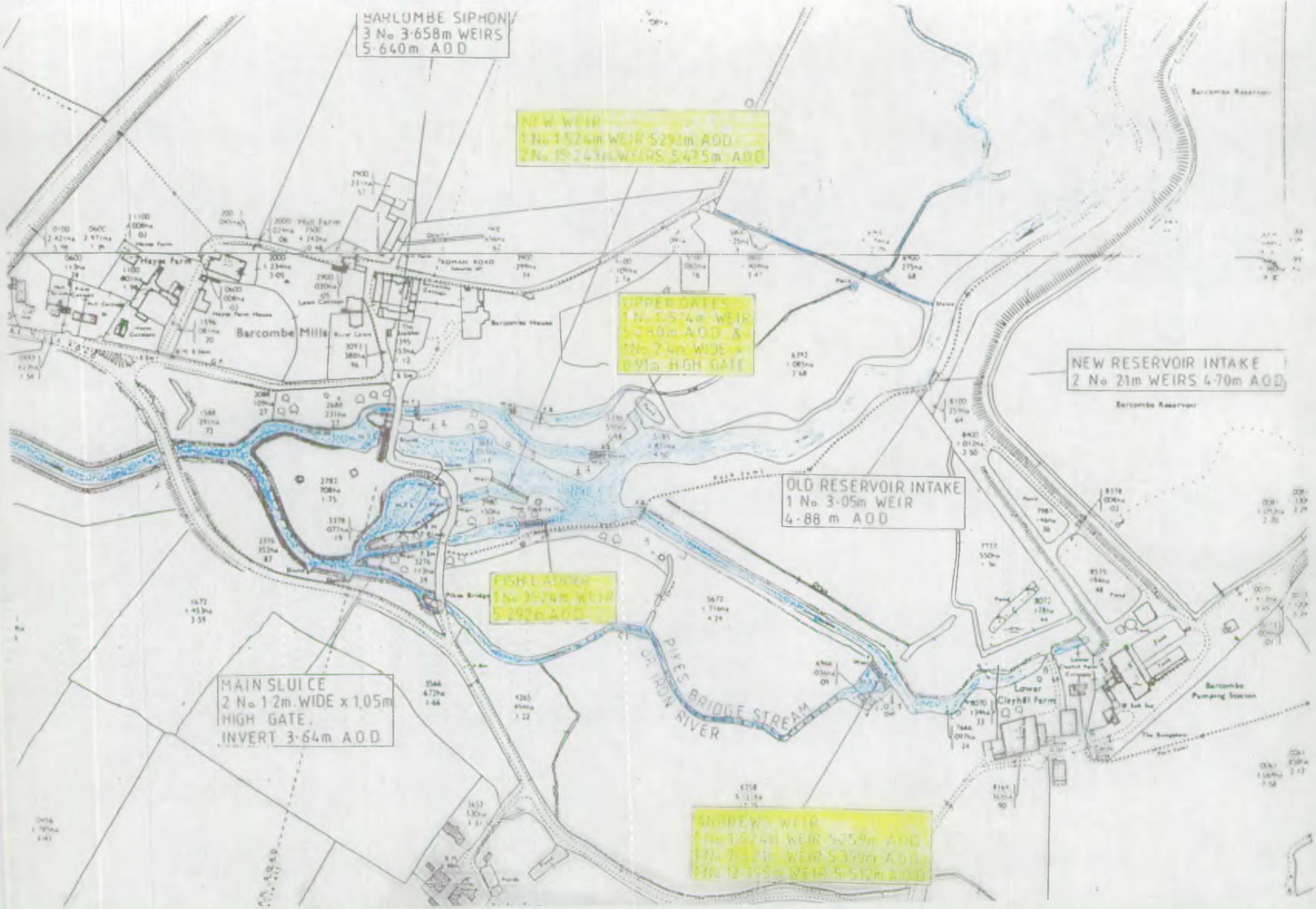
* Hydrolog can obtain data via telemetry so may be very beneficial as backup to RECS etc.

Robert S Harding
9/10/95

Barcombe Flow Measurement and Ardingly/Ouse Operation

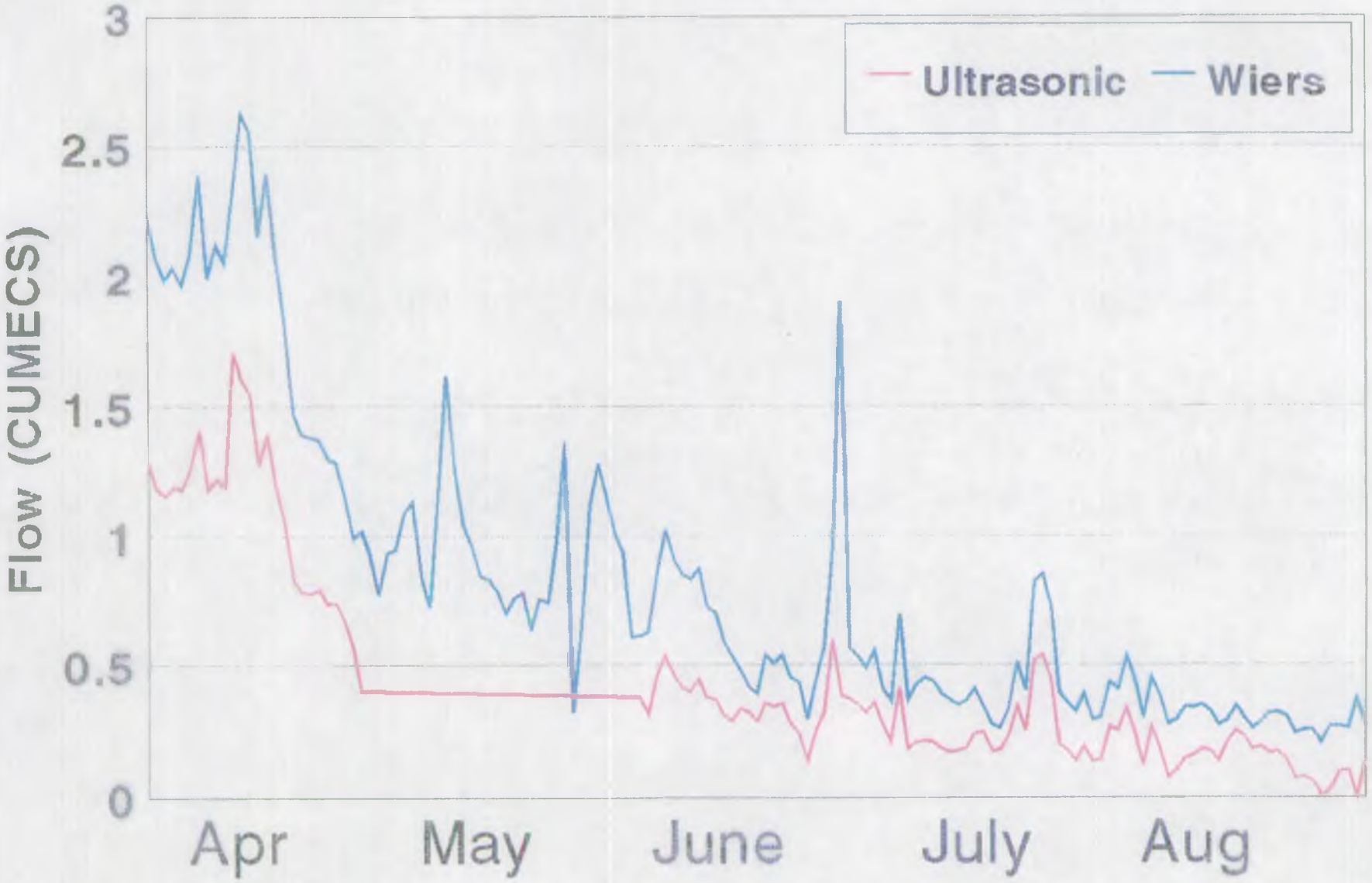
By

JOHN HEADEY


BARCOMBE SIPHON
3 No 3·658m WEIRS
5·640m AOD
NEW WEIR
1 No 1·524m WEIR 5·292m AOD
2 No 19·243m WEIRS 5·475m AOD
UPPER GATES
1 No 1·524m WEIR
5·480m AOD &
1 No 2·44m WIDE x
0·91m HIGH GATE
NEW RESERVOIR INTAKE
2 No 21m WEIRS 4·70m AOD
Barcombe Reservoir
OLD RESERVOIR INTAKE
1 No 3·05m WEIR
4·88 m AOD
FISH LADDER
1 No 1·524m WEIR
5·292m AOD
MAIN SLUICE
2 No 1·2m WIDE x 1·05m
HIGH GATE.
INVERT 3·64m AOD
PIKES BRIDGE STREAM
OR IRON RIVER
ANDREWS WEIR
1 No 1·524m WEIR 5·259m AOD
1 No 21·31m WEIR 5·379m AOD
1 No 12·195m WEIR 5·512m AOD
Barcombe Mills
Hayes Farm
Lower Clayhill Farm
Barcombe Pumping Station

Flows Recorded at Barcombe Mills

River Ouse 1995



HER in Sussex

By

NIGEL HEPWORTH

HER in Sussex

1. The sub-projects and how they came about.

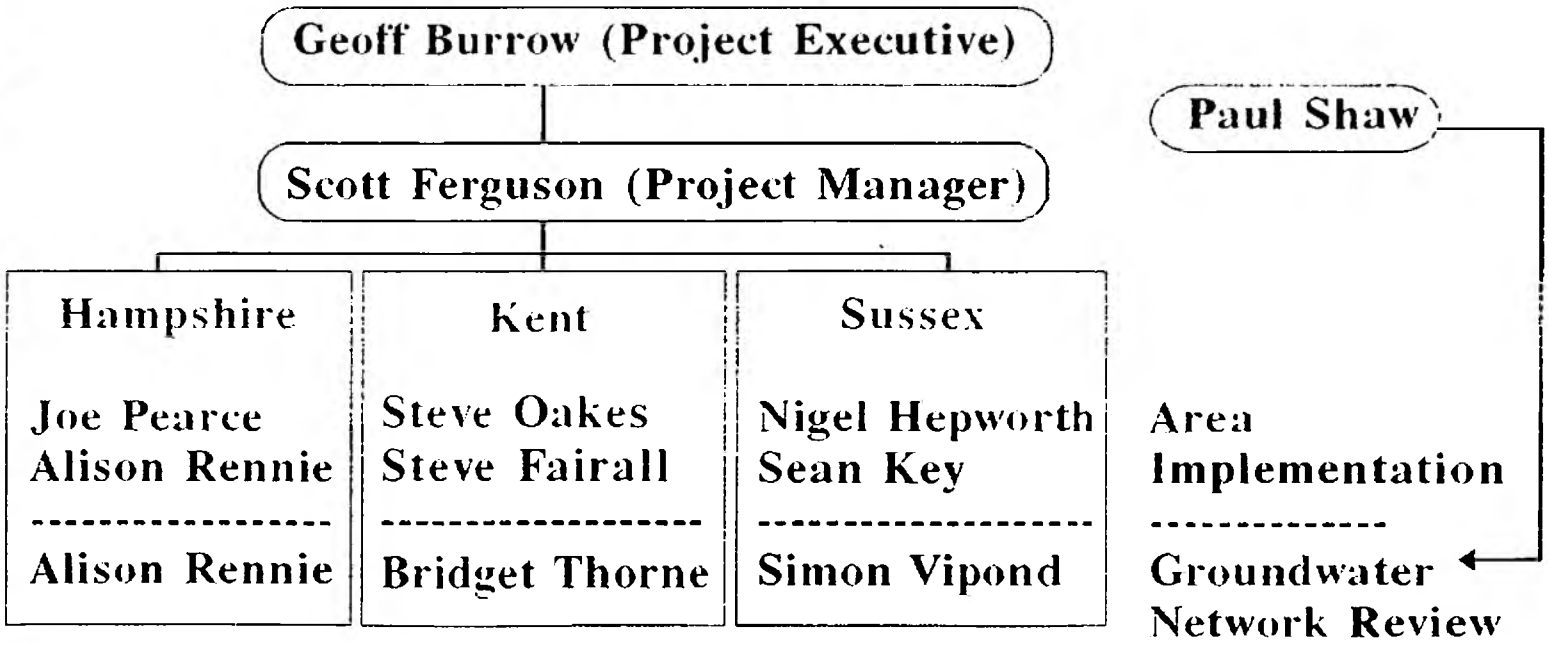
Sub-projects:

- Gauging station classification
- Site Maintenance Contracts
- Site Audits
- Standards / Best Practices
- National Training
- Improved Customer Focus (SLA)
- Reduced Revenue Investigations
- Network Reviews

These represent implementation of selected recommendations of the "HYDROMETRIC EFFICIENCY REVIEW" Report (October 1994), as endorsed by the NRA BOARD.

The NATIONAL HYDROMETRIC GROUP is coordinating, guiding and assisting with the implementation of the Board's decisions.

2. How we are going about this work.:-Southern Region Project Team.



- GAUGING STATION CLASSIFICATION:

- **Gauging Station Data Quality Assurance by Assessing Rating Curves**

- **To apply the agreed HER method there are two requirements:-**

- **Gaugings at structures.....but sparse, almost negligible historical practice in Sussex.**

- **Collation, confirmation of sites/structure details.**
  (In future we need better documentation/archiving of details of OUR ASSETS!)

- **The immediate workload is to set down an initial classification.**

- **The longer term workload is to perform the necessary gaugings**
  -I've estimated, for 43 Sussex Stations,
  600 man days of gauging may be needed,
  and a 5 to 10 year timescale.

- **Culture change!?**

- SITE MAINTENANCE CONTRACTS

- **Grass cutting**	|
- **In channel weed clearance**	|----- **Sensible to go out**
- **Gravel and silt removal**	|
- **Building Maintenance**	|----- **Sensible to go out** **A culture change?**
- **Weir crest and gauge board cleaning**	|
- **Cableway Maintenance**	|-----**Technical concerns**

- **The aim, and plausible result:-**
  to save technician time for better things.

- STANDARDS / BEST PRACTICES

- Rainfall data collection
- Current Meter Gauging
- Ground Water Measurement

- The Rainfall Questionaire

  - Differences in practice even between two Districts in Sussex.

EG. - Whether monthly check gauges are in place or not.
- Calibration checks made in-house or by reliance on Lab. tests.
- Methods of quality assuring data.

- Already an indication that standards could be improved and certainly made more consistant.

- GENERAL ISSUES AND OTHER HER SUB-PROJECTS

- Overall workload to complete HER

  - For the PID I estimate:-

		Man-Days
Gauging Station Classification	(excluding Gaugings)	- 28.5
National Training	(staff attendance at)	- 35.0
Standards / Best Practices		- 21.0
Site Audits	(technicians time with auditor)	- 6.5
Site Maintenance Contracts		- 29.0
Customer Focus (Southern Region SLA)		- 7.5
Reduced Revenue Investigation		- 10.0
Groundwater Network Review		- 17.0
	TOTAL	- 154.5

- Obvious difficulties in carrying out all this work.

- SOME SUGGESTIONS

- **A sensible SLA may represent a way forward.**

- **Management and Technical Group Meetings.**
  WRB, Area Resources, (RECS), NHG, AMT, RMT

- **A regular regional Hydrometric Group Meeting SCF, SO, JP, NDH**

- **The use of staff**
  - **Responsibility and Accountability.**
  - **The pool of staff and abilities.**

A KIND OF SUMMARY:-

- EFFICIENCY AND EFFECTIVENESS

- **Is there wastage?**
- **Where is it?**
  - **Management**
  - **Technicians**

- **HER can and will result in savings of technician time**
- **We must not let this result in further staff cuts**

- **Improved practices, standards and quality assurance**

- **There is much more Resources / hydrometric work that we could and should do with the extra time made available.**

WAMS Data Cleaning

By

JOE PEARCE

NRA
Southern Region

Data Cleaning Project

Reference Data

Functionality from Day 1

Missing/Additional Data

Aviod Duplication

Allow Migration

Guildbourne House Chatsworth Road Worthing West Sussex BN11 1LD
Tel: (01903) 820692 Fax: (01903) 821892

NRA
Southern Region

Reference Data

Grid References (consistent format)

Instruments - Business Names

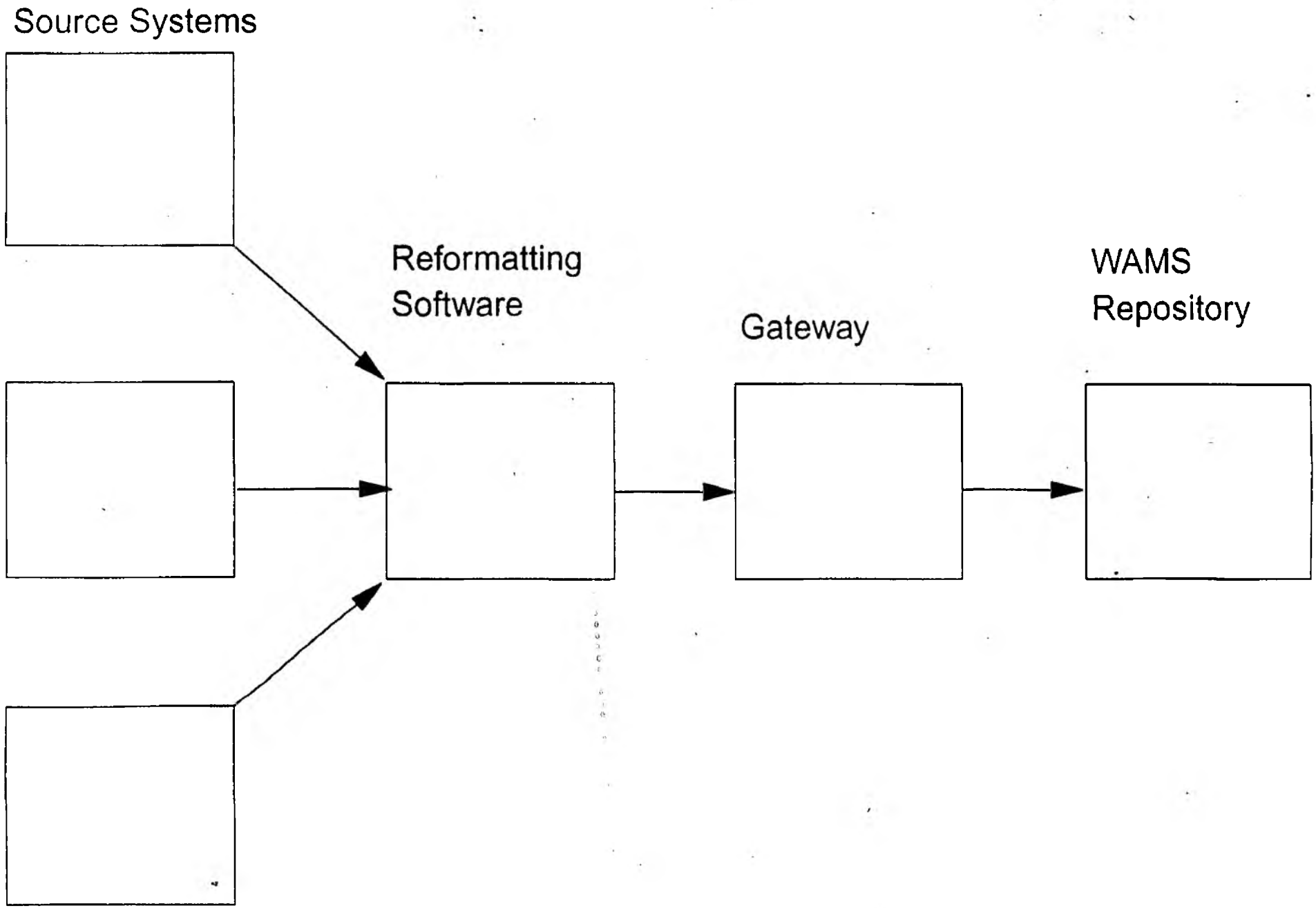
Dates of applicability

Determinands - Business Names

Data Conversion Methods

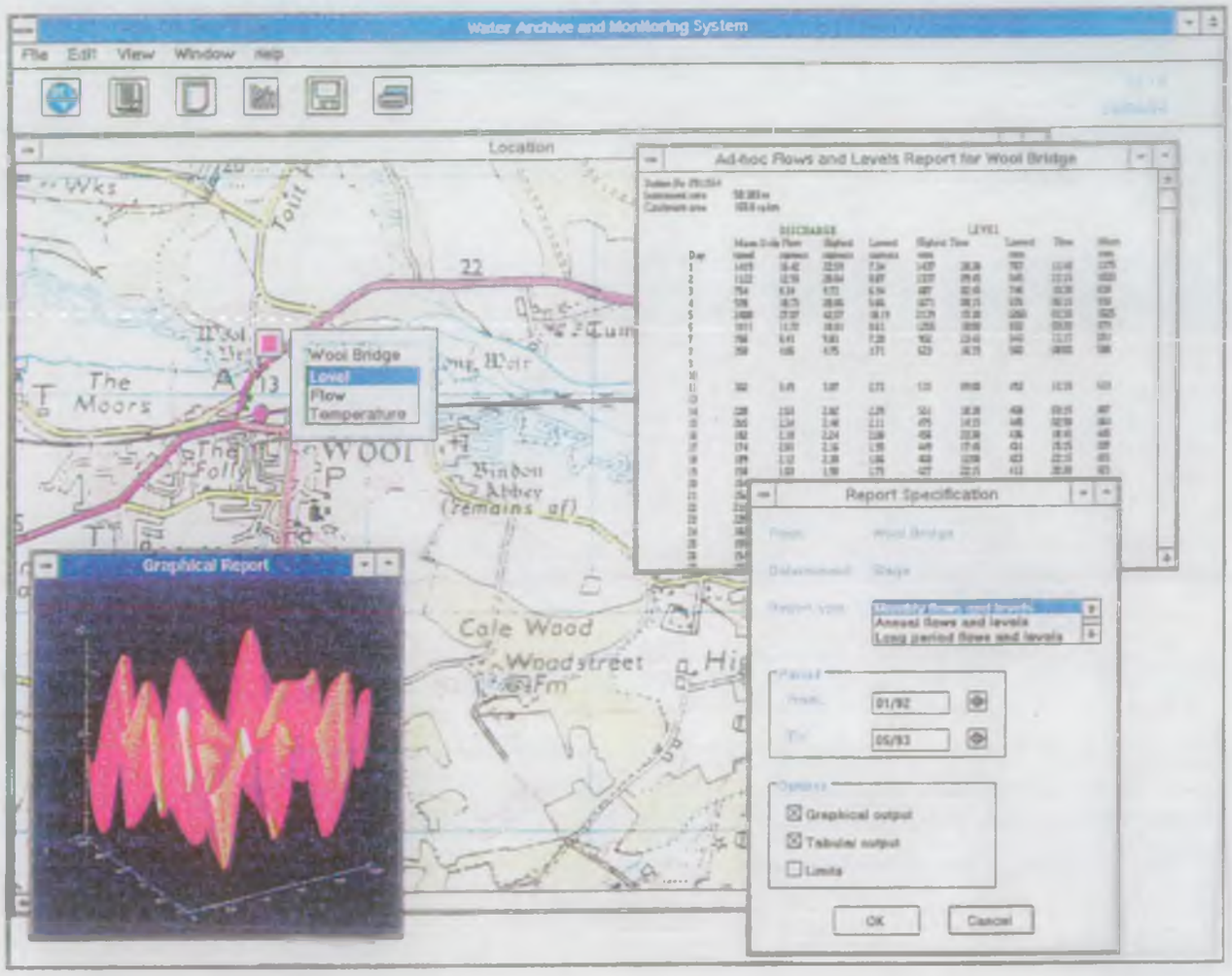
etc

Data Migration



LOGICA IN
RIVERS
MANAGEMENT

WATER ARCHIVE AND MONITORING SYSTEM



SYSTEM ARCHITECTURE

logica

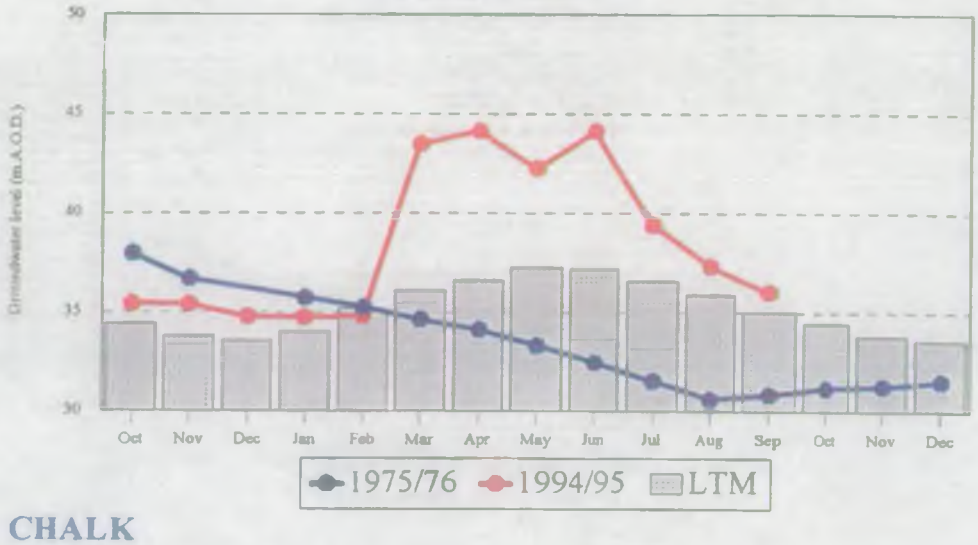
The Drought of 1995: a Kent Perspective

By

STEVEN OAKES

Groundwater at Westdown Farm Meopham

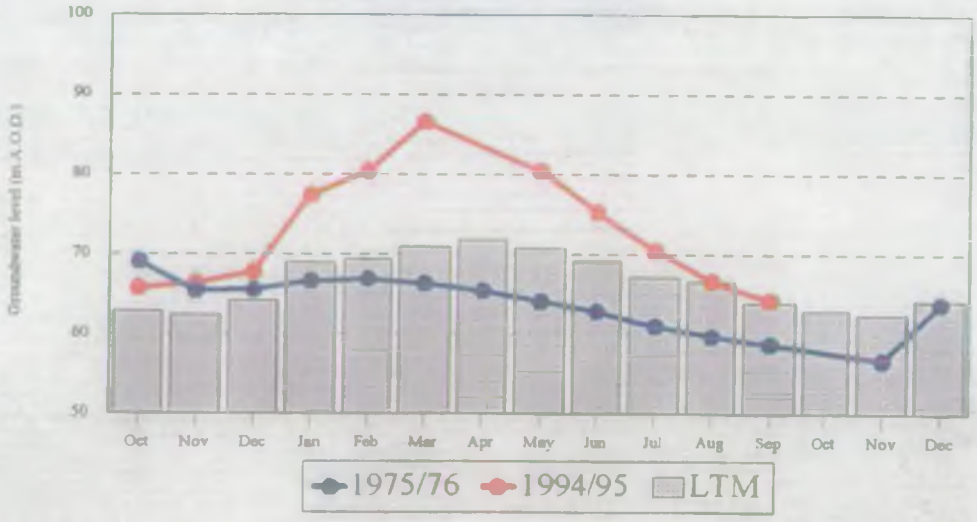
NGR. TQ6263 6600



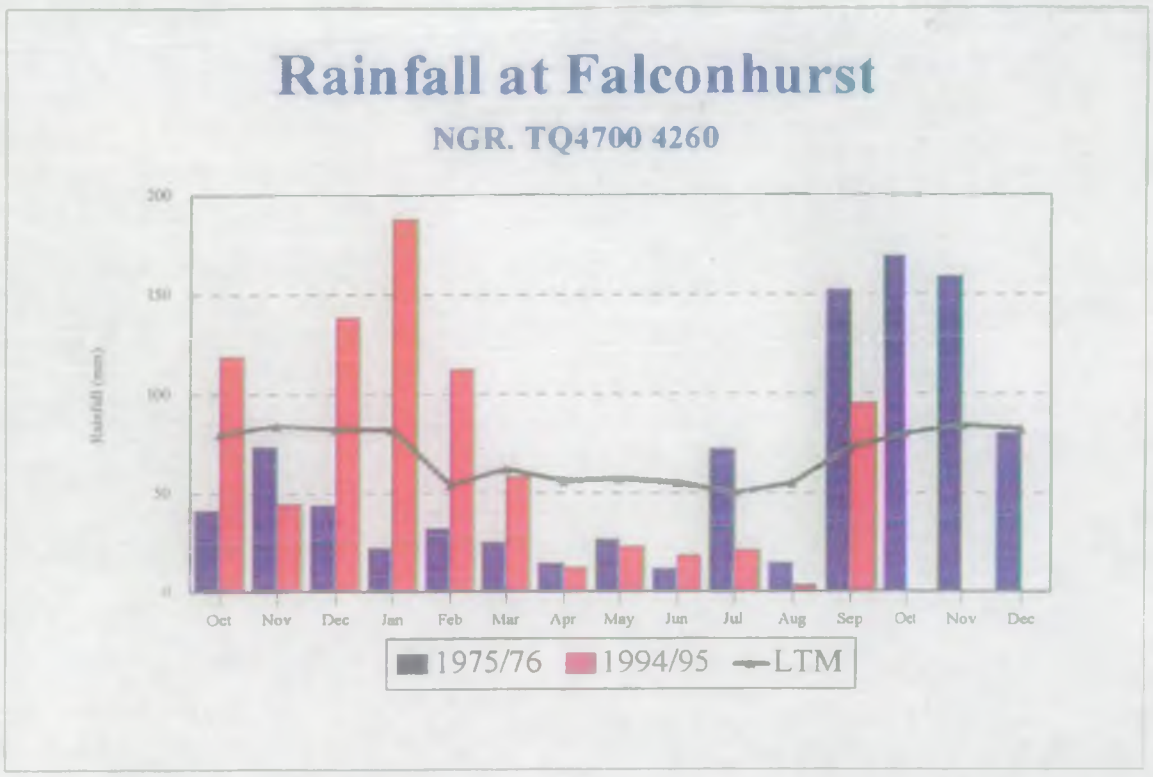
CHALK

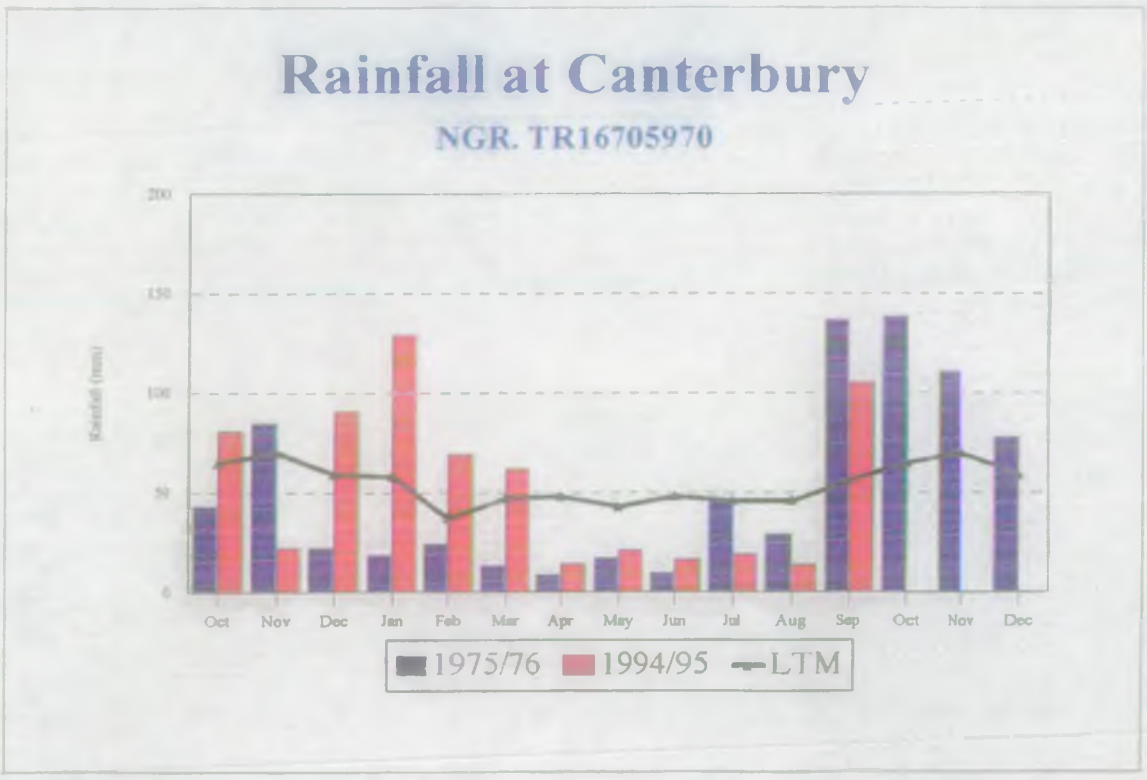
Groundwater at Little Bucket

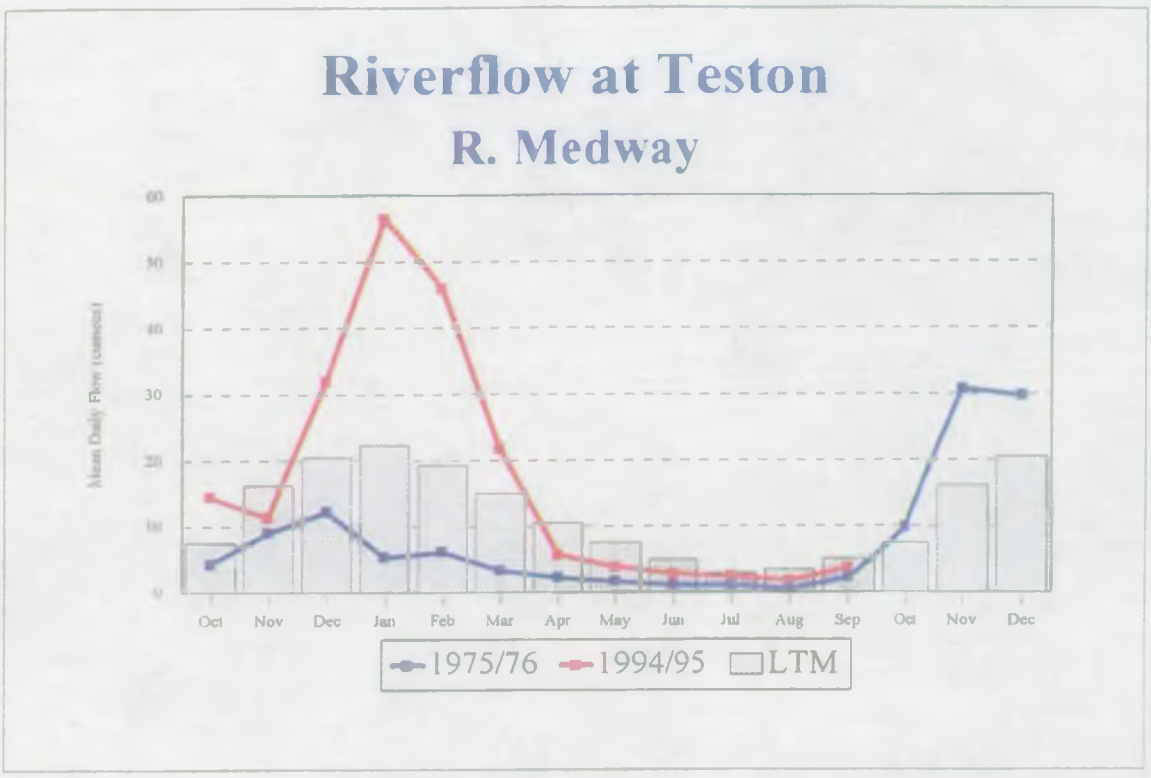
NGR. TR1225 4690

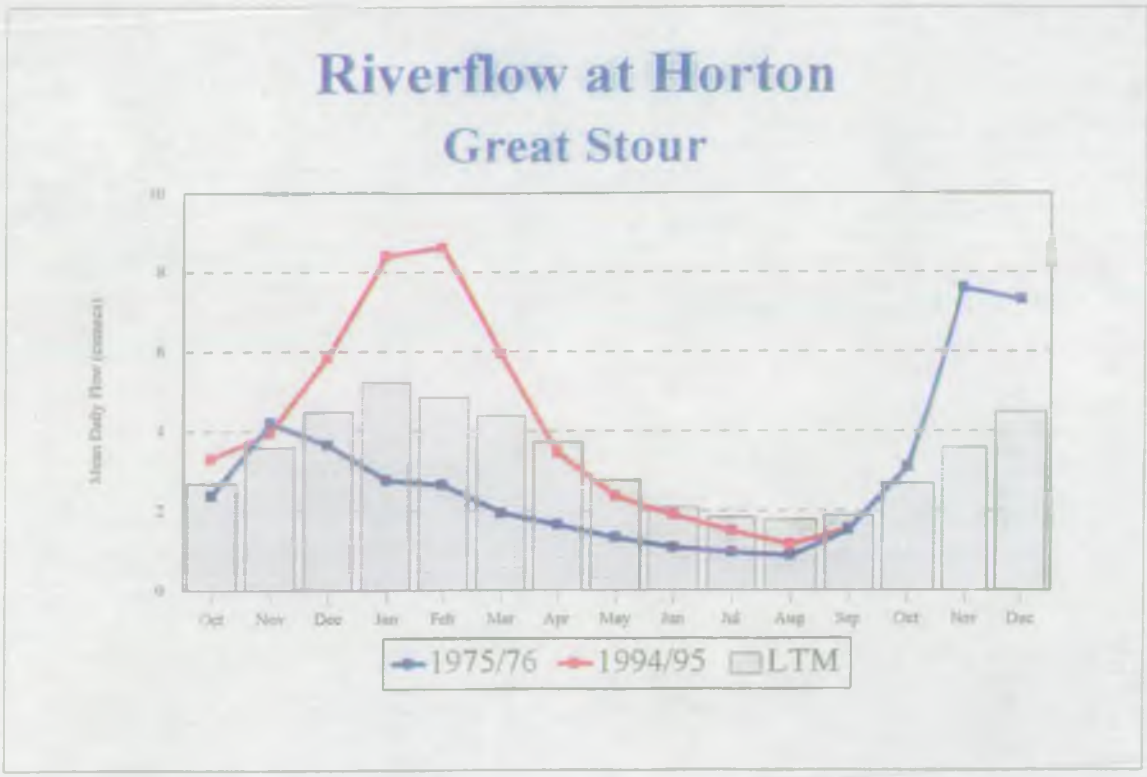


CHALK


Rainfall at Falconhurst
NGR. TQ4700 4260
200
150
100
50
0
Rainfall (mm)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1975/76
1994/95
LTM

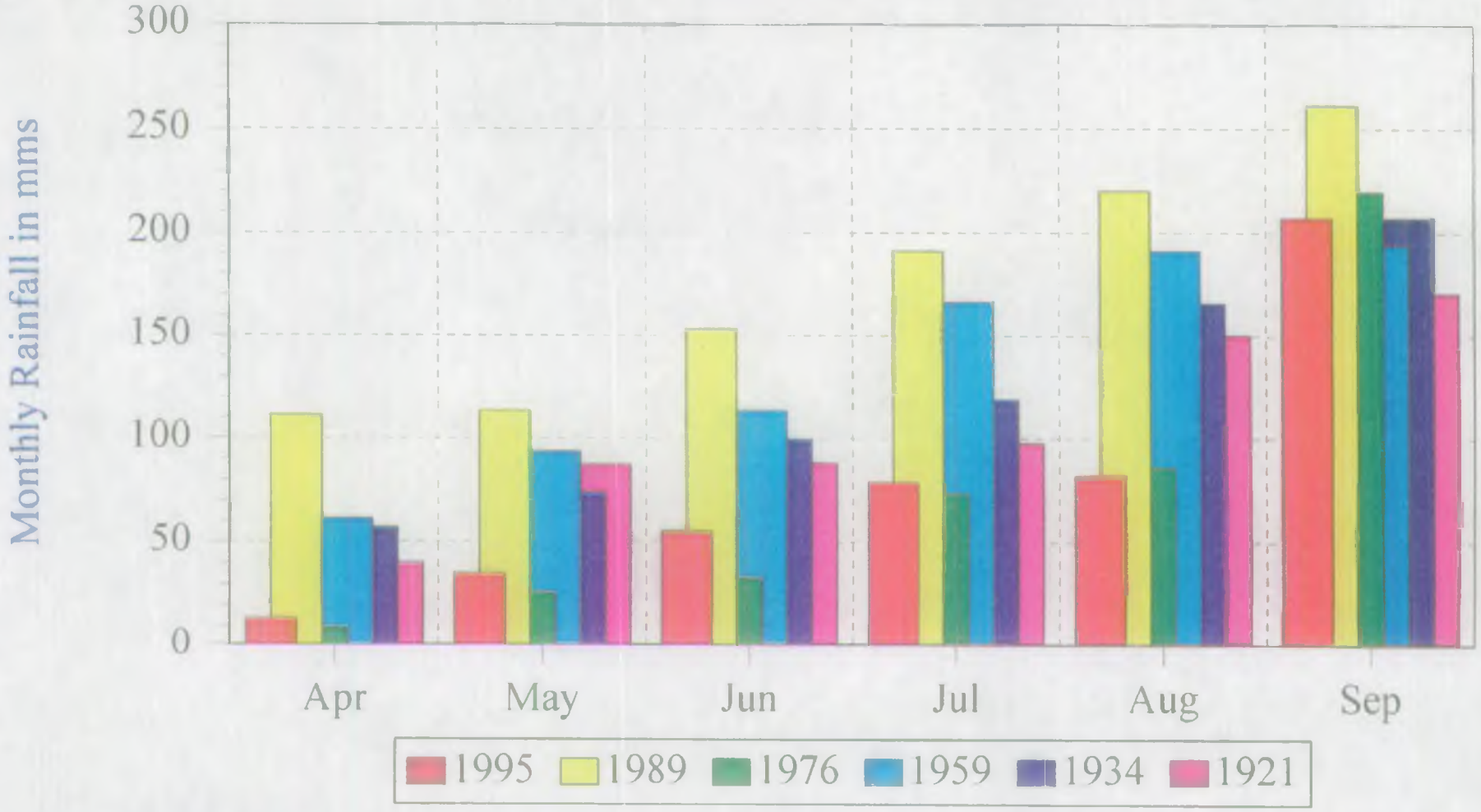

Rainfall at Canterbury
NGR. TR16705970
200
150
100
50
0
Rainfall (mm)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1975/76
1994/95
LTM


Riverflow at Teston
R. Medway
Mean Daily Flow (cumecs)
60
50
40
30
20
10
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1975/76
1994/95
LTM


Riverflow at Horton
Great Stour
Mean Daily Flow (cumecs)
10
8
6
4
2
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1975/76
1994/95
LTM

SCOTNEY CASTLE

Cumulative Summer Rainfall



NGR TQ 685354

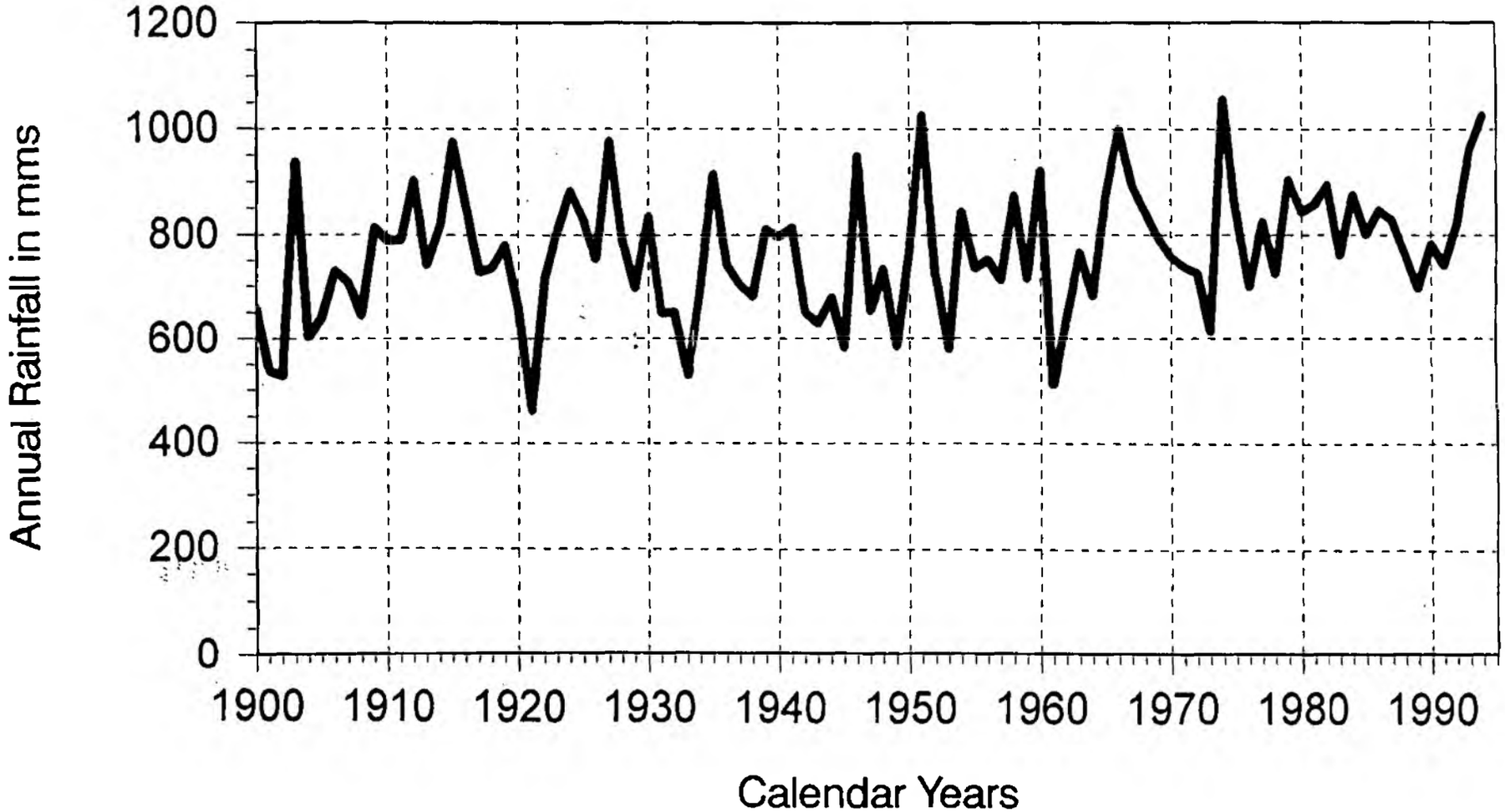
Comparison of Droughts at Kew & Scotney Castle
Based on 5 Month Droughts

	KEW	Dr	SCOTNEY CASTLE	Dr
1	FEB 1938	-0.728	APR 1976	-0.697
2	APR 1995	-0.692	APR 1995	-0.692
3	JUN 1921	-0.68	APR 1961	-0.675
4	APR 1976	-0.675	FEB 1944	-0.61
5	JUN 1972	-0.665	FEB 1929	-0.608
6	JUL 1947	-0.633	MAY 1991	-0.588
7	MAY 1959	-0.624	FEB 1938	-0.578
8	OCT 1933	-0.603	APR 1949	-0.563
9	MAR 1990	-0.576	MAY 1921	-0.532
10	JAN 1929	-0.574	MAY 1959	-0.52
11	FEB 1895	-0.57	MAY 1990	-0.514

$Dr = (R - Ra) / Ra$

SCOTNEY CASTLE

Plot of Annual RainfallTotals



NGR TQ 685354

DROUGHT CLASSIFICATION
TABONY (1977)

Type of Drought	Definition	Explaination
Meteorological Drought	Dr = R-Ra/Ra	Rainfall deficiency compared with "average"
Meteorological Drought	DrPE = (R-Ra) - (PE-PEa) / Ra	An index based both on rainfall and PE
Hydrological Drought	Dh = HER	An attempt to define hydrologically effective rainfall by indicating that rainfall which becomes Infiltration or Runoff
Grassland Drought	Da = PE - AE	An attempt to define "agricultural" droughts

TABLE 4.7 - RANKING OF SELECTED DROUGHTS AT KEW FROM 1871 TO 1991

	Duration	1890	1893	1898	1921	1933	1947	1959	1964	1972	1976	1990
	30 days	-	-	-	-	-	-	0	-	-	0	7
	60 days	-	2	-	1	-	10	6	-	-	-	-
	90 days	-	-	-	2	-	5	-	-	9	3	-
	4 months	-	-	-	1	9	4	-	-	8	5	-
	5 months	-	-	-	2	7	5	6	-	4	3	8
D_R	6 months	6	-	-	3	-	10	8	-	4	2	9
	9 months	6	-	-	2	5	-	7	-	3	1	4
	12 months	-	-	4	1	5	-	-	-	2	3	9
	18 months	-	-	6	1	4	-	8	-	2	3	10
	24 months	-	-	5	2	1	4	-	-	3	-	6
	30 months	-	-	5	1	4	2	-	-	3	10	7
	36 months	-	-	8	2	3	5	-	9	1	-	7
	30 days	-	-	-	7	-	-	8	-	-	2	1
	60 days	-	4	-	3	-	10	5	-	-	2	-
	90 days	-	-	-	3	-	7	4	-	-	1	6
	4 months	-	7	-	3	-	5	2	-	9	1	4
	5 months	-	10	-	4	-	7	2	-	9	1	3
D_{RPE}	6 months	-	8	-	4	10	9	2	-	7	1	3
	9 months	-	9	-	3	6	10	4	-	5	1	2
	12 months	-	-	9	2	6	-	4	10	3	1	5
	18 months	-	-	8	3	4	-	5	-	6	1	2
	24 months	-	-	7	5	2	6	10	-	4	3	1
	30 months	-	-	7	6	5	3	9	10	2	4	1
	36 months	-	-	10	7	4	5	-	9	1	6	2
	1 year	0	-	5	-	0	-	-	0	0	-	-
D_H	2 year	6	-	10	8	2	4	-	7	1	-	-
	3 year	-	-	-	3	4	8	-	2	1	-	-
D_A	1 year	-	5	-	4	-	-	3	-	7	1	2

LIST of NOTABLE DROUGHTS

Compiled by Tabony & Woodley

Date	Dry Period	Significance
1890	Winter Drought Sep 90-Apr 91	Hydrological Drought
1893	Summer Drought Mar - Sep	Grassland Drought
1895-1902	Protracted sequence	All types
1921	All year	Meteorological Drought
1933	24 month dry period from Nov 32 to Nov 34	
1938	Feb - July	Meteorological Drought
1947	Dry winter continuing into 1948	
1959	May - Sept	Meteorological Drought
1964	Winter Drought	Hydrological Drought
1972	36 month dry spell	Meteorological Drought
1975-1976	Winter/Summer Drought	Grassland Drought
1989-1992	3 fine summers	Longest drought sequence
1995	Apr- Aug	Meteorological & Grassland Drought

Waiting For WAMS - the alternatives

By

SCOTT FERGUSON

Criteria for deciding

1) WAMS - when and what

2) Cost - business case saving

3) Cost - upheaval and disruption of the change

4) Functionality - loss/gains

Importance of Management as a Regional database

1) Integrity of the data

2) Security of the data

3) Access to the data

4) Co-ordination

5) Consistency

HYDROLOGIC - What they cannot provide

1) Audit trails, site, data and reference change history

2) Data and archive security issues - possibly too easy to edit data

3) Archive fragmentation and management

4) Rainfall QA, i.e. nearest neighbours

5) Search facilities

6) Loss of some site reference information

HYDROLOGIC - What can they provide

1) A Regional database (or databases) for rainfall, surface water, groundwater, and climate data

2) Reliability, user friendliness, easy access

3) Facilities to import and export data

4) Facility to display and Quality control data

5) The vast majority of functionality we have at present - plus more

6) Will be core for future migration to WAMS

7) National standardisation

8) Historic data migration service

What are our Options

5 options currently available

1) Continue with current system
   high cost - limited, outdated functionality
   increasing un-reliability,
   questionable support commitment

2) Bespoke software, designed around Southern's needs
   major undertaking
   no standardisation

3) Implement IoH software (Hydata)
   limit of 1000 sites
   loss of some functionality

4) Implement South Western Regions system of WIMS with Hydrolog front end
   not actually in existence yet
   large IS resource requirement

5) Implement Hydro-Logic software (HYDROLOG & RAINARK)
   limited networking ability
   loss of some functionality

WAITING FOR WAMS - THE ALTERNATIVES

<u>Background</u>

- We currently spend £600k on the ICL per year

- WAMS was going to be our saviour

- Where do we go from here?

SESSION

III

WATER RESOURCE MANAGEMENT

REGIONAL WATER RESOURCES REVIEW - Arundel Stakis Hotel, 5 October 1995

NOTES FROM SESSION 111 - WATER RESOURCE MANAGEMENT [5.10.95.]

1. **Water Level Management Schemes in Sussex** [Simon Taylor]

All such schemes comprise existing SSSI's. In many instances (including Sussex) the Authority is involved by effectively being called upon to perform the functions of an IDB and, moreover, the Plans fall under the Authority's statutory responsibilities by virtue of Section 17 of the Water Resources Act and may sometimes fall within arrangements made for Countryside Stewardships. They have also been incorporated as a Water Resource target within the latest version of the Authority's Corporate Plan.

The Pevensey Levels and Amberley Wildbrooks were adopted for such schemes in April 1995.

The schemes assess the value of current practices and there is an obvious need to review the proposed conservation-conscious controls in terms of their desirability from Flood Defence and Land Drainage standpoints. Because of the need for accurate measurement of the level and flow elements involved, such assessments are, in the end, "down to hydrologists".

The Authority usually finds itself having to initialise, plan long term monitoring and direct related investigative works itself and comes under pressure from a diverse range of conservation bodies and environmental action groups - effectively all too often playing the role of "kitty in the middle".

Questions were responded to thus: 1. "Set Aside" schemes could not compete in that they offered a much higher rate of return to farmers. 2. The initiative for such schemes originated from water level/habitat changes to former wetlands reclaimed often during the immediate post-war period for agricultural use, and now no longer needed. 3. Q. Who is responsible for drafting the schemes ? A. The NRA (again !) as acting IDB. 4. In terms of cost /benefit appraisals there was, so we were informed , always a (appropriately weighted?) net balance in favour of the gain to Conservation.

2. **Darent Action Plan** [Ian Hogg]

This presentation was accompanied by some excellent purpose-designed colour viewfoils which neatly served to present the mechanics of the proposals for the rejuvenation of the River. The geology was briefly sketched and the role of the feeding LGS springs and underlying highly permeable Chalk aquifer highlighted. The causal sharp increase in actual abstraction from 1940-60 was also emphasised as also was the inappropriateness of LOR issue during the '60's - of 178Mld licensed abstraction in the catchment, and utilising a 30% effective recharge quota, estimated annual average recharge is calculated to be only 140Mld, resulting in the profound effects upon baseflow of the year-on-year '89-'92

drought during which period much of the River disappeared. This critical situation was not improved by the presence of a trunk main parallelling the River which transmitted virtually all hard-surface run-off directly to the sea rather than into the aquifer.

The Plan proposals were summarised. An effective Conjunctive Augmentation Scheme is to be set up: This will essentially comprise six new augmentation boreholes operating within a Water Resources Management Scheme which will seek a 70% reduction of the existing "take" of TWU licences - an operational regime already effectively in operation by "gentleman's agreement" with the Water Company since the mid-eighties.

Target Flows had been set along the river profile and a "Memorandum of Agreement" signed between TWU and the NRA in August of this year.

Questions were responded to thus: 1. Efforts made to estimate chalk river bed permeabilities and the necessity to incorporate augmentation boreholes into the scheme to meet the Target Flows were discussed. Groundwater modelling undertaken by consultants GDC had indicated that reduced abstraction was alone insufficient to restore the river to the target flows. A pilot augmentation scheme would serve to trial the effectiveness of full scale operation. 2. Augmentation was expected to be a feature of the fully operational scheme almost every year. 3. The DRIPS committee had not been provoked to negative response by some admitted slippage in scheme progression.

3. The Hardham Scheme [Simon Taylor]

The current combined surface and groundwater licences at Hardham are supposed to be operating conjunctively but recent usage belies this: During 1992 and '93 surface water utilisation had reduced and groundwater abstraction increased, the groundwater component having risen from 35% of the total in 1992 to 57% in 1993.

Whilst Southern Region's Water Resource Strategy document (Nov 1994) has allowed scope for the further development of the Hardham sources, it has left yield determination for both Hardham stages I and II open ("to be determined"), and thus any form of developmental constraint has yet to be defined.

The Church Farm site, adjacent the Arun, constitutes the area proposed for groundwater development. This has the advantage of a Gault Clay cap which should ensure minimal river/aquifer inter-reaction and associated turbidity problems. Preliminary water level measurements have indicated the cone of depression from the site to extend well to the east, beyond the flood plain of the Arun channel.

There is concern, therefore, that there will be a loss of springflow at the edges of the Hardham Basin with resultant detrimental impact upon the Pulborough Brooks (RSPB) wetlands. However, Horsham District Council will require a full EIA even before any trial development boreholes are allowed to be emplaced. A published pamphlet (SWS) has indicated that a gestation period of several years monitoring and exploration work will be necessary prior to the emergence of any active development proposals.

In response to questions it was reported that an interim progress report was due from Southern Science before the end of the year. Criticisms were offered or implied concerning, firstly, the apparent failure of the proposed scheme at Hardham to in any way incorporate the original idea of conjunctive use, and, secondly, the total abandonment of the idea of using an apparently ideal site to develop the concept and practice of groundwater recharge and re-use.

4. **Demand Management** [David Howarth]

Southern Region was identified in 1993 as being the national "Centre of Excellence" for Demand Management.

Central to the topic are the Authority's duties and responsibilities to effect appropriate controls under Sections 19 and 188 of Water Resources Act.

The considerable scope of the subject field was contrasted with a reference to the severe staffing limitations of the unit.

The twin roles of the unit were identified as being liaison with external bodies and provision of support to both Bristol and the Regions.

The three major projects undertaken by the Centre since its inception included a survey of domestic consumption, the production of "Saving Water" - a recently published advisory document, plus a review of a national metering trials.

R&D project work had concluded that a 58% reduction in current levels of public water supply to the consumer was possible presuming adoption of the most stringent of controls. The proposals listed in the published NRA Water Resources Strategy document clearly showed that Demand Management means much more than merely addressing leakage and promoting metering in areas of shortage.

Queries were concerned with perceived customer attitudes towards extra charges which might be associated with Demand Management controls eg. toilet conversion, meter installations, and also with Company attitudes to the recommended need for tighter controls; not surprisingly these had been found to vary considerably on both of these counts. In closing, reference was made to a bi-monthly up-date bulletin which was provided NRA-wide to a broad spectrum of recipients.

SHV 10.10.95.

Water Level Management Schemes in Sussex

By

SIMON TAYLOR

WATER LEVEL MANAGEMENT

- Draw up plans for operational procedures where water levels are managed by NRA or IDBs
- Plans for SSSI's should take priority

NRA

QUESTIONS

- Is it possible and desirable to raise water levels on a piece of land?
- Will other interests be affected by the changes?
- How can these changes be achieved most efficiently and effectively?

NRA

LIST OF SSSIs WHICH ENGLISH NATURE CONSIDER TO BE THE HIGHEST PRIORITY FOR THE PRODUCTION OF A WATER LEVEL MANAGEMENT PLAN

County	SSSI Name	Grid Ref.	Area (ha)	Op. Auth	IDB or NRA Region
Avon	Gordano Valley	ST 435730	143.2	I D B	Gordano Valley
Cambs	Ouse Washes	TL 393747	2403.0	I D B	Hundred Foot Washes
Devon	Exe Estuary	SY 980845	2181.6	NRA	South Western
* E Sussex	Pevensey Levels	TQ 650070	3501	NRA	Southern
Norfolk	Alderfen Broad	TG 355195	20.63	I D B	Smallburgh
Norfolk	Ant Broads & Marshes	TG 362213	735.11	I D B	Smallburgh
Norfolk	Breydon Water	TG 500075	306.50	I D B	L.Bure, Halvergate & Acle, Burgh Castle. Abuts Langley
Norfolk	Broad Fen Dilham	TG 343255	36.86	I D B	Smallburgh
Norfolk	Bure Broads & Marshes	TG 337166	736.50	I D B	Middle Bure, Smallburgh
Norfolk	Burgh Common & Muckfleet Marshes	TG 440117	116.00	I D B	Muckfleet & South Flegg
Norfolk	Calthorpe Broad	TG 412258	43.5	I D B	Smallburgh
Norfolk	Cranberry Rough, Hockham	TL 934936	61.4	I D B	East Harling
Norfolk	Crostwick Marsh	TG 263165	11.2	I D B	Middle Bure
Norfolk	Damgate Marshes, Acle	TG 413097	63.9	I D B	Lower Bure, Halvergate & Acle
Norfolk	Decoy Carr, Acle	TG 405090	55.36	I D B	Lower Bure, Halvergate & Acle
Norfolk	Ducans Marsh, Claxton	TG 339027	3.6	I D B	Lower Yare Second
Norfolk	East Ruston Common	TG 340280	38.3	I D B	Smallburgh
Norfolk	Geldeston Meadows	TM 396916	13.43	I D B	Lower Waveney
Norfolk	Hall Farm Fen, Kemsby	TG 481170	9.00	I D B	Muckfleet & South Flegg
Norfolk	Halvergate Marshes	TG 435060	162.00	I D B	Lower Bure, Halvergate & Acle
Norfolk	Hardley Flood	TM 380997	48.10	I D B	Lower Yare Second
Norfolk	Limpenhoe Meadows	TG 399031	11.60	I D B	Limpenhoe & Reedham
Norfolk	Ludham-Potter Heigham Marsh	TG 410178	99.00	I D B	Smallburgh
Norfolk	North Norfolk Coast (Overy)	TF 690443	7700.00	NRA	Anglian
Norfolk	Poplar Farm Meadows	TG 370021	7.23	I D B	Lower Yare Second
Norfolk	Priory Meadows	TG 417254	24	I D B	Smallburgh
Norfolk	Shallam Dyke Marshes	TG 399165	71.7	I D B	Repps, Martham & Thurne
Norfolk	Smallburgh Fen	TG 327246	7.27	I D B	Smallburgh
Norfolk	Stanley & Alder Carrs	TM 434928	43.5	I D B	Lower Waveney
Norfolk	Upper Thurne Broads & Marshes	TG 430210	1159.15	I D B	Smallburgh & Happisburgh
Norfolk	Upton Broads & Marshes	TG 390137	194	I D B	Middle Bure
Norfolk	Winterton to Horsey Dunes	TG490210	427.2	I D B	Happisburgh-Winterton
Norfolk	Yare Broads & Marshes	TG 330063	735.83	I D B	Lower Yare First & Lower Yare Fourth
Somerset	Catcott, Edington & Chilton Moors	ST 390420	1063.0	I D B	Lower Brue
Somerset	Curry & Hay Moors	ST 323273	472.7	I D B	Curry Moor
Somerset	Kings Sedgemoor	ST 400330	822.0	I D B	Aller Moor,Kings Sedgemoor
Somerset	Langmead & Weston Level	ST 353330	168.8	I D B	Chedzoy
Somerset	Moorlinch	ST 390360	226.0	I D B	Kings Sedgemoor
Somerset	North Moor	ST 325305	676.3	I D B	Northmoor, W.Sedgemoor
Somerset	Southlake Moor	ST 370300	196.1	I D B	Othery M/Zoy & W/Z/Land
Somerset	Tealham & Tedham Moors	ST 420450	917.6	I D B	Lower Brue, Upper Brue
Somerset	Wet Moor	ST 448244	491.0	I D B	Langport District
Somerset	West Moor	ST 420220	213.0	I D B	Langport District
Somerset	Westhay Moor	ST 456445	513.7	I D B	Upper Brue
Somerset	West Sedgemoor	ST 361258	1016	I D B	W Sedgemoor District
Staffs	Baswich Meadows	SJ 950227	12.92	NRA	Severn Trent
Staffs	Cop Mere	SJ 802297	37.6	NRA	Severn Trent
Staffs	Doxey & Tillington Marshes	SJ 906245	123.9	NRA	Severn Trent
Staffs	Rawbones Meadow	SJ 985225	20.4	NRA	Severn Trent
* W Sussex	Amberley Wild Brooks	TQ 033142	322.6	NRA	Southern

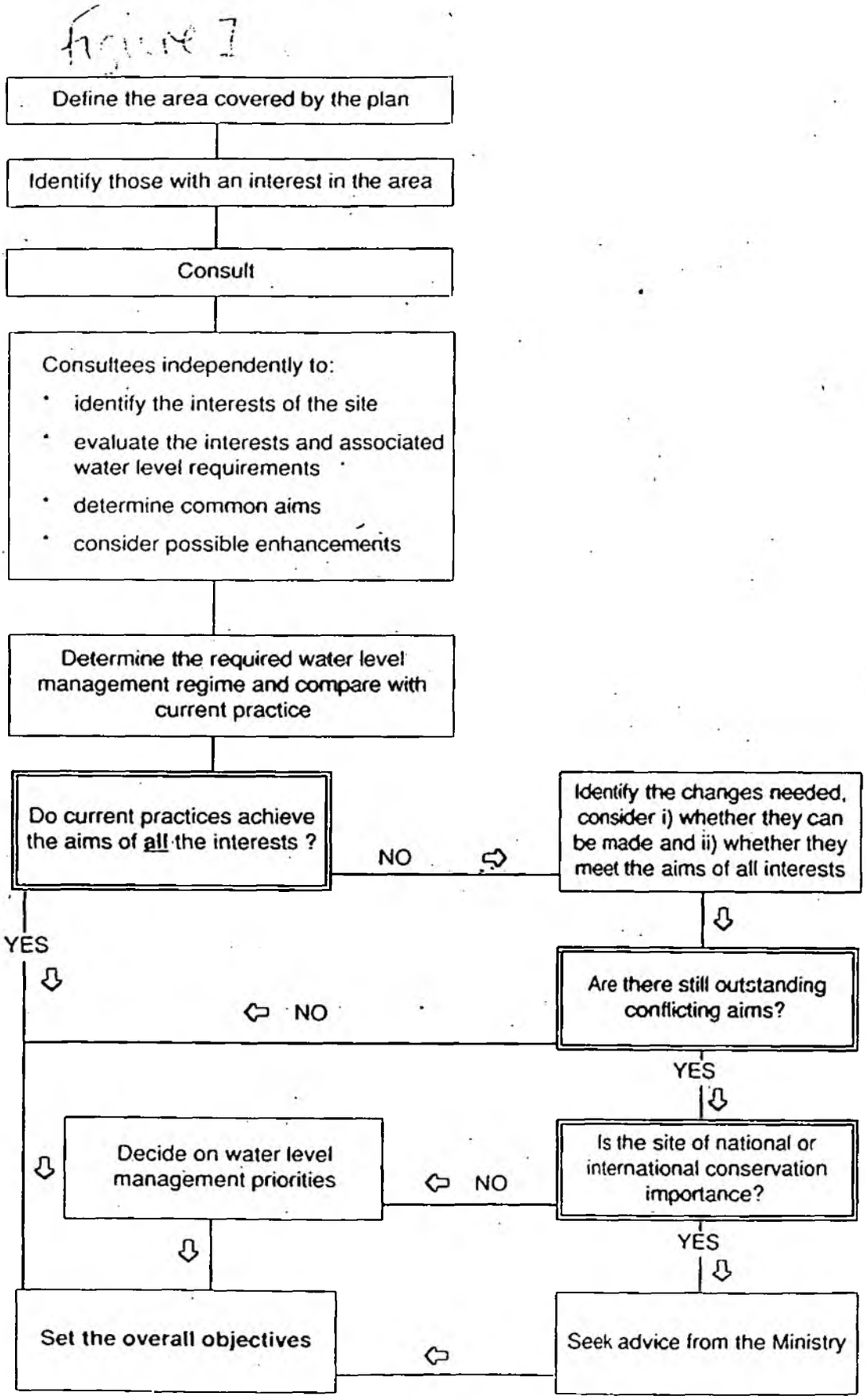


Figure 1: Outline procedure for setting the objectives

CONSIDERATIONS

How much water?

- Flows
- Evapotranspiration
- Abstraction

WHAT IS POSSIBLE?

Water Movement

- Ditch system
- Pumps
- Sluices

High water levels

- Wet fencing
- Wildlife
- Feeding

WHAT IS DESIRABLE?

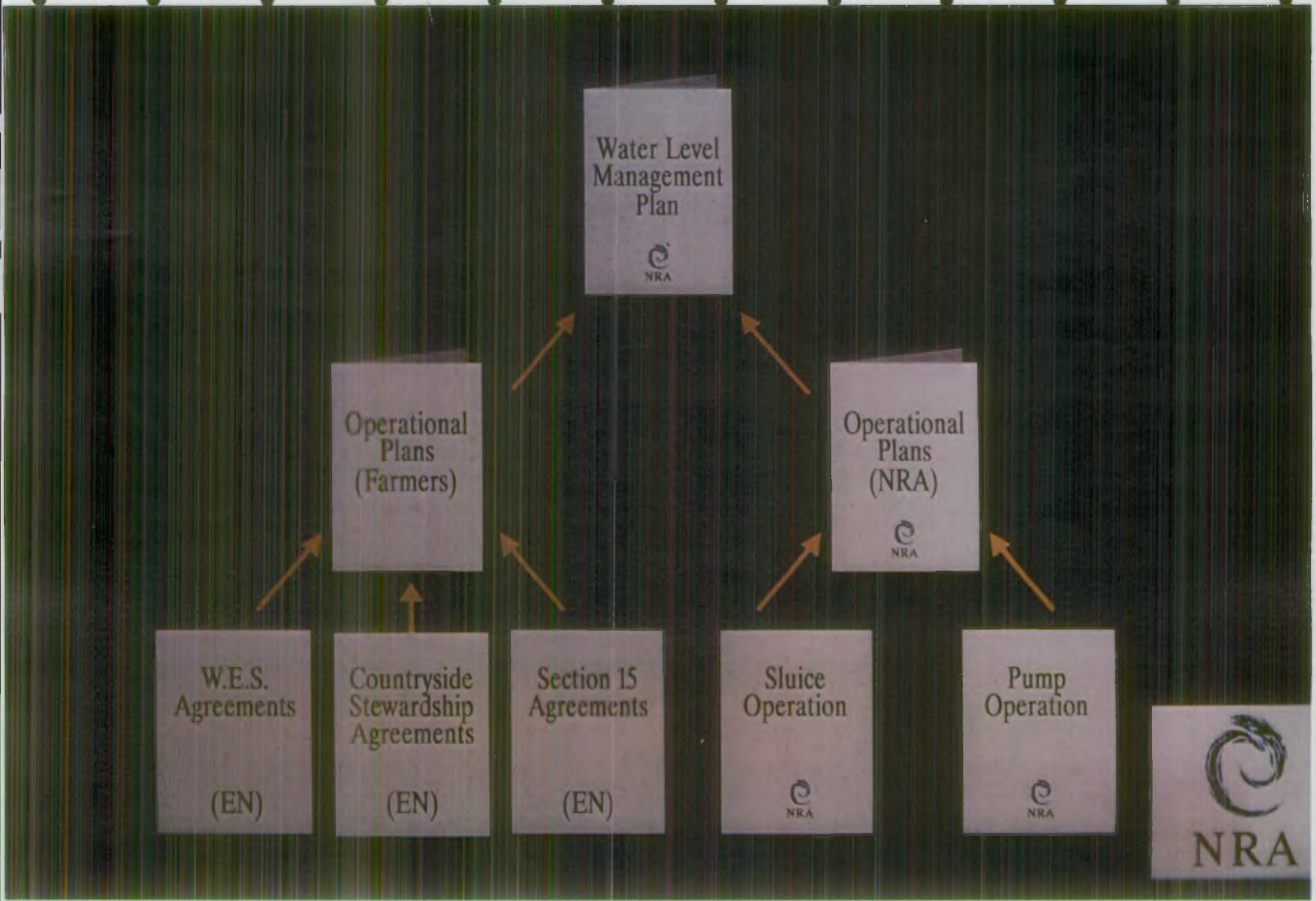
Low water levels

- Flood defence
- Drainage

Surveys

Water Management Plan

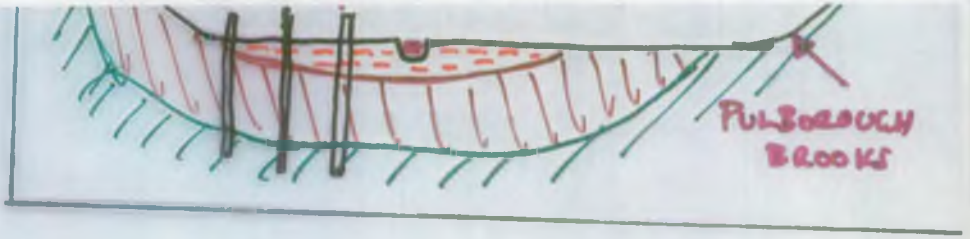
NRA

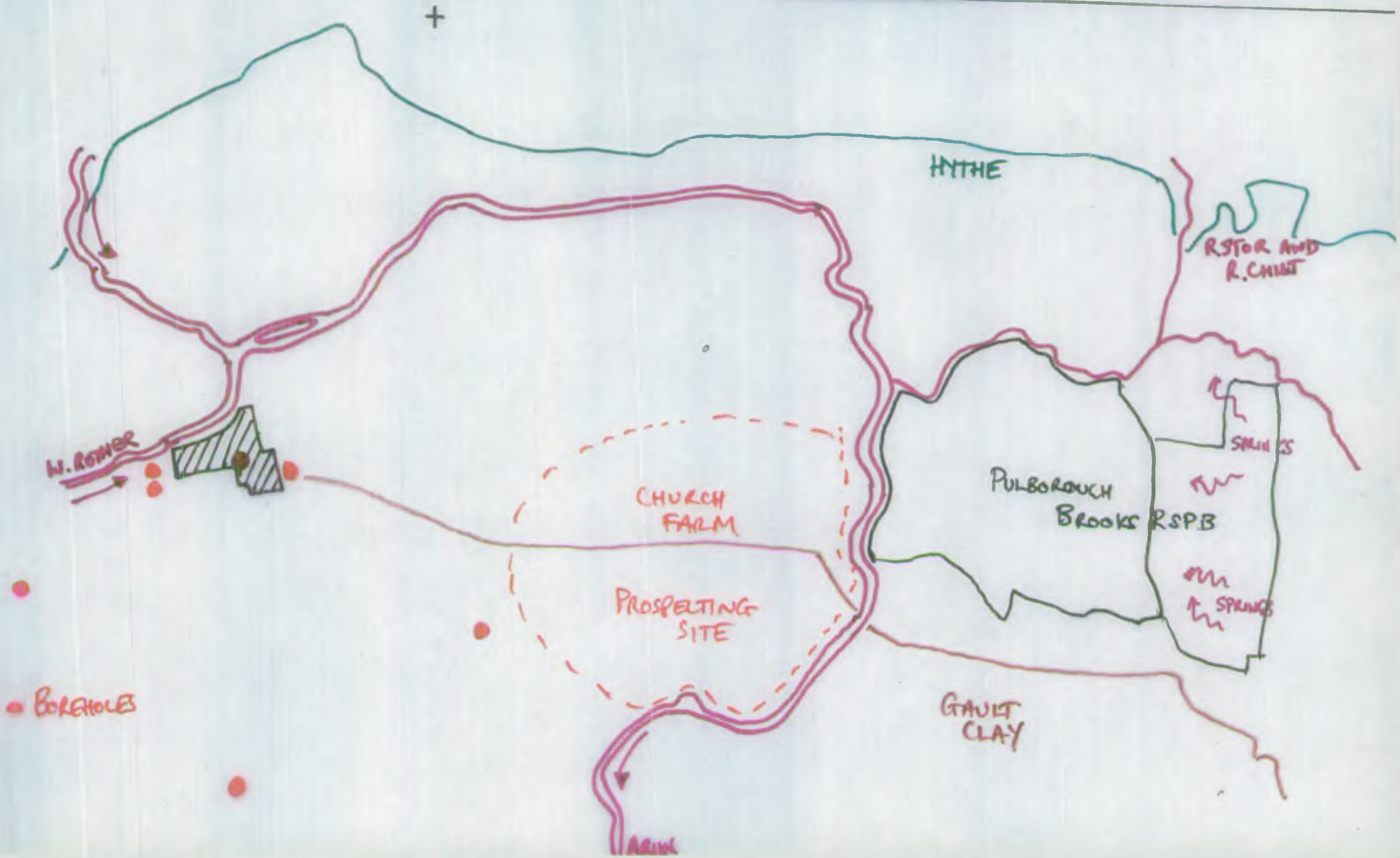

Water Level Management Plan
NRA
Operational Plans (Farmers)
Operational Plans (NRA)
NRA
W.E.S. Agreements
(EN)
Countryside Stewardship Agreements
(EN)
Section 15 Agreements
(EN)
Sluice Operation
NRA
Pump Operation
NRA
NRA

Hardham Scheme

By

SIMON TAYLOR


PULBOROUGH
BROOKS


HYTHE
R.STOR AND
R.CHILT
W. ROTHER
CHURCH
FARM
PROSPECTING
SITE
PULBOROUGH
BROOKS RSPB
SPRINGS
SPRINGS
GAULT
CLAY
BOREHOLES
ARUN

HARDHAM ABSTRACTION; NATIONAL RIVERS AUTHORITY VIEW

The decision over whether more water can be abstracted will be made by the NRA. That decision will be based on an assessment of a number of factors such as:

- whether environmental damage would occur
- that there is a proven need for the water
- that enough has been done to cut losses from supply pipes
- whether additional water might be found from other, under-used sources

The NRA must be satisfied on all these points before any extra water is allocated to Southern Water Services. The NRA has already said that an environmental impact assessment must be done by Southern Water Services. The NRA has started discussions with conservation bodies in the Hardham area, to ensure all their concerns and worries have a voice.

It will be quite a number of years before there will be enough information collected in order to back-up any application made to the NRA. During that time, also, much environmental data will become available for examination so that any decision by the NRA is based on the best possible understanding of the locality.

FOR FURTHER INFORMATION

Should you require further information about this project please contact either Rod Armstrong or Graham Amy at

- **Licence Conditions**

Groundwater

Annual Licence	13,272	Ml/a	
Daily	36	Ml/d (1)	
Actual 1992	4747	Ml/a	(35%)
1993	7555	Ml/a	(57%)

Surface

Annual Licence	16,500	Ml/a	
Daily	75	Mld (1) (2)	
Actual 1992	13,415	Ml/a	(81%)
1993	10,332	Ml/a	(62%)

(1) Combined daily limit 75 Ml/d
(2) Subject to MRF of 63 Ml/d

- Actual daily output 29 June 1995 72 Ml/d

- Water Resources Strategy November 1994

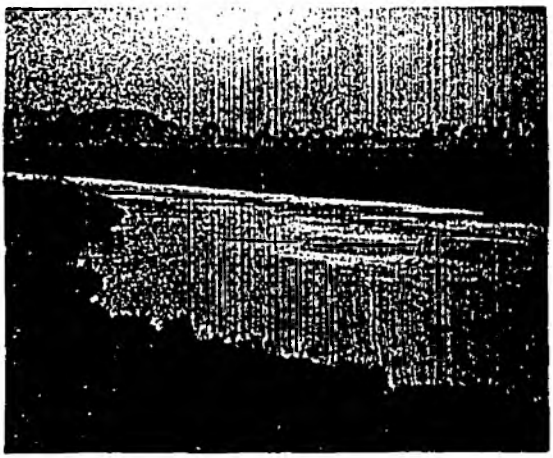
  Stage I develop Hardham beyond 65 Ml/d

  Stage II Hardham yield - to be determined.

SIMON TAYLOR
Area Water Resources Manager

26 September 1995

Misc158.ST/JB



INTRODUCTION

Southern Water Services are to undertake long-term investigations into groundwater levels and flows in the River Rother.

These investigations will ascertain whether the company can increase water abstraction from the aquifer without any detriment to the environment.

WHY IT IS NECESSARY

Water consumption has risen very considerably both in terms of population growth and increased customer usage of domestic appliances such as washing machines, dish washers etc.

Southern Water need to ensure that sufficient water is available for essential domestic and other legal uses not only now but for generations to come.

We are constantly looking for improved quantity as well as quality of supplies. We regard water as a valuable resource that must not be wasted. As a result Southern Water have put a lot of effort in the last few years into leak detection. Repairs to leaking pipes have saved nearly 12 million gallons per day in Sussex alone. However, more water will be required in the future especially during hot weather.

HARDHAM WATER SUPPLY WORKS

One of Southern Water's main sources of supply for West Sussex is the Hardham Works which is situated 1.5 kilometres south west of Pulborough, on the south bank of the River Rother and its confluence with the tidal River Arun.

The River Rother which rises near Liss in Hampshire provides one source of water, whilst boreholes sunk in the sandstone aquifer beneath the works and the

SOUTHERN WATER

surrounding area provide a second source. One of the boreholes is on the nearby Church Farm.

CHURCH FARM

Southern Water recently bought Church Farm and in the longer-term hope to develop further boreholes on part of the land. These can be sunk without the need for major development and disruption, whilst still allowing the farm to be run as a commercial enterprise. However this will not be done until it can be confirmed that no harm will be caused to the surrounding environment.

PUBLIC CONSULTATION

Southern Water believe in fully consulting with their neighbours when undertaking matters of such environmental importance as this. We will be consulting with local residents, the NRA, local landowners, RSPB who own and manage the nearby Pulborough Brooks Reserve and other interest groups.

THE PROGRAMME

Talks will begin shortly with the main interested parties and extensive monitoring will be done at the boreholes and at river gauging stations before any development takes place.

This information will be assessed with the aid of computers and eventually we should have an improved picture of the potential resources available in the area.

Photographs:
Far left: River Rother at dusk
Left: RSPB Reserve at Pulborough Brooks
Above and front cover: Church Farm, Hardham

Southern Water

Fig.11 Low Scenario Resources Strategy, Main Features

Low Scenario (required) Scheme

Increased Use of Existing Sources / Links

New Sources / Links

Reference Number (details in text)

1 Ringwould, Martin Gorse, Martin Mill

2 Medway Scheme Transfers

Hardham (stage 1)

4 Medway Scheme resource reallocation

5 SWS Kent Medway to Kent Thanet

6a SWS Hampshire to Sussex West & Coast via River Rother

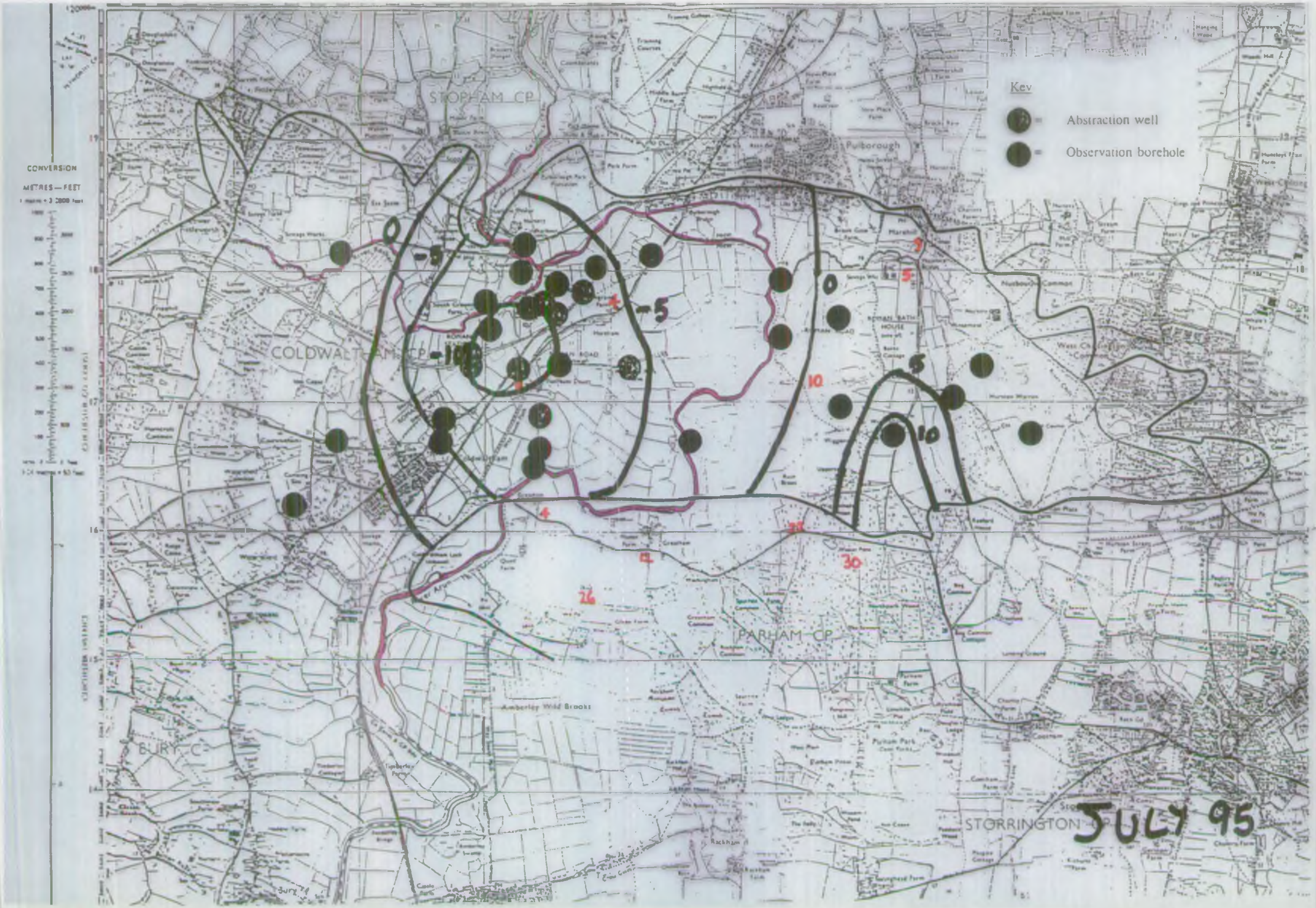
6b SWS Hampshire to Sussex West & Coast via coa.. l main

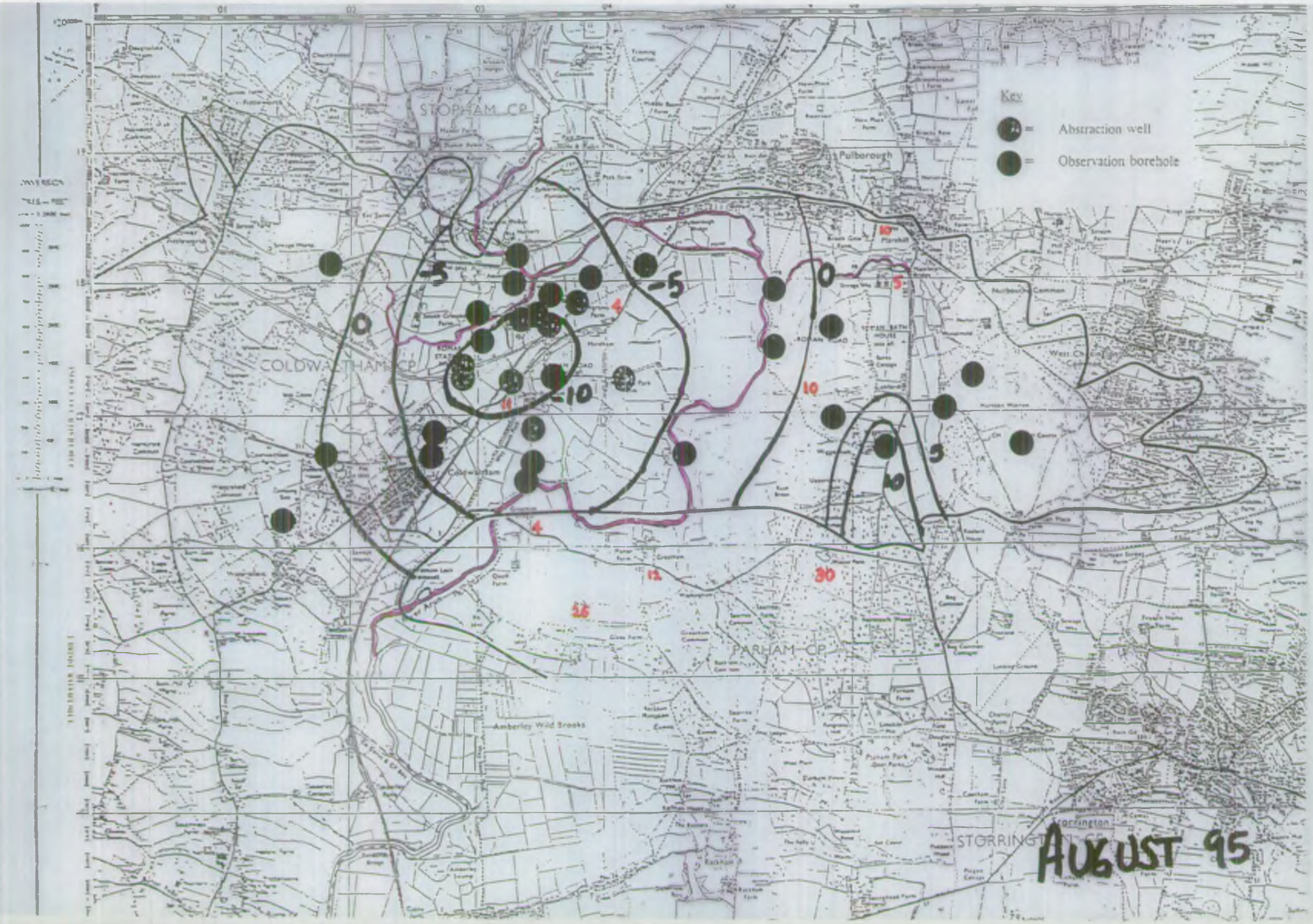
7 SWS Kent Thanet to Folkestone & Dover

Hardham to Sussex Coast

High Scenario Schemes (to be Investigated)

Broad Oak

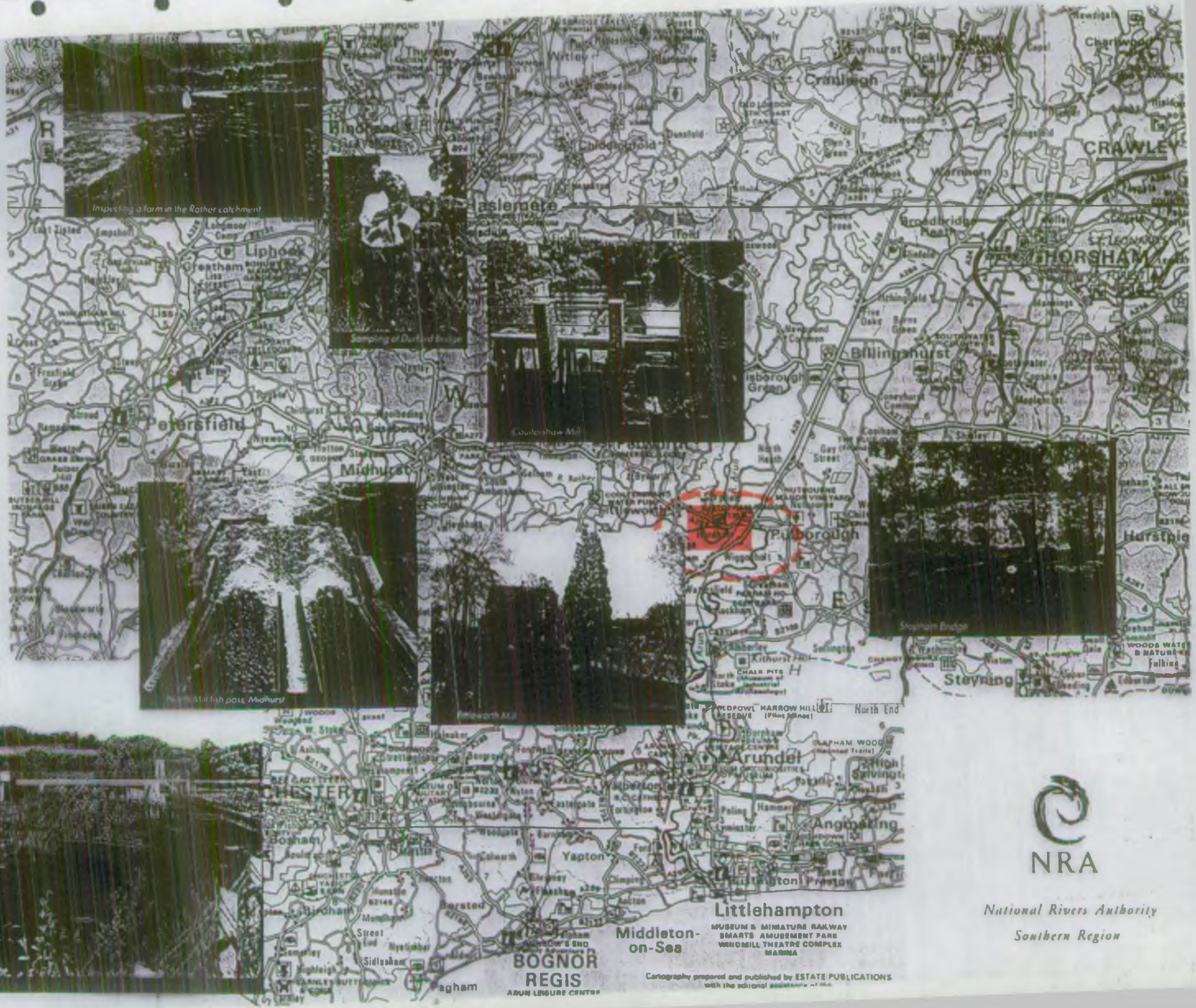

Key
Abstraction well
Observation borehole
STOPHAM CP
COLDWALTHAM CP
PARHAM CP
STORRINGTON
Pulborough
Amberley Wild Brooks
CONVERSION
METRES — FEET
JULY 95


Key
= Abstraction well
= Observation borehole
STOPHAM CP
COLDWALTHAM CP
PARHAM CP
STORRINGTON CP
Pulborough
Coldwaltham
Amberley Wild Brooks
Storrington
-5
-5
0
4
-10
11
10
5
10
4
12
30
26
AUGUST 95

North Mill Midhurst

Swan-upping was once carried ut on the river by the Water Bailiff. *Hee is likewise against the second f August yearly being the swann-ooking or swan-hopping day to ammon owners of swanns that ave swan markes on the stream see their young signetts marked, nd taken up if they desire it, aying for marking every signett d taking any up vid."*

Swans were royal birds and could rictly speaking only be owned by rant from The Crown, and their ossession was therefore a mark of istinction. Not only were they lued as handsome and distinctive fts but had aesthetic value as rnamental assets of a man's estate. efore the advent of the turkey ey were a favourite Christmas eal. Royal grants had been made the Earl of Arundel, the Bishop of hichester, Sir William Goring, rd Viscount Montague and alter Bartlett as well as to a mber of other riparian owners.



NRA

National Rivers Authority

Southern Region

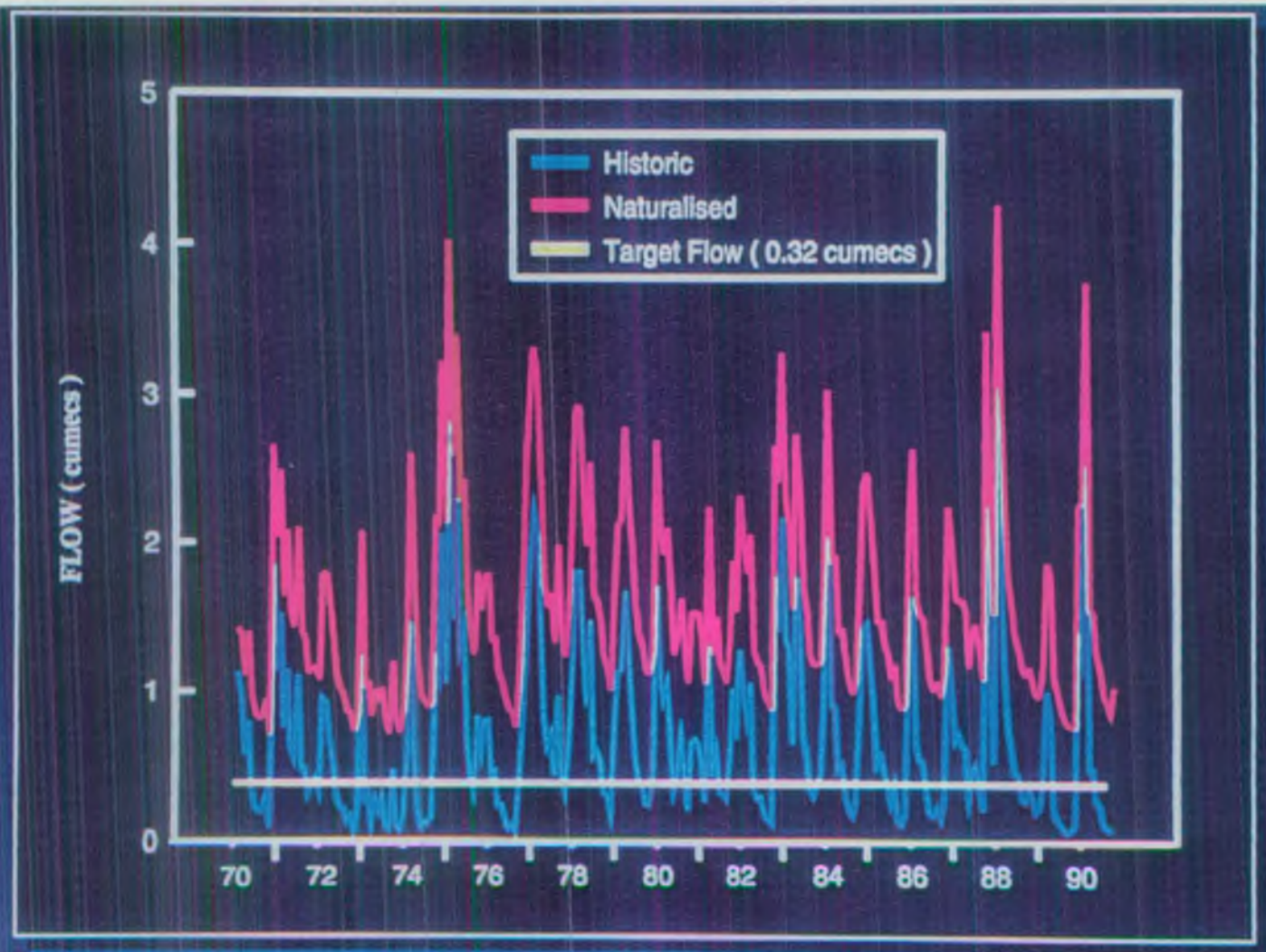
Darent Action Plan

By

IAN HOGG

The River Darent - Location

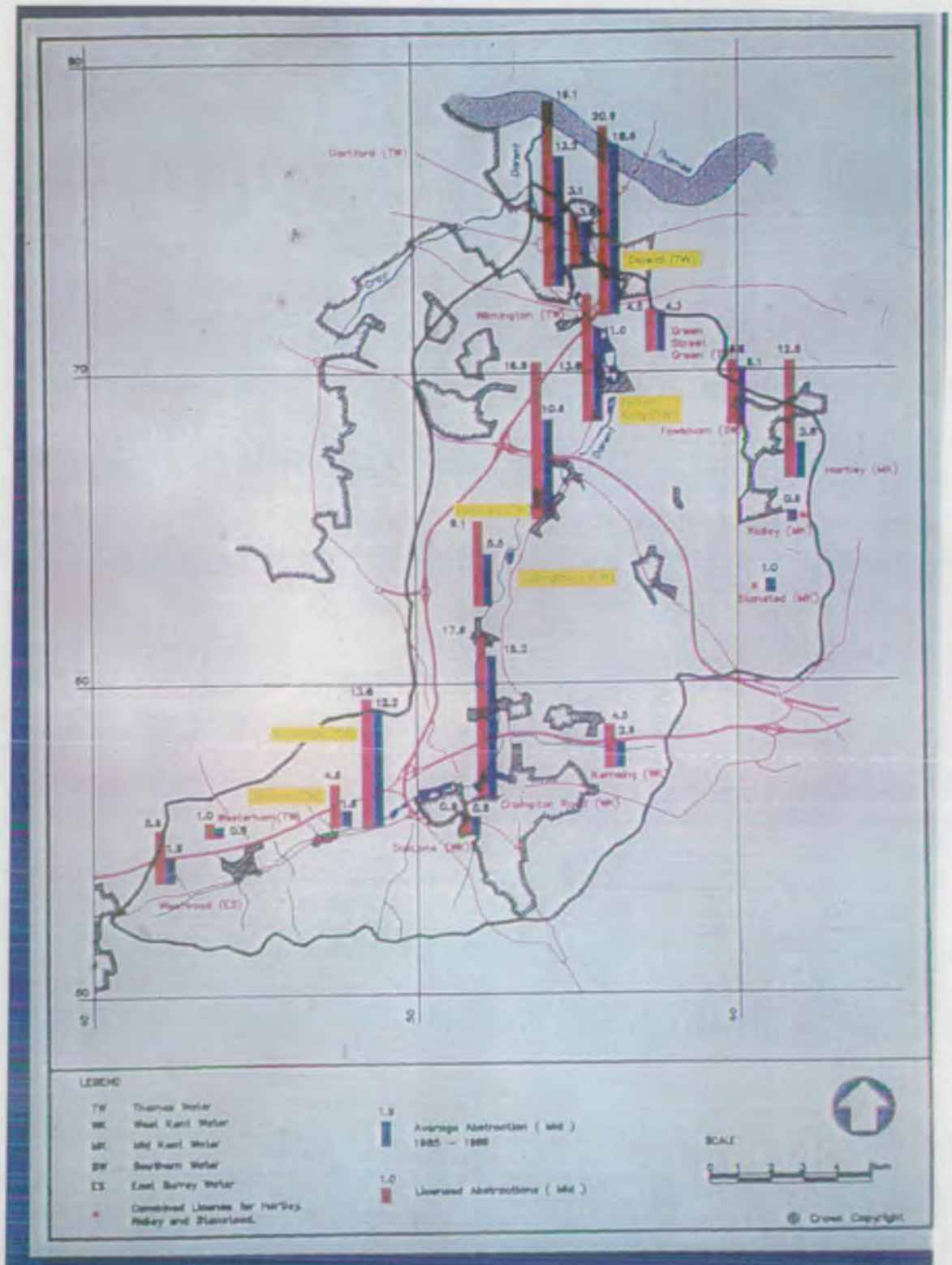
The River Darent - Geology



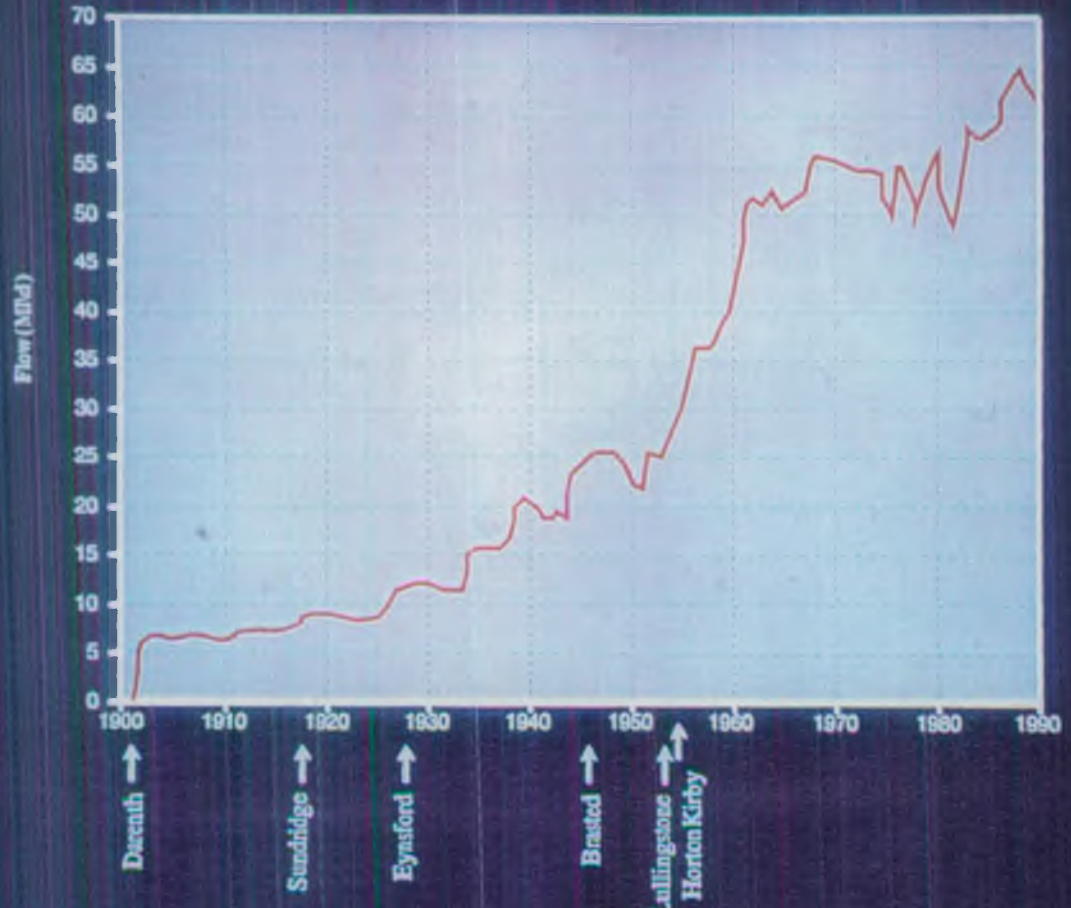
NRA

River Darent

Historic and Naturalised Flows at Hawley



River Darent - Public Water Supply Abstractions



NRA

River Darent

Increase in Thames Water Borehole Abstraction 1900-1990

River Darent
Appraisal Of Management Options

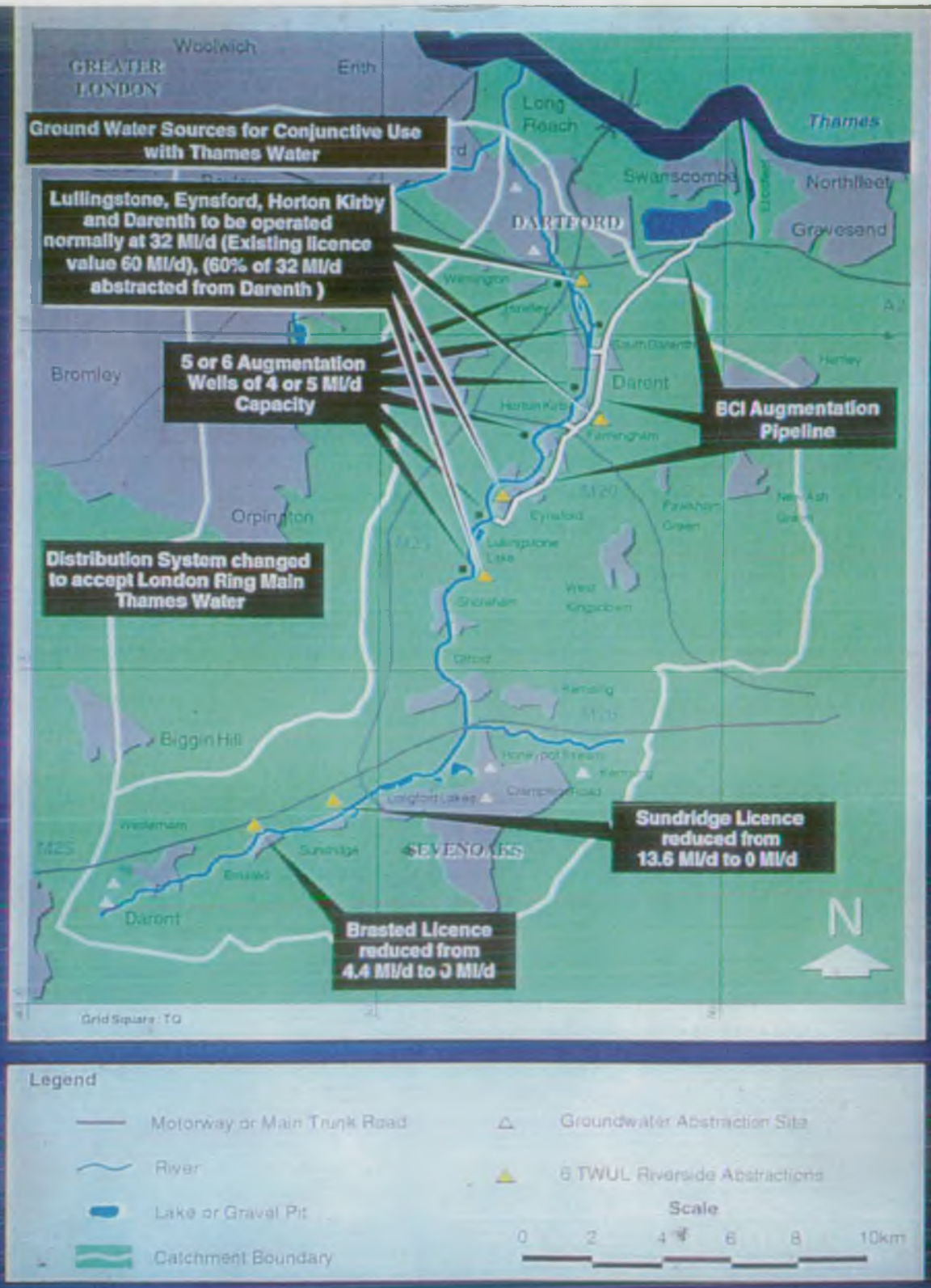
- Sewage effluent re-use
- Artificial springs
- Re-use of BCI water
- Abstraction reduction
- Demand management

NRA

THE DARENT ACTION PLAN

- Reductions in TWUL abstractions
- Conjunctive use with River Thames Water
- Water Resources Management Scheme
- NRA Augmentation by artificial springs
- NRA augmentation by pipeline from BCI quarries

NRA



The River Darent - Action Plan

River Darent
Contingent Valuation Analysis

Willingness to Pay Surveys

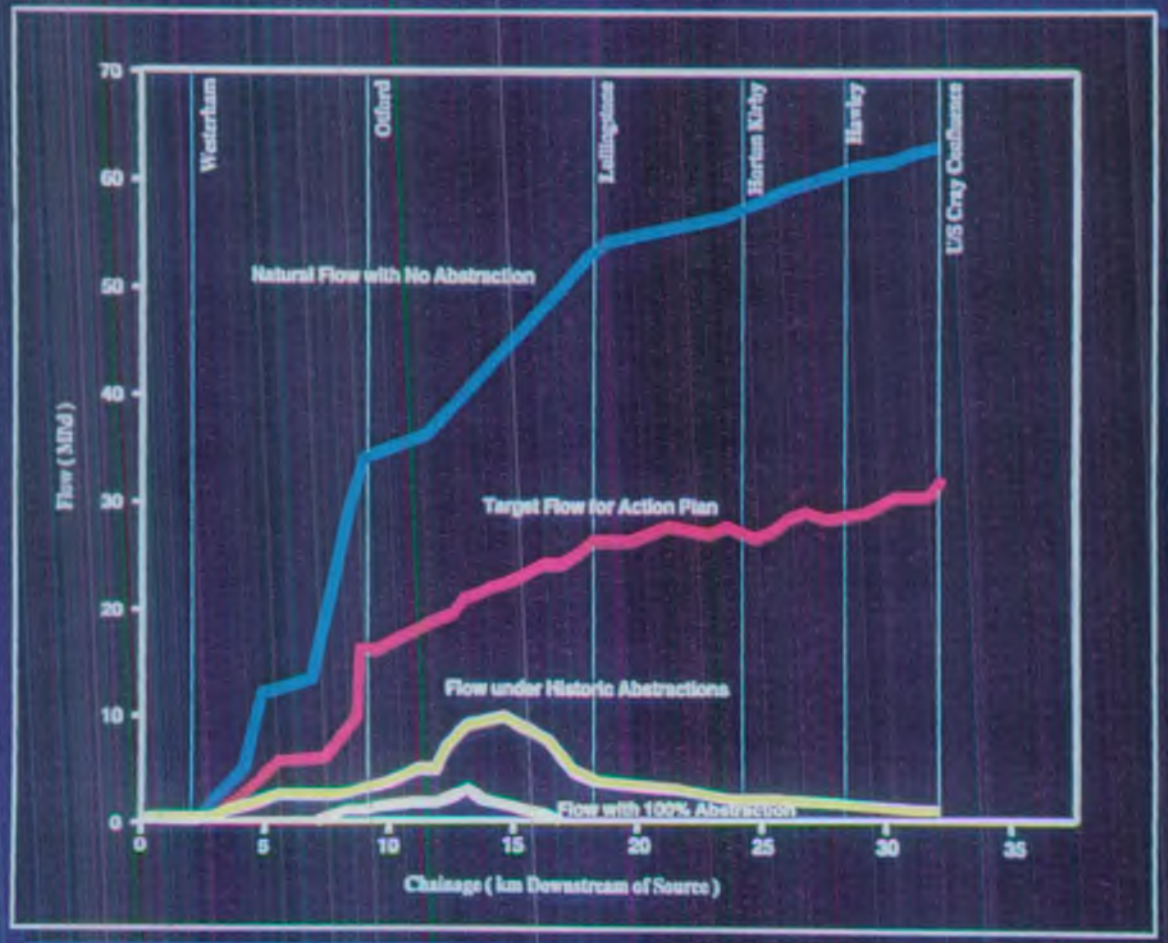
Use valuation

- 325 local residents, within 2 km of river
- 335 visitors June - August 1993

Non-use valuation

- 758 general public at 44 locations up to 60 km from the Darent

NRA



NRA

Comparative Low Flow Profiles in the River Darent For 1 in 20 Year Drought

Demand Management

By

DAVID HOWARTH

NRA NATIONAL CENTRES

Centre	Region	Centre Head
Fisheries Laboratory	Anglian	Nigel Tomlinson
Groundwater	Severn Trent	Andrew Skinner
Demand Management	Southern	Peter Herbertson
Instrumentation and Marine Surveillance	South Western	David Palmer
Rod Licence Administration	North West	Martin Maitland
Environmental Policy Unit	Anglian	Dave Stanley
Toxic and Persistent Substances	Anglian	Mick Pearson

NEED FOR DEMAND MANAGEMENT CENTRE

- Water Use and Demand Studies one of three 'must do' national projects for the water resources function in the 1993/94 Corporate Plan

- Increasing Importance of Demand Management
  * Using Water Wisely
  * Post Report 'Dealing with drought'
  * Sustainable Development

- Role of NRA
  * Section 19 of Water Resources Act 1991 'to conserve, redistribute or otherwise augment water resources and to secure their proper use'
  * Section 188 'to collate and publish information from which assessments can be made of the actual and prospective demand for water....'

Scope for Demand Management

- Demand Forecasting
- Domestic water consumption studies
- Domestic and non-domestic metering
- Leakage on company and customer pipes
- Industrial demand
- Agricultural demand
- Water Use Restrictions
- Levels of service
- Tariffs and economic incentives
- Water saving technology
- Customer and water company education on efficient use

Demand Management Centre

Clear Dual Role

- Liaison with external bodies, policies, influencing
- Support to NRA Regions and Head Office

Completed projects

- Domestic Consumption Monitoring Survey
- Demand Management Review and Strategy 'Saving Water'
- Review of National Metering Trials

R & D Projects

- Completed - Demand Forecasting methodology

- 95/96 approved projects
  * Effective methods of education
  * Water Savings by Direct Abstraction
  * Water Saving Technology in Buildings
  * Economics of Demand Management
  * Autonomous Technologies in buildings

- Probable 96/97
  * Reduction in potable water demand by on-site recycling of grey water

OTHER DMC INITIATIVES

- Presentation to All Party Parliamentary Water Group, Jan 1995
- Contract with WRc 'Economic levels of leakage'
- Provision of WC flushing data to DoE
- Water Saving Guide for NRA Offices
- 'Managing Leakage' training
- 'BABE' training
- US Water Conservation project
- Demand Management Bulletin
- National Demand Management Seminar

Key Points from 'Saving Water'

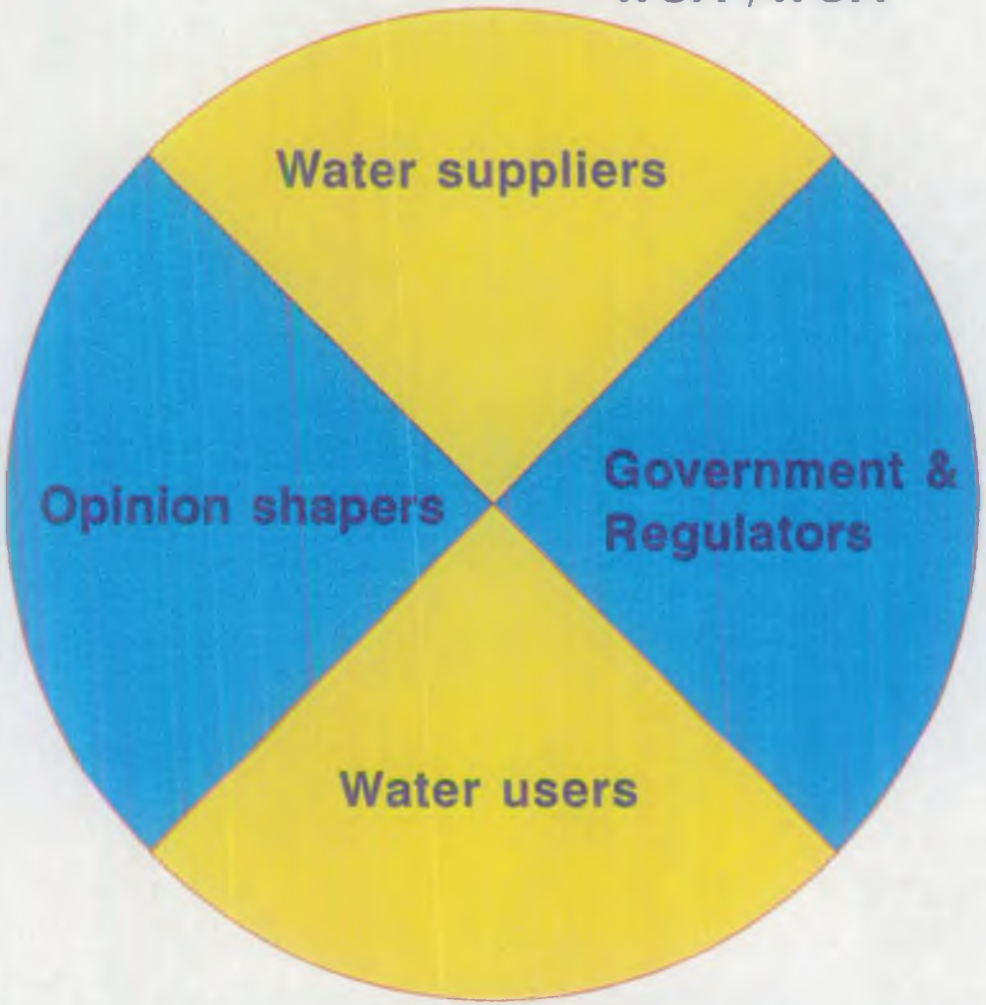
- leakage control, converting WC's, efficient washing machines and flush controllers on urinals are all cheaper than developing resources
- PWS could be reduced by as much as 42%
- metering slightly more expensive than high cost reservoir development

Key Points from 'Saving Water'

- NRA's practical involvement is limited, but key role in influencing
- Suggestion of National Water Conservation Committee
- NRA's own work programmes; (Leakage, demand forecasting & monitoring, national co-ordination, education, R&D, domestic metering)

The four main responsibilities and interests

Water Cos
WSA /WCA



CPRE
FoE
CBI
NFU

DoE / WO
OFWAT
NRA / EA
DTI

Household customers
Industrial customers

Main proposals of strategy

(1)

- Establishment of National Water Conservation Committee
- Water companies consider full range of demand management options as part of their licence applications
- Water companies set and achieve leakage targets to be agreed by NRA and OFWAT
- selective domestic metering is progressed with appropriate safeguards for low income families
- water conservation in building codes and byelaws

Main proposals of strategy

(2)

- Relevant organisations instigate educational initiatives
- Economic instruments for abstraction charges are developed
- A low cost water audit service for commercial premises, industry and agriculture is established
- waste minimisation in business and industry is promoted
- A UK water conservation manual to assist practitioners on water conservation planning is prepared

SESSION

IV

FORWARD LOOK

Water Resources in Envage - Key Issues

By

PETER HERBERTSON

WATER RESOURCES

NOT SO GOOD

- REGIONAL DROUGHT P R
- RESPONDING TO INFORMATION REQUESTS
- STAFF DEVELOPMENT/TRAINING
- TEAMWORK/COMMUNICATIONS
- FINANCIAL CONTROL (REVENUE)
- UNION RAIL
- CATCHMENT MANAGEMENT PLANS
- CORPORATE PLAN
- FINDING NEW STAFF
- MANAGEMENT EFFICIENCYACCOUNTABILITY
- DELEGATION/EMPOWERMENT

WATER RESOURCES - SUCCESSES

VIEW FROM OUTSIDE WR IN SUSSEX

- REGIONAL WATER RESOURCES STRATEGY
- DMC - BULLETIN, 'SAVING WATER'
- CHICHESTER FLOODS - HYDROMETRY, MODEL, FORECASTS
- STRATEGIC LICENCES:

- SEW	CROWURST/POSTERN
- SWS WATER	BEWL/DARWELL
- SWS	TORTINGTON
- PW Co	ALDINGBOURNE
- MK	CHERING No 7

- CONTINUED SERVICE IN SPITE OF CHANGE
- NATIONAL DROUGHT MANAGEMENT
- CAPITAL PROGRAMME
- DARENT MILL
- WAMS DATA CLEANING
- LICENCE TURNAROUND
- ADAPTING TO RESTRUCTURING
- PEVENSEY/AMBERLEY WL MANAGEMENT

SUCCESS?

A VIEW FROM OUTSIDE RESOURCES

- MARKET TESTING (HER) - 5
- CHICHESTER CHALK BLOCK - 8
- CHICHESTER FLOODS - 9
- DROUGHT INFORMATION TO DoE - 8
- DEMAND CENTRE - 9
- CAPITAL PROGRAMME - 8
- GP2 PID - 8
- CONSULTATION RESPONSE (KENT)

DIDN'T THEY DO WELL!

KEY ISSUES

- ENVIRONMENT AGENCY
- PROFESSIONAL DEVELOPMENT AND TRAINING
- HYDROMETRIC SYSTEMS
- COMMUNICATIONS
- MARKET TESTING
- WORKING UNITS

ENVIRONMENT AGENCY

- GROUNDWATER
- DEMAND MANAGEMENT
- DROUGHT PERMITS
- BOUNDARY SLA's

PROFESSIONAL DEVELOPMENT AND TRAINING

- PROFESSIONAL VS MANAGEMENT DEVELOPMENT
- TECHNICIAN TRAINING AND NEW TECHNOLOGY
- MOVEMENT WITHIN GRADES
- PUBLICATIONS AND PAPERS

HYDROMETRIC SYSTEMS

- CASE FOR INTERIM WAMS
- TEAMWORKING WITH SYSTEMS ACROSS REGION
- DATA ANALYSIS, INTERPRETATION, PUBLICATION
- EDUCATING THE CLIENT
- DATA QA : STAFFING
- ADAPTING TOWARDS TELEMETRY : NIS/SLA's
- MULTI SKILLED HYDROMETRIC STAFF
- COMMUNICATE PURPOSE OF DATA TO HYDROMETRIC STAFF

COMMUNICATIONS

- WRB
- DELEGATE TO 4TH TIER
- WR SEMINARS - INCLUDE OTHER FUNCTIONS
- BOOST EXTERNAL PR - POLICY STATEMENTS
- REPORT BACKS - WRM'S, ALG, HER ETC

MARKET TESTING

- WON'T GO AWAY
- IMPLMENT HER PROJECT EFFECTIVELY
- TIMESHEETS
- YORKSHIRE/NORTHUMBRIA:
  CLIENT/CONTRACTOR INVESTIGATE/REPORT

WORKING UNITS

- STAFF LOCATIONS/CRITICAL MASS
- REGION/ AREA/ DISTRICT
- CROSS FUNCTION WORKING

THE WAY FORWARD

GENERAL

- WRB monthly meeting - Sharpen
- Delegate to zap teams / sub groups
- Seminars for Communication
- Publish policy statements etc.

THE WAY FORWARD

ENVIRONMENT AGENCY

- Promote groundwater management quantity/quality
- Leakage targets/monitoring - Corp. Plan

PROFESSIONAL DEVELOPMENT

- Review status in Region
- Help for temp staff.

HYDROMETRIC SYSTEMS

- Interim WAMS - Corp. Plan
- Data QA - Corp. Plan
- Publications - drought report/year book
- Seminars to educate clients:-
  HMIP, WRA's, EQ, FD, FRCN

THE WAY FORWARD

COMMUNICATIONS

- Identify key publications (Corp. Plan)
- Publish Groundwater management policy (CP)
- Function reports to RMT
- Publish Regional Strategy update (1996/7?)
- Seminars
- Secondments

MARKET TESTING

- Start co-ordinated timesheets
- Progress HER

KEY ISSUES

1. ENVIRONMENT AGENCY

- Groundwater
- Demand Management
- Drought Permits
- Boundary SLA's

2. PROFESSIONAL DEVELOPMENT AND TRAINING

- Professional vs Management Development
- Technician Training - New Technology
- Movement within Grades
- Publication/Papers

3. HYDROMETRIC SYSTEMS / INTERIM WAMS

- Case for Interim WAMS
- Teamworking Across Region by Resources Staff
- Data Analysis, Interpretation, Publication
- Educating the Client
- Data QA

4. COMMUNICATIONS

- WRB
- Delegate to Sub Groups
- WR Seminars - Include Other Functions
- Boost External PR
- Report Back on WRM's / AGL etc.

5. MARKET TESTING

- Won't Go Away
- Implement HER Project Efficiently
- Timesheets

6. WORKING UNITS

- Staff Locations Critical Mass
- Region / Area / District
- Cross Functional Working