Hydrogen Peroxide Dosing Trials
Lea Marston
18 and 19 March 1996

J.Stone/D.Freakley April 1996

NRA - Water Quality 66

Contents

Bob,
This was tabled at the Pollution Alley WG 28/9. May be of interest to you or Keith.
Splendid stuff but costs is a f/H year.
What became of the Pollutes Pays Principle?
Chris 28/9

1. Introduction

On 10 July 1995, following a period of approximately six weeks dry hot weather with minimal rainfall, a number of localised thunderstorms over Birmingham and the Black country caused large volumes of contaminated surface run off to enter the River Tame. There followed a rapid reduction in dissolved oxygen levels in the River Tame which resulted in thousands of fish deaths, with the stock mortality of the Tame estimated at over 95%. The Trent fishery was also affected as far as Burton on Trent. Only extensive remedial actions involving direct oxygen injection, the cessation of water abstractions and the use of three cooling towers to aerate water, prevented further downstream fish mortality.

This incident, along with others in the Region, has highlighted the need for an emergency response method which can oxygenate large volumes of deoxygenated river water. Following an earlier trial using Hydrogen Peroxide on the River Avon at Finham STW, this trial was instigated on the River Tame.

The aims of this report are to:

- Describe the dosing and monitoring methods used in the trial

- Record and interpret the water quality data obtained.

- Identify possible improvements to the dosing and monitoring regimes used in this trial.

- Produce recommendations for further investigatory work, and where appropriate future investment and emergency response systems.

1. Chemistry of Hydrogen Peroxide

Hydrogen Peroxide is a colourless liquid with a slight pungent odour. It is a powerful oxidising agent and can ignite spontaneously when in contact with many materials. It is corrosive to mucous membranes, eyes and skin. Under normal storage conditions a solution of 35% hydrogen peroxide will release oxygen equivalent to 1% volume per month. Hydrogen peroxide is a potentially unstable compound which readily decomposes to liberate oxygen:

$2H_2O_2 \rightarrow 2H_2O + O_2$

When added to watercourses the liberation of oxygen is initiated by contact with impurities such as those associated with treated sewage and industrial effluent, urban run off and major organic pollution incidents.

2. Dosing regime

2.1 Dosing events

Three separate additions of Hydrogen peroxide were undertaken as follows:

Addition 1 One Tonne of Hydrogen peroxide was added to the river channel downstream of Lake 1 at 11.10 hours on 18 March.

Addition 2 Two Tonnes of Hydrogen Peroxide were added to the inlet channel of Lake 1 at 14.30 hours on 18 March

Addition 3 Two Tonnes of Hydrogen Peroxide were added to the inlet of Lake 1 at 14.45 hours on 19 March

A site plan showing the location of the dosing sites is attached. Dosing rates for all the additions were 1 Tonne per 8 mins, as there was minimal control on the valves.

2.2 Storage conditions

On delivery the containers were placed on top of double thickness plastic, in a bunded fenced area labelled with 'No Entry' and No Smoking' signs. The valves were padlocked to prevent accidental spillage. Outside normal working hours a security company was engaged to look after the store.

2.3 Dosing method

A safe system of work for the trial was agreed with the Regional safety Officer and is attached in Appendix A.

Each addition was carried out by a two person team in full protective equipment using the procedures agreed in the Safe system of work. To enable all team members to have 'hands on' experience the dosing teams were rotated during the trial.

At the beginning of each dosing trial the relevant coordinator arranged for the Hydrogen peroxide container to be transported from the bunded area to the dosing site. This had been prepared with suitable bunding and plastic sheeting by the dosing team. The containers empty by gravity and as a result of this the dosing site needs to be flat and allow some fall along the delivery hose. After dosing empty containers were returned to the storage area and the site was cleared.

2.4 Costs

Costs of the trial, excluding significant staff time necessary in extensive pre-planning were as follows:

Hire of rough terrain forklift:	£340
Security guard for the H2O2 store:	£540
Security fencing/locks/chains:	£90
2 weeks portacabin hire:	£124
Dosing team (2FTEs for two days:	£800
5 Tonnes Hydrogen peroxide (Excluding container hire of £3100):	£2200
Portable eye wash	£400
Total Costs:	£2514

3. Monitoring regime

3.1 Data collection

Water quality data was obtained using manual dissolved oxygen meters, residual H2O2 field test kits, spot sampling, automatic composite samples, and the use of Grant/YSI data loggers. The location of these sampling points is shown in Fig 5.

3.2 Costs

All equipment used in monitoring was available internally at no cost as follows:

Three Grant YSI data loggers.
Two automatic sampling machines.
Residual H2O2 test kits.

Staff costs to monitor downstream quality were equivalent to 14 man days at an estimated cost of £3000.
Lab costs were £12.65 per sample.

4. Impact of dosing on water quality

Dosing events 2 and 3 (inlet to Lake 1) had no noticeable effect on downstream water quality. An immediate vigorous reaction was visible throughout the addition as the oxygen released by the hydrogen peroxide was taken up by the sediments in the Lake bed.

Dosing event 1 did have a recorded effect on downstream DO levels (Figs 1, 2 and 3). DO concentrations at Kingsbury were increased from 75% (8.83 mg/l) at 13.30 hrs to a maximum level of 86% (10.09 mg/l) at 14.30 hrs. The one tonne of hydrogen peroxide added raised DO levels above normal for just over 3 hours at this point.

At Hopwas DO readings increased from 62% (7.38 mg/l) to a

maximum of 65.8% (7.82 mg/l). The DO was elevated above normal levels in the watercourse for 2.5 hours. At Alrewas DO levels increased by just under 2% from 57.3% (7 mg/l) to 59% (7.21 mg/l). Elevated oxygen levels were recorded for approximately 3 hours.

Under extreme deoxygenation conditions, such as occurred on 10 July 1995, to raise DO concentration from 0 to 2 mg/l in flows of 2000 Ml/d would require 4 Tonnes of oxygen. This is equivalent to 9 Tonnes of hydrogen peroxide, assuming that there is 100 % transfer into the watercourse. Estimates of the quantity of oxygen added to the river during exercise 1 are as follows:

Kingsbury approximately 20%
Hopwas approximately 10%

As a result of these estimates the quantity of hydrogen peroxide necessary to re oxygenate the Tame could be considered to be 45 Tonnes. This however ignores the expected difference in reaction kinetics when the oxygen concentration is at very low levels.

5. Conclusions and recommendations

- Due to the rapid removal of oxygen by the sediments in Lake 1 any hydrogen peroxide additions will need to take place downstream of Lake 1.

- A further dosing trial should be undertaken with up to 5 Tonnes of hydrogen peroxide added at 1 and half hour intervals at times when the DO levels are low (e.g early morning). This will enable both the ease of oxygen uptake to be quantified when levels are low, and the optimum dosing interval between additions necessary to maintain downstream oxygen levels above critical concentrations for fish survival.

- The use of alternative valves on the dosing tanks should be investigated as part of this trial to improve the control of the dosing rate.

- Any further trial should utilise the River Rover which has been adapted to be compatible with hydrogen peroxide. This would investigate the potential for this equipment to provide better mixing in the river.

- A nitrification Project on Lake 2A, to look at the possible injection of oxygen injection to reduce the increase in ammonia concentration within the Lake system, is programmed to be let in June 1996. It is recommended that this project should be widened to include the potential for reaeration of the river under all conditions e.g oxygen blowers and/or hydrogen peroxide dosing with costs.

6. Summer 1996 contingency plan

- Need a CWQM alarm on the Water Orton monitor to notify pollution control standby staff of any reduction in DO. If this is not possible a flow alarm will need to be in place.

- H2O2 should be available on site from the beginning of June to the end of September to deal with low DO incidents.

- The existing contingency plan should be redrafted to provide a detailed Action Plan for low DO situations.

J.W Stone/D.C Freakley
April 1996

Fig 1

Lea Marston Hydrogen Peroxide Trials
Kingsbury Monitoring Site
18 to 20 March 1996

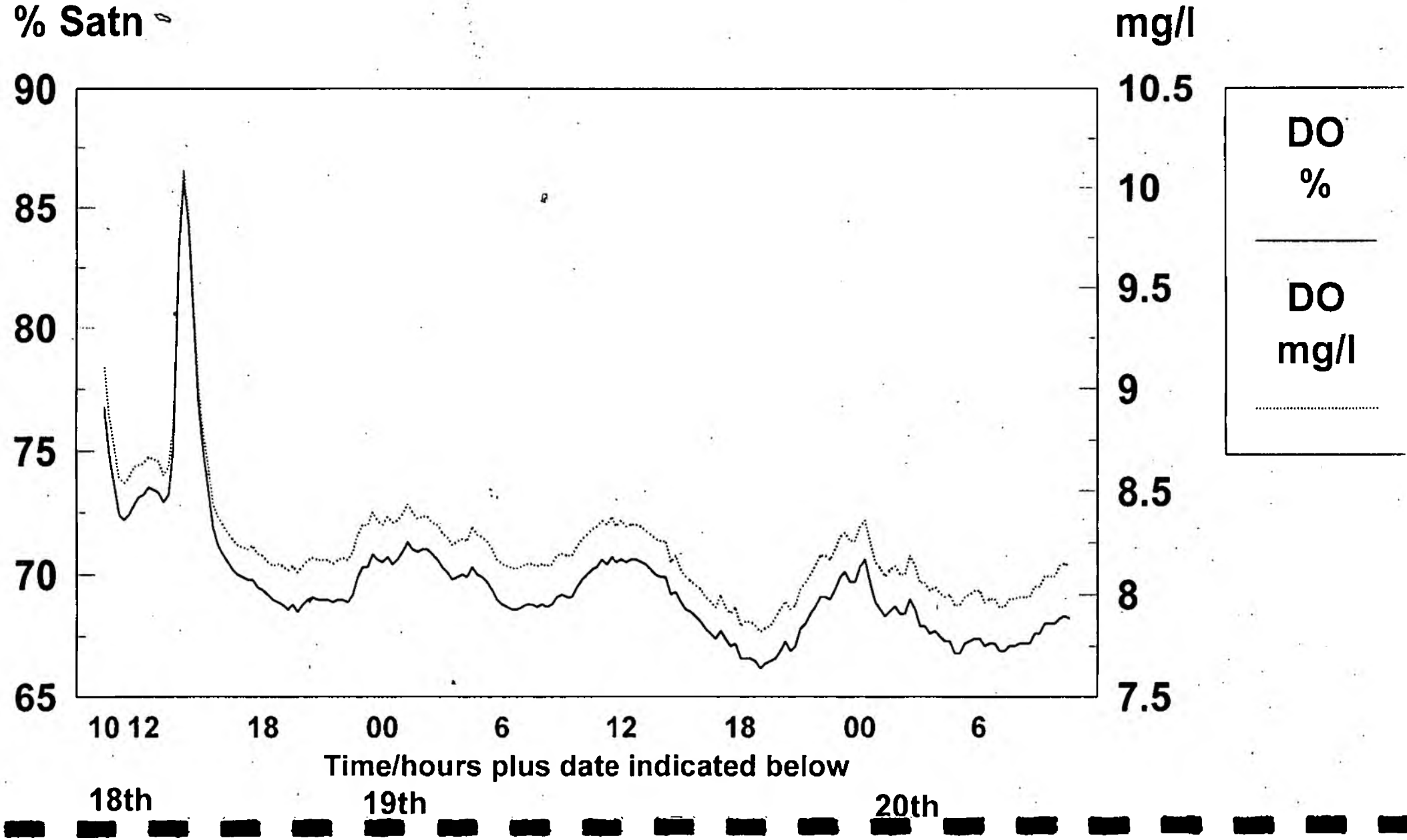


Fig 2

Lea Marston Hydrogen Peroxide Trials
Hopwas Monitoring Site
18 to 20 March 1996

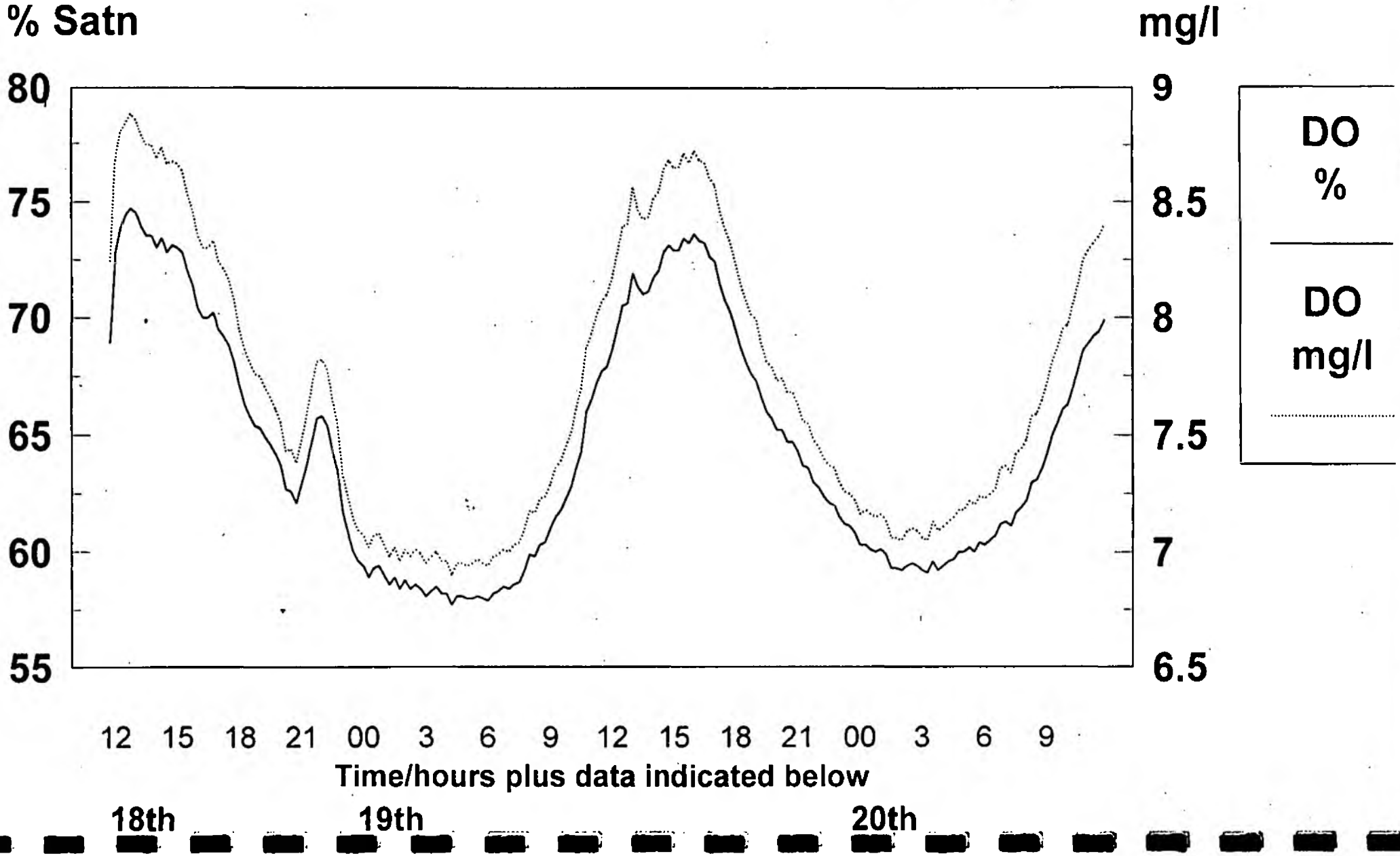
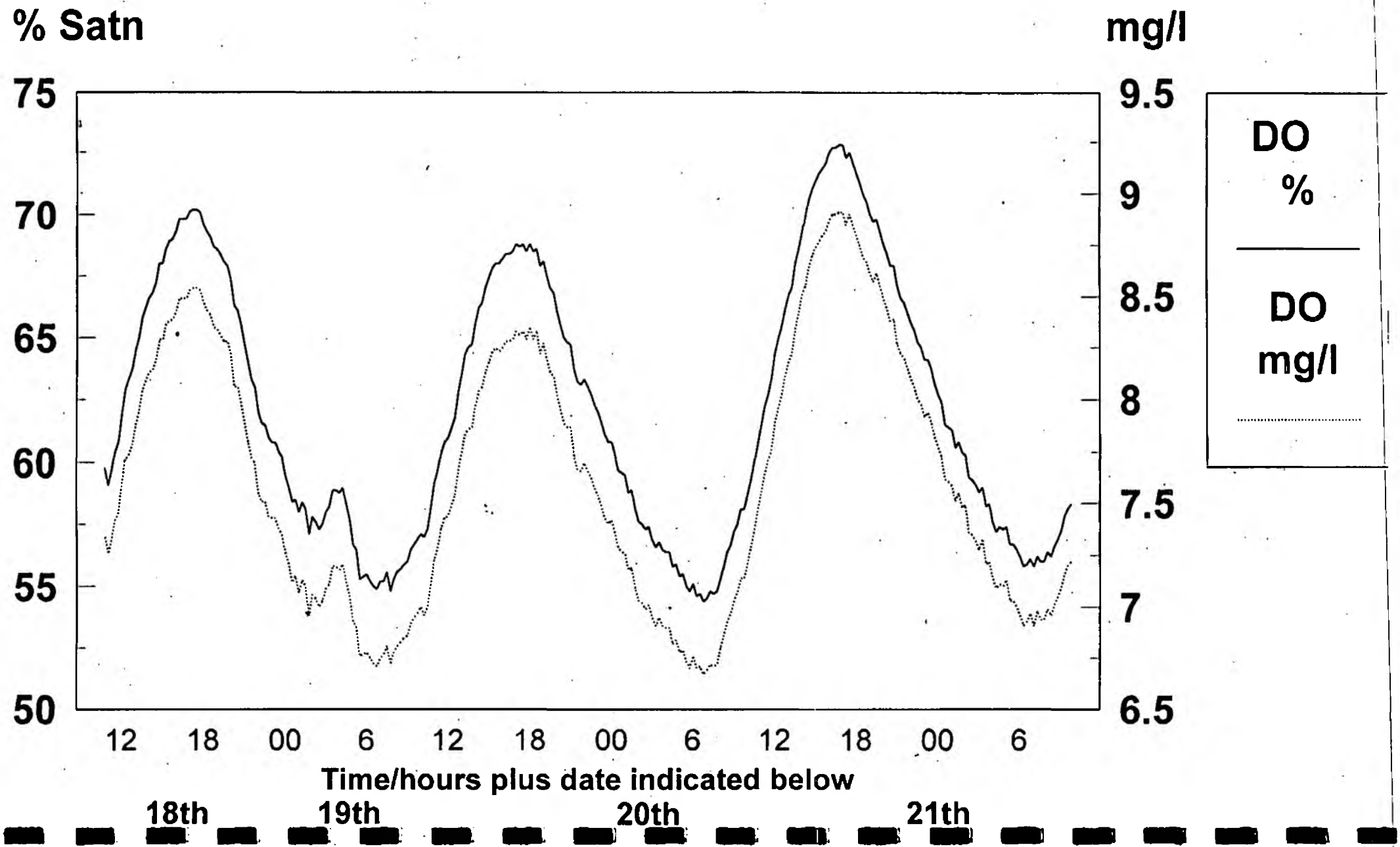


Fig 3

Lea Marston Hydrogen Peroxide Trials
Alrewas
18 to 21 March 1996



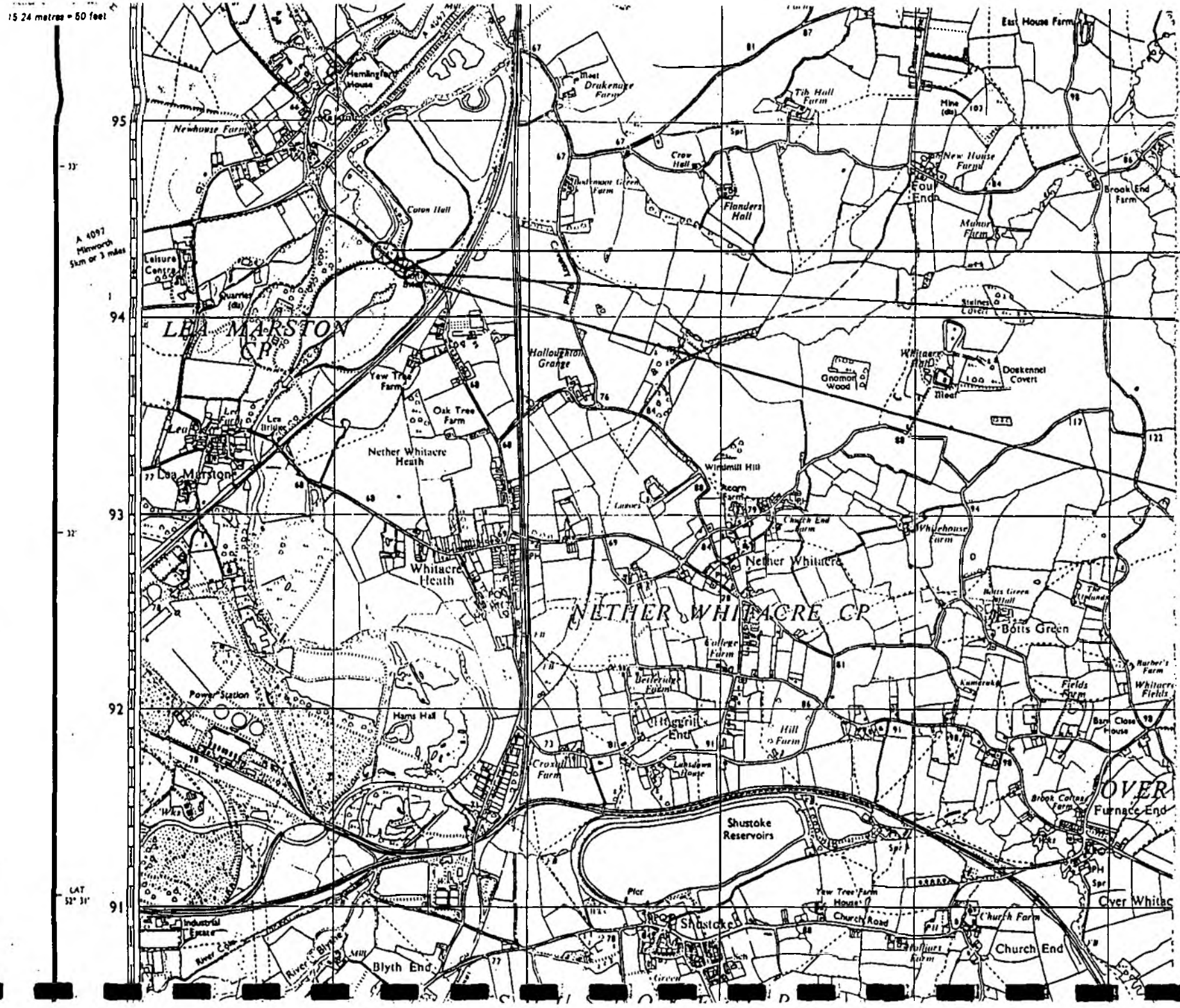


Fig 4

590087 55
D/S LAK 1A O/L
SP 2125 9431

590087 65
D/S LAK 1A O/L
(2ND OUTLET)

590087 60
CWDM LM OUT
SP 2152 9423
(3RD OUTLET)

HYDROGEN PEROXIDE TRIALS
SAMPLE POINT LOCATIONS

Fig 5

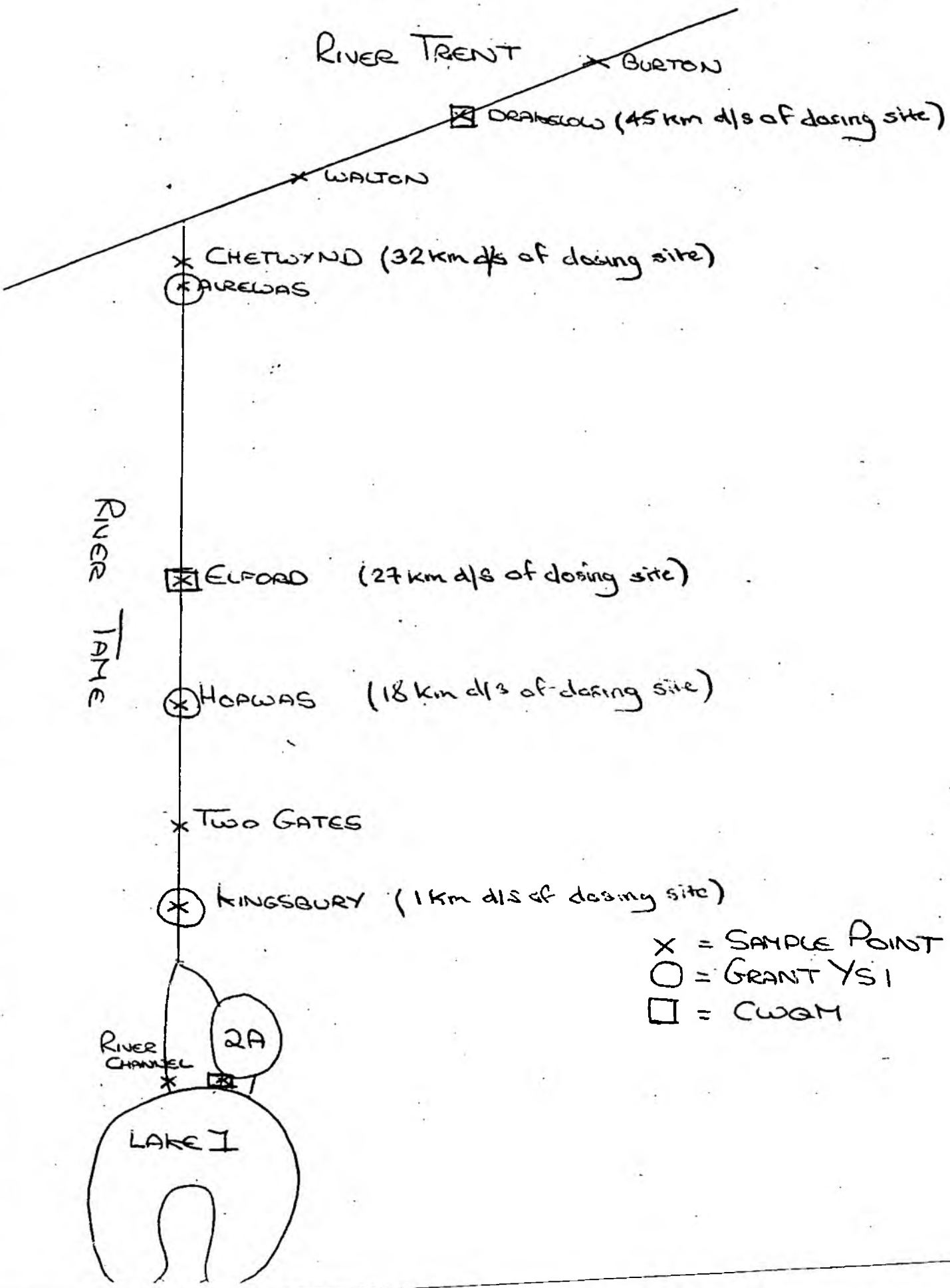


Fig 5

	CW QM	YSI	Res H_2O_2	Sp O_T	A TO	1 10.00-12.00 18/3	2 14.00-16.00 18/3	3 14.00-16.00 19/3
U/S 0h	2,3.				2,3	—	(14.00-16.00)	(14.00-16.00)
Lake				1		(10.00-13.00)		
Rves Channel			1					
D/S LM. 6h	1) 2 3		2,3		2,3	N/A.	20.00-24.00 18/3	20.00-24.00 19/3
Kingsbury		1,2 3	1	1		10.30-13.30 18/3		
Two Gates			1	1				
Tlworth	—	—	—	—	—			
Hopwas		1,2 3	2,3	2,3				
Elford 20h	1 3 2		2,3	2,3		E 0.00 19/3	E 10.00 19/3 3	E 10.00 20/3
(Checkley) (CAW) AcRewAS		1 (2,5)	2,3	2,3		E 03.00 19/3	E 13.00 19/3	E 13.00 20/3
(Wychnor)			2,3	2,3				
Walton			1	1				
Drakelow PS 23h	1,2 3		1	1		E 13.00 19/3	E 23.00 19/3	E 23.00 20/3
Burton			1	1				
Newton Solney	—	—	—	—	—	E 18.00 19/3	E 05.00 20/3	E 05.00 20/3
40h Willington	—	—	—	—	—	E 21.00 19/3	E 07.00 20/3	E 07.00 21/3

APPENDIX A

LEA MARSTON PURIFICATION LAKES
HYDROGEN PEROXIDE DOSING EXERCISE MARCH 96

Proposed Safe System of Work.

1. Storage

The Hydrogen Peroxide, in five x one tonne containers will be stored; both immediately prior to and during the trial, within a bunded area on an impervious base. During dosing operations containers will be stored on double thickness polythene sheeting over concrete kerbs/sand berm at the dosing site.

Within the bunded storage area containers will be stored in a secure fenced area and signed "NRA Chemical Store - Restricted Area." No smoking signs will also be posted. After dosing spent containers will be returned to the bunded area.

2. Staffing

The following staffing levels will apply:-

Dosing team (2 persons)
Co-ordinator
Site Monitoring (2 persons)
Downstream Monitoring (2 persons)

During dosing a first aider will be present at all times. One of the dosing team will undertake any necessary work. The second member to man emergency water supply hose and portable emergency wash cylinder.

All staff involved must have seen Interox training video and will be given a personal copy of this note.

3. Safety Clothing/Equipment

The minimum safety clothing for staff working in vicinity of the dosing area is:-

PVC Splashsuit
Hard Hat/Chemical Hood and Full-face visor
PVC Gauntlets
PVC/Rubber Wellington Boots.

Both of the dosing team should be fully attired as above at all times whenever any work is being carried out to the dosing equipment.

Portable 'face' wash is to be located adjacent to the working area before any dosing commences. An emergency water supply hose shall also be provided such that water is available with minimal delay in the event of an accident. The second member of the dosing team should man this hose at all times while dosing is being effected.

All staff involved in this exercise must have cell phones available to summon assistance in the event of any difficulties.

No smoking or naked lights to be allowed in the vicinity of the storage and dosing areas. No food or drink to be consumed in the vicinity of the dosing area.

4. Emergencies

Contact with skin:	Wash with copious amounts of water . Remove contaminated clothing. Seek medical attention.
Contact with eyes:	Wash with copious amounts of water. Continue for 15 minutes. Seek medical attention.
Spillages:	Drench with water.
Fire:	Drench with water.
Inhalation:	Move the victim out into fresh air. Seek medical attention.
Nearest Hospital:	Good Hope General Hospital, Rectory Road, Sutton Coldfield, Tel: 0121 378 2211

5. Dosing Operation

- Wash out delivery hose before attempting to connect to delivery valve
- Check delivery valve is in closed position. If not close
- Carefully remove cap (there may be a small amount of product contained within cap.
- Connect hose ensuring both securing levers are tensioned fully **AT THE SAME TIME**. Failure to do so may result in incorrect seating of coupling and consequent leakage.
- Secure delivery hose to ensure discharge into centre of river channel.
- Once a container has been emptied the valve should be closed. The residual amount in the delivery hose should be drained into the river channel before the hose is removed.
- Carefully remove the coupling. **CAUTION**: there may still be some product in the hose/valve assembly. The delivery hose should then be washed through with water.
- Repeat above steps for a further container, if one is required.

Dosing rate/timing and downstream monitoring shall be based on a plan specific to each of the three planned dosing exercises.

D. C. Freakley
Senior Pollution Control Officer