NRA

National Rivers Authority
Thames Region

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RISING GROUNDWATER LEVELS IN THE CHALK-BASAL SANDS AQUIFER OF THE CENTRAL LONDON BASIN

PROGRESS REPORT - MARCH 1995

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SUMMARY

Chalk groundwater level maps have been produced for January 1995. During the last 12 months additional information has become available from Thames Water Utilities Ltd (TWUL) continued exploration, now mainly centred in SE London and the Ravensbourne Valley. The maps have indicated that the rate of rise in the centre of the cone of depression is accelerating slightly. Rates of over 3m/year have been recorded at two boreholes in the central cone compared with a maximum increase of 2.75m/year last year. The groundwater levels in the centre of the cone are around -44moD with the borehole at Trafalgar Square currently recording a water level of -43.74mOD.

Rising groundwater beneath Central London represents a water resource but the likely interest in using it for public or private water supply will be insufficient to achieve incidental control of the rise to protect threatened subsurface structures. Specific pumping will be needed to protect such structures and under the present institutional and legislative arrangements this will be the responsibility of the owners of the assets.

1. INTRODUCTION

This is the fourth annual report on Rising Groundwater Levels under London[1]. As well as indicating the current Chalk aquifer groundwater level and rate of rise, this report pulls together the conclusions of the last five years work by the National Rivers Authority (NRA) and Thames Water Utilities Ltd (TWUL). No new aquifer modelling has been carried out, the improvements to the groundwater monitoring network by drilling new observation boreholes (OBH's) are now complete and TWUL have now completed all their own work on drilling and testing sites in Central London to assess the resource potential of rising groundwater, although they are continuing to evaluate resources in the SE London area. As a result, the NRA Thames Region issued a situation statement to the DoE in December 1994. The essentials of this statement are reproduced in Section 4 of this report. The main thrust of work now lies with TWUL and London Underground Ltd (LUL) who are working on joint projects to abstract groundwater in the vicinity of certain parts of the tube tunnel network.

2. IMPROVEMENTS TO THE MONITORING NETWORK

During 1994 9 boreholes were added to the London Basin observation boreholes network. Of these 6 lie in the area of the rapidly rising cone of depression in Central London. Various drilling exercises and site visits at opportune times have produced "one off" reading of water level at nine sites in the central London Basin area.

The NRA Thames Region will continue to monitor all observation boreholes in the area although the frequency of observation may reduce in the future. An opportunistic approach will be maintained in obtaining "one off" and short term data from the many ground investigations continually taking place. People and organisations are asked to contact the NRA Hydrogeology Group if Chalk water level data can be made available.

3. GROUNDWATER LEVEL AND RATE OF RISE

Chalk groundwater level data for the London Basin has been collated enabling the following two maps to be drawn.

i. Groundwater levels of January 1995.
ii. Average rate of rise December 1992 to December 1994, metres/year.

3.1 Groundwater levels at January 1995

Figure 1 shows the current groundwater level map of the London basin for January 1995. An enlarged area of Central London is shown in Figure 2 enabling groundwater contours to be drawn clearly at 5 metre intervals.

The general pattern of the groundwater level contours in the London basin is

similar to last year (Figure 3) except in the centre where a sudden rise in groundwater level has been measured in one of the observation boreholes. The hydrograph for this borehole in Hyde Park, TQ 28/153, is shown in Figure 4.

The groundwater level at Trafalgar Square, TQ 28/119, continues to rise steadily at a rate of just over 2 metres per year and is now at -43.74 metres above ordnance datum. (mOD). The hydrograph for this borehole is shown in Figure 5.

A small cone of depression remains to the east of London towards Essex. The cone is centred around Wanstead with groundwater levels at around -24m aOD and rising at about 1 metre per year.

3.2 Average rate of rise December 1992 - December 1994

Figure 6 shows the average rate of rise of groundwater levels in the London Basin for December 1992 to December 1994. Comparing this recent map with the previous map for December 1991 to December 1993, Figure 7, shows that the rate of rise has increased in the centre of London. Two observation boreholes have had rises of over 3 metres per year recorded, the largest increase occurring at St Agnes well in Hyde Park, the other at British Telecom (Figures 5 and 8). These,plus boreholes at Trafalgar Square, TQ 28/119, and Lloyds Bank, Cornhill, TQ 38/A90, Figures 5 and 9, all in the deep cone of depression, show a steady rate of rise of over 2 metres per year.

Some areas, particularly to the south of the Thames have been affected by short term localised pumping altering the general rate of rise.

Rates of rise of over 1 metre per year occur in the Lee Valley area, North of London around grid square TQ 39 resulting from changes in abstraction rates.

4. THE CURRENT SITUATION

In the central London cone of depression groundwater levels are currently around -44 mOD, having risen from a low of -90 mOD in 1967. The current rate of rise has accelerated slightly to 3m/year in some places.

The drilling and test pumping by TWUL have demonstrated the great variability in yield and quality of groundwater at sites throughout the area. Not surprisingly in the west London Basin area where the Chalk is very deeply buried, yields are poor but rising levels do not pose a problem anyway. In the Central London Basin area substantial yields of up to 4Ml/d at individual sites have been obtained whilst other sites have had a very poor yield or the water quality has been very poor. The current situation is that TWUL has investigated about 20 sites of which 7 have indicated yields of sufficient quantity and treatable quality to be used for public water supply.

The work with LUL has demonstrated the feasibility of controlling groundwater rise in the vicinity of tube tunnels.

In conclusion, sufficient OBH's now exist and sufficient aquifer modelling, on site testing and hydrogeological research have been carried out to understand the rising groundwater problem to the extent that technical decisions can be made on controlling it.

5. THE CURRENT WATER RESOURCES STRATEGY FOR CENTRAL LONDON

During 1994 a number of factors became clear.

a) The relaxation of restrictions on abstraction licensing in London has produced almost no new abstractions and the long term decline in abstraction from the Chalk aquifer under London continues. The NRA has concluded that it is unlikely that sufficient control of rising levels will be achieved through licensable non-public water supply abstractions.

b) TWUL have reviewed their demand deficit in the London area in the light of:-

i. improved leakage control
ii. the success of the North London recharge/abstraction scheme (currently 36 groundwater abstraction sites)
iii. the major enhancement of the distribution of strategic resources by the completion of the London Tunnel Ring Main System
iv. the findings of preliminary investigations in the South London groundwater resources project
v. the results of yield and quality tests in central London
vi. improvements and rationalisations of the New River Aqueduct, Lee Reservoirs, Coppermills Treatment Works infrastructure system.

TWUL have concluded that developing new groundwater resources in central London is generally not a commercially viable option in the short to medium term at least.

c) The slightly accelerated pace of groundwater rise and the problems now occurring to the LUL tunnels has meant that some action to alleviate problems of rising groundwater has already been started by that body.

6. FUTURE CONTROL

In the short to medium term, and probably in the long term also, the balance of view must now be that rising groundwater will not be controlled sufficiently as an incidental benefit of increased water supply abstraction, public or private. Instead there will need to be deliberate abstraction solely for the purpose of protecting deep tunnels and foundations. For tunnels this need is starting now; for deep foundations it is still generally some 20-30 years in the future.

As institutional and legislative arrangements stand at present it is the responsibility of the owners of the assets involved to take their own action to protect their assets. This action will normally take the form of groundwater pumping to hold levels below a critical threshold (although occasionally pumping out of invading water may be practicable).

Under Section 30 of the Water Resources Act 1991, groundwater abstraction "to prevent interference with the carrying out or operation of any underground works" is exempt from licensing. However, anyone proposing to construct boreholes etc. for this purpose must give notice to the NRA. In return, the NRA may issue a 'Conservation Notice' specifying "reasonable measures for conserving water". Through such notices the NRA would seek to secure the proper use of water resources and protect the groundwater resource by imposing as appropriate conditions to:

- agree threshold control levels
- dispose of abstracted water
- monitor levels and abstracted quantities
- protect existing rights to abstract.

Action by the owners of assets, or their agents, will result in control on a piecemeal basis. To a great extent, control will be self-limiting as no-one is likely to pump more water than necessary to control their own problem. It is not envisaged therefore that conditions that the NRA would seek to impose through Section 30 would generally be in conflict with the interests of the owners of assets.

Controlling conditions at one site may have incidental benefits for the owners of adjacent sites. This is perhaps more likely to arise in relation to tunnels for which it may be necessary to protect significant lengths by pumping at several locations. The requirement for incidental beneficiaries to reimburse those actually incurring costs will need to be considered.

Water abstracted under a Section 30 Conservation Notice is not licensable and does not therefore attract abstraction charges. However, the water may then be put to use without charge for some secondary purpose which, if it had been the primary purpose of the abstraction, would have been licensable and therefore chargeable. Nevertheless, the interest in making secondary use of the water for public or private supply seems to be limited. It is therefore likely that some or most of the water pumped to protect subsurface structures will have to be disposed of either into sewers, storm water drains or the surface drainage system. If such water were of potable quality, disposal in these ways would represent a waste of water resources.

7. THE RISING GROUNDWATER LEVEL WORKING GROUP

This has been functioning for nearly two years and is now chaired by TWUL. At present representatives of the NRA, Loss Prevention Council, Association of British Insurers and the British Property Federation attend meetings of this group. Whilst there is a rapidly growing momentum of co-operation between TWUL and LUL, the main objectives of the group are to greatly widen the discussion on rising levels and

to continue to bring to the attention of property owners and government the possible consequences of the relentless rise in levels. TWUL see their potential activities and current expertise as the mechanism through which levels can be controlled. Any organisation is welcome to join the working group on a permanent or ad hoc basis. The contact point is Mr R Sage, TWUL, Nugent House, Vastern Road, Reading RG1 8DB.

It should be made very clear that the co-operation between TWUL and LUL will only maintain the integrity of certain vulnerable length of tube tunnel. Large areas of the capital still remain vulnerable to rising groundwater levels. The engineering implications of this were spelled out in the CIRIA (2) report of 1989. Most structures, of course, are unlikely to be affected by the problem. A very specific set of conditions were required to be present to endanger a structure. A civil engineering assessment of each structure is required to determine this. Very few organisations and property owners have taken any action in this direction. The Rising Groundwater Level Working Group can provide further insight and advice.

8. CONCLUSIONS

(i) Groundwater levels in the Chalk-Basal Sands aquifer under Central London are still rising; the rate of rise appears to be accelerating slightly.

(ii) The network of observation boreholes for monitoring groundwater levels is now adequate. Sufficient aquifer modelling, on site testing and hydrogeological research have been carried out to understand the problem of rising groundwater and make technical decisions on controlling it.

(iii) Rising groundwater represents a water resource but the likely interest in using it for public or private water supply, in the short to medium term and probably also in the long term, will be insufficient to achieve incidental control of the rise to protect subsurface structures threatened by it.

(iv) Deliberate pumping will be needed to protect subsurface structures. Under the present institutional and legislative arrangements this will be the responsibility of the owners of the assets.

(v) Where necessary the NRA will seek to protect the water resource, and those with rights to abstraction from it, through Conservation Notices under Section 30 of the Water Resources Act 1991.

ACKNOWLEDGEMENTS

The NRA would like to thank Thames Water Utilities and Bridge Iron Works (Engineering) Ltd for their assistance in the data collection for this report.

REFERENCES

(1) NRA, Thames Region, 1991, 1992, 1993, 1994. Annual Reports - Rising Groundwater Levels in the Chalk-Basal Sand Aquifer of the Central London Basin.

(2) CIRIA, 1989. The Engineering Implications of Rising Groundwater Levels in the Deep Aquifer Beneath London. Special Publication 69.

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Figure 1. London Basin Chalk Groundwater Levels, January 1995.

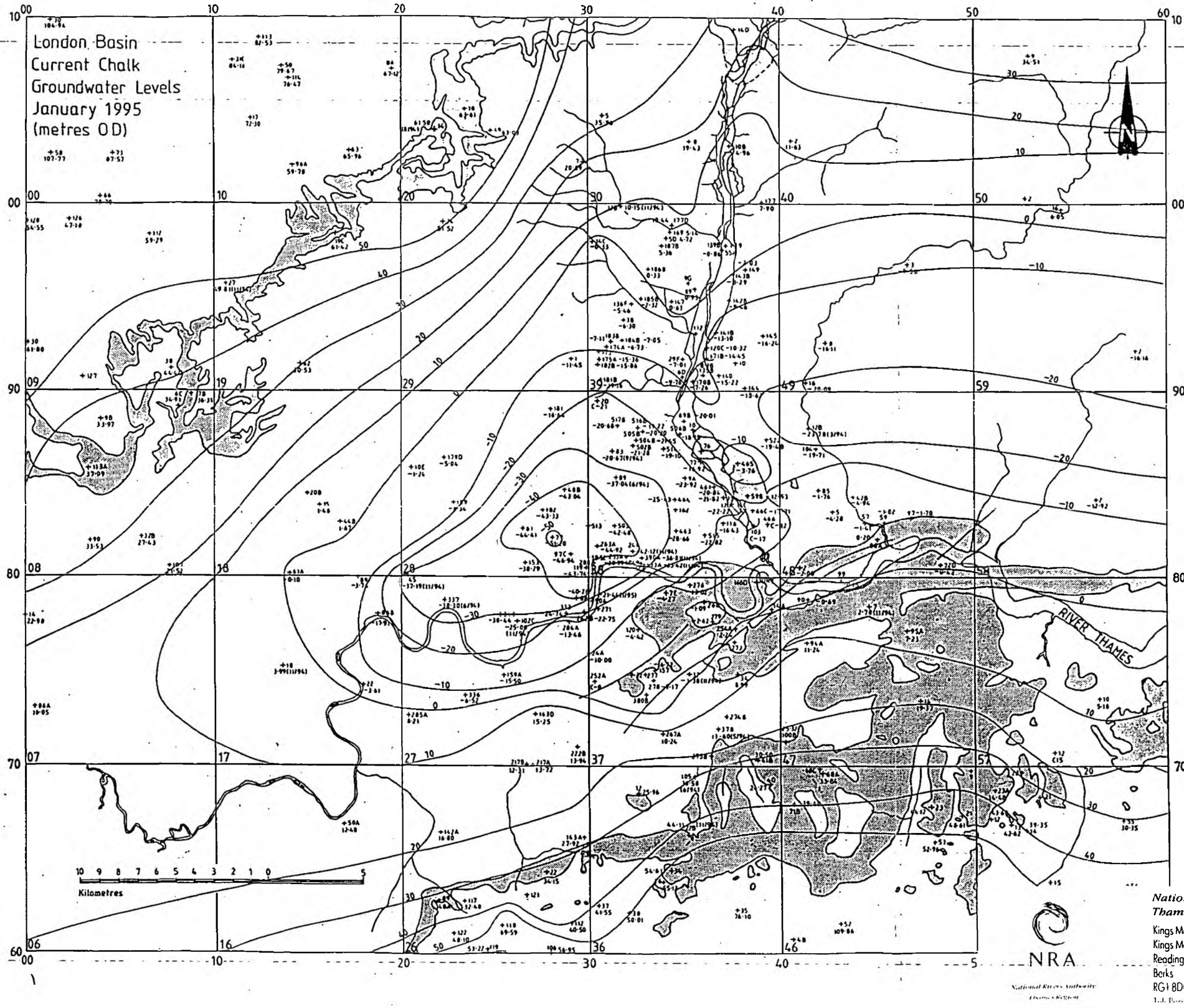

Figure 2. Enlarged Central Area Chalk Groundwater levels, January 1995.

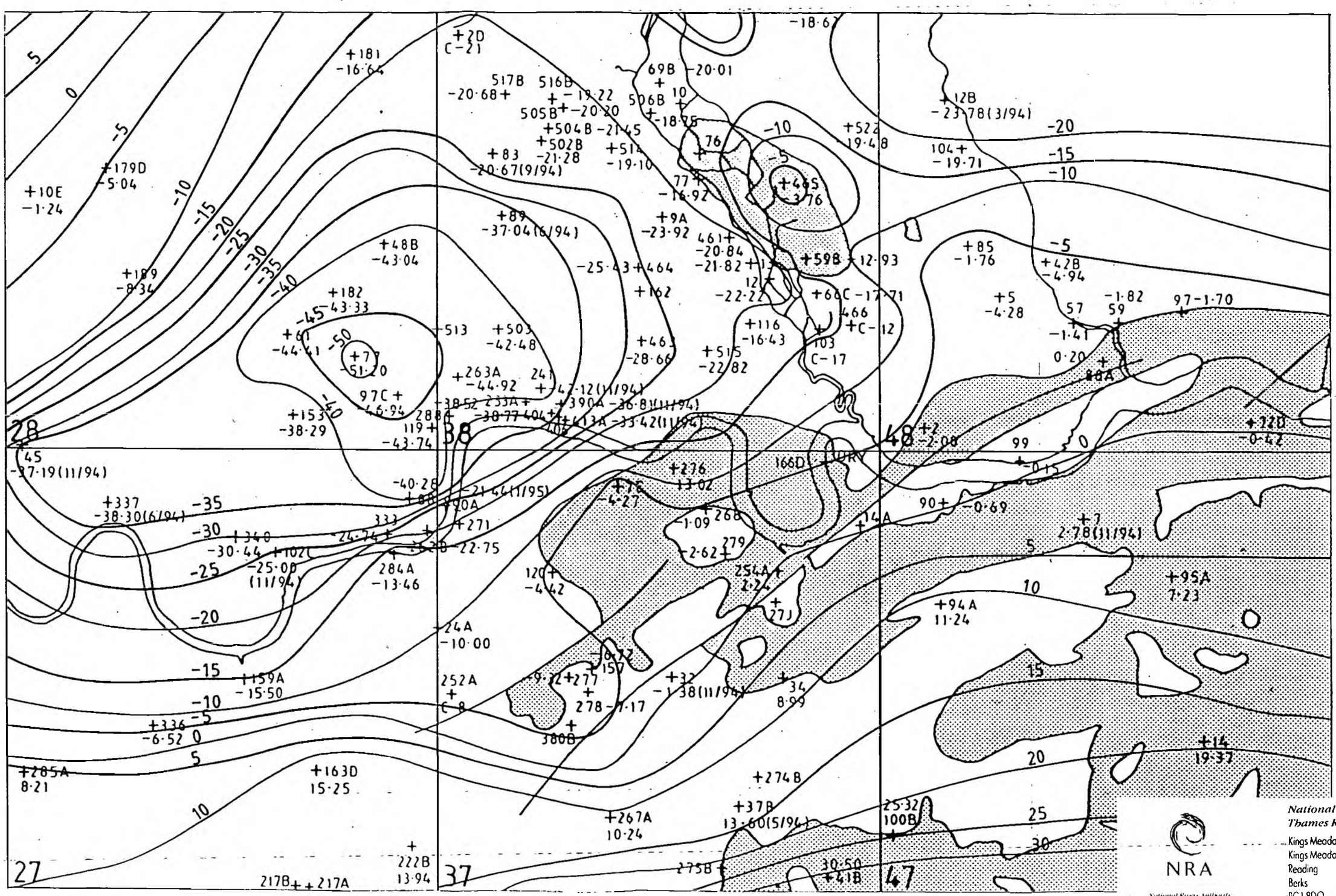

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Figure 3. London Basin Chalk Groundwater levels, January 1994.

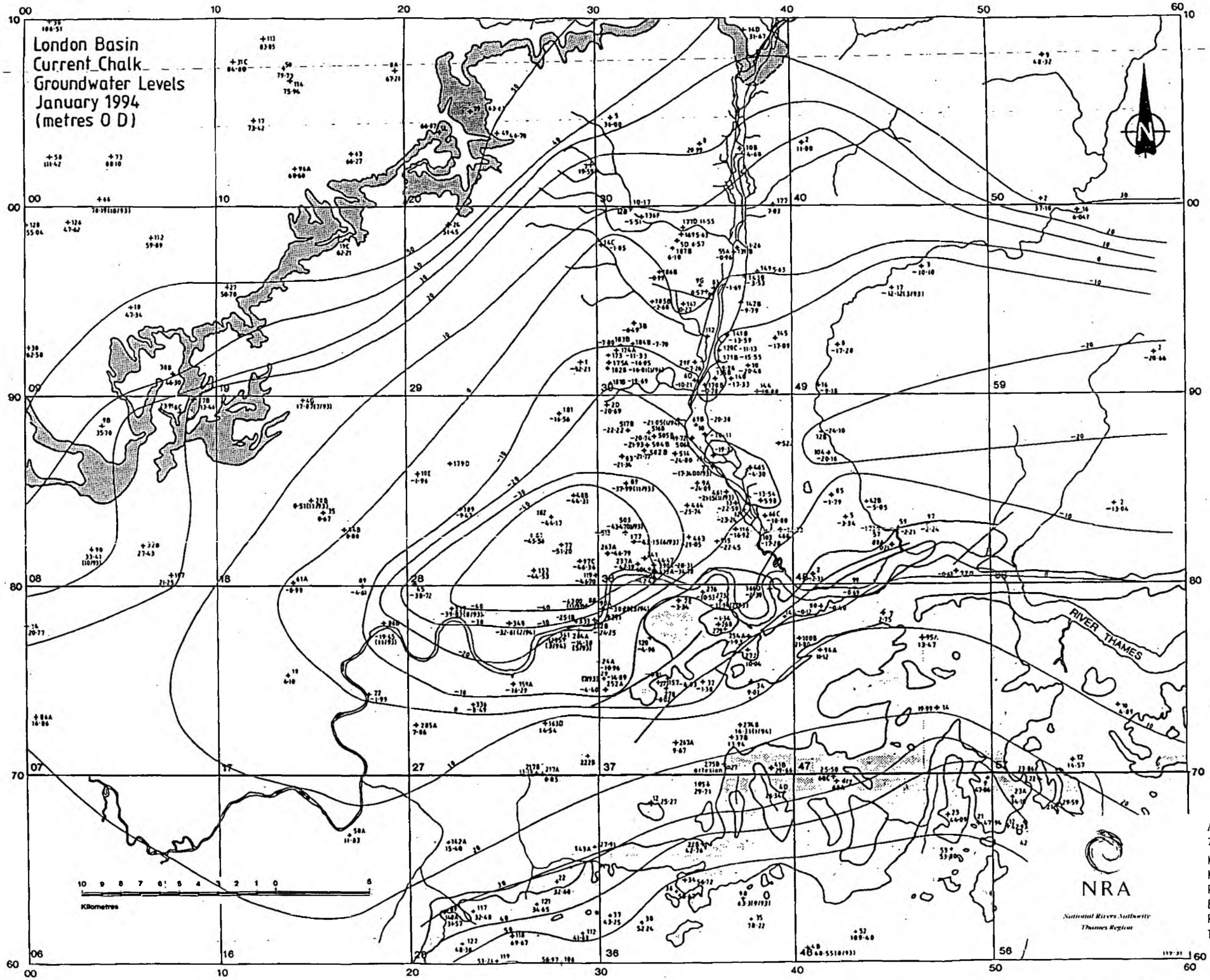

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Figure 4. Hydrograph at St Agnes Well, Hyde Park, TQ 28/153.

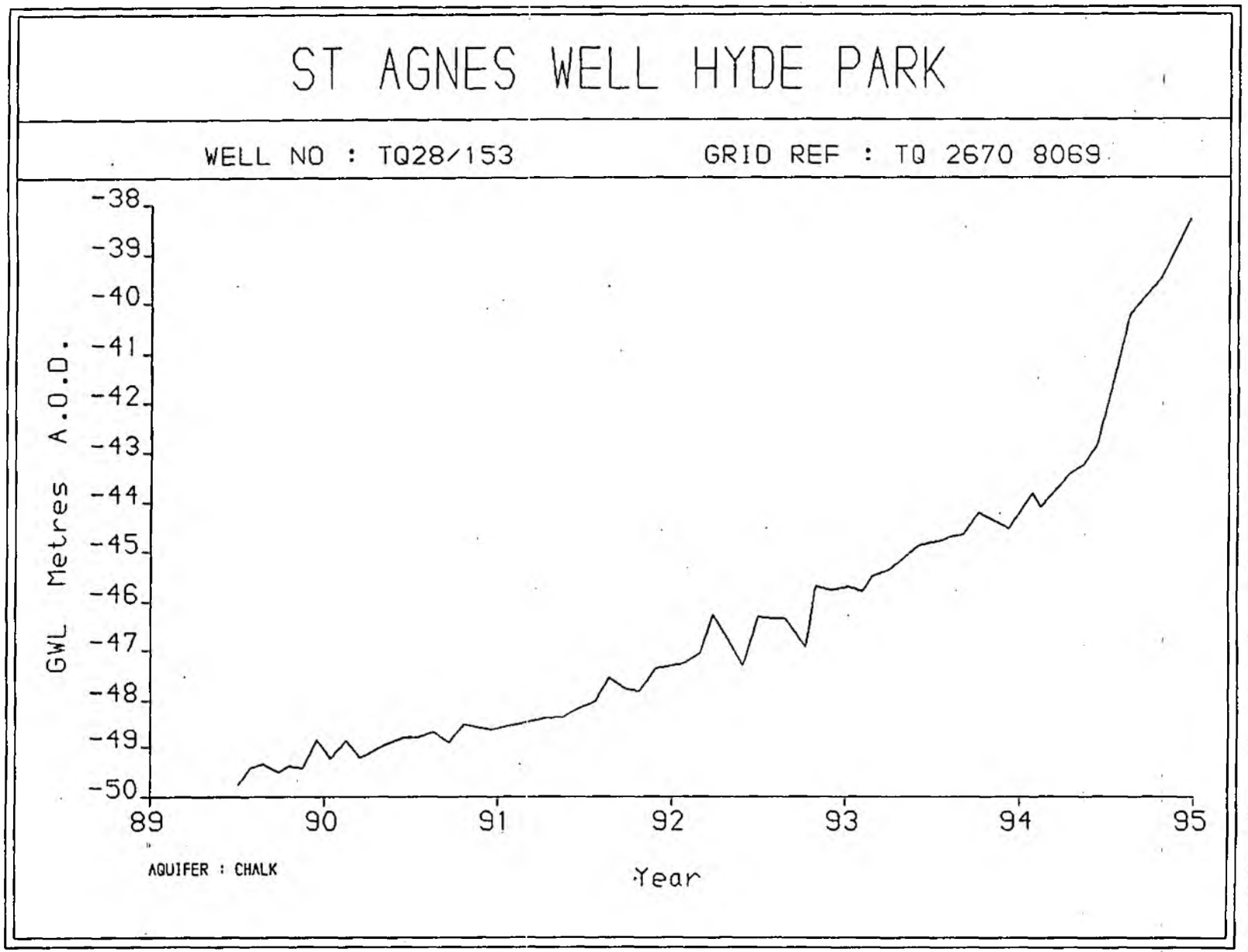

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Figure 5. Hydrograph at Trafalgar Square, TQ 28/119.

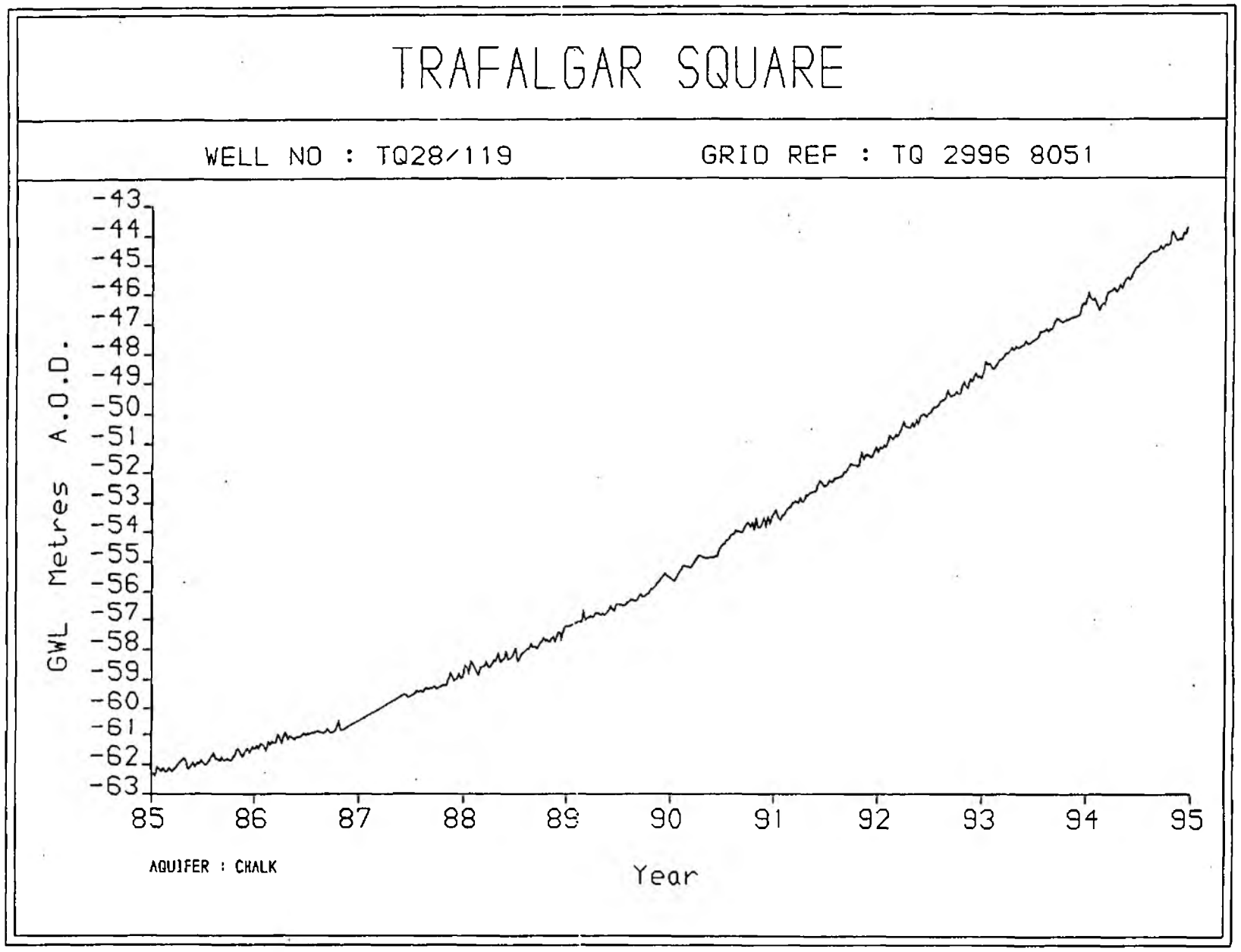

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Figure 6. London Basin Average Rate of Rise of Chalk Groundwater Level Dec 1992 - Dec 1994.

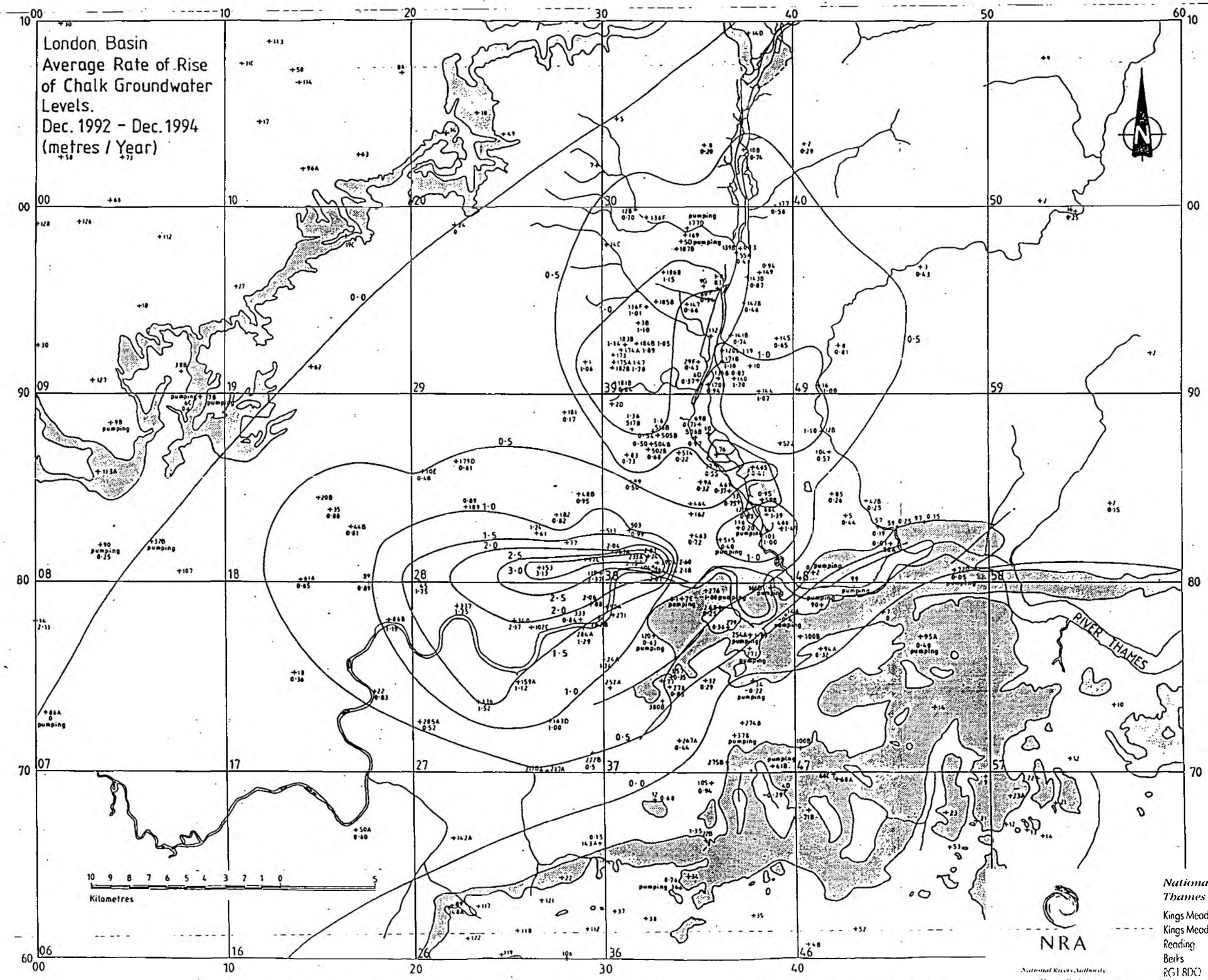

Figure 7. London Basin Average Rate of Rise of Chalk Groundwater Level Dec 1991 - Dec 1993.

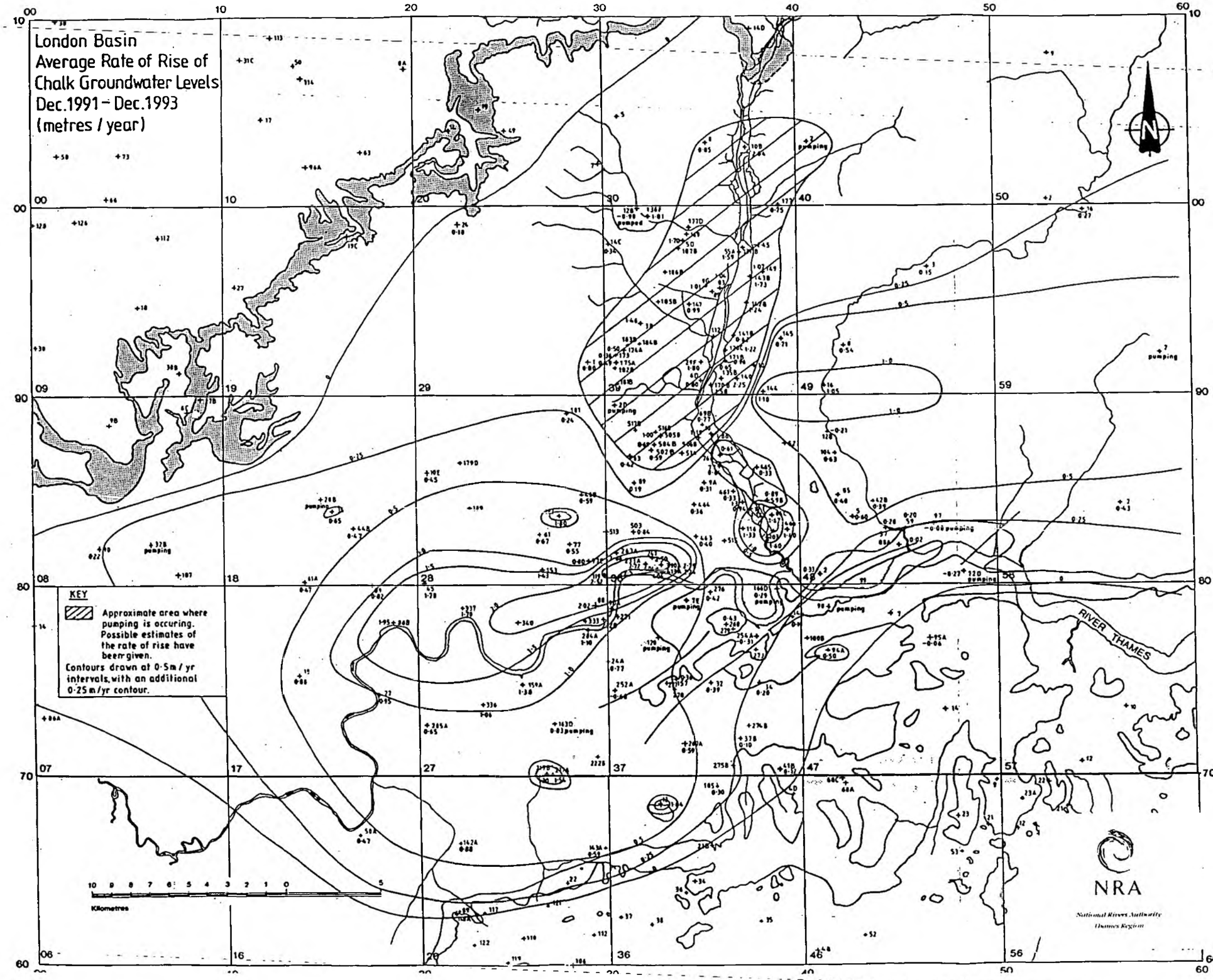

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Figure 8. Hydrograph of British Telecom, TQ 38/A33.

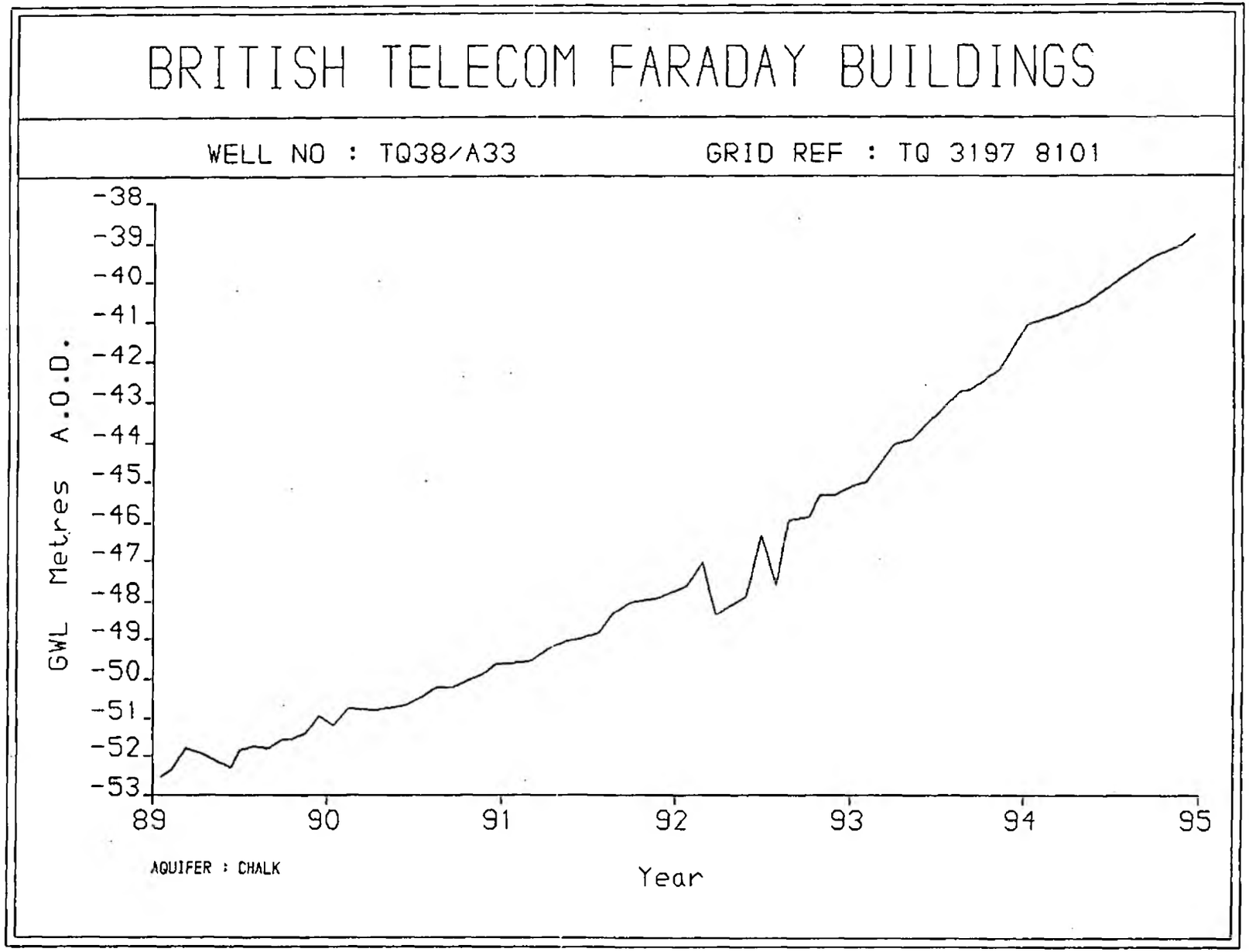

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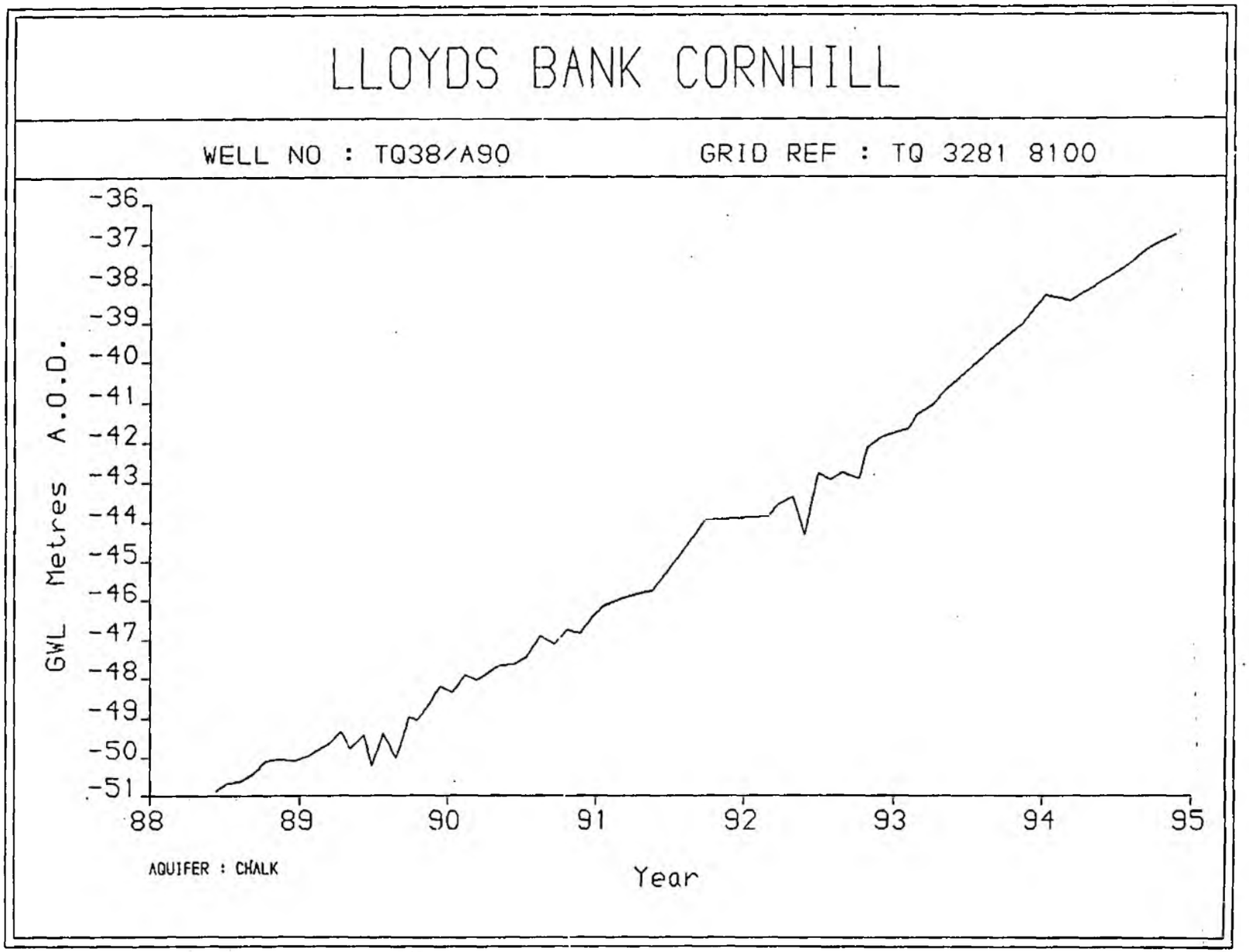
Figure 9. Hydrograph at Lloyds Bank, Cornhill, TQ 38/A90.



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