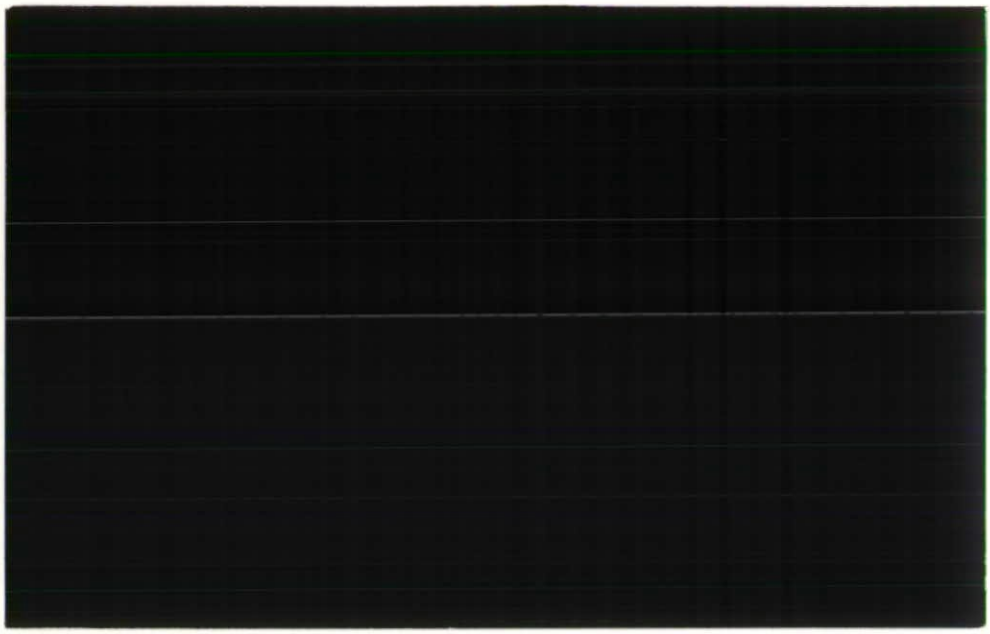
Institute of Hydrology



Natural Environment Research Council

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BURNHAM BEECHES
GROUNDWATER MONITORING
1989 - 1993

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Contents

Burnham Beeches Groundwater Monitoring 1991-1993

1. INTRODUCTION

This document was drafted by IH, at the request of the Corporation in order to assess the results of the monitoring programme up to 1993.

The groundwater monitoring programme established in 1989 and 1990 has been continued by the Corporation. Water levels in wells have been monitored weekly and rainfall measured at one locality daily with only occasional gaps during holidays (shown as 1 mm on the rainfall hydrographs). Consequently a good dataset has been built up of conditions prior to the proposed gravel extraction. It is understood that pumping at the existing pit ceased in 1991 and has not been resumed since.

The data has been entered onto GRIPS (the IH GRoundwater Information Processing System) up to the end of 1993 and output in the form of well hydrographs accompany this document. Rainfall data is similarly presented. As groundwater flow in the monitored area is complex it is difficult to draw a conventional water table map. Two maps representing high and low water levels in 1993 are presented however which show some of the aquifer units identified in the 1991 IH report. The monitoring results from each aquifer unit are discussed below. The data from BB25 is presented but not discussed since it has only been monitored since 16.02.93 and water levels in the chalk aquifer are considered of little relevance.

2. RAINFALL DATA

Overall 1992 and 1993 were wet years following the drier years of 1990 and 1991. This is reflected in the hydrographs eg from wells at the back of the Boyn Hill terrace (BB24 BB26) and at the base of the inter-terrace bluff (BB35, BB36 and BB40) which show little response to rainfall until the winter of 1992/93.

The winter of 1991/92 was unusually dry. Hydrographs from, for example, the Winter Hill terrace (BB13, BB14, BB17, BB31, and BB32) do not show a winter peak with a subdued summer peak in 1992.

The variability of rainfall and corresponding hydrographs, demonstrates the need for several years data.

3. WINTER HILL GRAVEL AND CONNECTED SOLIFLUCTED GRAVEL

This aquifer unit together with the Soliflucted Gravel unit at the pumping test site is delineated in blue on the water table maps, with flow in a southwesterly direction.

Wells in the Winter Hill Gravel aquifer are BB13, BB14, BB17, BB31, BB32 and BB34. Hydrographs all show a rapid response to the same rainfall events with a pronounced seasonal fluctuation as well. Water levels are generally more shallow than found in the Boyn Hill Gravel and Reading Beds aquifers. BB34 shows more pronounced response to rainfall events and also responses not shown on the other Winter Hill Gravel hydrographs eg in September

1991 with a peak on 17.09.91.

Wells in the Soliflucted Gravel in presumed hydraulic connection with the Winter Hill Gravel are those wells at the pumping test site screened in gravel ie BB42B, BB42-1, BB42-2, BB42-3B and BB42-4 which although at a lower elevation, with the exception of BB42-2, show similar hydrographs to the wells in the Winter Hill Gravel. The more peaky hydrograph of BB42-2 has an affinity with Winter Hill Gravel hydrograph at high water levels but an affinity with the lower elevation Reading Beds Sand hydrograph (BB42A and BB42-3A) at low water levels indicating connection with different aquifers at different seasons. Water levels at BB42-3B are consistently lower than the other wells screened in gravel at the test site indicating leakage to the lower Reading Beds aquifer around the well.

4. SOLIFLUCTED GRAVEL ON THE INTER-TERRACE BLUFF

Delineated in red on the water table maps this aquifer is represented by wells BB8, BB10 and BB22.

Hydrographs all show little seasonal range of water levels but variable levels from week to week responding rapidly to rainfall events.

Wells BB8 and BB10 are located where the gravel is thin and during the summers of 1989 and 1990 BB10 was dry, whereas BB8 was consistently dry until the exceptionally wet late November early December of 1992.

5. BOYN HILL GRAVEL

Delineated in green on the water table maps this aquifer is represented by wells BB4, BB11, BB24, BB26, BB27, BB37 and BB39.

Groundwater flow is confined to an area between the brickearth with an initial steep hydraulic gradient to the south then a gentle gradient to the southwest towards the inferred sink holes.

Hydrographs BB37 and BB39 show a seasonal response to recharge, particularly following the rainfall of November 1992. Weekly variability is less than wells in the Winter Hill and Soliflucted Gravel aquifers above, giving characteristically smooth hydrographs during this period.

BB27 was dry when drilled but surprisingly became wet on 03.09.91 (a dry day following 10 previous days with no rainfall). This well remained wet thereafter, recording a very peaky response to the high rainfall during winter 1992/93. Such a response is not surprising bearing in mind the aquifer here was found to be only 0.4m thick overlain by about 4m of brickearth.

The hydrograph of BB4 does not have much affinity with surrounding wells. Levels fluctuate on a week to week basis responding rapidly to rainfall events. The response to the winter rainfall of 1992/93 is less peaky and of a similar magnitude to previous seasonal high water levels. Levels at BB4 are consistently higher than nearby wells indicating local recharge in this area. Surprisingly the hydrograph of BB4 has greatest affinity with the hydrograph of BB29 both in shape and elevation suggesting similar conditions or even a connection.

Hydrographs of wells BB24 and BB26 show a subdued response to recharge during winter 1990/91 and spring 1992 with minimal weekly variability but a good response to the wetter winter of 1992/93.

Monitoring of BB11 ceased on 26.11.91. The hydrograph of this well shows no affinity with nearby wells on the Boyn Hill terrace with the possible exception of BB4. Water levels at BB11 tend to respond well to individual rainfall events but do not show a pronounced seasonal effect.

6. ALLUVIUM

Delineated in yellow on the water table maps this aquifer is represented by BB29 and BB30.

The hydrograph of BB30 shows a strong affinity with hydrographs of wells at the pumping test site screened in Reading Beds Sand (BB42A and BB42-3A) indicating hydraulic connection (also indicated by the drawdown of the pumping test reaching BB30). Both seasonal and weekly fluctuation at BB30 are more subdued than at BB42A and BB43-3A.

In contrast the hydrograph of BB29, further downstream along Swilly Brook, shows both a more pronounced seasonal fluctuation and a good response to rainfall events.

7. READING BEDS AND CONNECTED SOLIFLUCTED GRAVEL

The Reading Beds aquifer is delineated on the water table maps in orange and is represented by 1 group of wells in the Reading Beds Sand and connected Soliflucted Gravel, 3 groups of wells in the Reading Beds Sand and 1 well (BB41) in the Reading Beds Silt. The Reading Beds are interpreted as a multi-level aquifer system.

The group of wells in the Reading Beds Sand and connected Soliflucted Gravel lie towards the foot of the inter-terrace bluff and comprise BB35, BB36, BB40 and BB43A. The saturated sand at BB35 was logged as part of the overlying Soliflucted Gravel sequence (though it could be classified as Reading Beds Sand). Only 0.7m of Reading Beds Sand was logged at BB36 with the overlying saturated sands and gravels classified as Soliflucted Gravel. Hydrographs of both these wells show close agreement with each other and with hydrographs of BB40 and BB43A screened entirely in Reading Beds Sand.. These hydrographs are all fairly smooth with a subdued response to both individual rainfall events and seasonal recharge except a seasonal response to the 1992/93 winter recharge. The affinity of these hydrographs with those of BB24 and BB26 of the Boyn Hill Gravel suggest a hydraulic connection of the Boyn Hill Gravel with the Reading Beds Sand at least as far as BB40 and BB43.

The upper aquifer at BB43 (BB43B) shows a similar hydrograph to that of BB21 with minimal seasonal fluctuation. Whereas levels fluctuate slightly from week to week at BB21 they remain more constant at BB43B.

The hydrograph of BB20 shows a similar pattern to BB35, BB36, BB40 and BB43A but there is a clear lagged response to seasonal recharge. BB20 is the only representative of this aquifer level within the Reading Beds.

The hydrographs of BB42A and BB42-3A screened in the Reading Beds Sand at the pumping

test site show a strong affinity with hydrographs of wells screened in the overlying Soliflucted Gravel and nearby Alluvium aquifers (referred to above) suggesting hydraulic connection.

The hydrograph of BB41 in the Reading Beds Silt aquifer shows a similar pattern to the hydrographs of the nearby Winter Hill Gravel although BB41 is more peaky particularly during the 1992/93 winter recharge period.

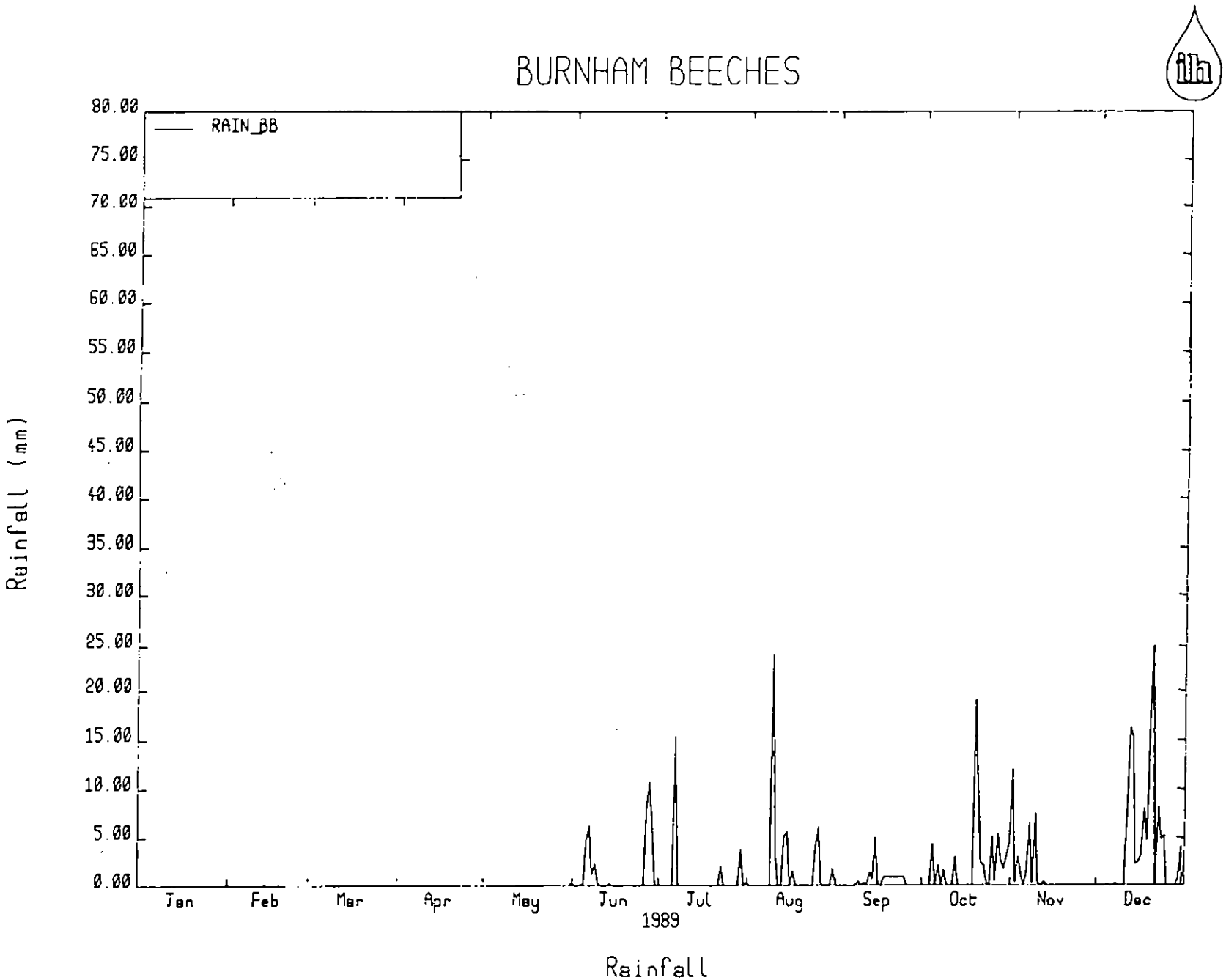
8. CONCLUSIONS

As a result of regular weekly monitoring of well water levels and daily measurements of rainfall, a very good dataset has been established. This data is not only essential information necessary to safeguard groundwater levels under Burnham Beeches, it is also of scientific interest and value.

The temporal variability of rainfall and the corresponding variability in the nature of the hydrograph response to recharge, demonstrates the need to have several years pre-extraction data.

Each aquifer unit is characterised by a particular type of hydrograph. Hydraulic connection of both wells and aquifers can be inferred on the basis of the degree of similarity of hydrograph shape.

It would be worth considering further modelling, using the monitoring data in order to improve our understanding of groundwater flow in the area. This would aid assessment of the suitability of the existing network to act as an early warning system and also improve predictions of the effect of gravel extraction.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Rainfall (mm)
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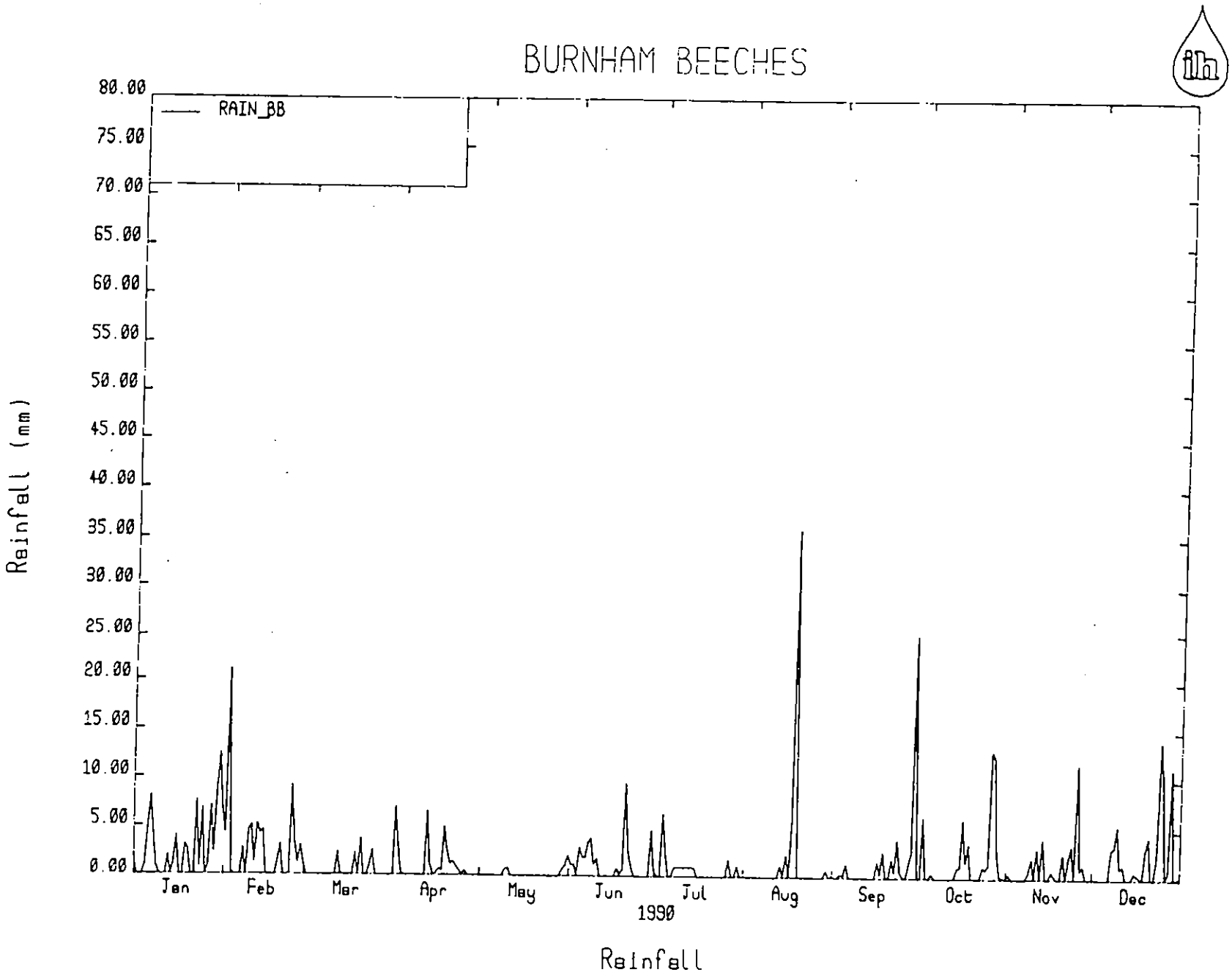
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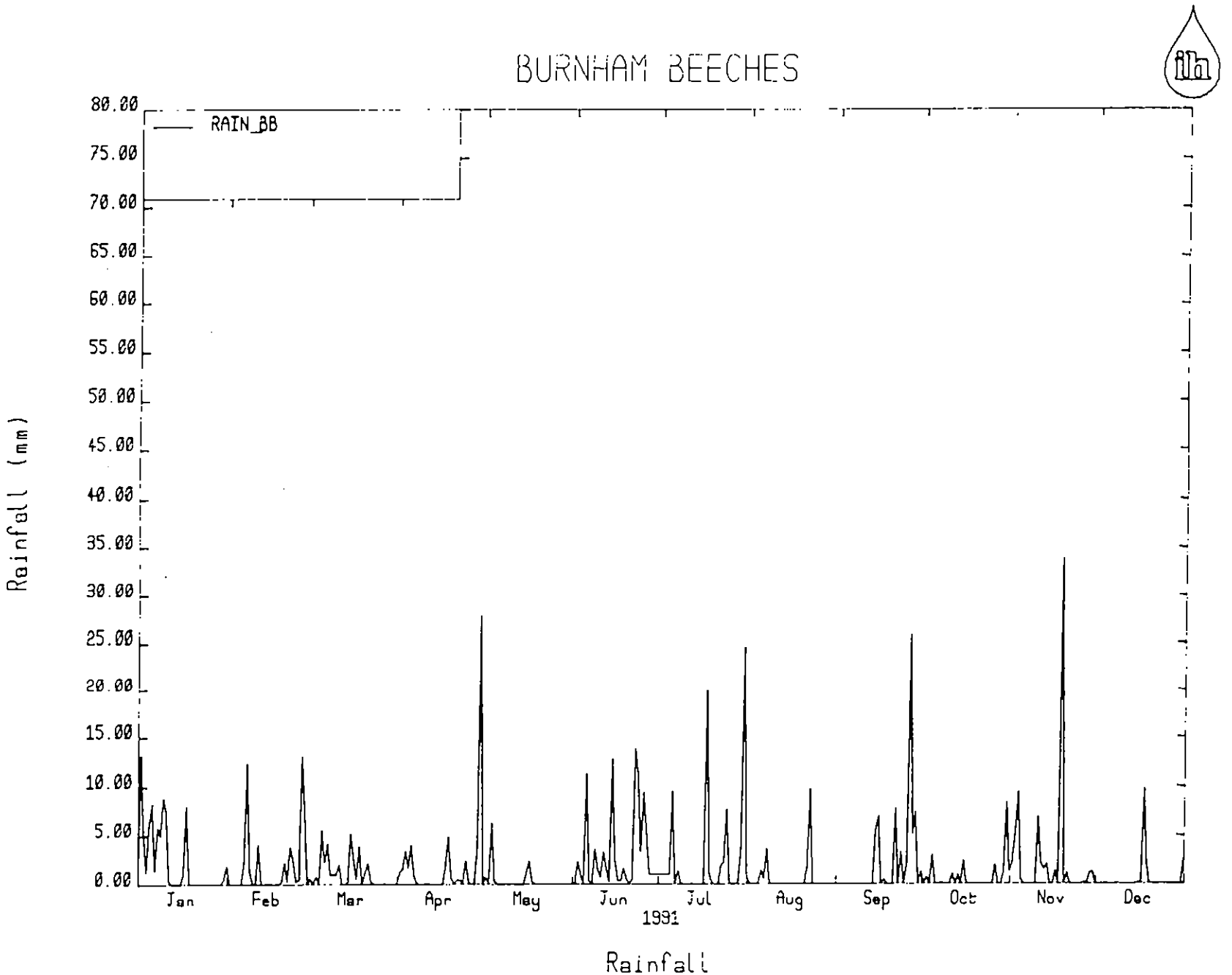
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Rainfall (mm)
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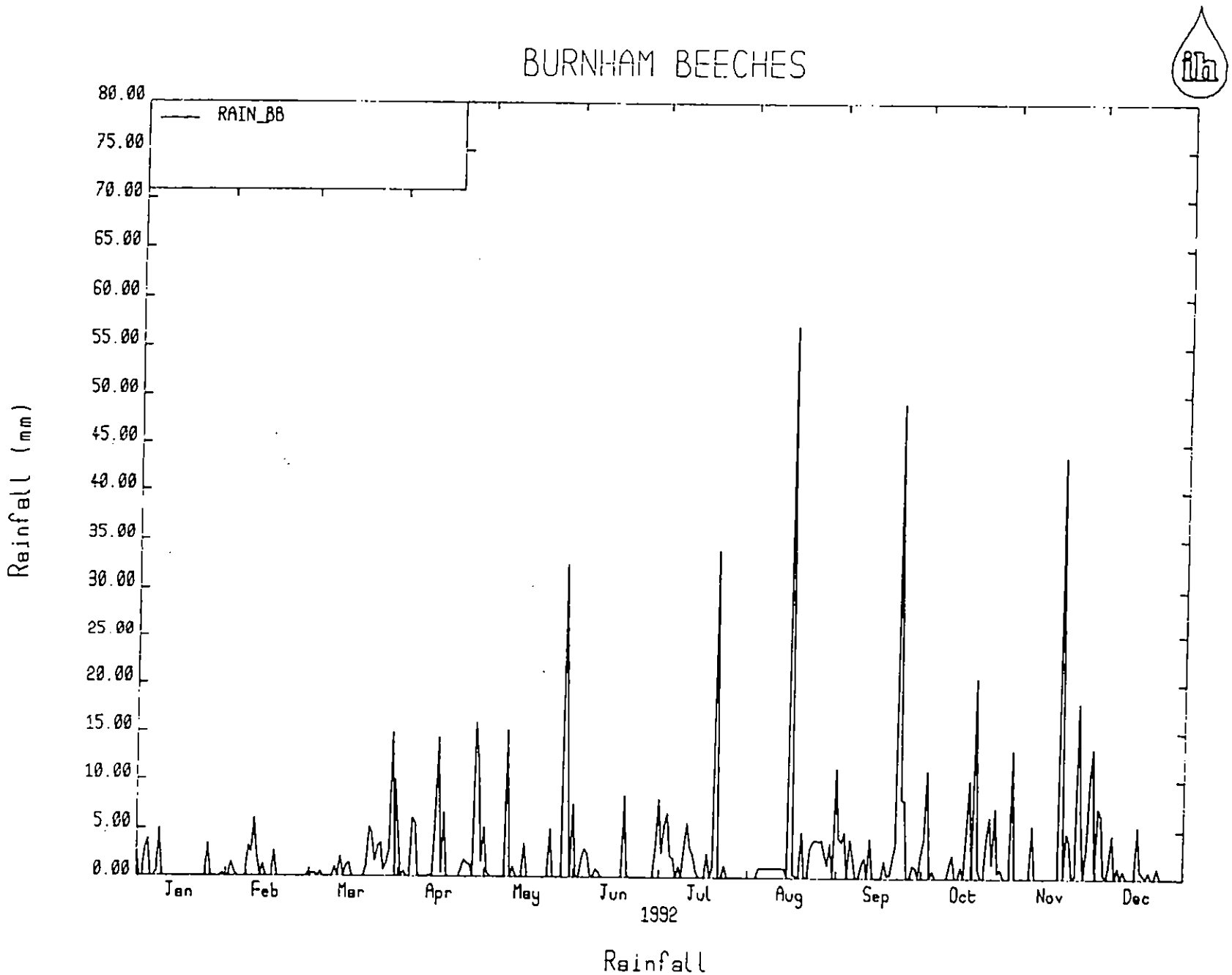
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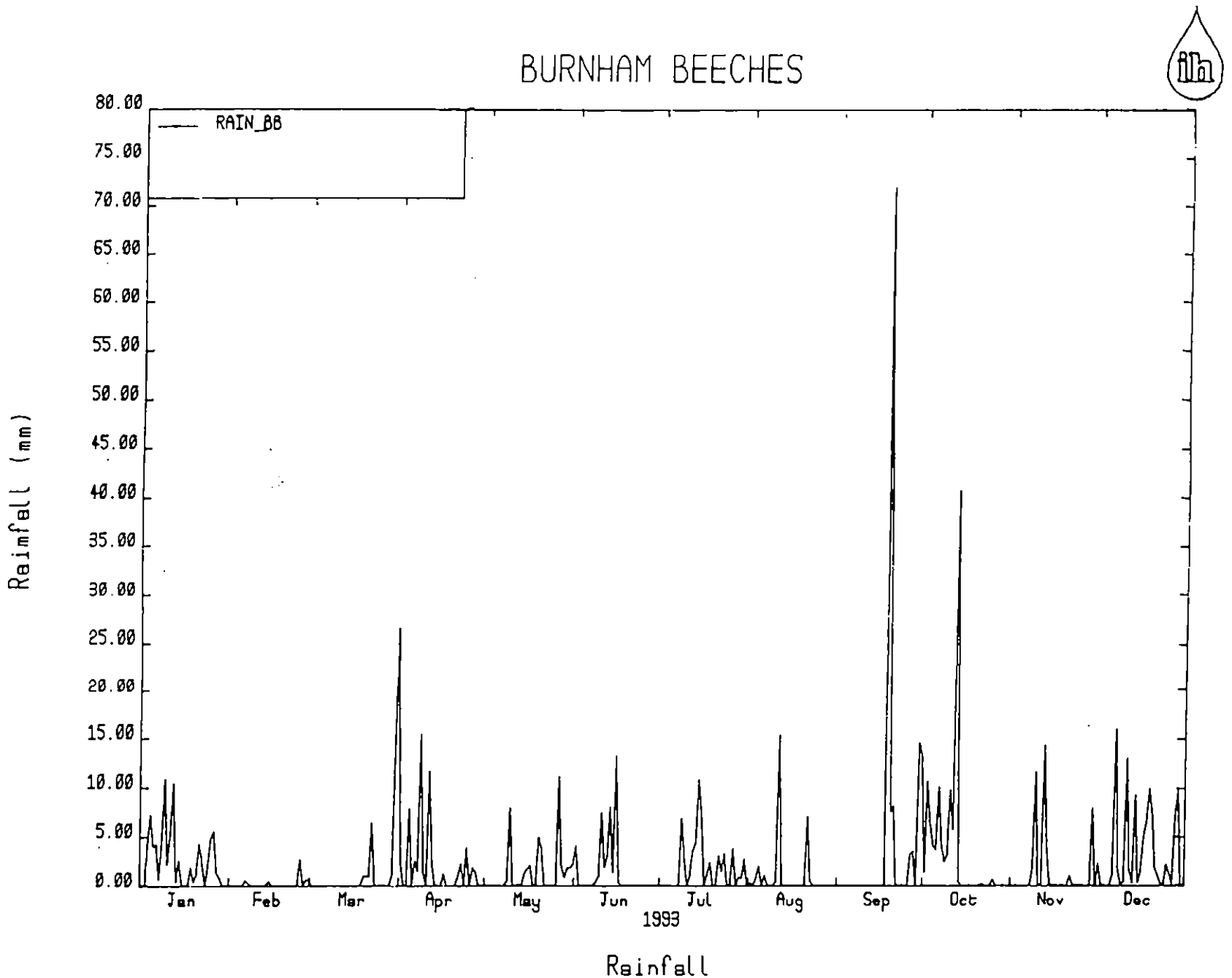
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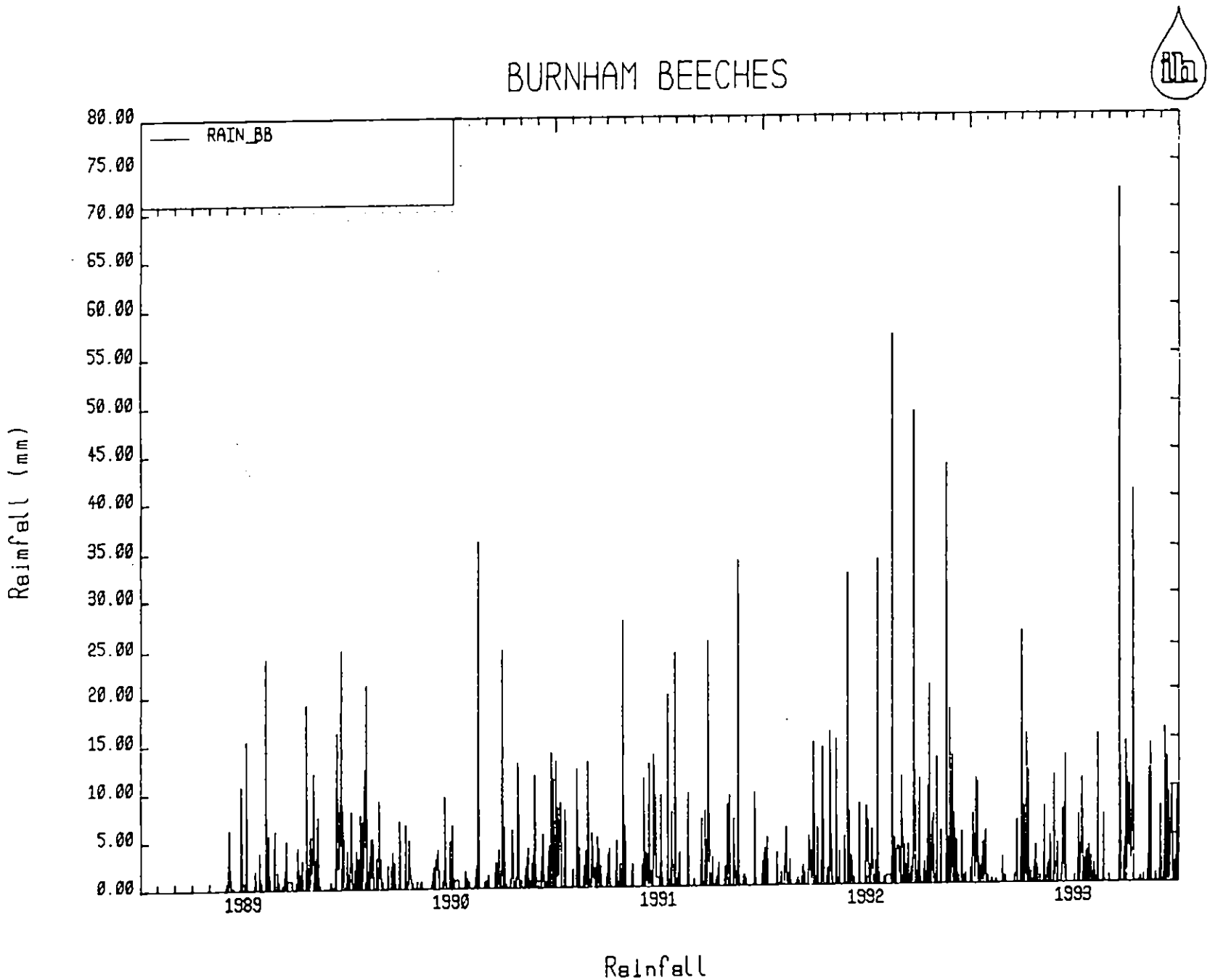
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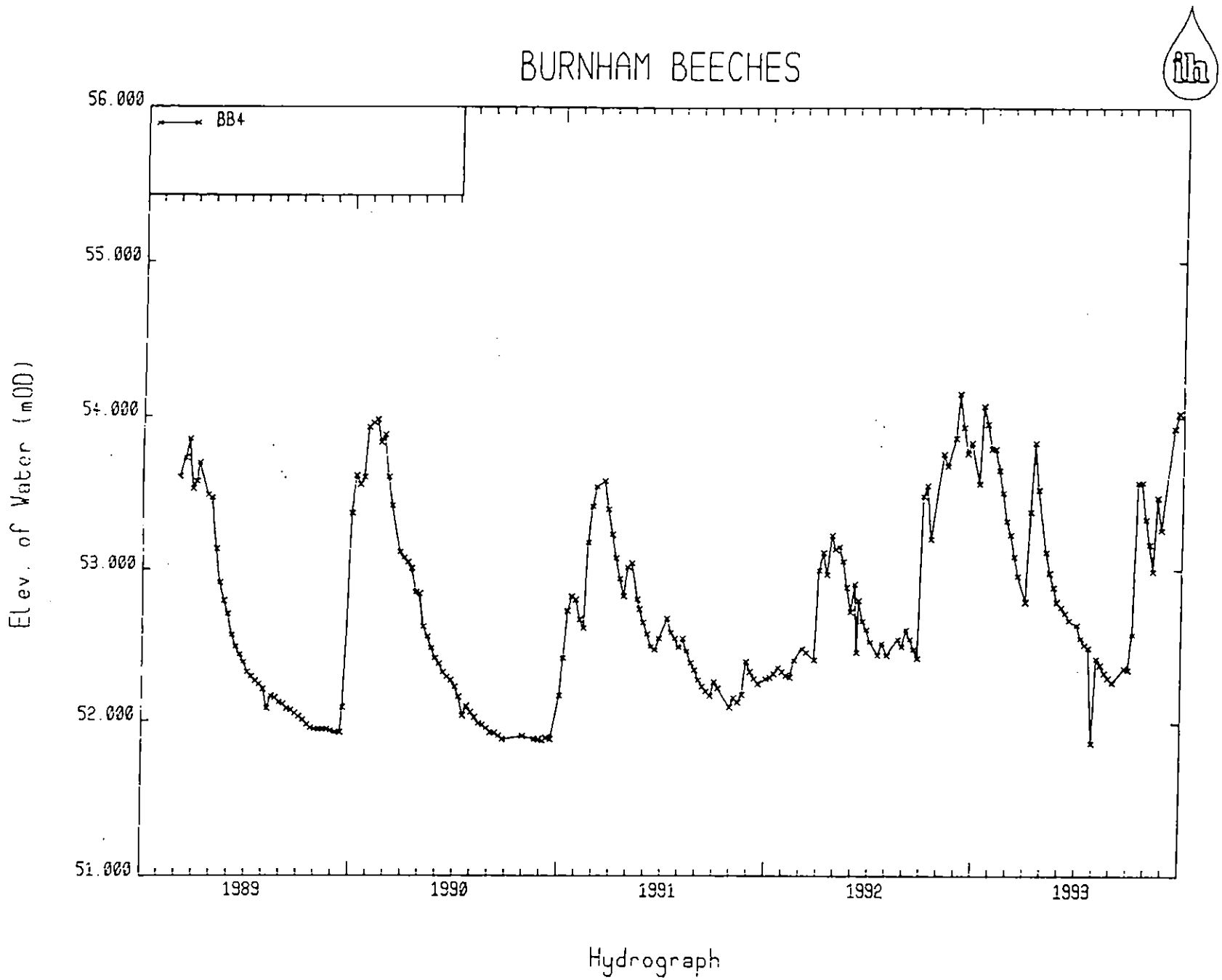
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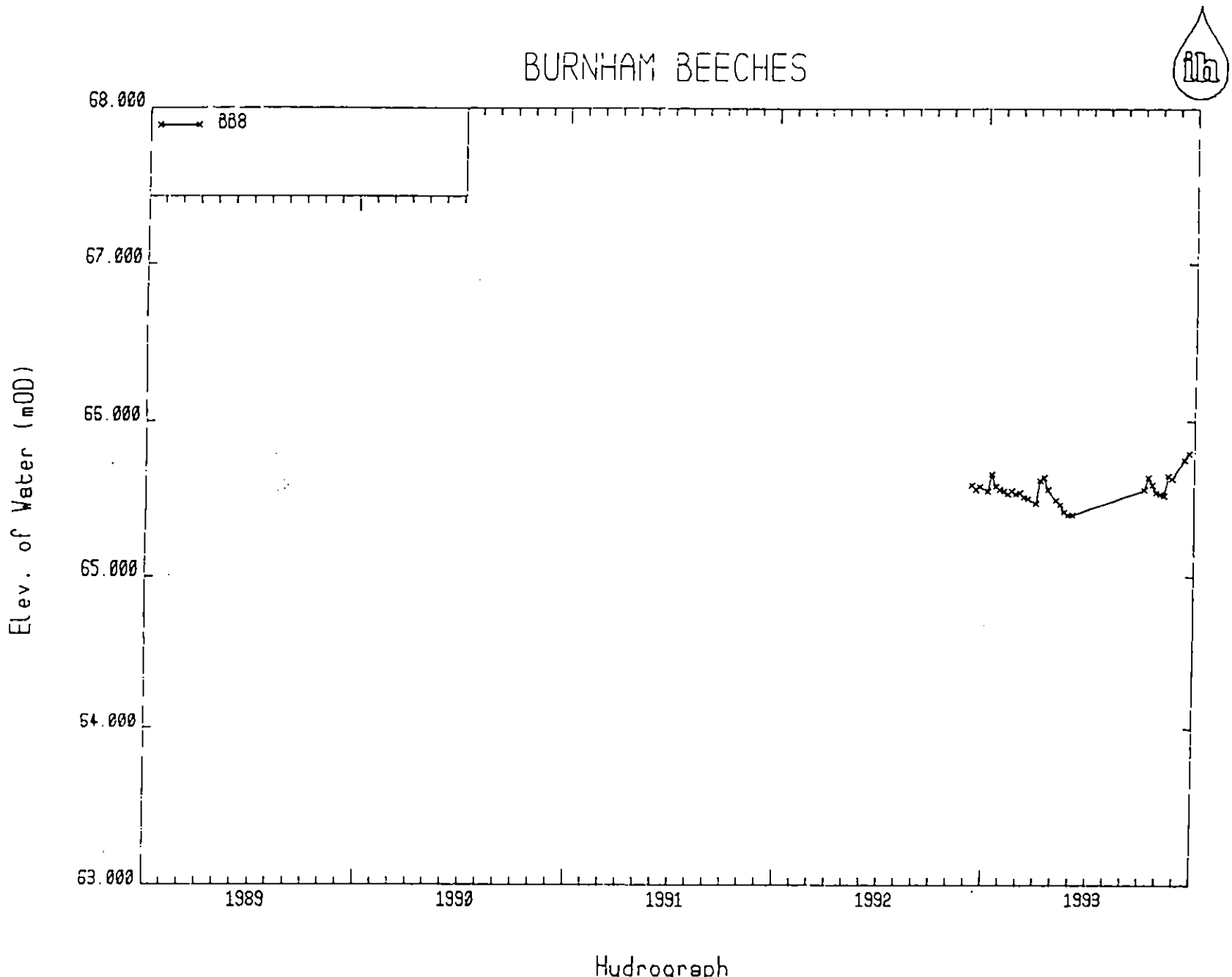
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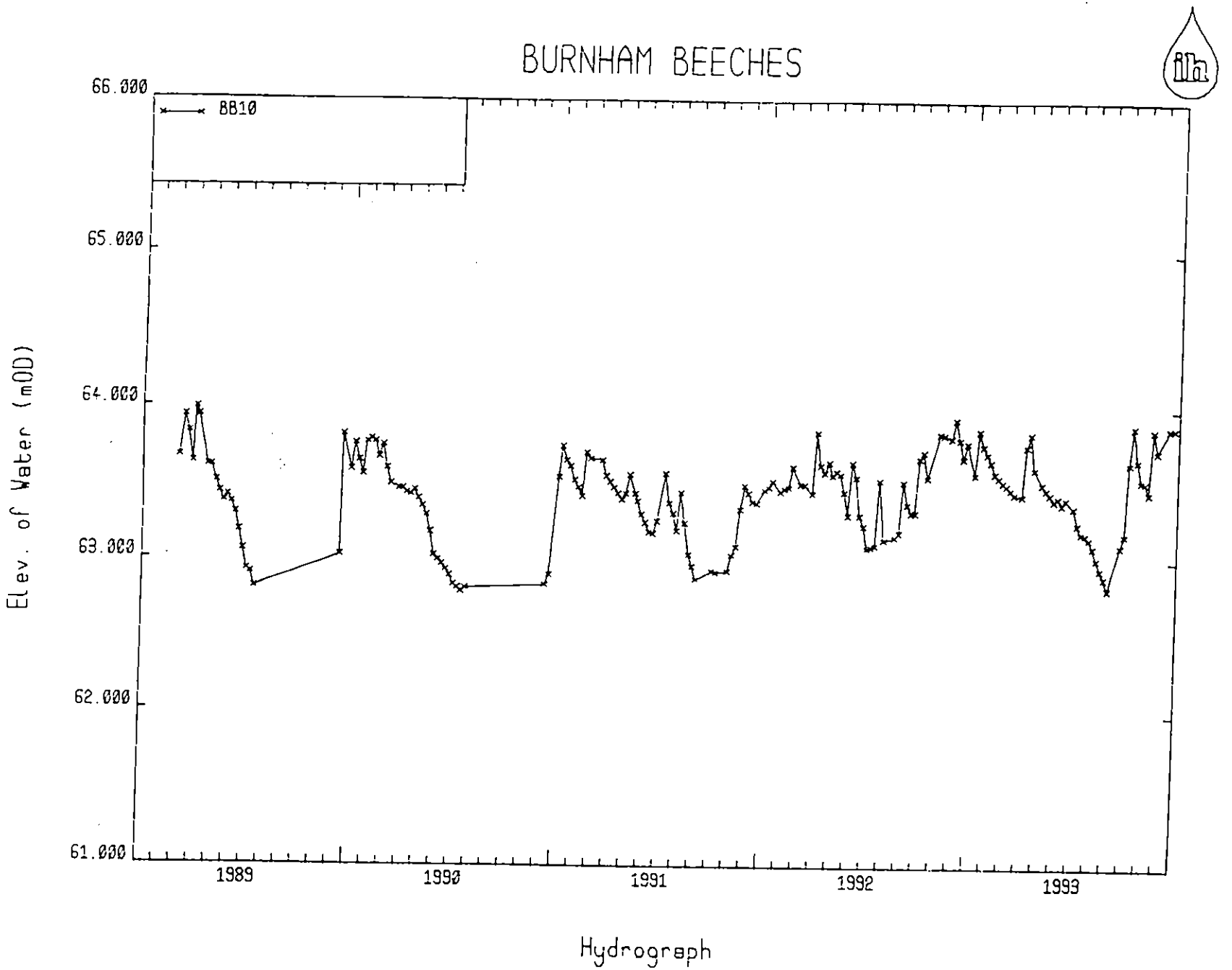
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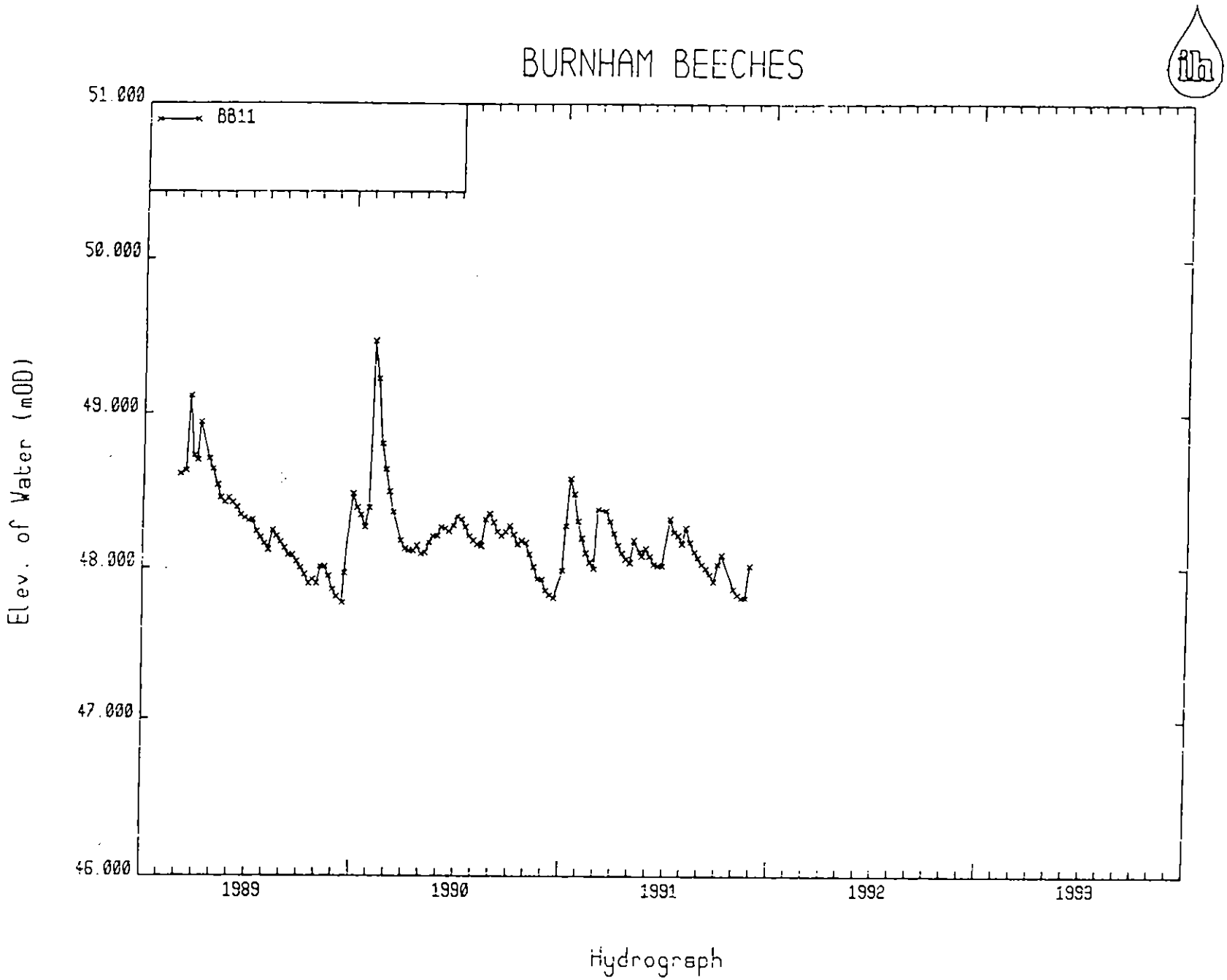
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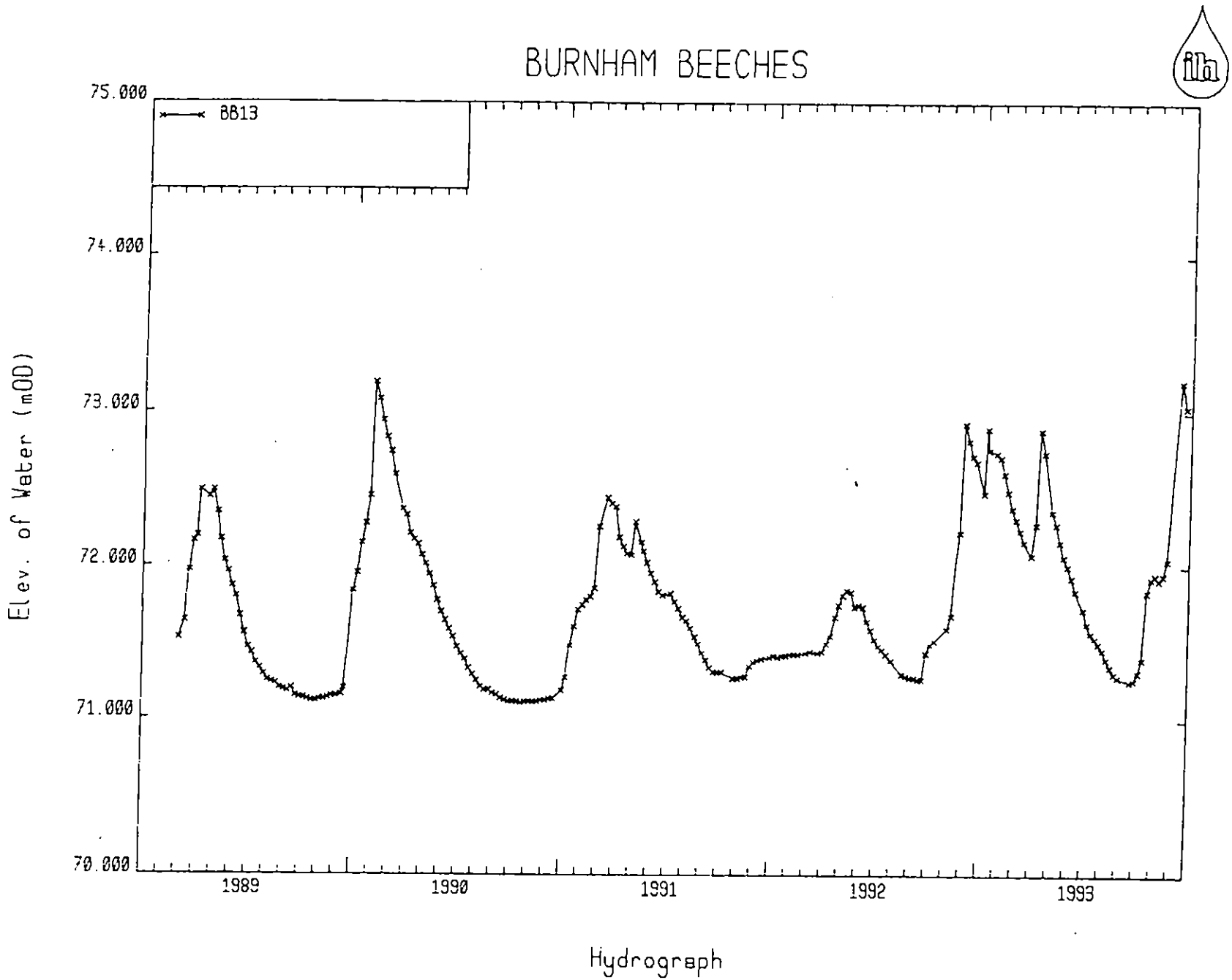
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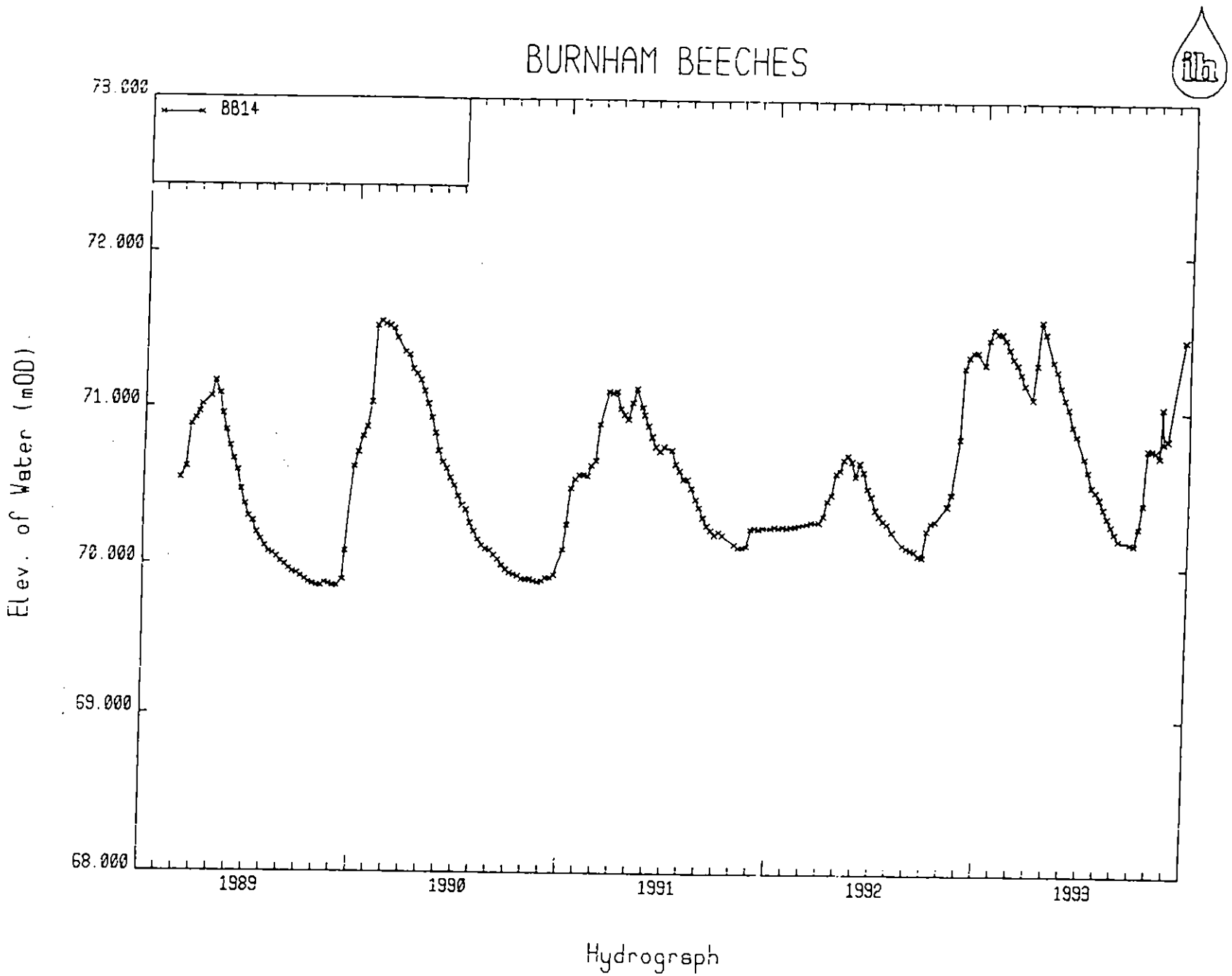
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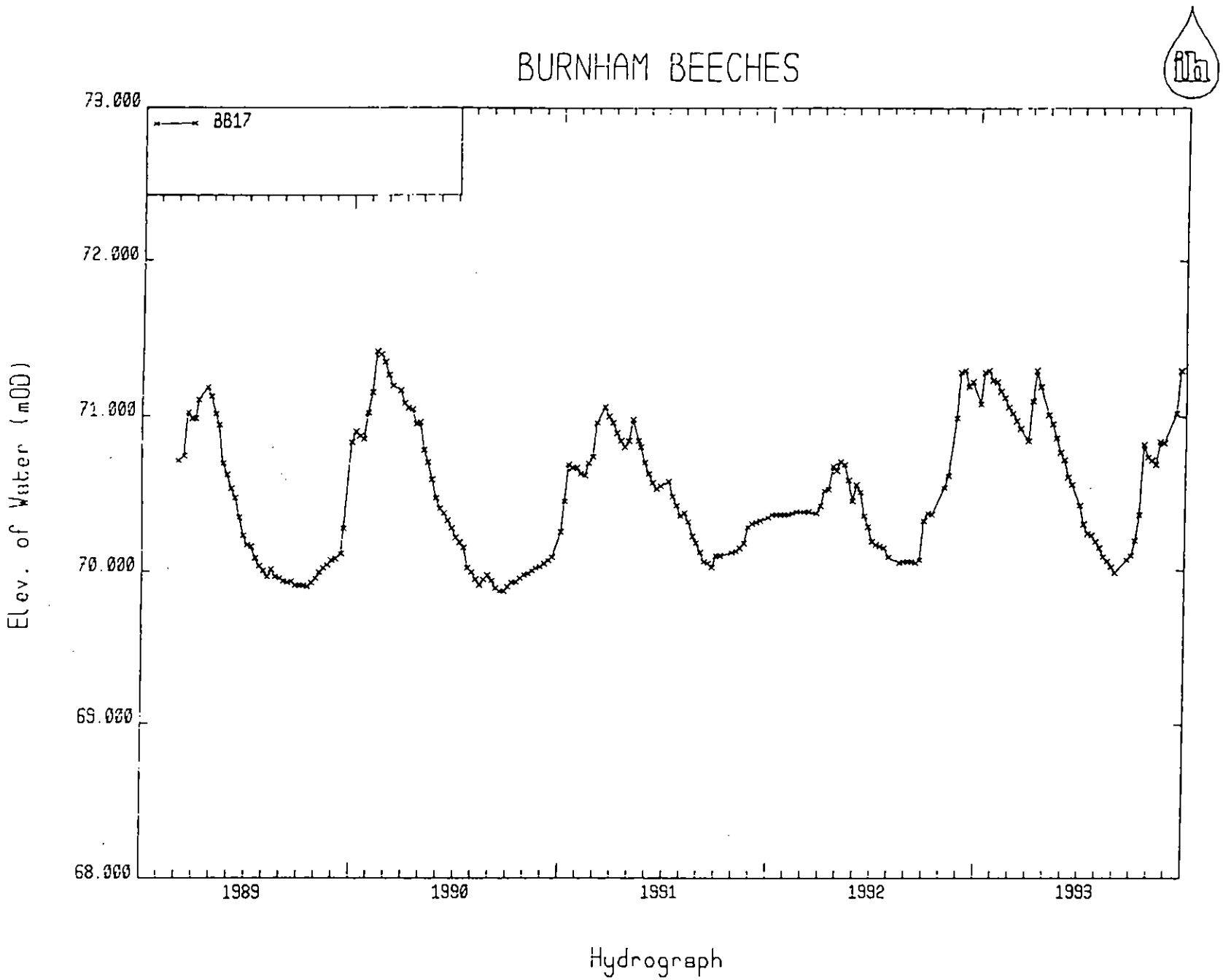
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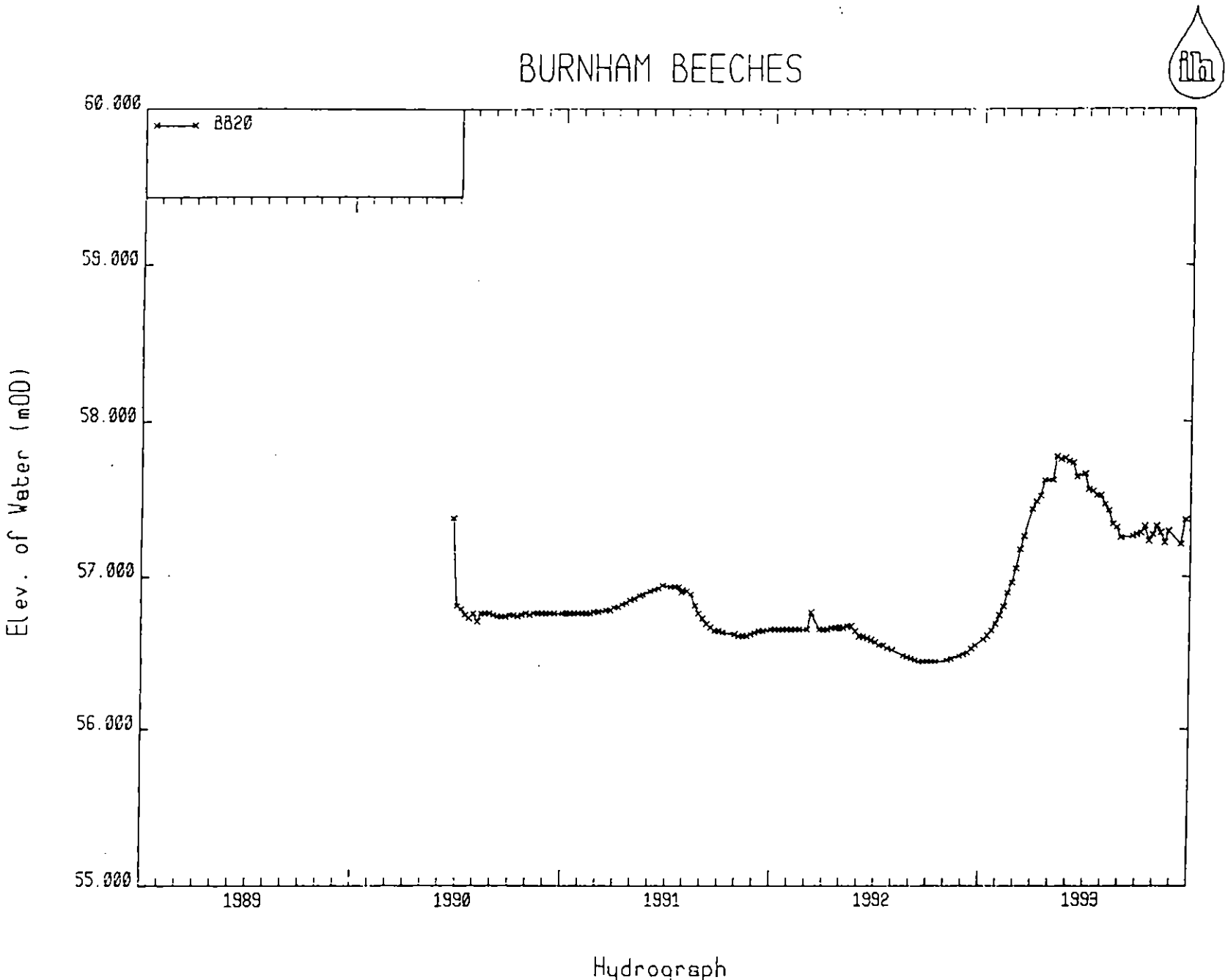
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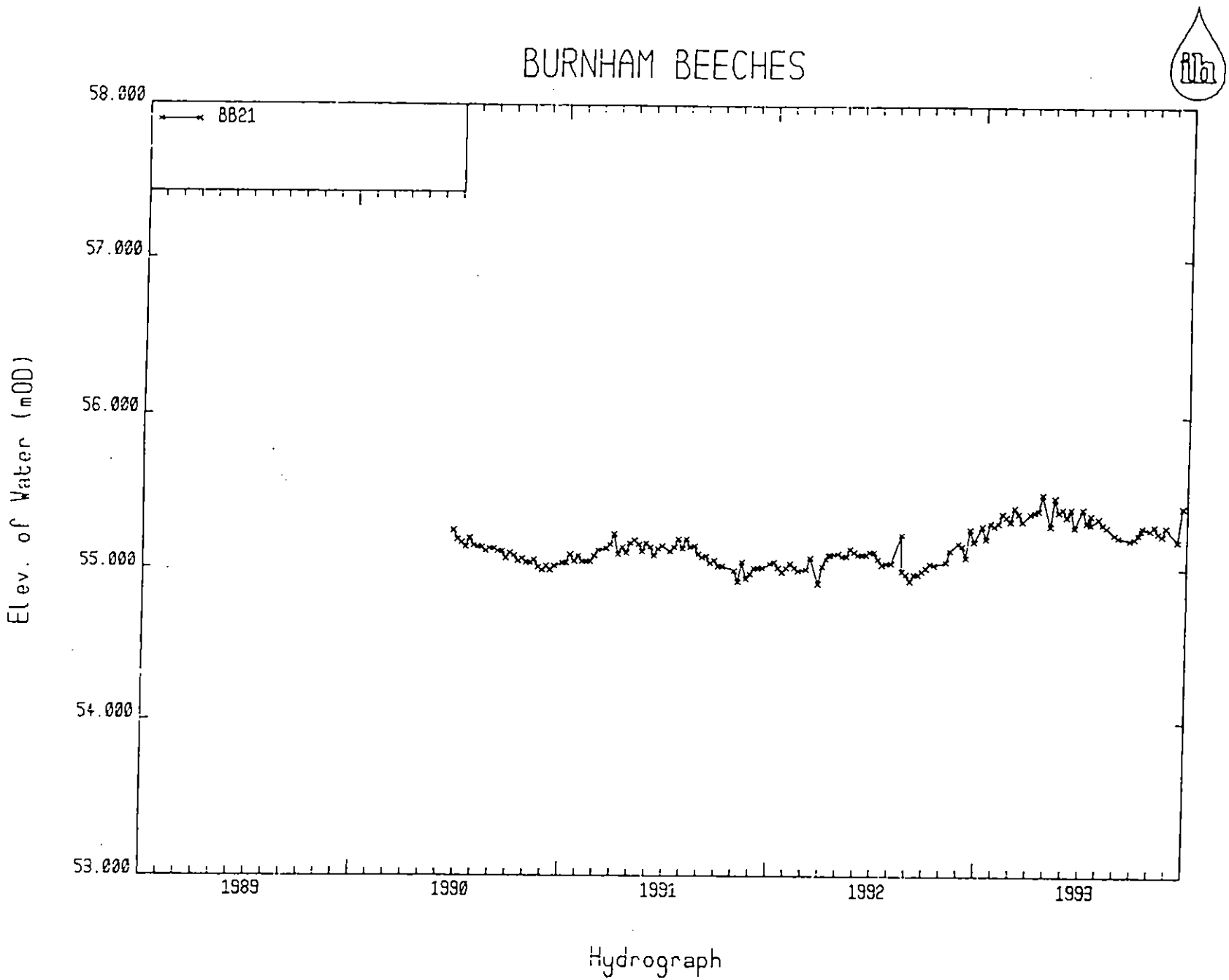
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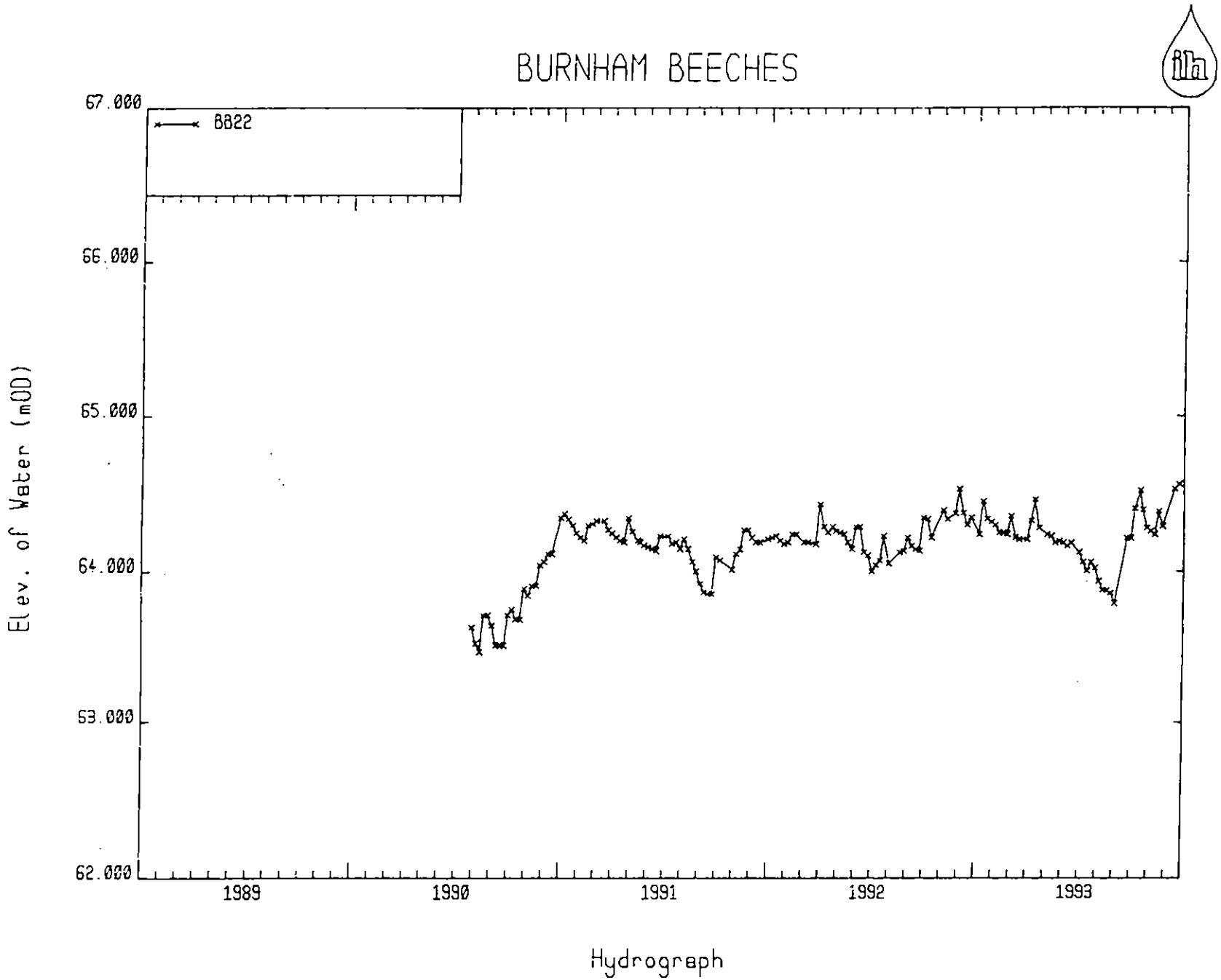
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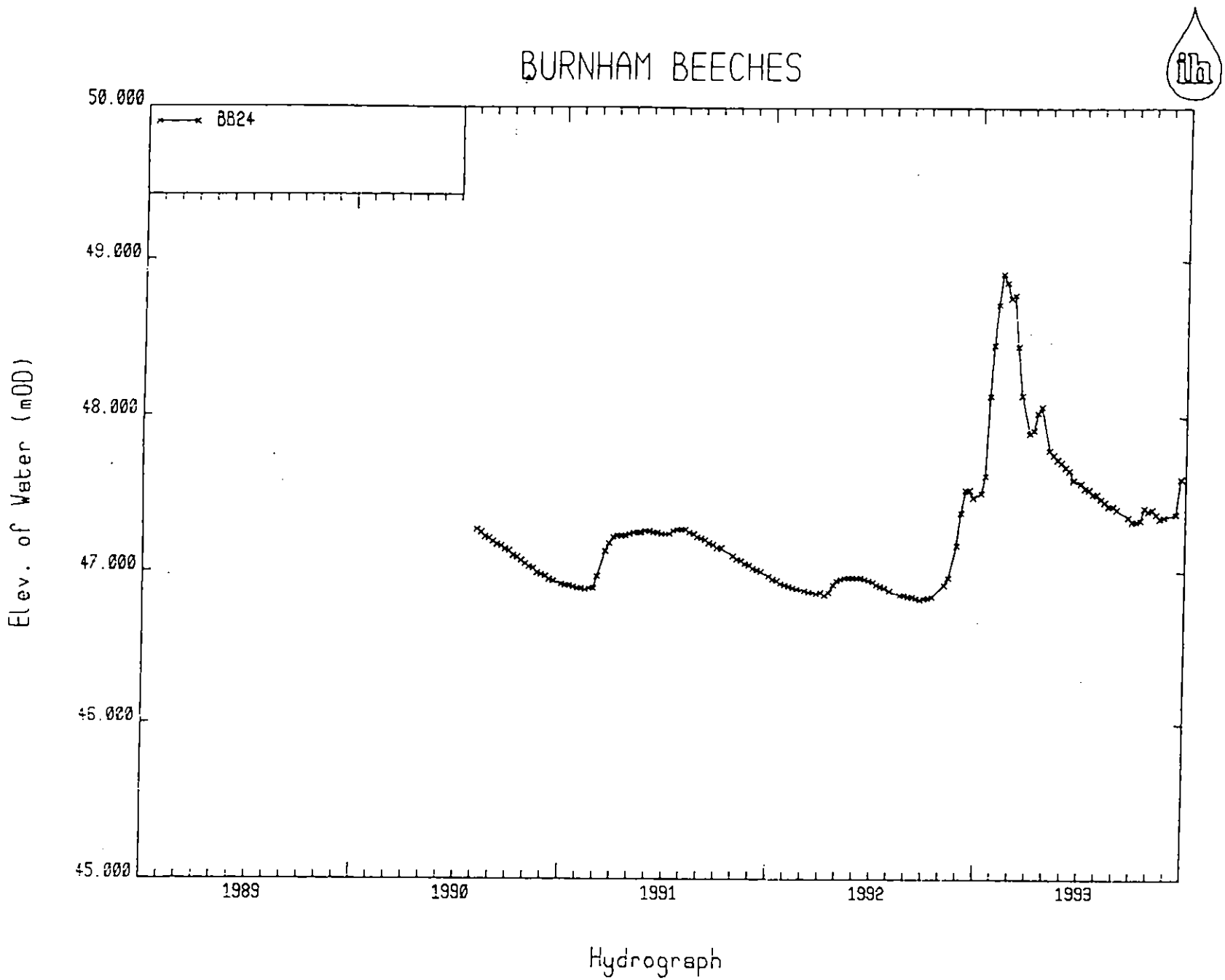
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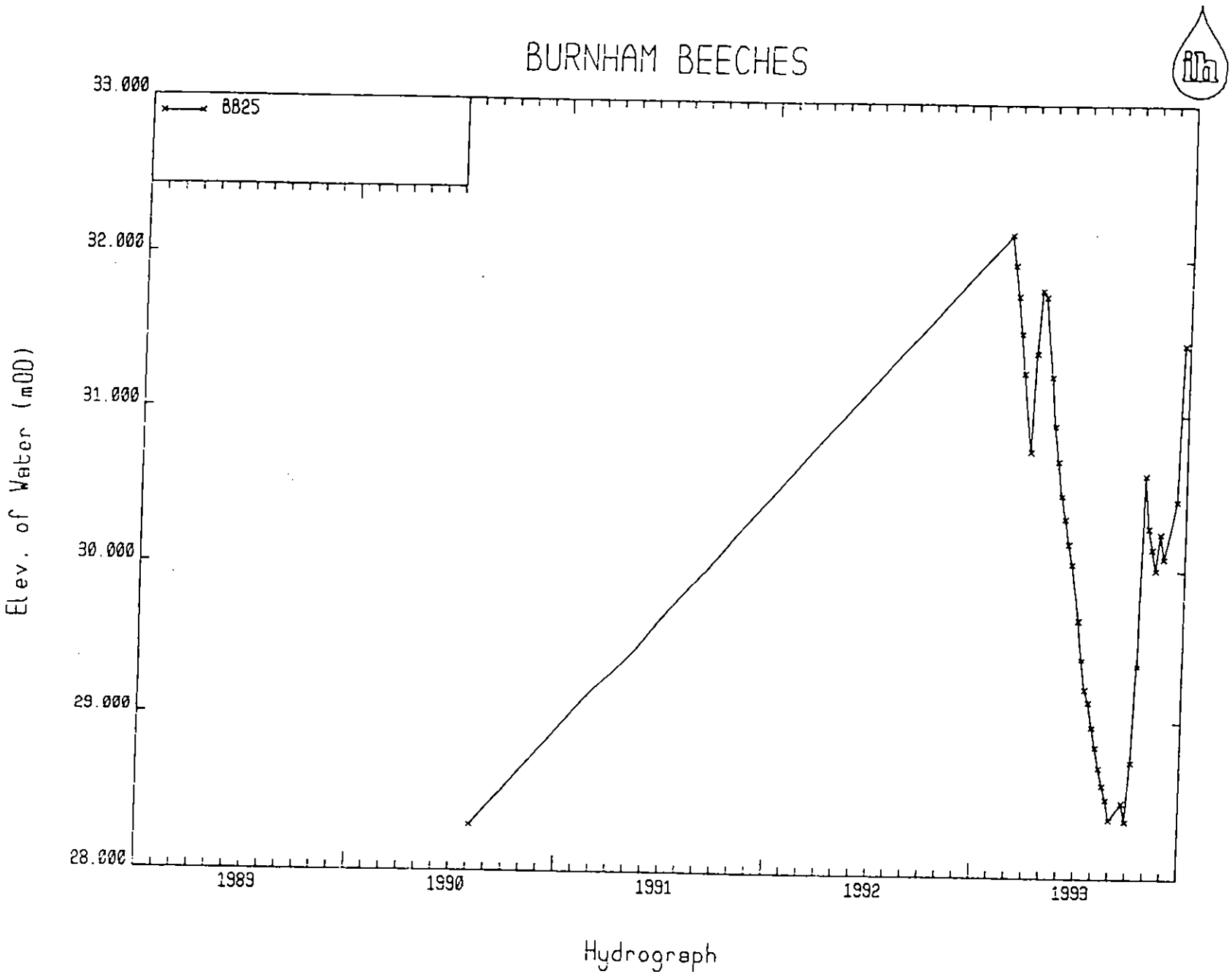
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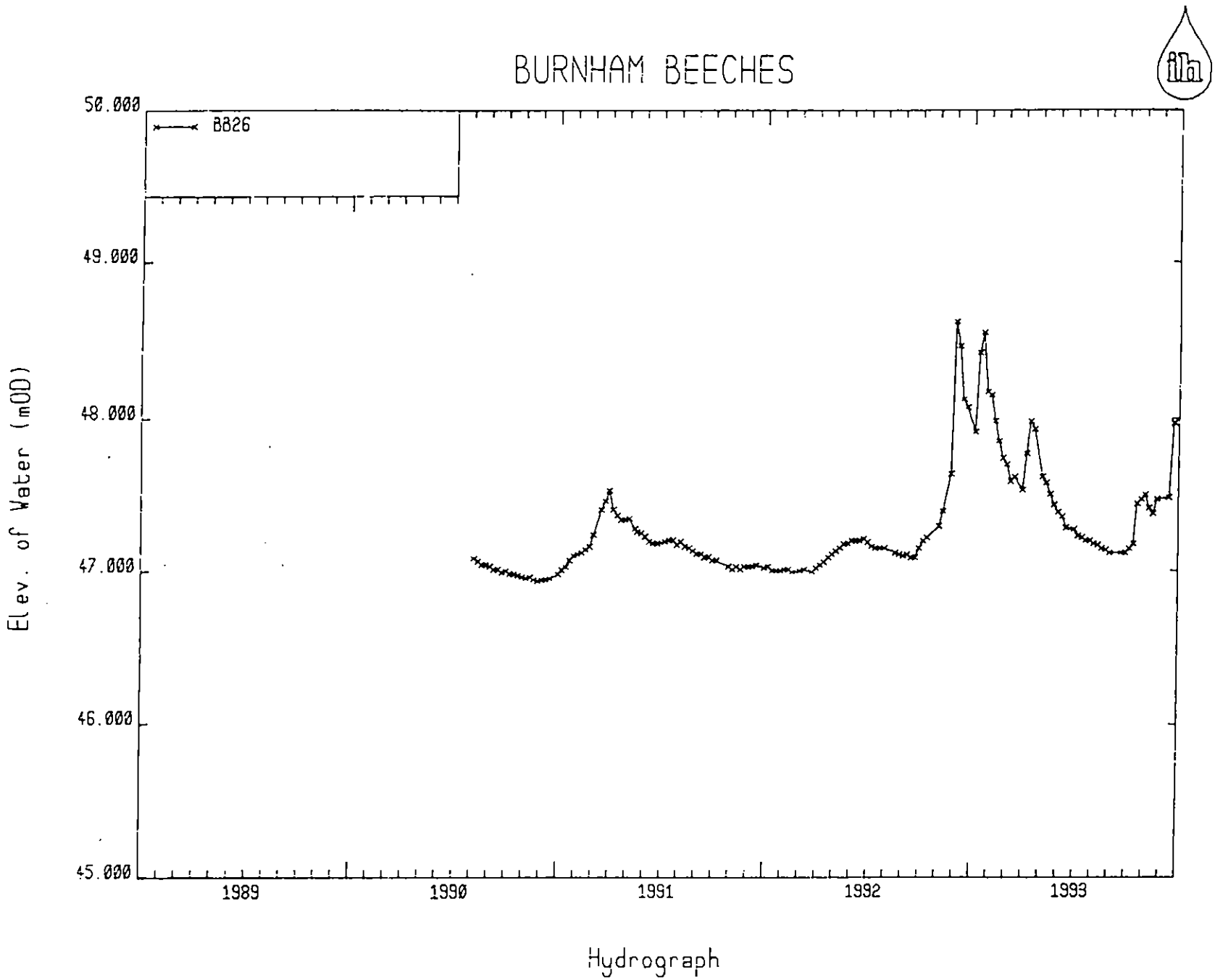
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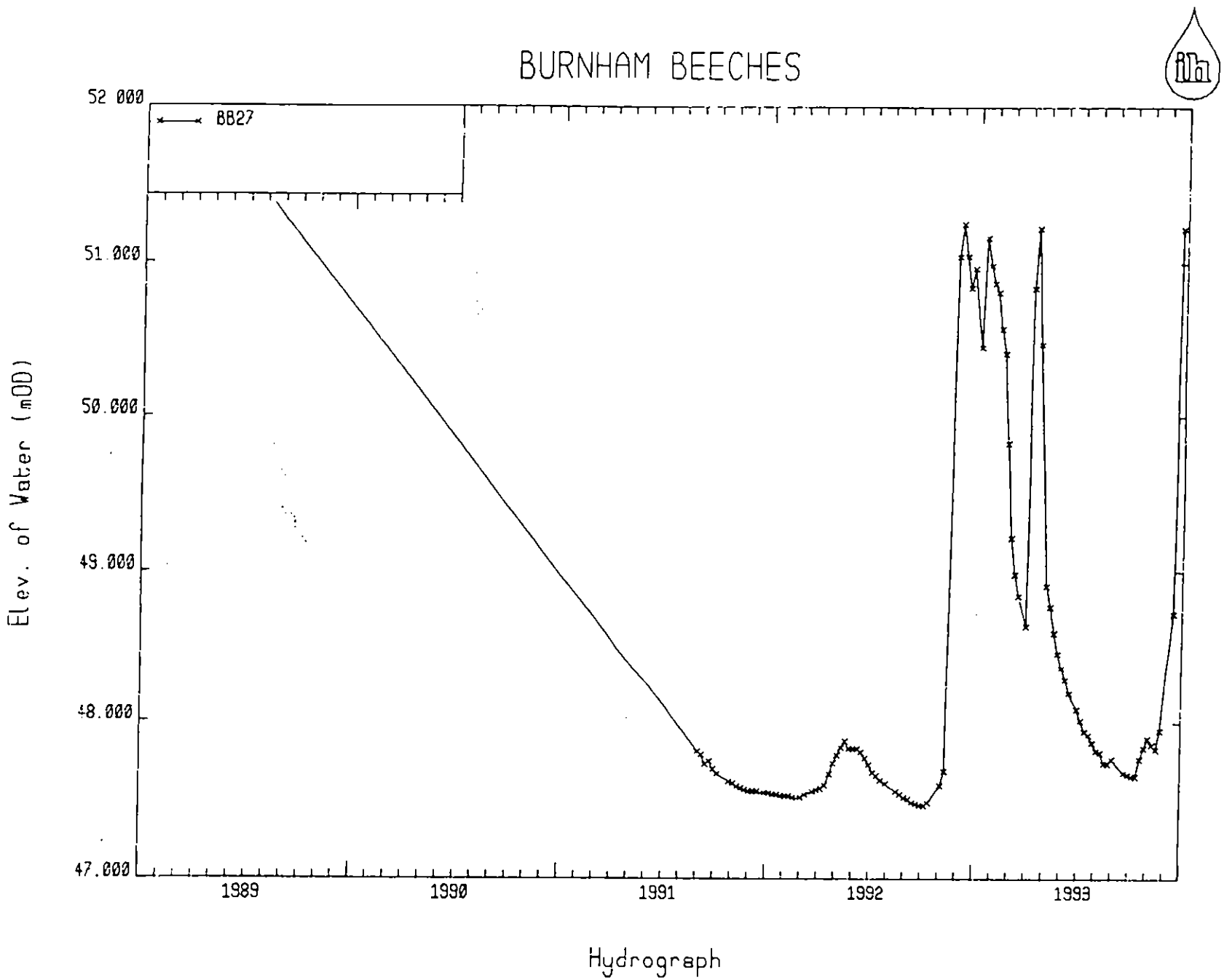
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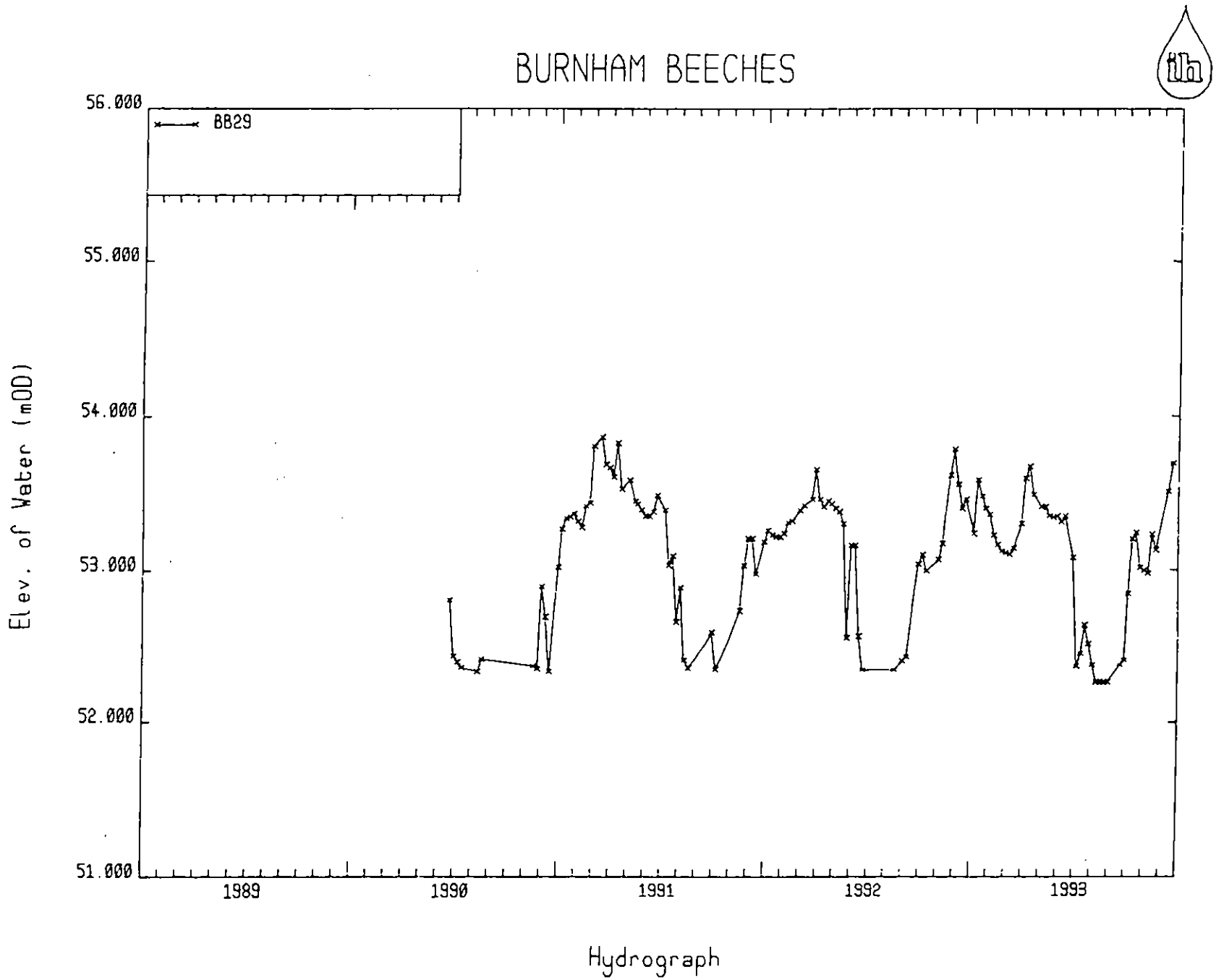
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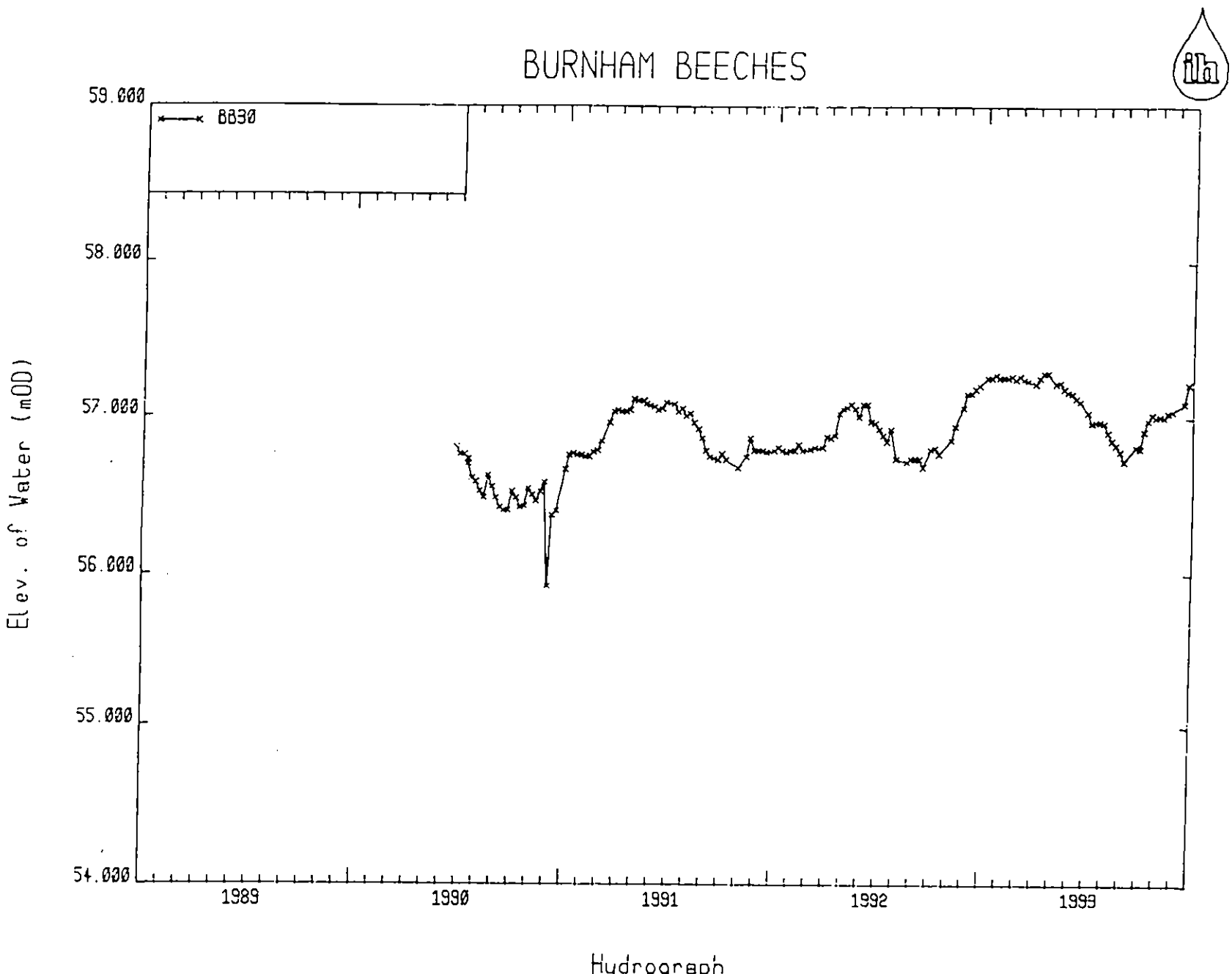
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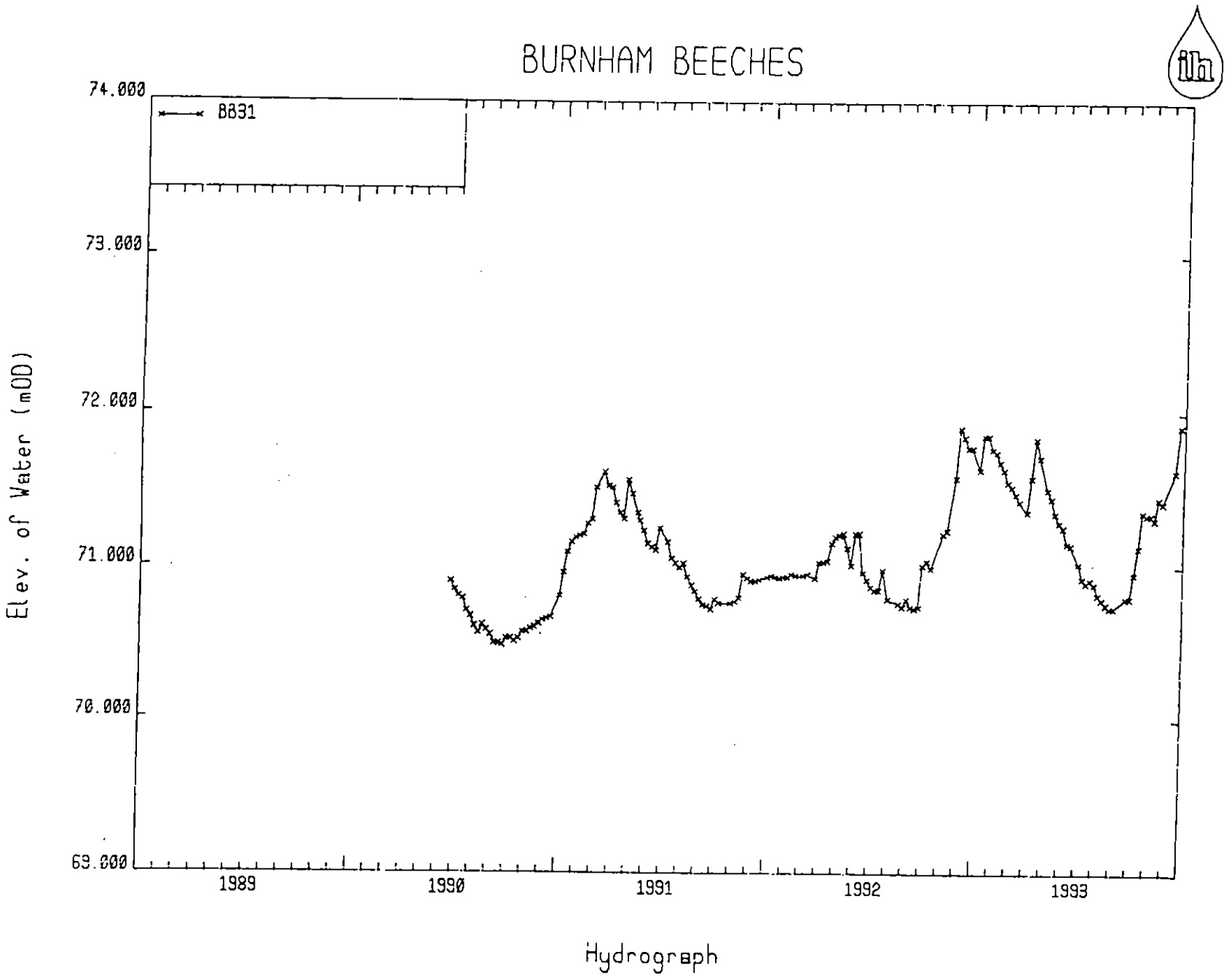
Hydrograph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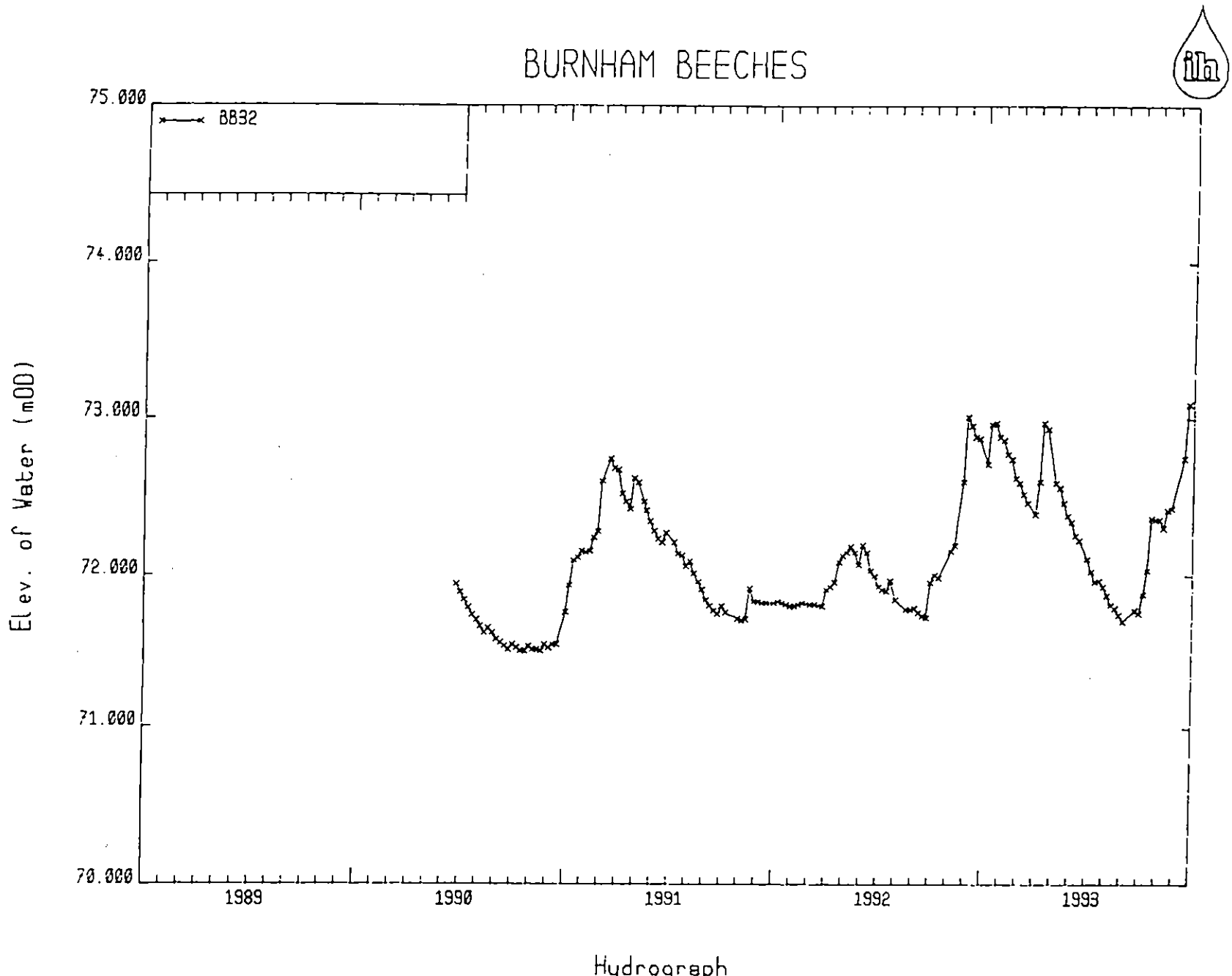
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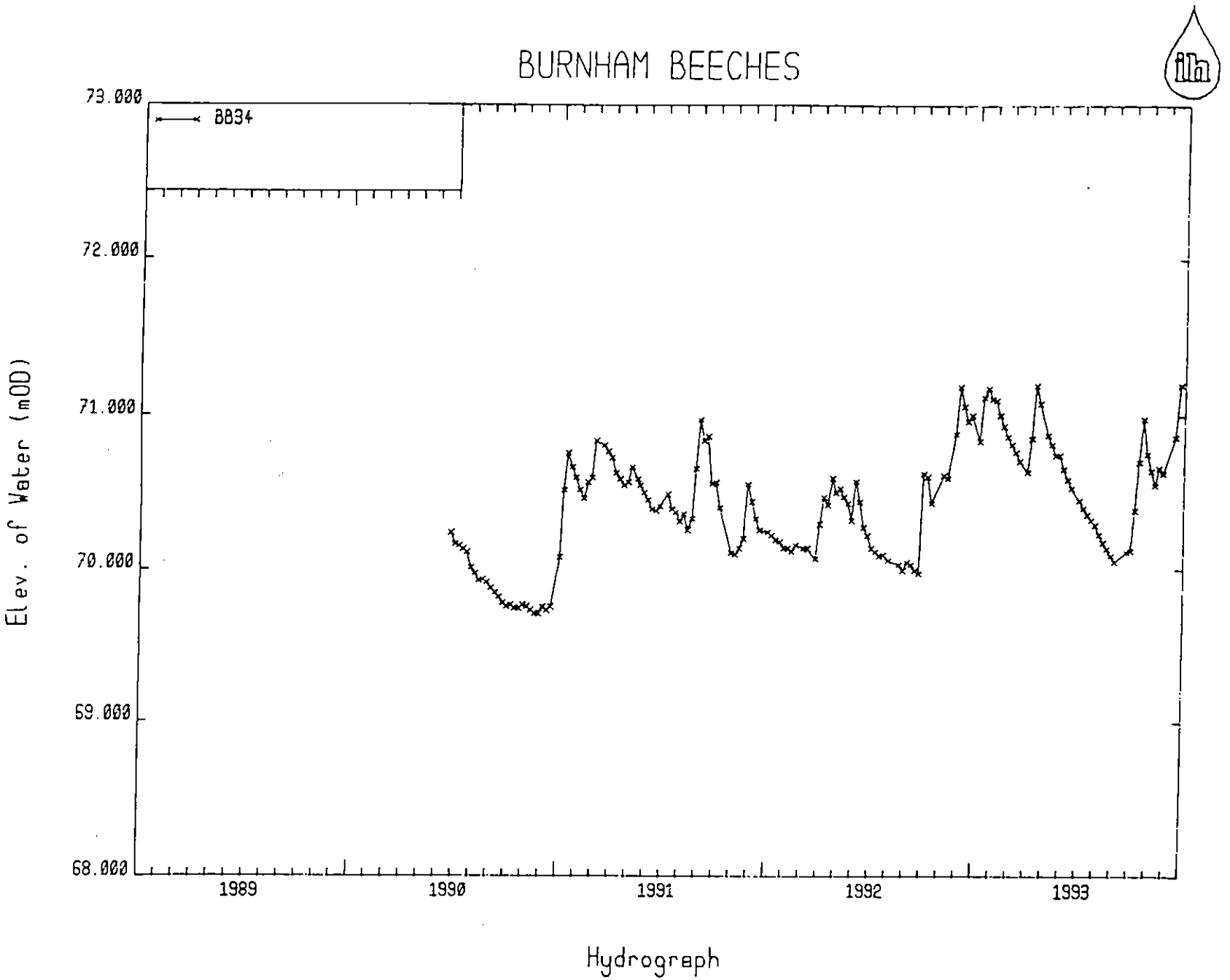
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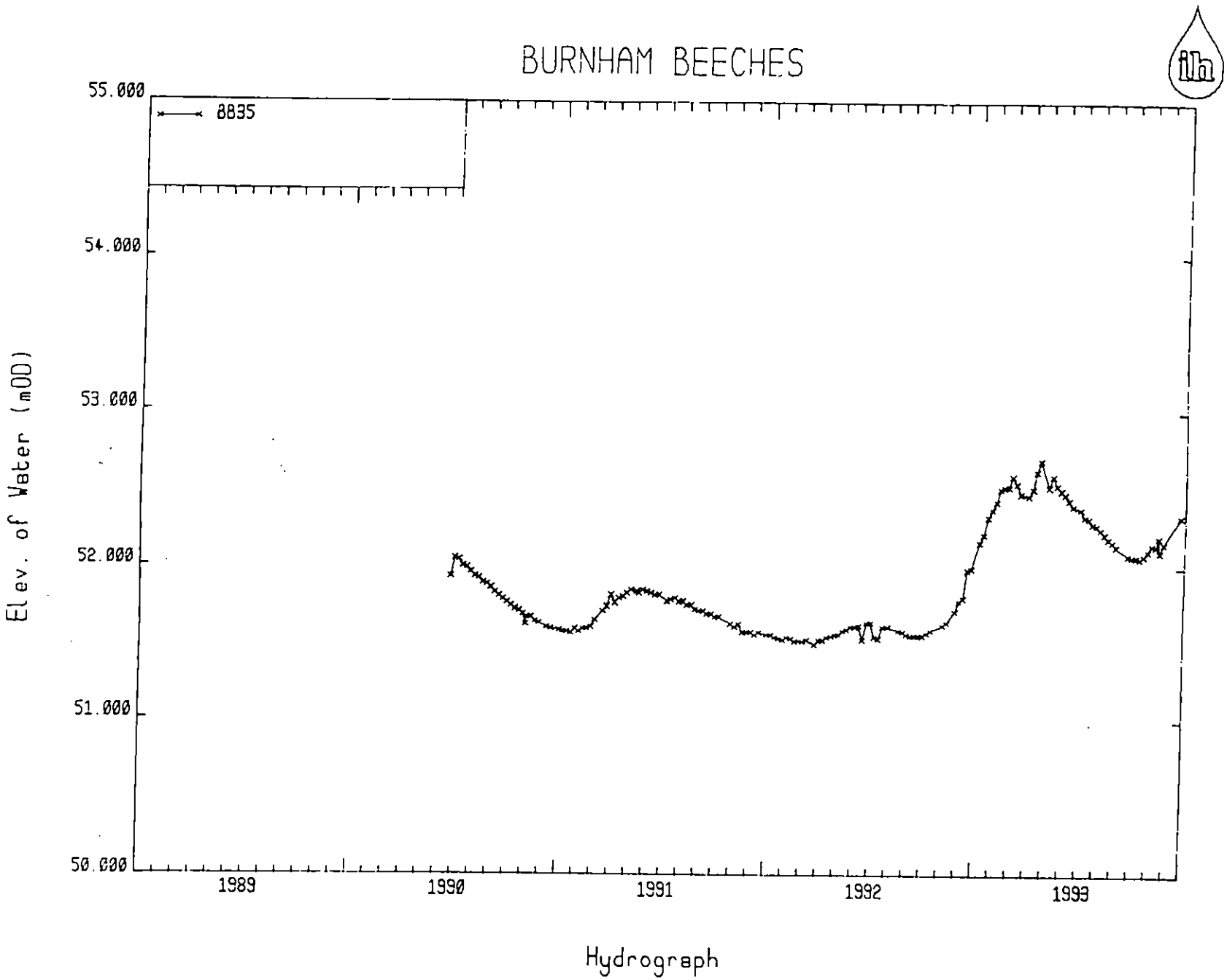
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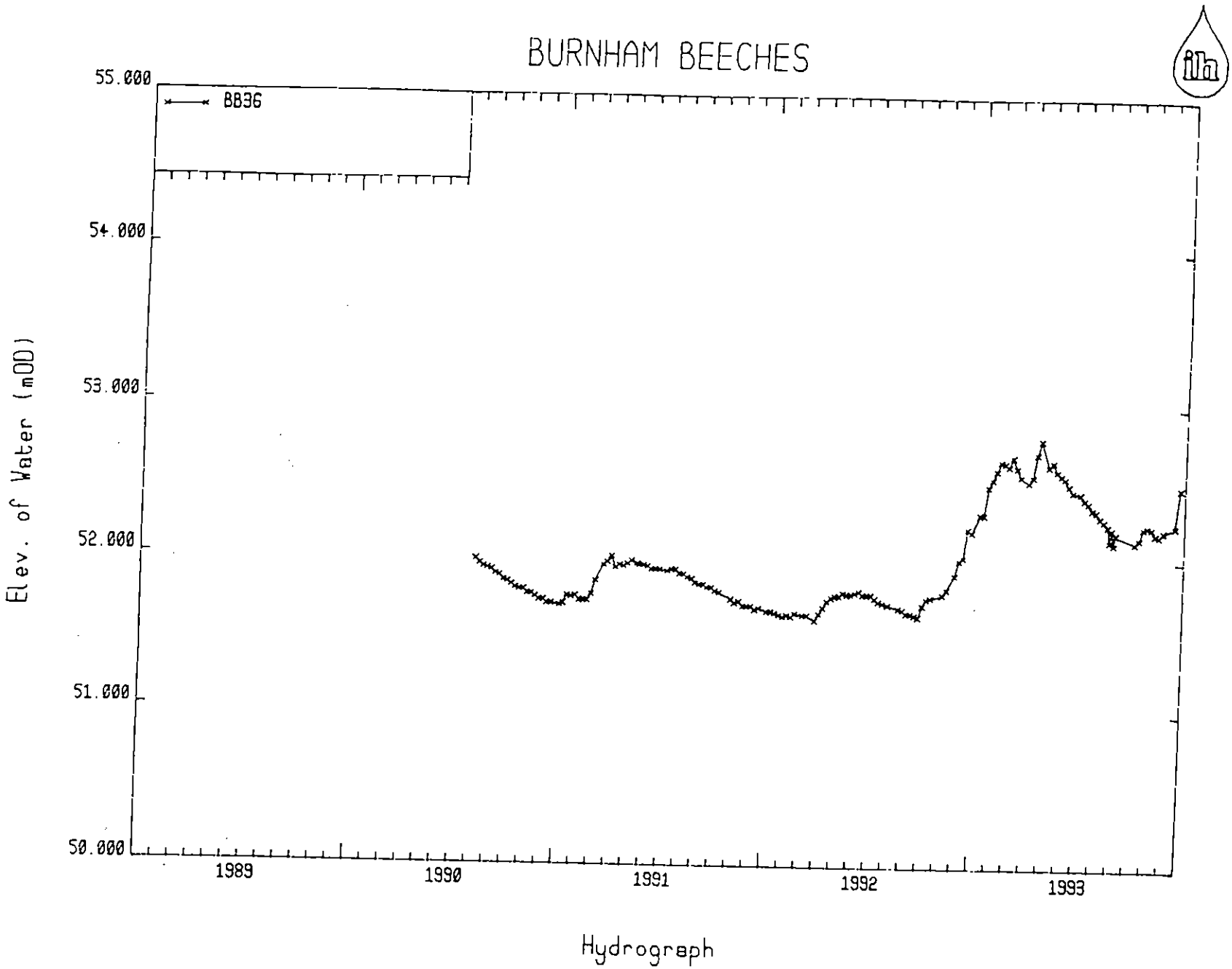
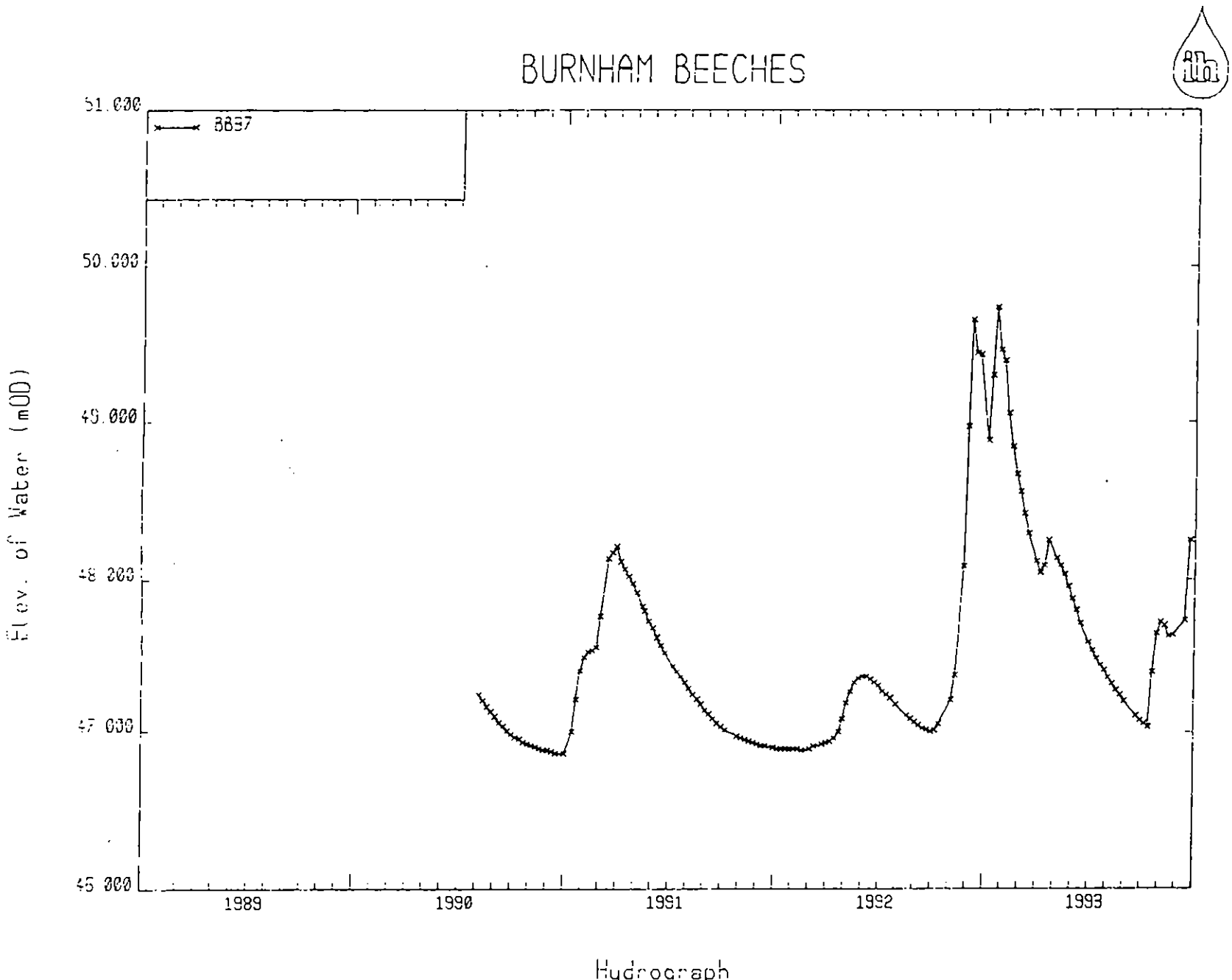
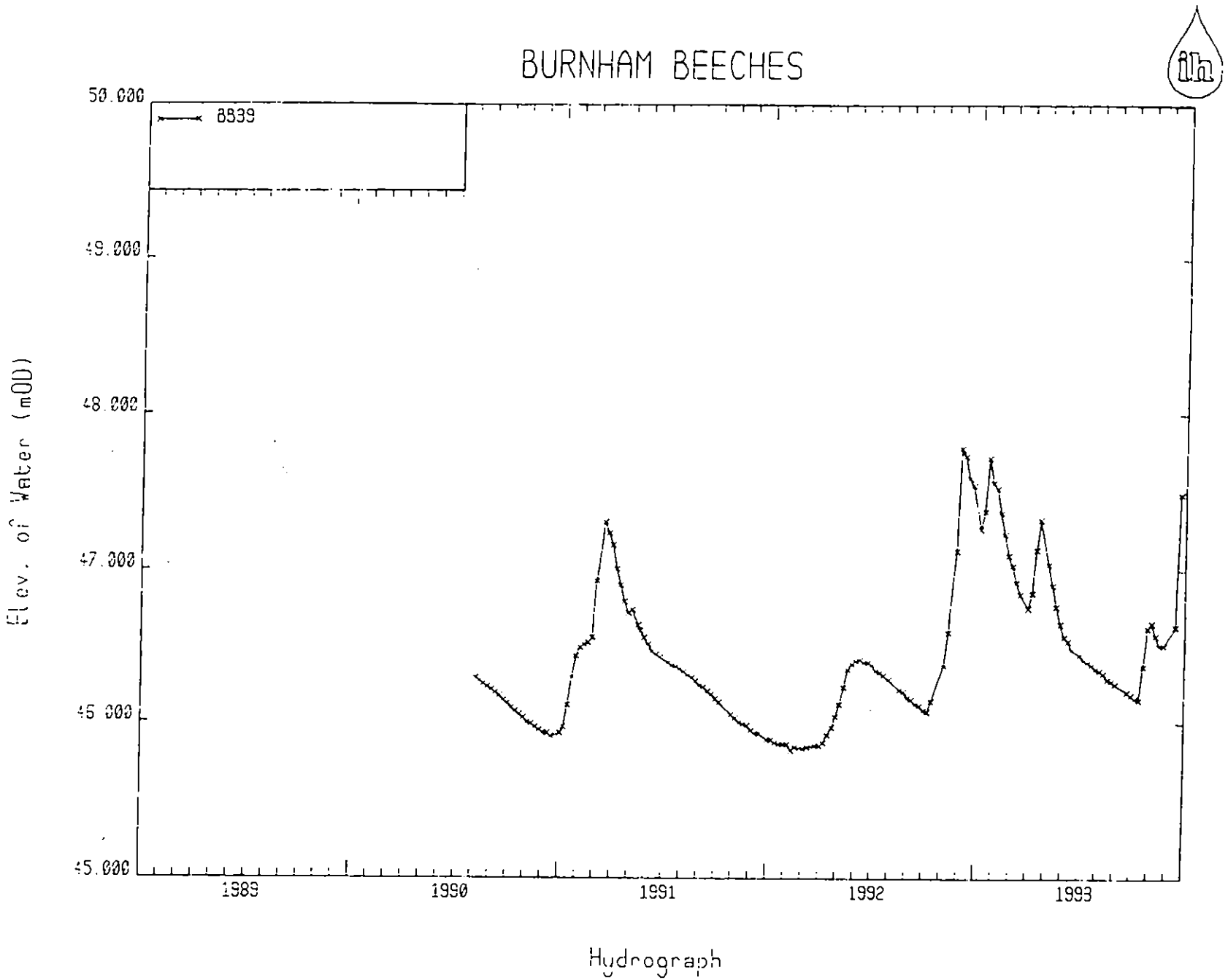
Elev. of Water (mOD)
1989
1990
1991
1992
1993
Hydrograph


BURNHAM BEECHES
BB36
55.000
54.000
53.000
52.000
51.000
50.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

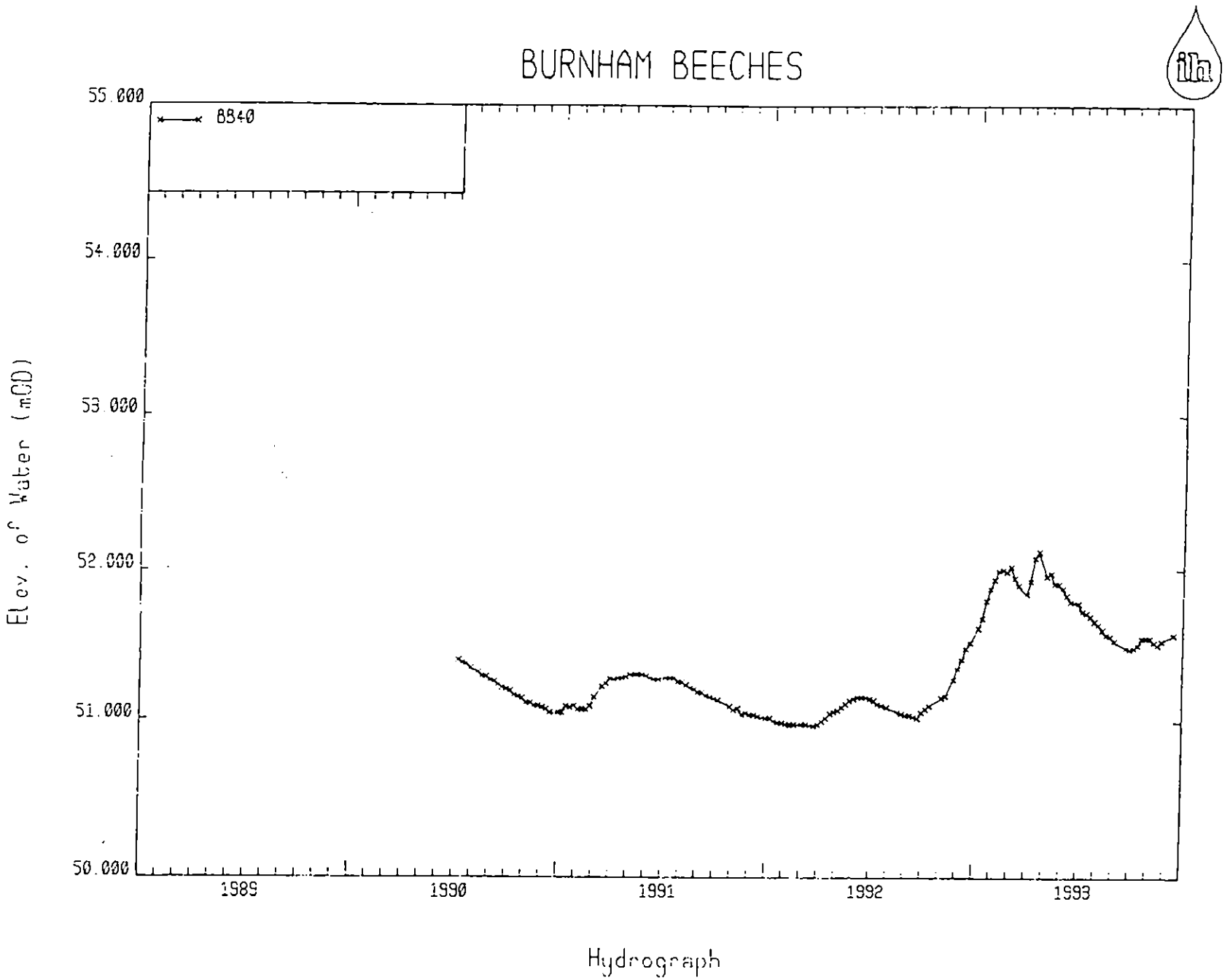
Hydrograph


BURNHAM BEECHES
8837
51.000
50.000
49.000
48.000
47.000
46.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
8839
50.000
49.000
48.000
47.000
46.000
45.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
BB40
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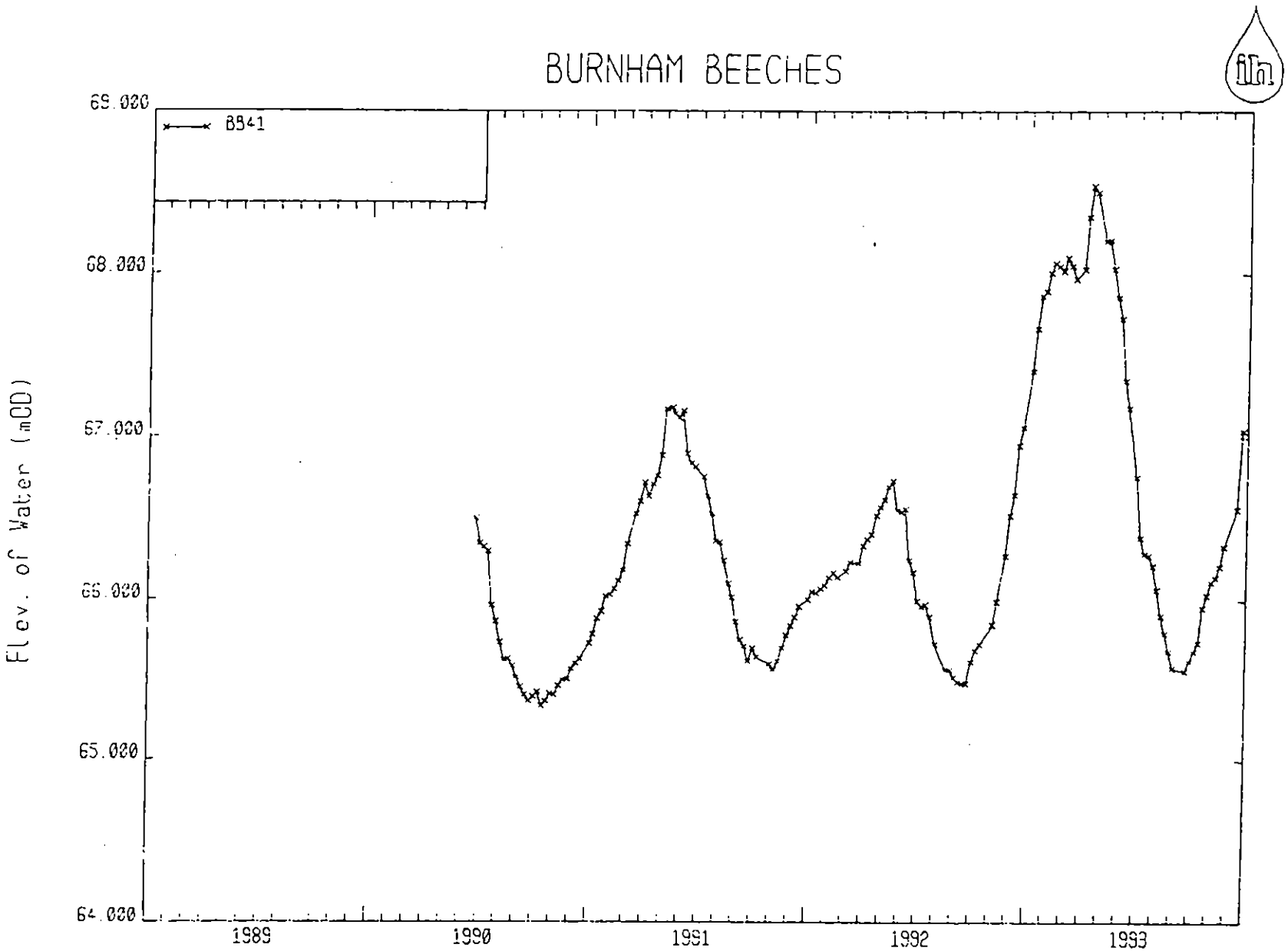
53.000
52.000
51.000
50.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
B841
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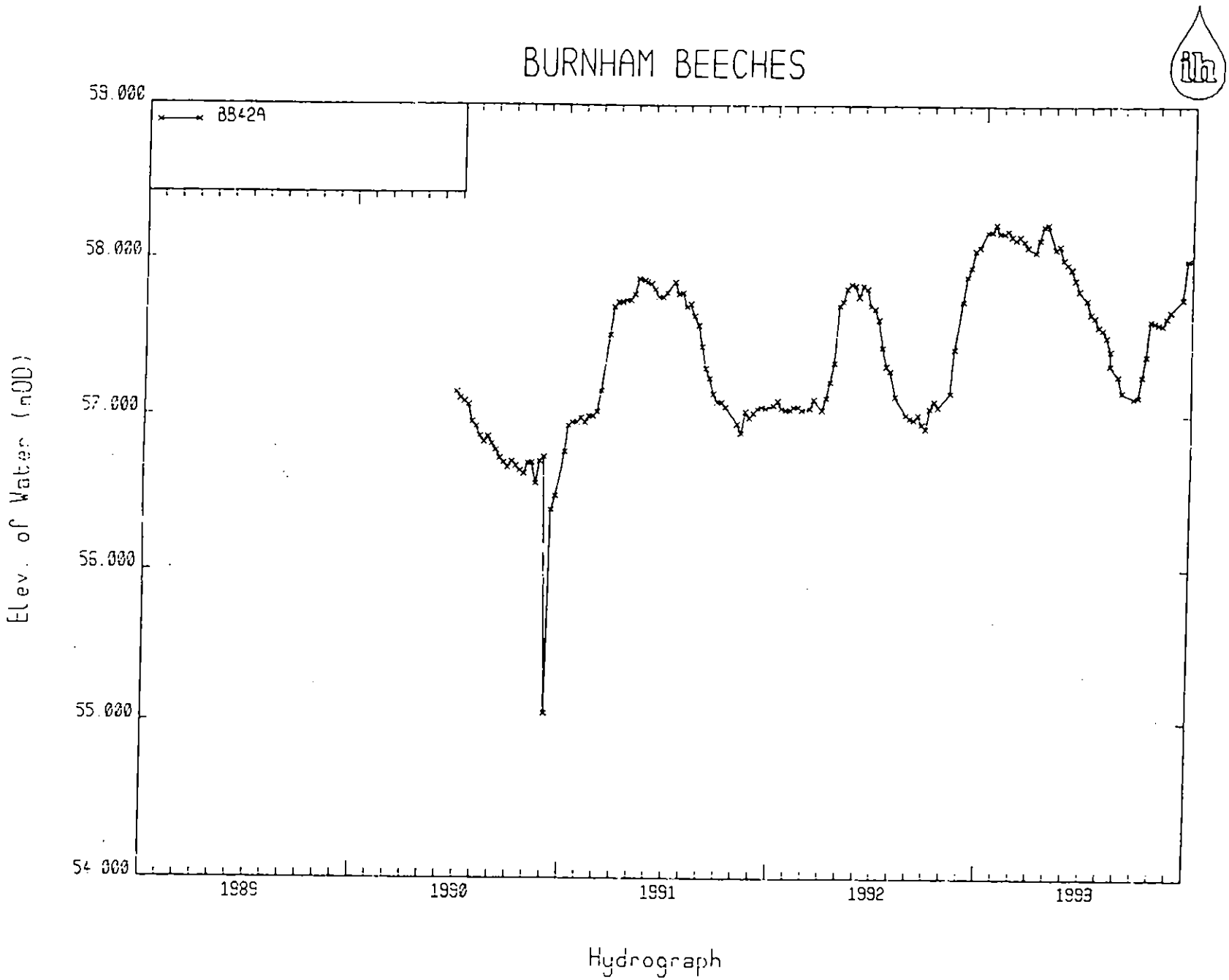
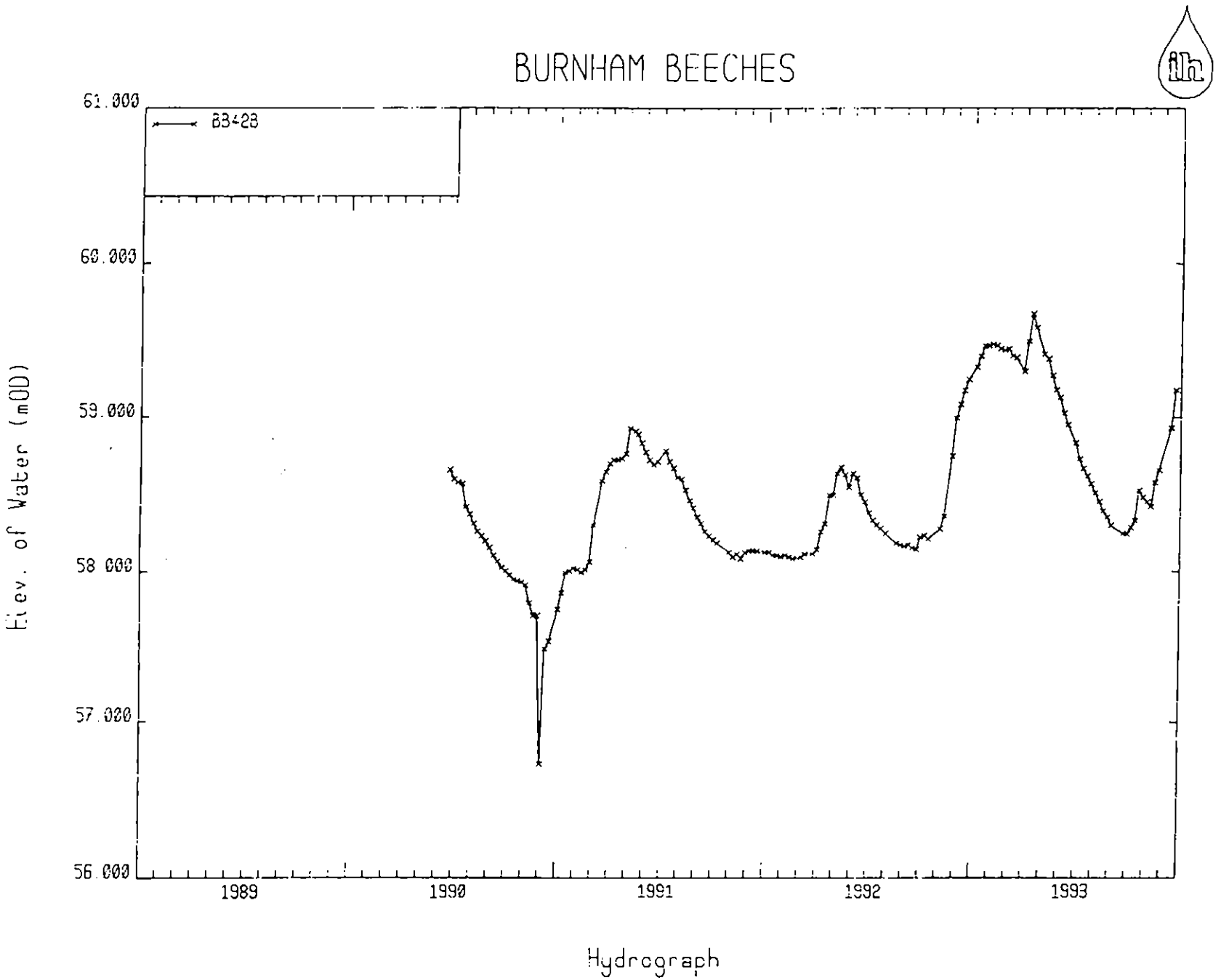
68.000
67.000
66.000
65.000
64.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
ih
88429
59.000
58.000
57.000
56.000
55.000
54.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph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B3428
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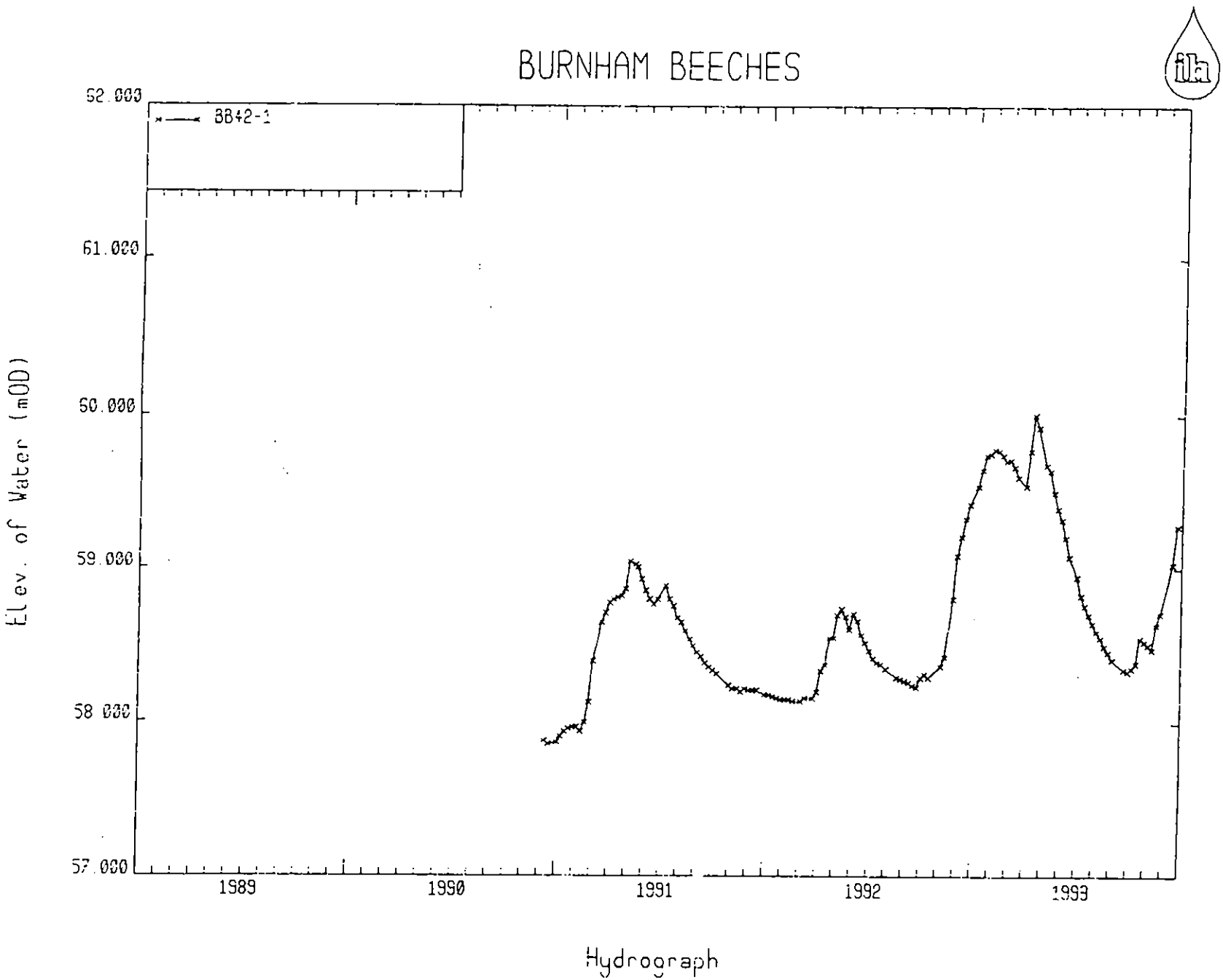
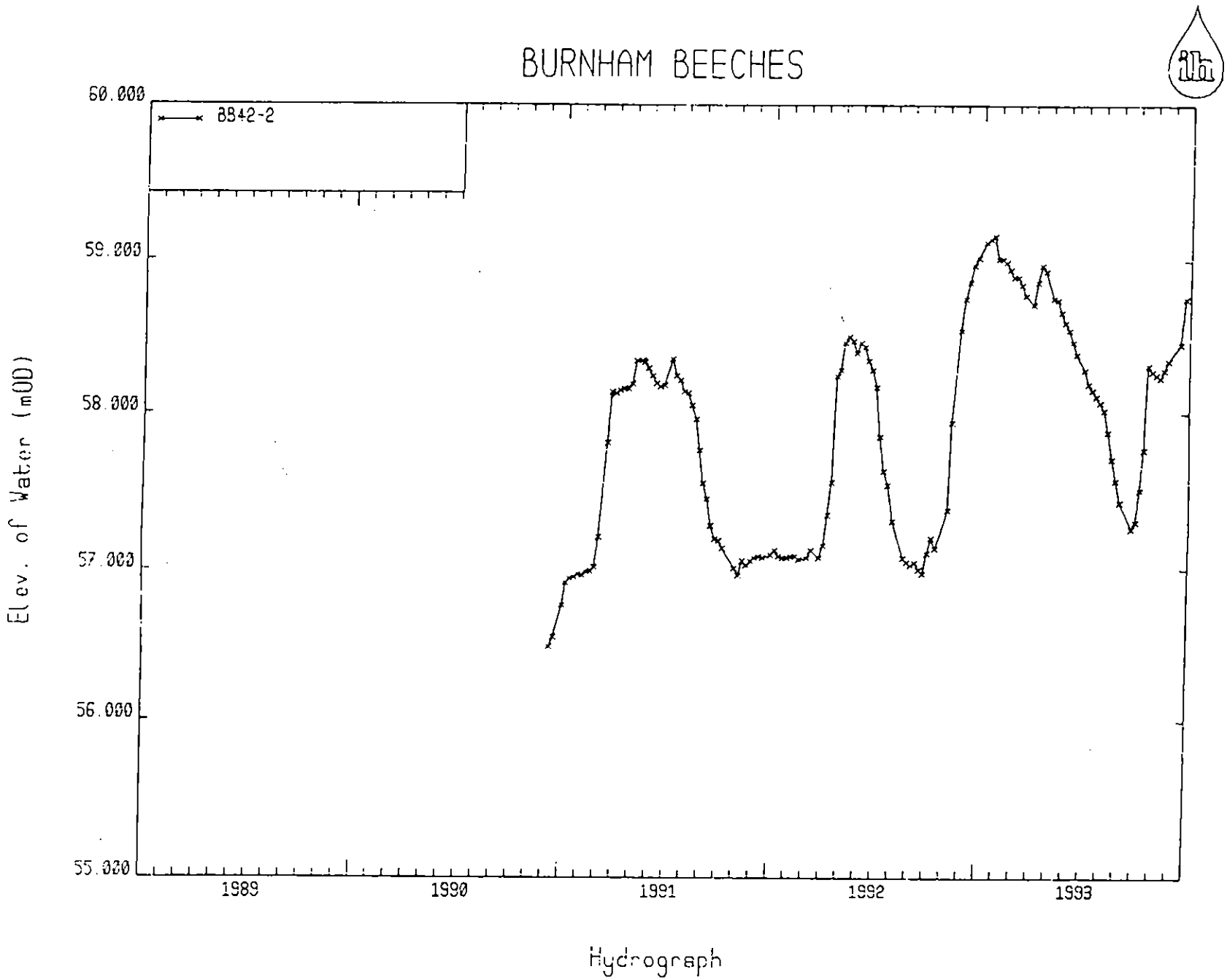
59.000
58.000
57.000
56.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
fih
3842-1
62.000
61.000
60.000
59.000
58.000
57.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993
Hydrograph


BURNHAM BEECHES
8842-2
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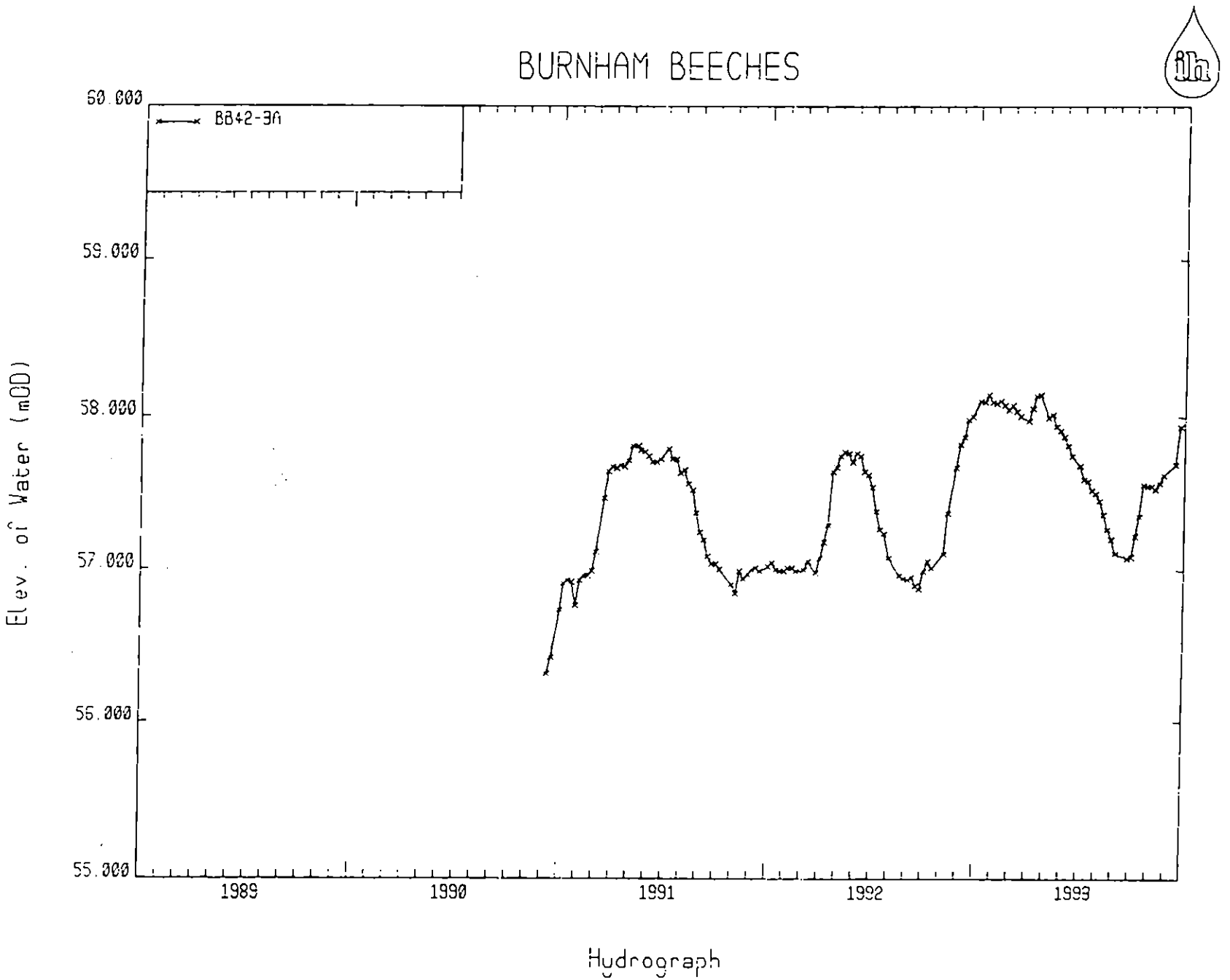
58.000
57.000
56.000
55.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
BB42-3A
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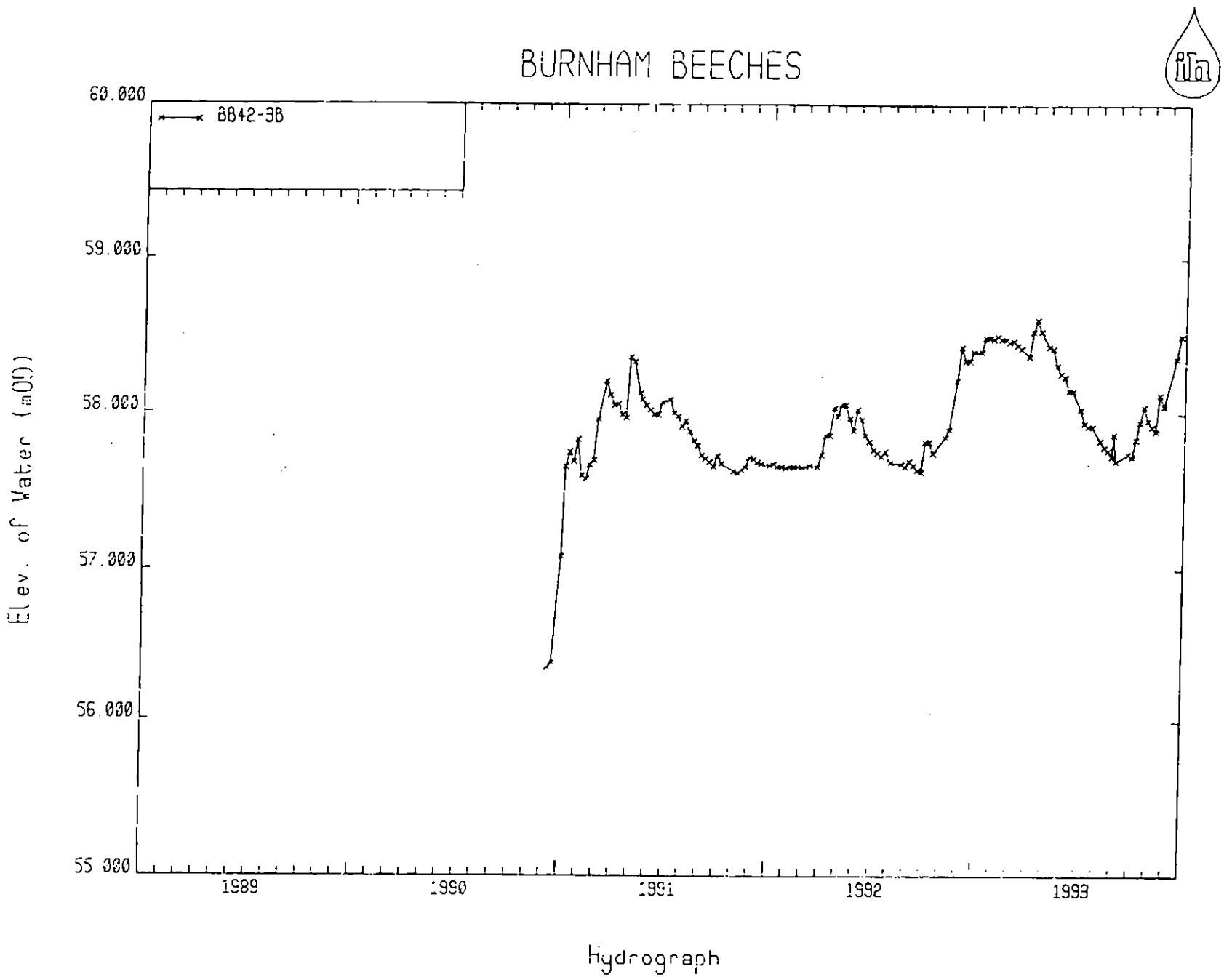
56.000
55.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993
Hydrograph


BURNHAM BEECHES
8842-3B
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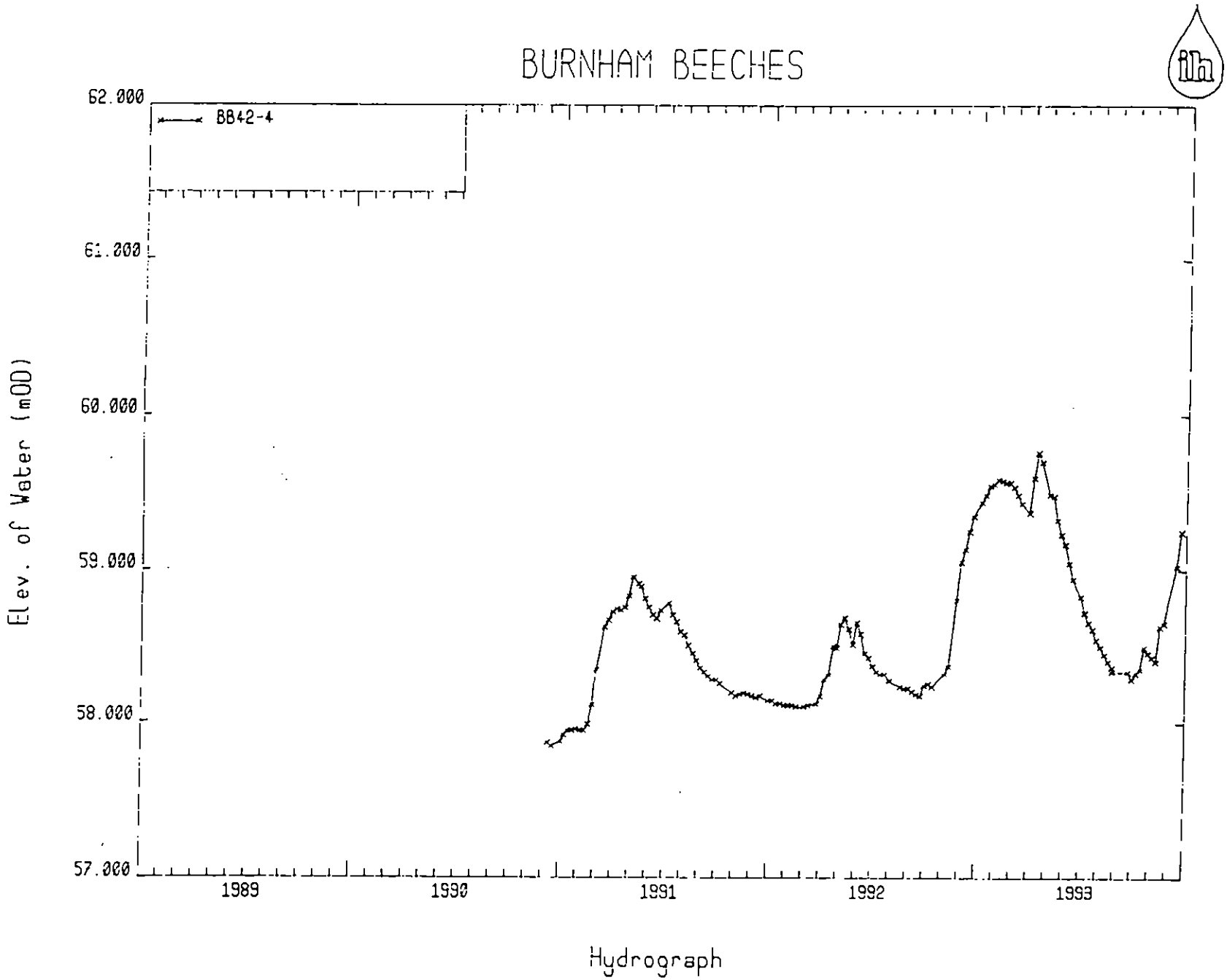
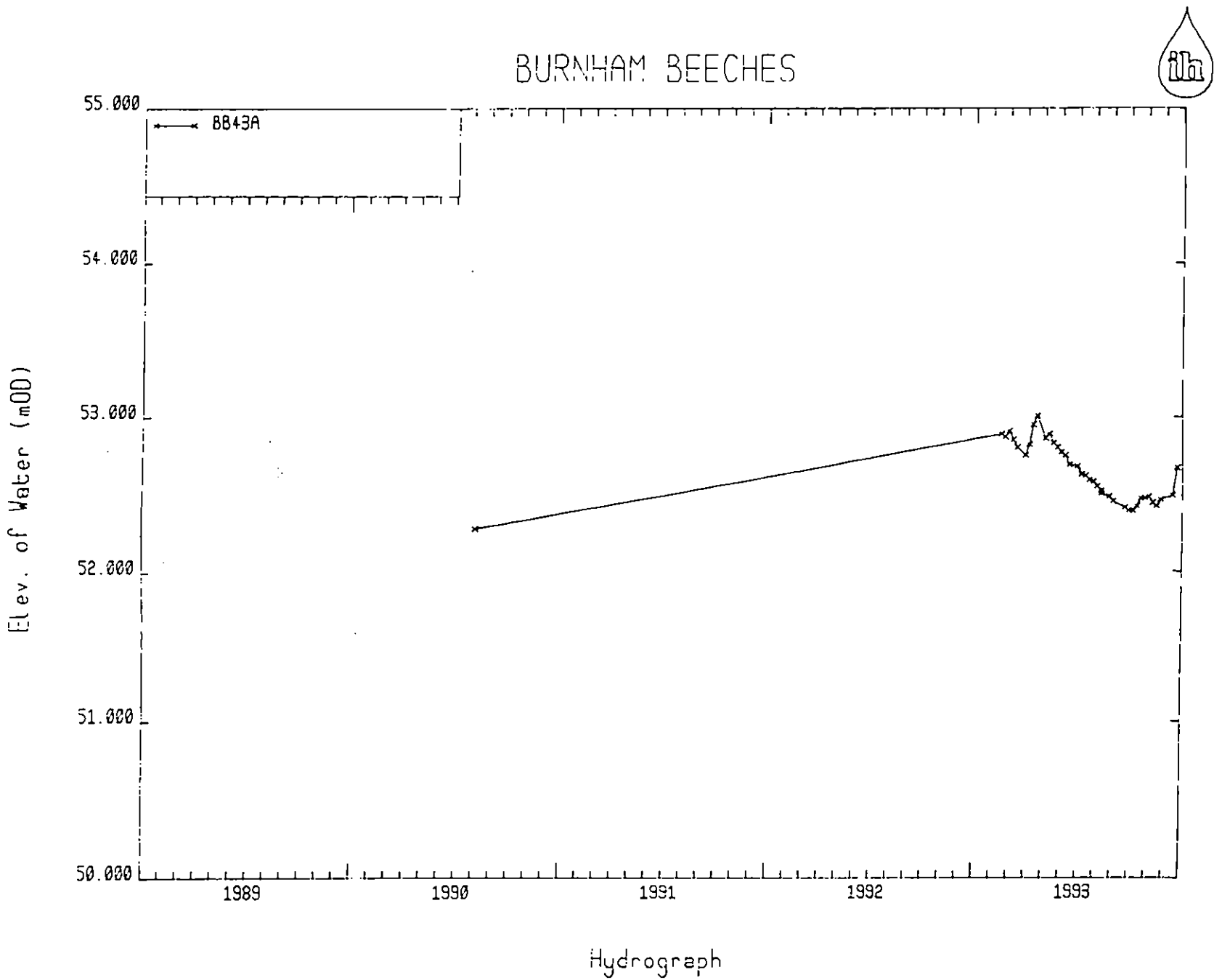
57.000
56.000
55.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
ih
62.000
61.000
60.000
59.000
58.000
57.000
BB42-4
Elev. of Water (mOD)
1989
1990
1991
1992
1993
Hydrograph


BURNHAM BEECHES
BB43A
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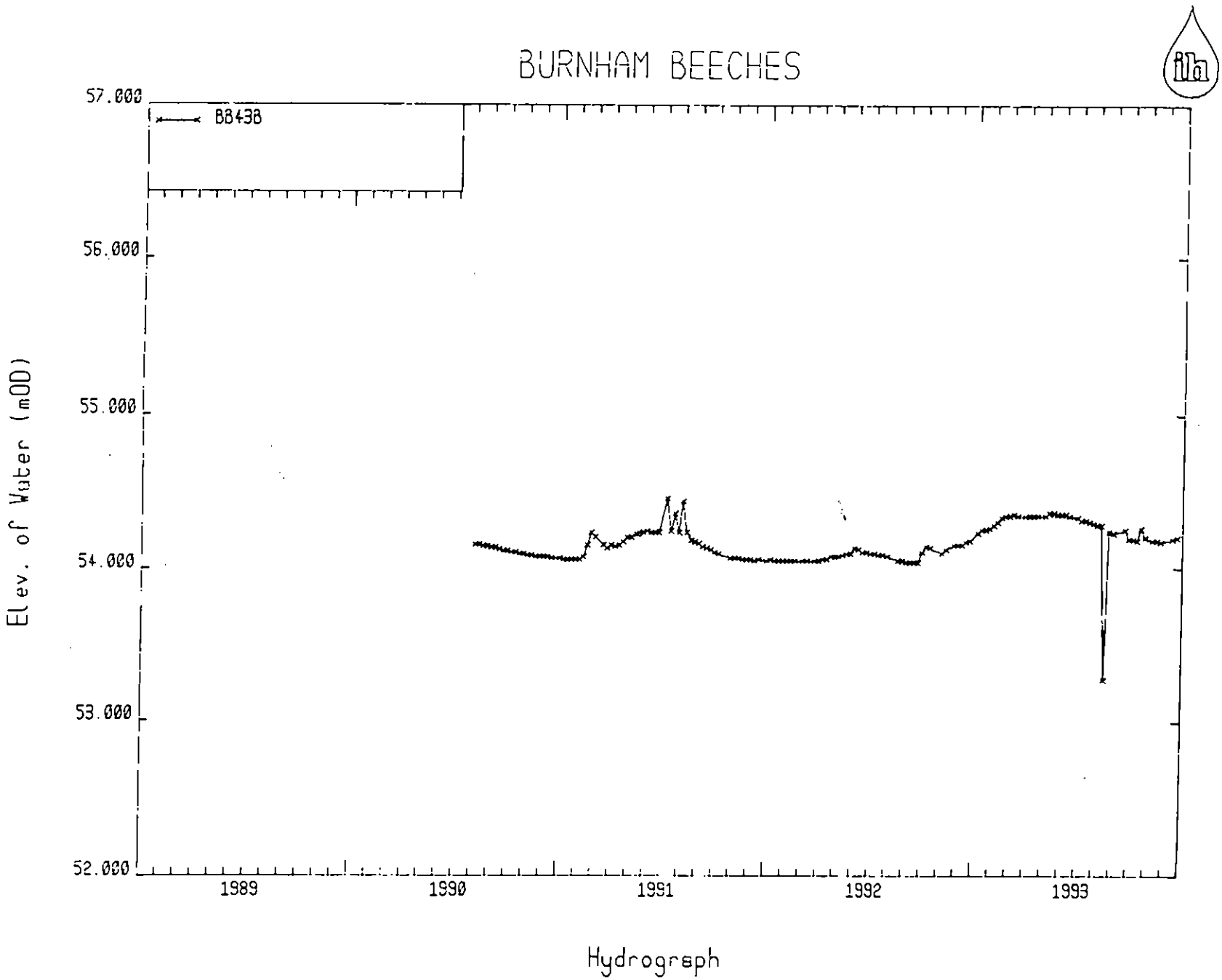
54.000
53.000
52.000
51.000
50.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph


BURNHAM BEECHES
B8438
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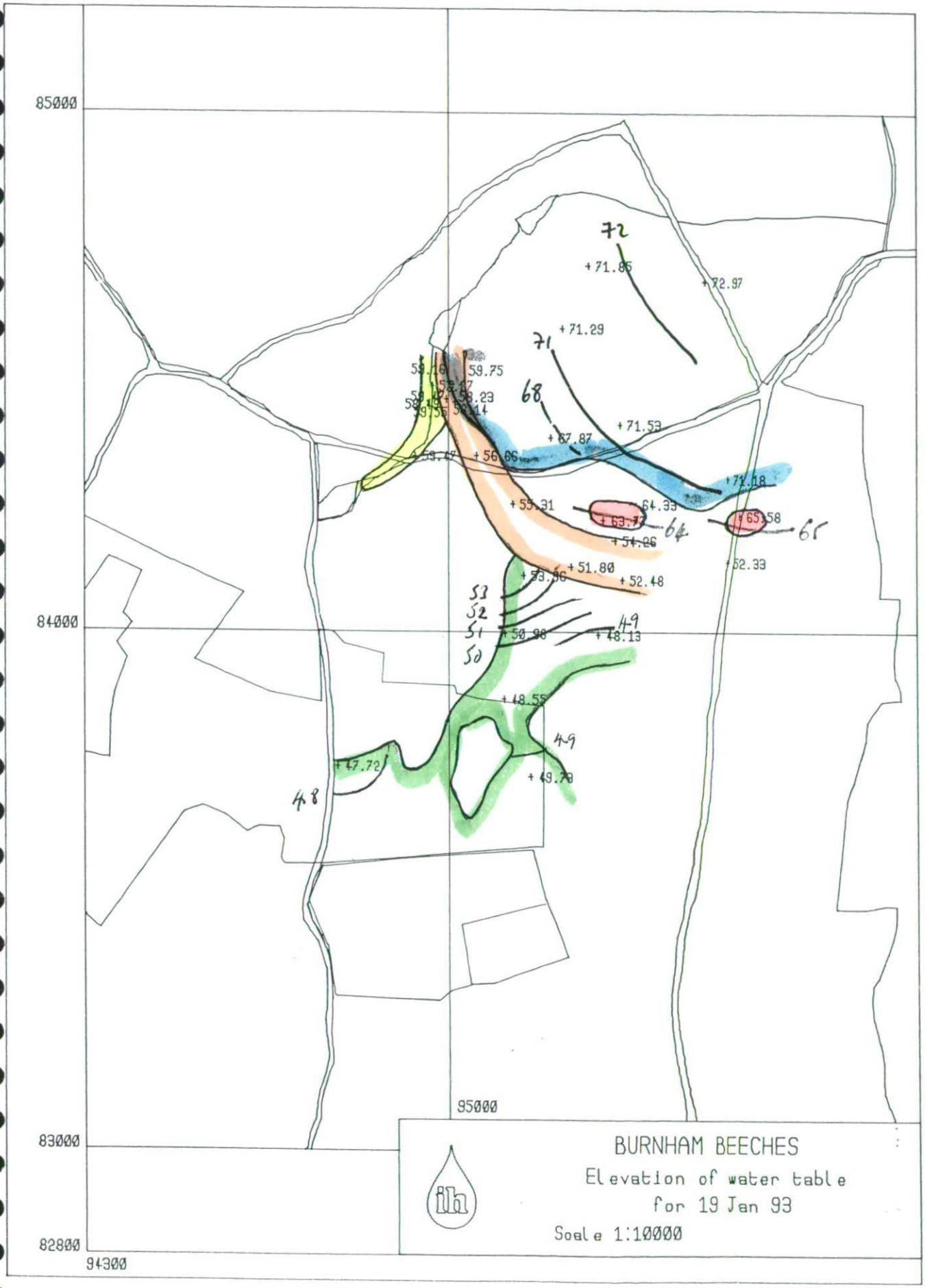
55.000
54.000
53.000
52.000
Elev. of Water (mOD)
1989
1990
1991
1992
1993

Hydrograph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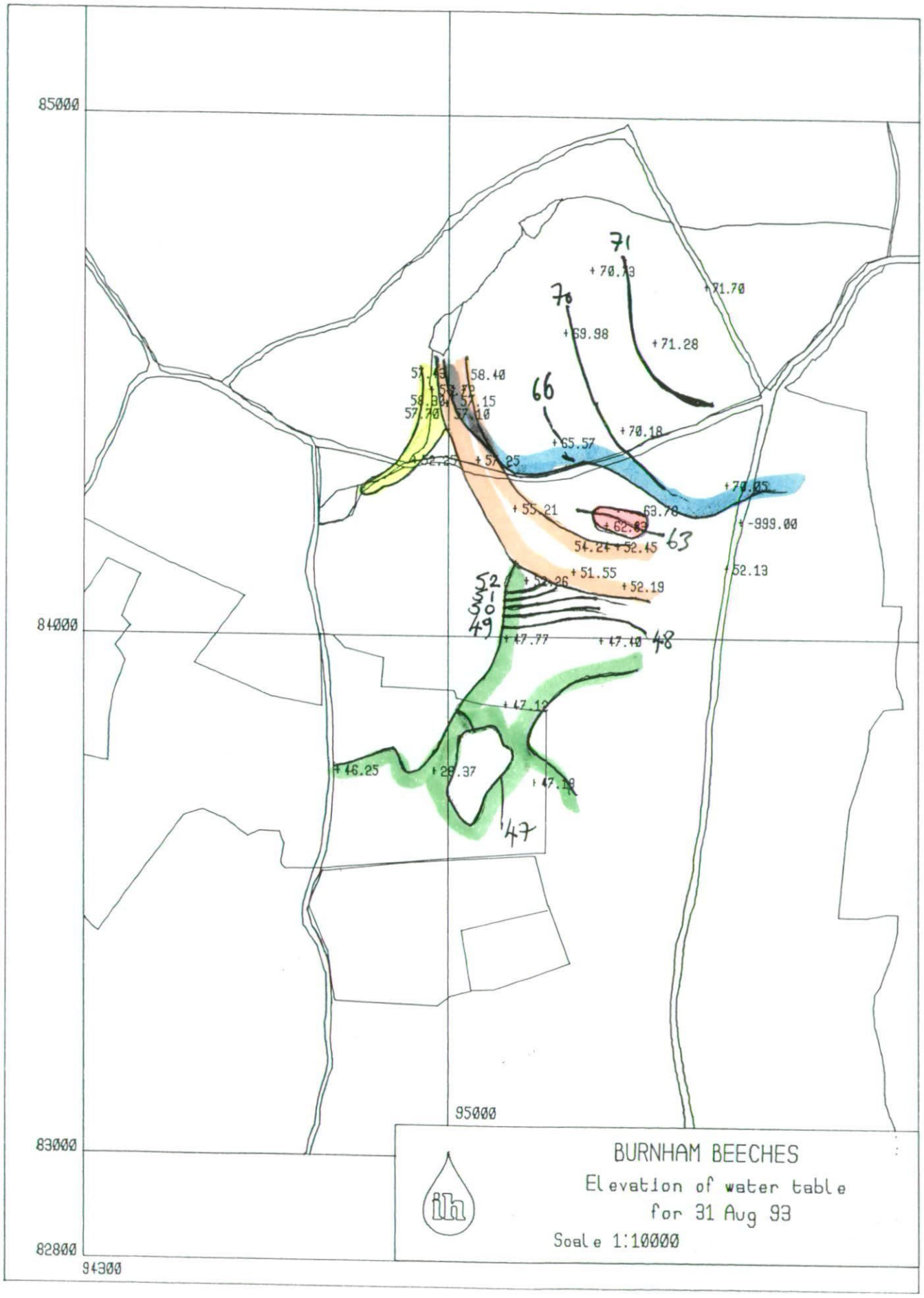
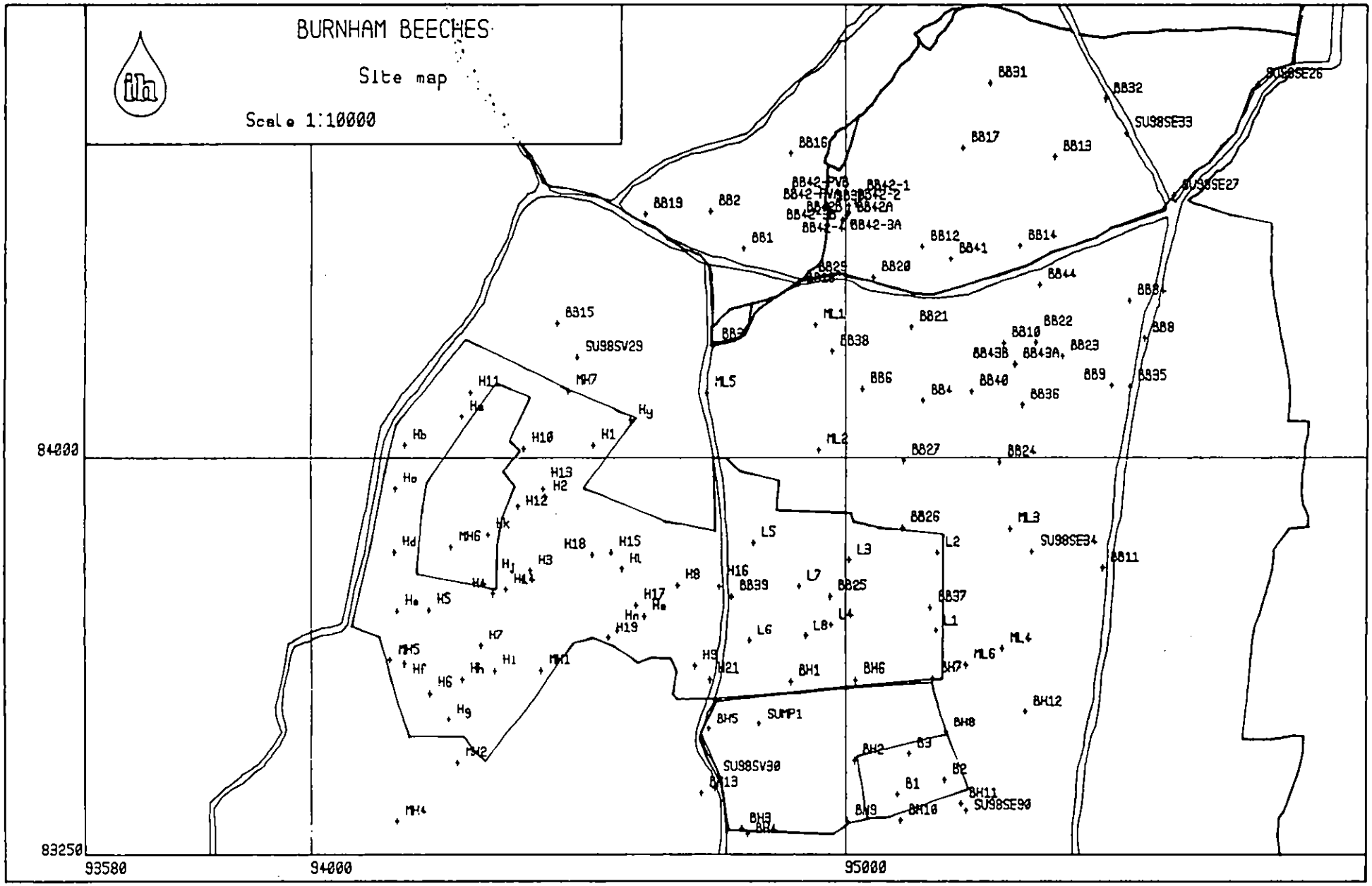
84000
83000
82800
94300
95000
72
+71.85
+72.97
71
+71.29
68
59.75
58.23
+71.53
+67.87
+56.66
+71.18
+55.31
64.33
+63.77
64
+54.26
65
+65.58
+52.33
+51.80
+52.48
53
52
51
50
49
+50.98
+48.13
+48.55
49
+47.72
48
BURNHAM BEECHES
Elevation of water table
for 19 Jan 93
Scale 1:10000
ih


85000
84000
83000
82800
94300
95000
71
70
66
63
52
51
50
49
48
47
+70.73
+71.70
+69.98
+71.28
58.40
57.15
57.10
+65.57
+70.18
+52.25
+57.25
+55.21
63.78
+62.63
54.24
+52.45
+51.55
+52.26
+52.19
+52.13
+-999.00
+47.77
+47.12
+46.25
+28.37
BURNHAM BEECHES
Elevation of water table
for 31 Aug 93
Scale 1:10000


BURNHAM BEECHES
Site map
Scale 1:10000
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83250
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95000
SU98SV29
SU98SV30
SU98SE26
SU98SE27
SU98SE33
SU98SE34
SU98SE90
SUMP1
BB1
BB2
BB3
BB4
BB5
BB6
BB7
BB8
BB9
BB10
BB11
BB12
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BB36
BB37
BB38
BB39
BB40
BB41
BB42-1
BB42-2
BB42-3A
BB42-4
BB42A
BB43A
BB43B
BH1
BH2
BH3
BH4
BH5
BH6
BH7
BH8
BH9
BH10
BH11
BH12
B1
B2
B3
L1
L2
L3
L4
L5
L6
L7
L8
ML1
ML2
ML3
ML4
ML5
ML6
H1
H2
H3
H4
H5
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H7
H8
H9
H10
H11
H12
H13
H15
H16
H17
H18
H19
H21
MH1
MH2
MH4
MH5
MH6
MH7