Ministry of the Community of Flanders
Environment and Infrastructure department
Waterways and Marine administration

Hydrological Research division

The September 1998 flood in the river Demer basin

by ing. Jos Heylen

Photo on cover: The inundation in Diest
(photo G. Coolens nv/Antwerp)

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INTRODUCTION

From Sunday afternoon 13th till Monday noon September 14th 1998 a real flood combined with a north - western storm fell over North- and East-Belgium.

In the afternoon of September 13th an extreme rainfall entered the north - east of the Antwerp province and then went slowly in north - east direction over the north - western part of the Flemish-Brabant province, after which the Limburg and Liège provinces followed.

Also in the Netherlands large parts of South - Holland, Zeeland, Brabant and Limburg were severely hit.

In the Flemish region particularly the basins north of Antwerp, with as the most problematic river the Groot Schijn, along with the basins of the Grote Nete, the Demer, the Jeker as well as the Berwinne, had to deal with extremely high quantities of water.

Besides enormous human suffering the material damage was extremely huge.

In this report the course of the water levels and discharges will be discussed in the river basin of the Demer, which was extremely heavily hit by the flood.

Exquisite work, often under an unreal pressure, was provided by the crisis centres of the Flemish-Brabant and Limburg provinces.

The Hydrological Research Division (DIHO) has provided, from Monday morning September 14th till Sunday September 20th, the necessary reports of the water levels and has contributed so in the struggle against the water by this.

Moreover the DIHO has performed a series of flow measurements during the entire week to acquire the most complete survey as possible of not only the extreme water levels, but also the utmost great discharges of the Demer and its tributaries.

Special thanks go to the co-operators of the Water division / Hasselt and Leuven (Aminal) along with the Water division of the Limburg and Flemish-Brabant provinces for their aid in making this report.
Thanks also go to the co-operators of the Royal Meteorological Institute of Belgium.

CHAPTER 1

THE HYDROMETEOROLOGICAL CIRCUMSTANCES

1.1. Data given by the Royal Meteorological Institute of Belgium

The Royal Meteorological Institute of Belgium (KMI), proclaimed the following notice:

"Summary
Since more than three weeks it is raining regularly in Belgium. On September 13th and 14th extremely high precipitations were noticed in the north and east of the country. As these precipitations fell down on an already saturated soil, they lead to high floods and damage on several places. Basing on the rainfall observations of the KMI network, we can say the quantities of precipitation of September 13th and 14th were exceptional in a greater part of the Antwerp and Liège provinces, in the south-west of Limburg, in the north-east of Flemish-Brabant and in the east of the East-Flanders province. Concerning the inundations it is necessary to report it is possible that they fell down outside the areas with exceptional quantities of precipitation and that the rivers beyond these areas had flooded.

Belgium endures a rainy period since more than three weeks.
Since August 21st it has been raining almost without intermission. At Ukkel, the total of precipitation of the last decade of August and the first decade of September reached 133,9 l/m². Since the beginning of the century this is the third highest value. In 1912 and 1996 the cumulating of the quantities during the same period reached respectively 166,2 l/m² and 163,0 l/m².

Years	*3rd decade of August*	*1st decade of September*	*Total of the two decades*
1998	*62,5 l/m²*	*71,4 l/m²*	*133,9 l/m²*
1912	*109,6 m/²*	*56,6 l/m²*	*166, 2 m/²*
1996	*158,8 l/m²*	*4,2 l/m²*	*163,0 l/m²*
1905	*85,4 l/m²*	*19,5 l/m²*	*104,9 /m²*
Average values	*26,5 l/m²*	*18,3 l/m²*	*44,8 l/m²*

The total precipitation of the first decade of September was also the second highest one recorded at Ukkel since the beginning of the century. With 71,4 l/m² it just comes behind the one of 1984 (83,7 l/m²). At Ukkel, September 1984 was the wettest September ever with 198,8 l/m², while the average count 69,8 l/m². This year we had already recorded 124,6 l/m² on September 15th at Ukkel.

The weather conditions of September 13th and 14th 1998.
During the weekend of September 12th and 13th, the weather conditions were characterised by an extensive depression with a centre in the south of Scandinavia. A rainy zone combined with this depression moved over the Northsea and ran the length of Belgium from Sunday evening (especially over the north – east part of the Antwerp province and the Liège region). The intensity of the precipitation was intensified by the simultaneous existence of fresh air at great altitude and relatively soft, but very moistened air near the surface of the relatively warm Northsea. On Monday September 14th the zone still extended from the region of

Antwerp up to the centre of Belgium and a heavy precipitation was still being recorded. The zones later moved eastwards and kept influencing the weather till the evening, especially in the north – east part of the Antwerp province, the Liège region and the east of the Ardennes.

The abundant precipitation of September 13th and 14th.

The 250 observers of the climatological measuring network, supervised by the KMI, measure daily at 08.00 AM the total of precipitation of the last 24 hours. The major part only sends only its results to the KMI monthly. Thirty-six of them form part of the Metagri-network (together with the synoptical stations) and send their results to the KMI by the computer daily. Nevertheless, in case of abundant precipitation the daily results of the Metagri aren't sufficient to define the zones concerned.

Exceptionally – and to complete the results of the Metagri-network quickly and to demarcate the stricken area that had suffered by the abundant precipitation of September 13th and 14th – the greater part of the observers of the climatological measuring network of the East-Flanders, Limburg, Liège, Antwerp and Flemish-Brabant provinces was contacted directly by telephone.

On the 14th in the morning several values of more than 100 l/m² were noticed. The total precipitation during 24 hours was extremely abundant in the East-Flanders, Antwerp, Limburg, Liège and Flemish-Brabant provinces (see annex 1a of this report). *The most remarkable day values so far known, are those of Wijnegem (146,8 l/m²) and Brasschaat (143 l/m²). Also 139 l/m² were measured in Rillaar, 132,2 l/m² in Westerlo, 122,8 l/m² in Ransberg, 120,2 l/m² in Liège, 111,3 l/m² in Diest and 93,6 l/m² in Gorsem, 81 l/m² in Elsenborn and in Belsele.*

*Another remarkable fact of this abundant precipitation is the enormous surface of the stricken area. The precipitation continued during the whole 14th and the 15th in the morning. Numerous values higher than 40 l/m² were still observed on the 15th in the areas that were stricken the day before by heavy precipitations (*see annex 1b of this report*).*

The extreme character of the precipitation of September 13th and 14th

The calculation of the possibly exceptional character of the observed precipitation of September 13th and 14th is based on the method proposed by Dupriez and Demarée in 1989 (miscellanea serie A, n° 9, KMI). This method is based on the correlation between the maximum quantities of precipitation over a period of 1 to 30 days (for a given period of frequency of occurence) and the annual averages of the precipitation.

For the stations of which we could contact the observers the values of precipitation, measured the 14th in the morning or the whole 14th and 15th, were compared with the possible maxima on one or two days, statistically determined by the study of Dupriez and Demarée. The period of frequency of occurence stands at 20 years; that is the period managed by the disaster fund to determine if a weather phenomenon is exceptional. In this way the stations were able to record where the precipitation during one or two days could be considered as exceptional, taking in account the criteria of the disaster fund.

Figure 3 (not included in this report) *show the results. The grey zone on the map is the zone with an exceptional precipitation, either during 24 hours (observations of September 14th in the morning), or during 48 hours (the whole 14th and 15th). We notice that the exceptional quantities of precipitation have fallen down in a great part of the Antwerp and Liège provinces, the south-west of Limburg, the north-east of Flemish-Brabant and the east of the East-Flanders province (Land van Waas).*

The effects of the rainy period from August 21st to September 14th.
The precipitation has fallen down over Belgium since August 21st saturated the soil with water. The extremely abundant precipitation of September 13th and 14th was not absorbed in the soil and caused an important discharge in several waterways and floods at many places. The intense discharge also lies at the base of important erosion of the soil, especially of the recently farmed fields on which the vegetation couldn't keep the ground any longer.
In conclusion we can say that the combination of the exceptional precipitation's in the north and east of Belgium with a long period of continuous precipitation cause the flood. One also should notice that the inundations may have stricken also areas – especially downstream or lower ones – where the quantities of precipitation cannot be considered as exceptional".

1.2. Data from the pluviographic measuring network of the Hydrological Research Division (DIHO)

Five recording rain gauges of DIHO in the Demer basin also give a very good picture of the rain.

The recording rain gauges are those of Aarschot, Ransberg, Linkhout, Hoegaarden en Sint-Truiden.

In this paragraph one can find some frequencies of occurence.

A frequency of occurence is stipulated to estimate the chance when such a precipitation (or a higher one) can happen.

A frequency of occurence of 1/100 for a certain precipitation means that such a precipitation can happen with a chance of 1 of 100.
Very often it is said that frequency of occurence announces the number of years between such precipitations. Such a formulation is insufficient, as it doesn't announce the possibility of such an extremely heavy rain being quickly followed by a second identical rain.

For the definition of the frequencies of occurence this report uses the results of the publication of the KMI series A / NR 116 "Intensity-Duration-Frequency Relationship of Point Precipitation at Uccle – Reference Period 1934-1983" by G. Demarée (1985).

The next extremely high values of precipitation were registered by the four recording rain gauges

Rain gauge Aarschot
- 48 hours-period 13th and 14th Sep : 79,7mm
- 24 hours-period 13th Sep/16h – 14th Sep/16h : 62,5mm or l/m²
- 13th Sep/16h – 14th Sep/22h : 64,3mm during 30 hours
- 13th Sep/19h – 14th Sep/01h : 38,9mm during 6 hours

Rain gauge Ransberg
- 48 hours-period 13th and 14th Sep : 99,7mm
- 24 hours-period 13th Sep/16h – 14 Sep/16h : 90,2mm
  frequency of occurence: 1/200

- 13th Sep/19h – 14th Sep/05h : 74,1mm during 10 hours
  frequency of occurence: 1/200
- From 14th Sep/17h till 15th Sep/04 there still fell 11,9 mm

Rain gauge Linkhout

- 48 hours-period 13th and 14th Sep : 139,22mm
- 24 hours-period 13th Sep/16h – 14 Sep/16h : 110,5mm
  frequency of occurence: > 1/200
- 13th Sep/18h – 14th Sep/05h : 92,4mm during 11 hours
  frequency of occurence: > 1/200
- From 14th Sep/16h till 15th Sep/05h there still fell 26,5mm

Rain gauge Hoegaarden

- 48 hours-period 13th and 14th Sep : 70,0mm
- 24 hours-period 13th Sep/16h – 14th Sep/16h : 64,2mm
  frequency of occurence: 1/26
- 13th Sep/23h – 14th Sep/05h : 27,3mm during 6 hours
- From 14th Sep/16h till 15 Sep/03h there still fell 7,6mm

Rain gauge Sint-Truiden

- 48 hours-period 13th and 14th Sep : 105,3mm
- 24 hours-period 13th Sep/16h – 14th Sep/16 h : 95,1mm
  frequency of occurence: > 1/200
- 13th Sep/20h – 14th Sep/05h : 75,7mm during 9 hours
  frequency of occurence: > 1/200
- From 14th Sep/16h till 15 Sep/04h there still fell 13,1mm

Annexes 2a, 2b and 2c give for the period of 24 hours 13/Sep/16h – 14 Sep/16h the precipitation per hour for the five rain gauges.

Remarkable though are the different totals of precipitation per hour of 6 mm and more, which were registered by the rain gauges of Aarschot, Ransberg, Linkhout and Sint Truiden during the period of 24 hours abovementioned.

1.3. Conclusions relating to the hydrometeorological circumstances

Two causes for the extreme character of the flood in the Demer basin have to be mentioned.

1/ A first – and the most important cause – is the utmost high intensity of precipitation of September 13th and 14th 1998.

Very exceptionally high frequencies were registered.

Still more explicit is the extreme character of the precipitation on Sept 13th and 14th with values of 75 to 110 mm during nine or ten hours, as one knows the normal precipitation total for the whole month of September is 69,8 mm; in other words, during nine or ten hours more precipitation fell in the locations mentioned than normally during the whole month of September .

2/ Belgium already suffered a very rainy period for more than three weeks before Sept 13-14th. The registered totals of precipitation for the last decade of August 1998 and the first decade of September 1998 were close on record-values.

Moreover, there was nearly no evaporation.

The result was that the soil on Sep 13th was nearly totally saturated, so that the rain nearly immediately streamed down to the watercourses of the Demer basin. As a result we got extremely high water levels.

The above-mentioned is obviously a second reason for the extreme character of the flood.

CHAPTER 2

REVIEW OF THE HYDROMETRICAL STATIONS IN THE DEMER BASIN

2.1. Hydrometrical stations, managed by the Hydrological Research Division (DIHO)

The following stations are located in the Demer basin.

- Demer/Aarschot
  Identification number: DIHO: 122
- Demer/Zichem
  Identification number: DIHO: 123
- Demer/Diest – 250 m upstream mouth Zwarte Beek
  Identification number: DIHO: 125
- Demer/Halen – 200 m upstream mouth Gete-Herk
  Identification number: DIHO: 129
- Demer/Linkhout
  Identification number: DIHO: 132
- Velp/Ransberg
  Identification number: DIHO: 145
- Gete/Halen
  Identification number: DIHO: 152
- Grote Gete/Hoegaarden
  Identification number: DIHO: 155
- Herk/Kermt
  Identification number: DIHO: 163

2.2. Hydrometrical stations, managed by the Aminal administration / Water Division (AMWA)

The following hydrometrical stations are located in the Demer basin.

The monitoring of the stations is executed by DIHO since March 1st 1997.

- Demer/Diest-downstream mouth Zwarte Beek
  Identification number: DIHO: 124

- Demer/Kermt
  Identification number: DIHO: 134
- Demer/Hasselt
  Identification number: DIHO: 136
- Demer/Bilzen
  Identification number: DIHO: 138
- Winge/Wezemaal
  Identification number: DIHO: 141
- Winge/Sint-Pieters-Rode
  Identification number : DIHO : 142
- Losting/Wezemaal
  Identification number: DIHO: 143
- Motte/Rillaar
  Identification number: DIHO: 144
- Hulpe/Molenstede
  Identification number: DIHO: 147
- Zwarte Beek/Zelem
  Identification number: DIHO: 148
- Gete/Budingen
  Identification number: DIHO: 153
- Kleine Gete/Budingen
  Identification number: DIHO: 154
- Melsterbeek/Rummen
  Identification number: DIHO: 156
- Dormaalbeek/Zoutleeuw
  Identification number: DIHO: 157
- Mangelbeek/Lummen
  Identification number: DIHO: 161
- Herk/Wellen
  Identification number: DIHO / 165
- Slangebeek/Kuringen
  Identification number: DIHO/167

- Munsterbeek/Munsterbilzen
  Identification number: DIHO 168

Annex 3 gives the river basin of the Demer, together with the implantation of the above-mentioned hydrometrical stations.

CHAPTER 3

THE FLOODS WATER LEVELS IN THE DIFFERENT HYDROMETRICAL STATIONS

3.1. The flood water levels in the hydrometrical stations

Annex 4 shows the water level hydrograph in the hydrometrical station Dijle/Haacht, which is managed by Maritime Scheldt division

The annexes 5 à 28 give the water level hydrographs of the in § 2.1. and 2.2. mentioned hydrometrical stations.

There are no registrations of the stations Demer/Diest-downstream mouth Zwarte Beek, Losting/Wezemaal and Slangebeek/Kuringen.

The distribution of the stations over the annexes is as follows:

Annex 5 :	Demer/Aarschot
Annex 6	Demer/Zichem
Annex 7	Demer/Diest – 250m upstream mouth Zwarte Beek
Annex 8	Demer/Halen – 200m upstream mouth Gete-Herk
Annex 9	Demer/Linkhout
Annex 10	Demer/Kermt
Annex 11	Demer/Hasselt
Annex 12	Demer/Bilzen
Annex 13	Winge/Wezemaal
Annex 14	Winge/Sint-Pieters-Rode
Annex 15	Motte/Rillaar
Annex 16	Hulpe/Molenstede
Annex 17	Zwarte Beek/Zelem
Annex 18	Velp/Ransberg
Annex 19	Gete/Halen
Annex 20	Gete/Budingen
Annex 21	Kleine Gete/Budingen
Annex 22	Grote Gete/Hoegaarden
Annex 23	Melsterbeek/Rummen
Annex 24	Dormaalbeek/Zoutleeuw
Annex 25	Herk/Kermt
Annex 26	Herk/Wellem
Annex 27	Mangelbeek/Lummen
Annex 28	Munsterbeek/Munsterbilzen

3.2. The inundations in the Demer basin

In the valleys of the Demer and its tributaries inundations have occurred nearly everywhere. The most extensive inundated areas were found in the Demer valley itself and this both between Werchter and Diest and upstream Diest till Kermt.
In the annexes 29a and 29b one will find the inundated areas in the Demer valley respectively between Werchter and Diest and between Diest and Kermt.

CHAPTER 4

THE FLOOD DISCHARGES IN THE DIFFERENT HYDROMETRICAL STATIONS

4.1. General observations

4.1.1. The discharge measurements

The by DIHO executed campaign of discharge measurements knew some difficulties.

On the one side it was not always possible to get the measuring cars near the measuring sections because of the flooded roads, on the other some measurements were impossible because of the existence of many erratic dirt.

4.1.2. Determination of the discharges

A detailed study of the discharges showed that the determination of the discharges in some hydrometrical stations using the normal water level-discharge curve was not possible.

On the one side there has been in the stations just upstream the retention reservoir "Het Schulensbroek" and the flooded plain an influence of the water levels by inundation of the whole area and its later emptying.

On the other side the water level fall of the Zwarte Beek and the tributaries of the Demer downstream Diest seems to be retarded by the extreme high water level in the Demer itself and the so caused inundation of the valley.

For the Zwarte Beek it also must be noticed that this tributary gets water of the Demer river via the K31 weir (width 10m), situated near to the retention reservoir "Webbekomsbroek", by a Demer water level above 21,50m TAW (reference level in Belgium) This has happened in the period from September 14th till 19th.

For those reasons it was concluded, for a great number of hydrometrical stations, to give in this report, only a summary of the average daily discharges registered from September 15th till 18th 98.

4.2. Controlled dyke breachs

The following data are communicated by the Maritime Schelde Division Zeeschelde

On the Demer in the area Aarschot-Diest at five locations dyke breachs were carried out by excavating.

These five locations were:

- Diest/km 1.300 – left bank :
  Open: 16 Sep/12h00 – 14h00 and 15h00 – 21h25
  17 Sep/14h45 – 22h15
- Zichem/km 6.000 right bank :
  Open: 17 Sep/12h00 – 21h15
- Testelt/900 m upstream bridge – left bank
  Open: 18 Sep/24h00 – 20 Sep/18h00
- Zichem/km 3.400 – left bank :
  Open: 18 Sep/17h00 – 20 Sep/13h00
- Testelt/250m upstream bridge – left bank
  Open: 18 Sep/23h00 – 20 Sep/18h00

4.3. The flood discharges in the hydrometrical stations of the Demer and its tributaries upstream Halen

4.3.1. Demer, Mangelbeek, Slangebeek and Munsterbeek

Demer/Kermt (catchment: 329km²)

Q: 14 Sep: 25,6m³/s
15 Sep: 26,0m³/s
16 Sep: 23,0m³/s
17 Sep: 14,2m³/s
18 Sep: 10,5m³/s

Mangelbeek/Lummen (catchment: 109km²)

Q: 14 Sep: 4,5m³/s
15 Sep: 5,1m³/s
16 Sep: 4,6m³/s
17 Sep: 4,0m³/s
18 Sep: 3,0m³/s

The peak average hourly discharge was on Sep 15/06h00 5,2m³/s.
The following dischage measurements have been done:

16 Sep: 4,44m³/s at 24,23m TAW
17 Sep: 4,11m³/s at 24,12m TAW
18 Sep: 2,71m³/s at 23,84m TAW

The total of the discharge of the hydrometrical station Demer/Kermt on the one side, multiplied by 1,10 to take in account the extra surface of the catchment of the Demer between the station of Kermt and the retention reservoir "Het Schulensbroek" and on the other side the discharge of the station Mangelbeek/Lummen gives:

Q: 14 Sep: 32,7m³/s
15 Sep: 33,7m³/s
16 Sep: 29,9m³/s
17 Sep: 19,6m³/s
18 Sep: 14,6m³/s

A calculation of the filling of the retention reservoir "Het Schulensbroek" gives a volume of 2.964.000 m³ for Sept 14th and 2.040.000 on Sep 15th till 16h00. or respectively 34,3 and 35,5m³/s.

Demer/Hasselt (catchment: 234 km²)

Q: 14 Sep: 19,1m³/s — 17 Sep: 6,4m³/s
15 Sep: 19,3m³/s — 18 Sep: 3,8m³/s
16 Sep: 14,9m³/s

The peak average hourly discharge was on Sep 14/ 12h00 ca.20m³/s
The following discharge measurement has been done:
17 Sep: 6,32m³/s at 31,15m TAW

Demer/Bilzen (catchment: 97km²)

Q: 14 Sep: 7,3m³/s — 17 Sep: 1,4m³/s
15 Sep: 6,3m³/s — 18 Sep: 0,87m³/s
16 Sep: 2,4m³/s

The peak average hourly discharge was on Sep 15/ 04h00 7,4m³/s
The following discharge measurement has been done:
16 Sep: 2,48m³/s at 41,42m TAW

In the hydrometrical station **Munsterbeek/Munsterbilzen** (catchment near the mouth: 45 km²) no measurements of the discharge were carried out, because of the quick fall of the water level after the maximum water level, which happened on Sep 14/04h00. So it seems to be very risky to give discharges.

In the station **Slangebeek/Kuringen** (catchment near the mouth: 44km²), which knew also a quick water level fall, a measuring of the discharge has been done on September 16th, when the water level had already fallen down with ca. 0,50m: the discharge noticed at that time 0,94m³/s at a relative water level of 0,44m.
For this station too, it seems very bold to give discharges.

In Halen/Linkhout downstream the retention reservoir discharge of 10,23m³/s was noticed in the Demer on September 17th.

4.3.2. Herk

Herk/Kermt (catchment: 280km²)

Q: 14 Sep: 18,9m³/s — 17 Sep: 14,7m³/s
15 Sep: 20,4m³/s — 18 Sep: 7,1m1/s
16 Sep: 19,8m³/s

The following discharge measurements have been done:
16 Sep: 20,03m³/s at 27,08m TAW
17 Sep: 13,93m³/s at 26,52m TAW
18 Sep: 6,21m³/s at 25,64m TAW

Herk/Wellen (catchment: 108km²)
In this hydrometrical station no measurements were carried out.
Via a correlation between the discharge of the nearby station Demer/Bilzen with a nearly catchment one can say that the average daily discharge for Sep 15 reached that day ca. 7,5 m³/s.
The peak average hourly discharge was on Sep 15 ca. 8,5m³/s.

4.3.3. Gete, Kleine Gete, Grote Gete, Melsterbeek

Gete/Halen (catchment: 811km²)

Q: 15 Sep: 27,7m³/s 17 Sep: 24,9m³/s
16 Sep: 27,4m³/s 18 Sep: 16,0 m³/s

The average maximum hourly discharge reached ca. 28m³/s on Sep 15th.

One has to notice that the discharges of this station on Sep 18,19 and 20th have been influenced by the little head loss between the water level in Halen and the one of the inundated plain around the basin "Het Schulensbroek".

Gete/Budingen (catchment: 555km²)

Q: 14 Sep: 20,8m³/s 17 Sep: 8,3m³/s
15 Sep: 18,9m³/s 18 Sep: 6,7m³/s
16 Sep: 11,8m³/s

The peak average hourly discharge reached ca. 22m³/s on Sep 14th/ 20h00

Grote Gete/Hoegaarden (catchment: 281km²)

Q : 14 Sep : 7,4m³/s 17 Sep : 1,4m³/s
15 Sep : 3,4m³/s 18 Sep : 1,2m³/s
16 Sep : 1,9m³/s

The peak average hourly discharge reached 10,7m³/s on Sep 14th/ 15h00

Kleine Gete/Budingen (catchment: 266km²)

It seems to be risky to fix the discharges of this station, which is situated only 750 m upstream the mouth of the Grote Gete in the Gete via the water level-dischange curve, because of a possible influence of the water level in this station by the water level in the Gete.

Melsterbeek/Rummen (catchment: 149km²)

Q : 15 Sep : 8,0m³/s 17 Sep : 5,7m³/s
16 Sep : 7,6m³/s 18 Sep : 2,5m³/s

The peak average hourly discharge reached 8,1m³/s on Sep 15th/ 06h00
The following discharge measurements of the discharge have been done :

14 Sep : 7,45m³/s at 29,26m TAW
16 Sep : 8,06m³/s at 29,22m TAW
18 Sep : 1,93m³/s at 28,05m TAW

Dormaalbeek/Zoutleeuw (catchment: 44km²)

In this station no discharge measurements were carried out, because of the very quick fall of the water level after the maximum water level. So it seems to be impossible to give discharges.

4.4. The flood discharges in the hydrometrical station Velp/Ransberg

The river basin is 96km².

Annex 30 shows the development of the discharges.
Those are influenced by the filling of the retention revervoir "Hoeleden", situated upstream.
The peak average hourly discharge was 16,9m³/s on Sep. 15th / 08h00.
On Sep 15th the discharge was 15,9m³/s.
The following discharge measurement has been done :
15 Sep : 16,41m³/s at 31,02m TAW.

4.5. The flood discharges in the Demer valley around Diest

In Diest the mouth of the Zwarte Beek in the Demer is situated.

4.5.1. Demer

On the Demer 250m upstream the mouth mentioned above the DIHO hydrometrical station Demer/Diest (catchment: 1775km²) is located

The discharges were :

14 Sep : 46,8m³/s	17 Sep : 51,1 m³/s
15 Sep : 50,3m³/s	18 Sep : 51,0m³/s
16 Sep : 50,5m³/s	

The peak average hourly discharge reached 51,1m³/s on Sep 17th/13h00
The following dischange measurements have been done:
16 Sep : 49,62m³/s at 20,48m TAW
17 Sep : 50,74m³/s at 20,69m TAW

Just upstream the weir "Grote Steenbeer" the **Begijnenbeek** flows in the Demer.
The catchment of this tributary is 52km².
According to an information of the Water division/ Hasselt the peak discharge in the night of Sept 13 to 14th reached, near the mouth, ca. 12m³/s.

One also informed that about half the discharge till Sep 15th was diverted to the retention reservoir"Webbekomsbroek", while the other half streamed on to the mouth in the Demer.

4.5.2. Zwarte Beek

On the Zwarte Beek the hydrometrical station **Zwarte Beek/Zelem** (catchment: 108km²) is located.
The discharges were :

Q : 15 Sep : 7,2m³/s	17 Sep : 5,7m³/s
16 Sep : 6,5m³/s	18 Sep : 4,9m³/s

The peak average hourly discharge reached on Sep 15th/10h00 7,5m³/s.
The following discharge measurements have been done :
16 Sep : 6,29m³/s at a relative H = 1,37m
17 Sep : 5,68m³/s at a relative H = 1,32m
18 Sep : 4,67m³/s at a relative H = 1,27

4.6. The flood discharges of the Demer in Zichem and Aarschot

The annexes 31 and 32 give the development of the discharges in respectively the hydrometrical stations in Zichem (catchment: 1973km²) and in Aarschot (catchment: 2163 km²).

In **Zichem** the registered discharges were :

15 Sep : 63,5m³/s	17 Sep : 66,8m³/s
16 Sep : 64,7m³/s	18 Sep : 67,1m³/s

The peak average hourly discharge on Sep 18 was 67,1m³/s.
The following discharge measurement has been done :
18 Sep : 67,5m³/s at 19,12m TAW

In **Aarschot** the registered discharges were :

15 Sep : 70,5m³/s	18 Sep : 69,7m³/s
16 Sep : 69,8m³/s	19 Sep : 70,6m³/s
17 Sep : 69,4m³/s	20 Sep : 70,3m³/S

The peak average hourly discharge on Sep 19/23.00 was 70,9m³/s.
The following discharge measurements have been done :
16 Sep : 68,8m³/s at 13,31m TAW
18 Sep : 70,6m³/s at 13,27m TAW
21 Sep : 66,7m³/s at 13,14m TAW

4.7. The flood discharges of the Hulpe, Motte and Winge

Hulpe/Molenstede (catchment:65km²)
Q : 15 Sep :6,8m³/s
From September 14th till 15th the water level in this hydrometrical station was about the same as the one in the inundation area on the right bank of the Demer between Diest and Testelt.
A rough estimate gives for the average daily discharges of Sep. 16, 17 and 18 a discharge of 4 à 3m³/s.
The following discharge measuring has been done :
16 Sep :7,1 m³/s at 18,99m TAW.

Motte/Rillaar (catchment: 34km²)
This hydrometrical station knew a quick water level fall after the maximum water level, which occurred on Sep. 14/12h00.
In this station a dischange measuring took place only on Sep. 17th : the discharge reached then 1,6m³/s on a water level of 20,18m TAW.
A rough estimate gives a for this station a peak average hourly discharge of 5 à 7m³/s on Sep. 14/12h00.

Winge/Sint-Pieters-Rode (catchment: 33km²).
The hydrometrical station knew, just as the station Motte/Rillaar, a quick water level fall after the maximum water level, which occurred on Sep 14th/06h00.
There were no discharge measurements
A rough estimate gives a peak average discharge of 3,5 à 4,5m³/s.
The average daily discharge on Sep 15 was then 2,2 à 2,5m³/s.
For Sep 16, 17 and 18 one has a discharge of respectively 0,67, 0,44 and 0,32m³/s.

Winge/Wezemaal (catchment: 64km²)

Q : 14 Sep : 2,8m³/s
15 Sep : 4,2m³/s
16 Sep :4,6 m³/s
17 Sep : 3,6m³/s
18 Sep : 2,7m³/s

The following discharge measurements have been done :
14 Sep : 3,2m³/s at 13,53m TAW
16 Sep : 4,8m³/s at 13,95m TAW
17 Sep : 3,8m³/s at 13,76m TAW

4.8. Summary of the discharges on September 15th 1998

It seems to be interesting to give a summary of the discharges, which have been registered in the different hydrometrical stations of the Demer basin on Sept. 15th 1998.
On may conclude that, for the whole basin, the highest discharges have been registered that day.

Annex 33 gives the summary of the discharges.

CHAPTER 5

FILLING OF THE RETENTION RESERVOIRS "HET SCHULENSBROEK", "WEBBEKOMSBROEK" AND "HOELEDEN".

5.1. Filling of the retention reservoirs"Het Schulensbroek"

5.1.1. The inner basin

From the reports of the Water division / Hasselt it appears that the maximum level in the inner basin (204 ha) reached 22,90m TAW.
This gives a filling volume for this inner basin of ca. 5.410.000m³.

5.1.2. The outer basin

As the outer basin (573ha) is considered the area limited in the north by the Demer and the inner basin, westwards by the Gete and in the south-east by the TAW of 22,5m altitude.

With an average height for the ground level of the surface of 21,10m TAW one gets a filling volume of ca. 8.020.000m³ for the outer basin.

5.1.3. Complete retention reservoir

For the complete retention reservoir one has a filling volume of ca. 5.410.000m³ + ca. 8.020.000 = ca. 13.430.000m³

5.2. Filling of the retention reservoir "Webbekomsbroek"

From reports of the Water division / Hasselt it appears that the maximum level in the inner basin (74 ha) reached 22,48m TAW and in the outer basin (86 ha) 21,95m TAW.

Taking in account a water level of 19,75m TAW at the beginning of the filling on Sept 14th, this gives a filling volume of ca. 2.020.000m³ for the inner and ca. 1.890.000m³ for the outer basin.

Together this gives a filling volume of ca. 3.910.000m³.

5.3. Filling of the retention reservoir "Hoeleden"

The division Water / Hasselt reported that the filling volume of this retention reservoir may be estimated at 960.000m³.

5.4. Total of the filling volumes for the three retention reservoir

The total of the filling volumes of the three retention reservoirs makes a total filling volume of ca. 18.300.000m³.

A juxtaposition of on the one side the total of the discharges for the period 14-16 Sep 98 of the Demer, Herk, Gete and Velp at the mouth of these last three tributaries into the Demer and on the other side the discharge of the Demer in Diest shows that the filling volume above mentioned is realistic.

Here it can also be reported at last that the total filling volume above mentioned would not have flooded totally downstream even without the construction of the three retention reservoirs.
A part of the volume clearly would have served for the inundation of the areas where the retention reservoirs have been constructed now.
Only a detailed study can give a decisive answer about it.

CHAPTER 6

THE SEPTEMBER 1998 FLOOD WATER LEVELS AND DISCHARGES, RELATED TO SOME FORMER FLOOD PERIODS

First, it should be mentioned that until the beginning of the sixties, the Demer was flowing through Diest. It is only at that time that the Demer has been deflected from the "Grote Steunbeer" via the Walgracht and the bed of the Zwarte Beek.

Besides that, one must take account of the use of the retention reservoirs "Het Schulensbroek", "Webbekomsbroek" and "Hoeleden".
The retention reservoir "Het Schulensbroek" was used for the first time in 1984, while the retention reservoir "Webbekomsbroek" was used for the first time at the flood described in this report.
Even the retention reservoir"Hoeleden" was filled for the first time in Sep 98.

6.1. Period before the January 1926 flood

P. Roovers reports in the "Note concerning improvements for a better runoff of the Demer" (ca. 1960/P.Roovers was an engineer at the Antwerp Maritime Scheldt division of the national Ministry of Public Works) the following floods.

Location		Jan 1891	Feb-March 1910	Sep 1912	Jan 1914
Diest ("De Teerlingen)		21,07	20,62	20,66	20,69
Zichem (weir)	upstream	18,20	17,93	17,92	18,00
Testelt (weir)	upstream	17,21	17,05	17,14	17,22
Aarschot (weir)	upstream	14,63	13,00	13,03	13,23
Werchter (weir)	upstream	11,42	10,02	9,90	10,31

For a flood in 1920 the following maximum water levels were found in a document in the archives of DIHO :

Location		
Zichem (weir)	upstream	17,99
Testelt (weir)	upstream	17,24
Aarschot (weir)	upstream	14,06

6.2. The January 1926 flood

About the January 1926 flood, a more extensive documentation was found in the archives of DIHO.

This documentation was reported by the "Administration des Pont et Chausées"/direction Brabant province in Brussels for the Minister of Public Works.

The flood period began end 1925 en knew the following maximum water levels.

Location		
Diest "De Teerlingen"		21,19 (04 Jan)
Zichem	upstream	18,03 (05 Jan)
Testelt	upstream	17,25 (05 Jan)
Aarschot	upstream	14,41 (05 Jan)
Werchter	upstream	11,43 (07 Jan)

The peak discharges downstream were at the weirs of Zichem, Aarschot and Werchter respectively 34,72 and 100 m^3/s.

These discharges represent, according to the documentation, only a part of the upper discharge of the Demer valley because of the existence of inundation areas in the inundated pastures.
The author of this report points out that be could not have found how these discharges had been fixed.

In the centre of Diest a major part of the streets was flooded.

Between Diest and Aarschot the valley was completely inundated.

In Aarschot the Demer downstream the weir had overflowed its banks and the town had to contend with inundations in the Laak valley.

Between Aarschot and Werchter the valley was also completely inundated, in spite of the fact that the Demer is diked at this location.
The water here came not only from the Demer itself but also from its tributaries as the Winge and the Laak, and the Dijle upstream the confluence with the Demer.

In Werchter itself the situation was very precious. The village was completely surrounded by water, but had, luckily, no inundation by the elevation and strengthening of an inner dike.

In annex 34 one finds the inundated area of the Demer between Diest and Werchter as it was reported just after January 1926.

6.3. Period Dec 1926 – Jan 1959

P. Roovers reports in his in § 6.1. described note also for this period some floods with their maximum water levels.

Location	Dec 1926	Mar 1942	Mar 1947	Jan 1952	Feb 1952	Dec 1952	Feb 1957	Feb 1958	Jan 1959
Diest "De Teerlingen"	21.13	21.12	20.60	20.82	20.80	21.05	21.29	21.20	21.20
Zichem(weir) upstream	18.00	18.76	18.12	18.12	18.07	18.16	18.17	18.25	18.11
Testelt(weir) upstream	17.27	17.32	17.27	17.12	17.09	17.30	17.31	17.32	17.02
Aarschot(weir)	14.13	14.25	13.05	12.89	12.95	13.81	13.80	13.62	13.19
downstream		13.85		12.50	12.60	13.40	13.30	13.12	12.60
Werchter(weir) upstream	11.06	11.36	10.63	10.02	10.15	10.80	10.95	10.63	10.12

6.4. Period since 1969

Already in the period 1965-1975, the Hydrological Research Division of the former national Ministry of Public Works has extended a complete measuring network of hydrometrical stations on the Demer between Aarschot and Linkhout, as well as on the Velp, Gete and Herk, the three main tributaries of the Demer upstream Diest.

As a result, DIHO has at its disposal now a number of time series, which make it possible to relate the Sep 98 flood to the floods in the Demer basin since 1969.

Because of both the length of the time series and the homogeneity of the hydrological regime in the neighbourhood of the hydrometrical station concerned, the registered water levels of the stations Demer/Zichem, Velp/Ransberg, Gete/Halen and Herk/Kermt are taken for the relationschip.

Demer/Zichem

- beginning of the observations by DIHO : 1972
- registered water levels ≥18,55m TAW
  - 30 Oct 74 : 18,55 *
  - 16 Dec 81 : 18,56 *
  - 02 Jan 87 : 18,56
  - 03 Mar 87 : 18,62
  - 02 Mar 88 : 8,56
  - 16 Mar 88 : 18,79
  - 28 Mar 88 : 18,72
  - 25 Dec 93 : 18,64
  - 06 Jan 94 : 18,64
  - 30 Jan 95 : 18,64

  * implantation station : next to the bridge road Zichem-Averbode

Velp/Ransberg

- beginning of the observations by DIHO : 1970
- registered water levels ≥ 30.55 m TAW
  - 18 Aug 77 : 30.55
  - 21 Jul 80 : 30.56
  - 15 Jan 81 : 30.55
  - 29 Jun 81 : 30.70
  - 12 Apr 85 : 30.63
  - 21 Dec 93 : 30.60

Gete/Halen

- beginning of the observations by DIHO : 1969
- registered water levels ≥ 23.00m TAW
  - 01 Dec 74 : 22.97
  - 22 Jul 80 : 23.10
  - 15 Jan 81 : 23.00
  - 30 Jun 81 : 23.26
  - 01 Dec 81 : 23.10
  - 09 Dec 81 : 23.15
  - 08 Oct 82 : 23.15
  - 26 May 83 : 23.09
  - 09 Feb 84 : 23.15
  - 29 May 84 : 23.07
  - 27 Jan 85 : 23,09
  - 12 Apr 85 : 23,04
  - 01 Apr 86 : 23.06
  - 03 Mar 87 : 23,02
  - 22 Dec 93 : 23,07
  - 06 Jan 94 : 23,05
  - 30 Jan 95 : 23,01

Herk/Kermt

- beginning of the observations by DIHO : 1977
- registered water levels 26,60m TAW
  - 07 May 78 : 26,60
  - 21 Jul 80 : 26,91
  - 29 Jun 81 : 26,64
  - 10 Dec 81 : 26,74
  - 26 May 83 : 26,66
  - 08 Feb 84 : 27,04
  - 29 May 84 : 26,84
  - 23 Nov 84 : 26,60
  - 02 Jan 87 : 26,66
  - 03 Mar 87 : 26,73
  - 15 Mar 88 : 26,69
  - 25 Mar 88 : 26,68
  - 12 Jan 93 : 26,66
  - 21 Dec 93 : 26,83
  - 23 Jan 95 : 26,66
  - 30 Jan 95 : 26,66

6.5. Conclusion

From a comparison of the known registered water levels in Zichem can be concluded that the Demer in Zichem has known a maximum-maximorum water level on Sep 18th 1998.
The maximum water level 19,10m TAW lies even 30 to 35cm higher than the one of March 1942 and March 16th 1998

Comparing the since 1969 registered water levels of the Gete in Halen together, one sees one has registered an extreme water level on September 15th 1998.
With its maximum water level of 23,86m TAW one reaches 60 cm higher than the maximum water level of June 30th 1981.

CHAPTER 7

GENERAL CONCLUSION

This report gives a description of the flood in the Demer basin of the middle of September 1998 together with the hydrometeorological circumstances at the basis of them.
Beside that, this flood is related to a number of former flood periods.

It is clear that we have known extreme hydrometeorological circumstances combined with a quasi totally saturated soil. So the discharge of extremely high quantities of water by the Demer and its tributaries became inevitable.

Very carefully one could conclude that the September 1998 flood for the Demer basin might have been "the flood of the century", at least when between now and the end of the year 2000 still higher water levels will not occur.

From the calculated filling volumes of the retention reservoirs "Het Schulensbroek" and "Webbekomsbroek" and the use of the retention reservoir"Hoeleden" it clearly appears that a still much greater disaster has been avoided by the great capacity of those reservoirs.

The chances that a precipitation as the one of September 13th and 14th falls down on a nearly completely saturated soil are of course extremely slight, but floods with a lower frequency of occcurence are for the Demer – just as for all the other rivers in Western Europe – inherent to nature, one has to live with, anyhow.

This means one will have to keep trying to reduce the inundations to a minimum, which are automatically the results of floods.

It is clear to the author of this report that there is a necessity for more space for water by creating (in accordance with an integral water management) inundation areas, so that one creates more possibilities for waterstorage.
This doesn't mean again one has to expect miracles of them, especially in lengthy flood periods.

Beside that, one will have to leave the existing social acceptation, that nowadays one doesn't any longer accept that water on the soil is rather normal at high water levels and this in spite of a better functioning of the water management

Brussels, February 1999

ing. J. Heylen
director Hydrological Research Division
and
composer of this report

ANNEXES

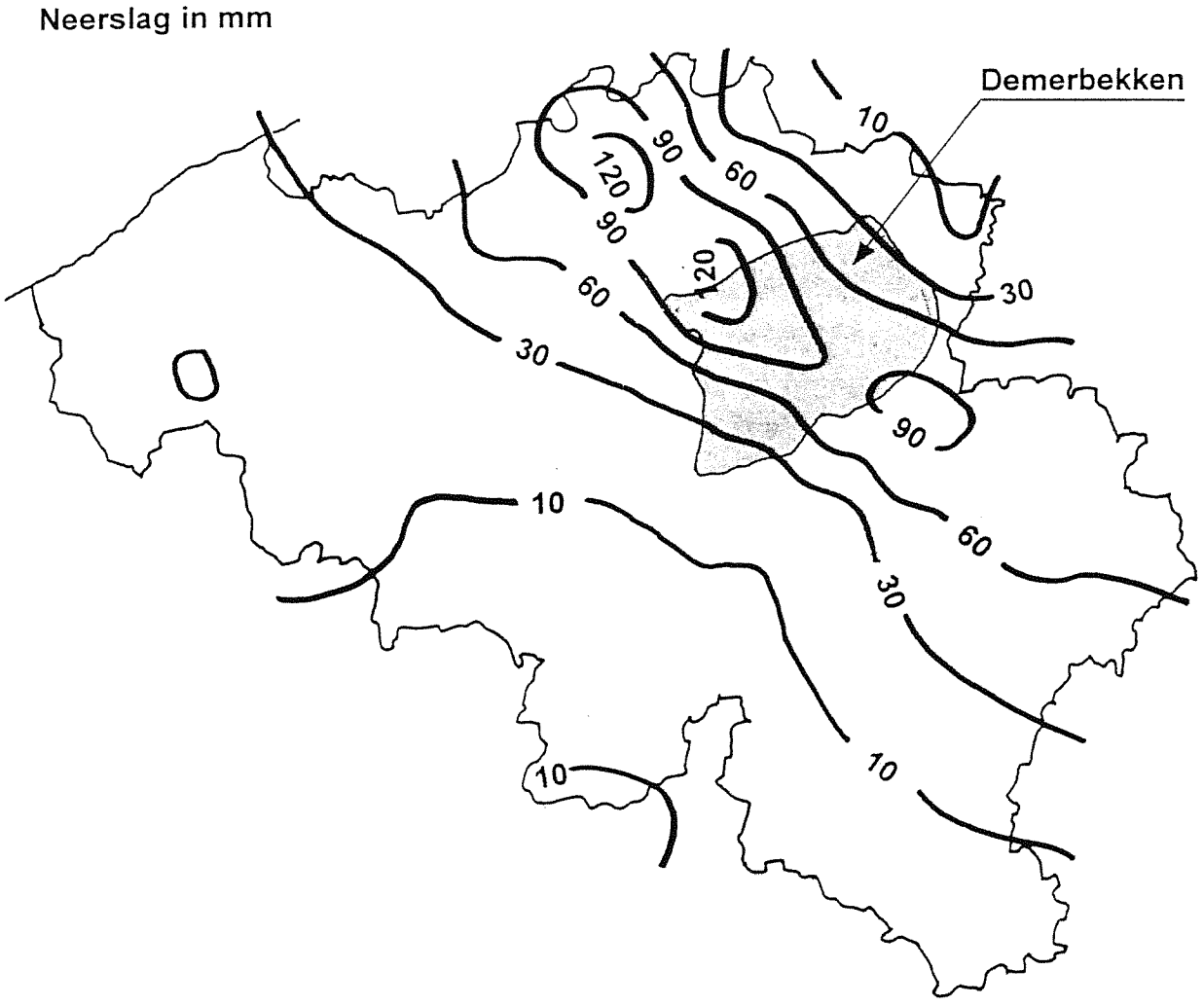
begin	: beginning
binnenbekken	: inner basin
buitenbekken	: outer basin
debiet	: discharge
geïnundeerd gebied	: inundated area
gemiddeld etmaaldebiet	: average daily discharge
hoge waterstand	: flood
hydrografisch bekken	: river basin / catchment
lozing	: emptying
neerslag	: precipitation
pluviograaf	: recording rain gauge
vulling	: filling
wachtbekken	: retention reservoir
waterstand	: water level

DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 1a

Neerslag van periode
13 Sep 98 / 08h00 - 14 Sep 98 / 08h00



Bron : Koninklijk Meteorologisch Instituut van België

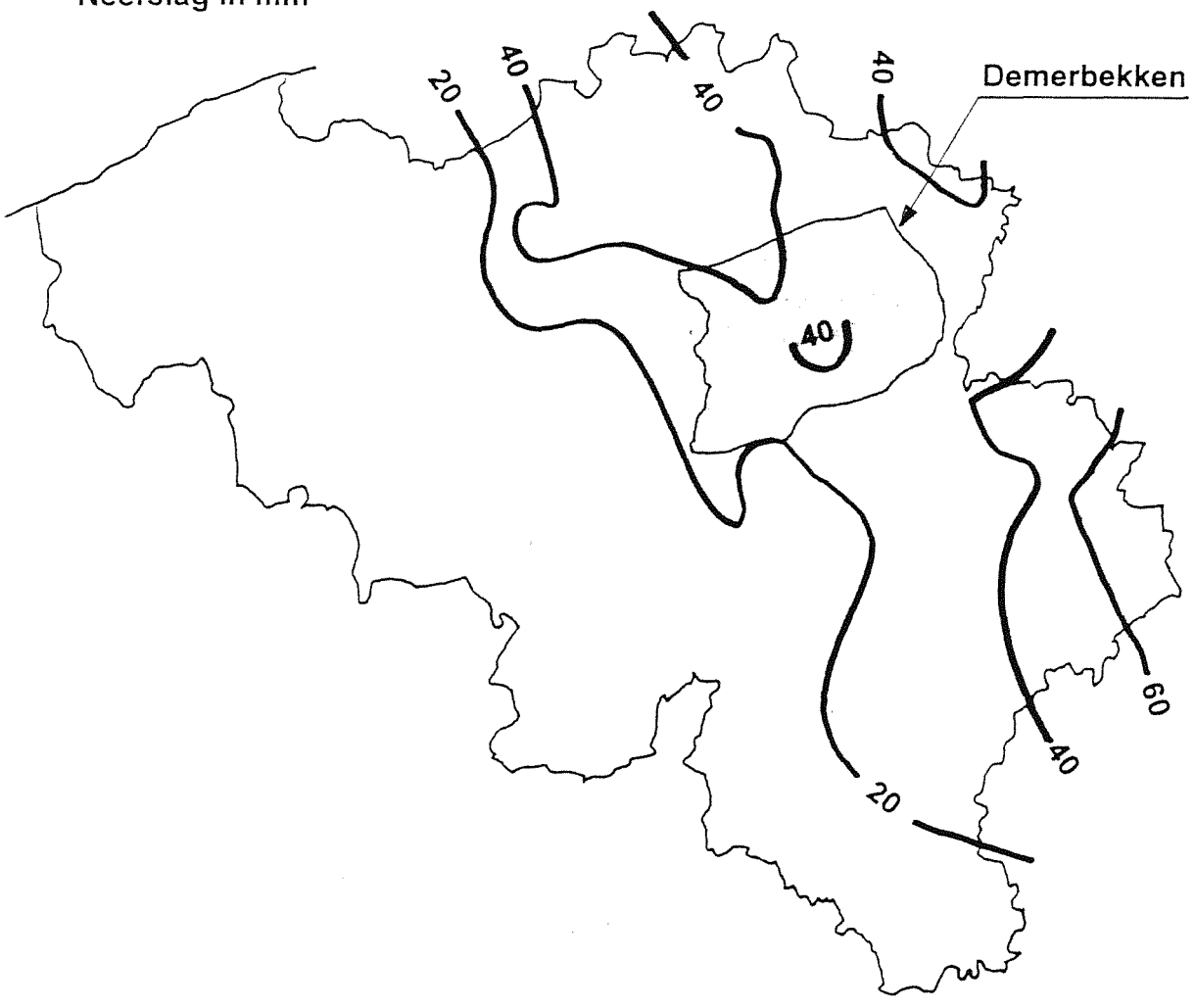
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 1b

Neerslag van periode
14 Sep 98 / 08h00 - 15 Sep 98 / 08h00

Neerslag in mm



Bron : Koninklijk Meteorologisch Instituut van België

DIHO dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

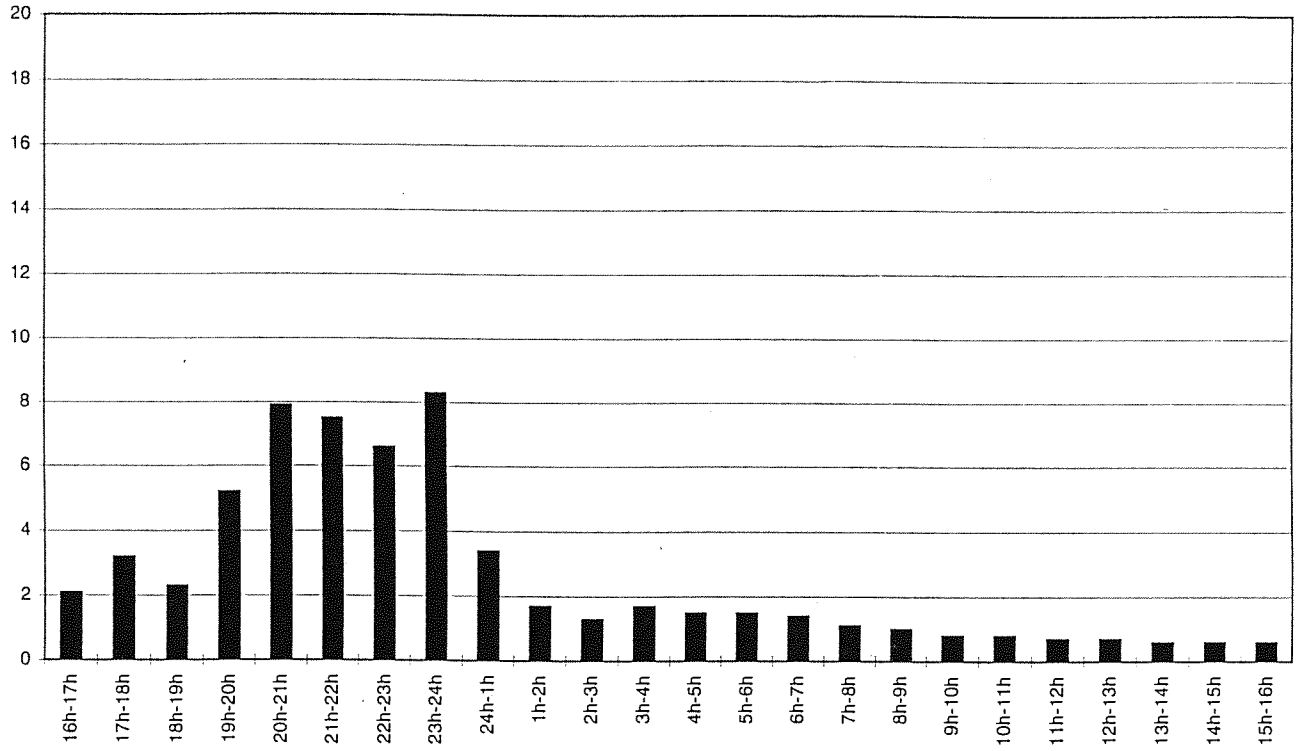
Bijlage 2a

Pluviografen AARSCHOT - RANSBERG

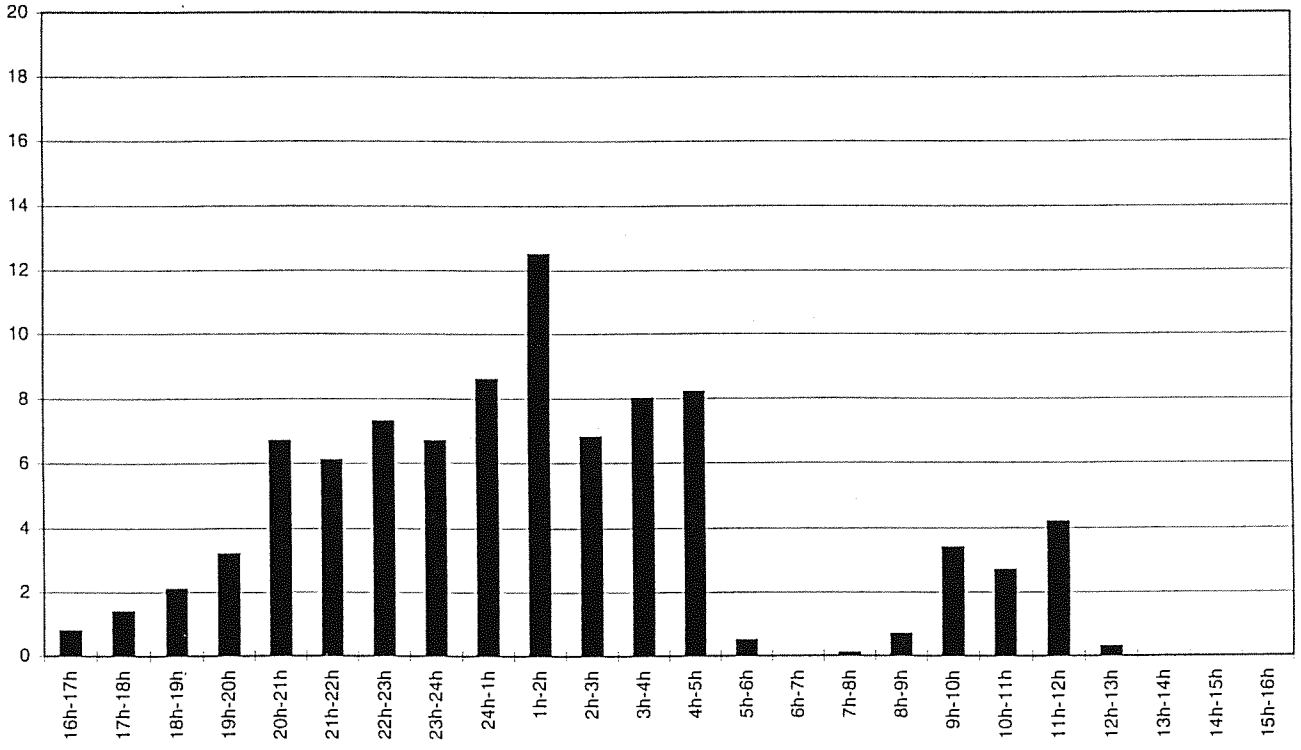
Neerslag van de periode 13 Sep 98/16h00 - 14 Sep 98/16h00

Neerslag in mm/h

Aarschot



Ransberg



DIHO dienst HYDROLOGISCH ONDERZOEK

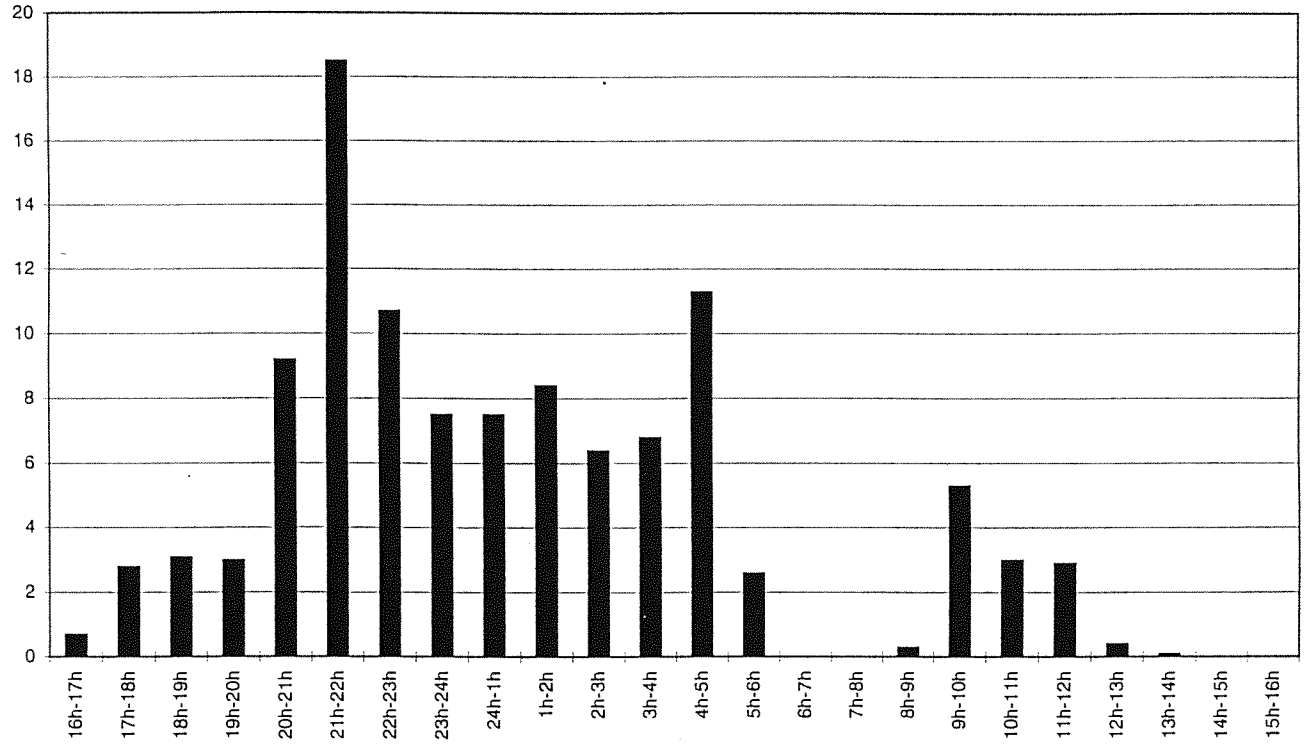
VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 2b

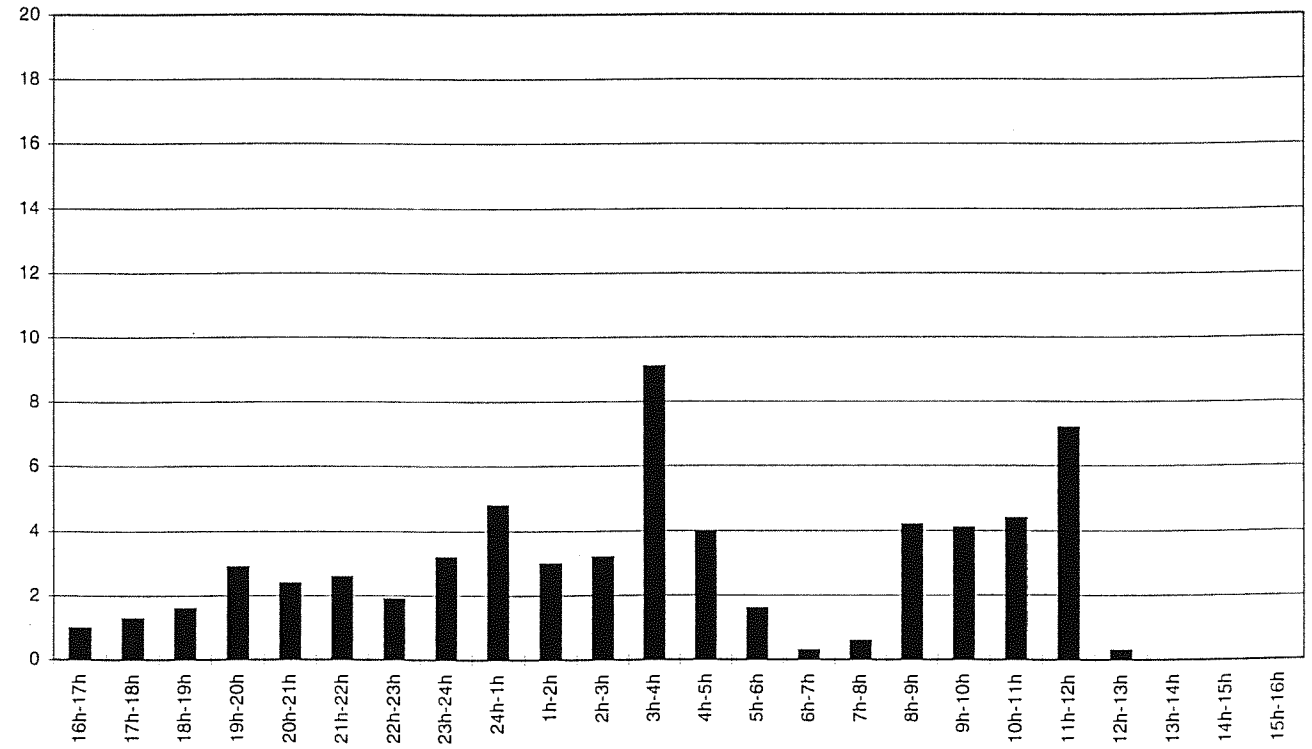
Pluviografen LINKHOUT - HOEGAARDEN

Neerslag van de periode 13 Sep 98/16h00 - 14 Sep 98/16h00

Linkhout



Hoegaarden



DIHO dienst HYDROLOGISCH ONDERZOEK

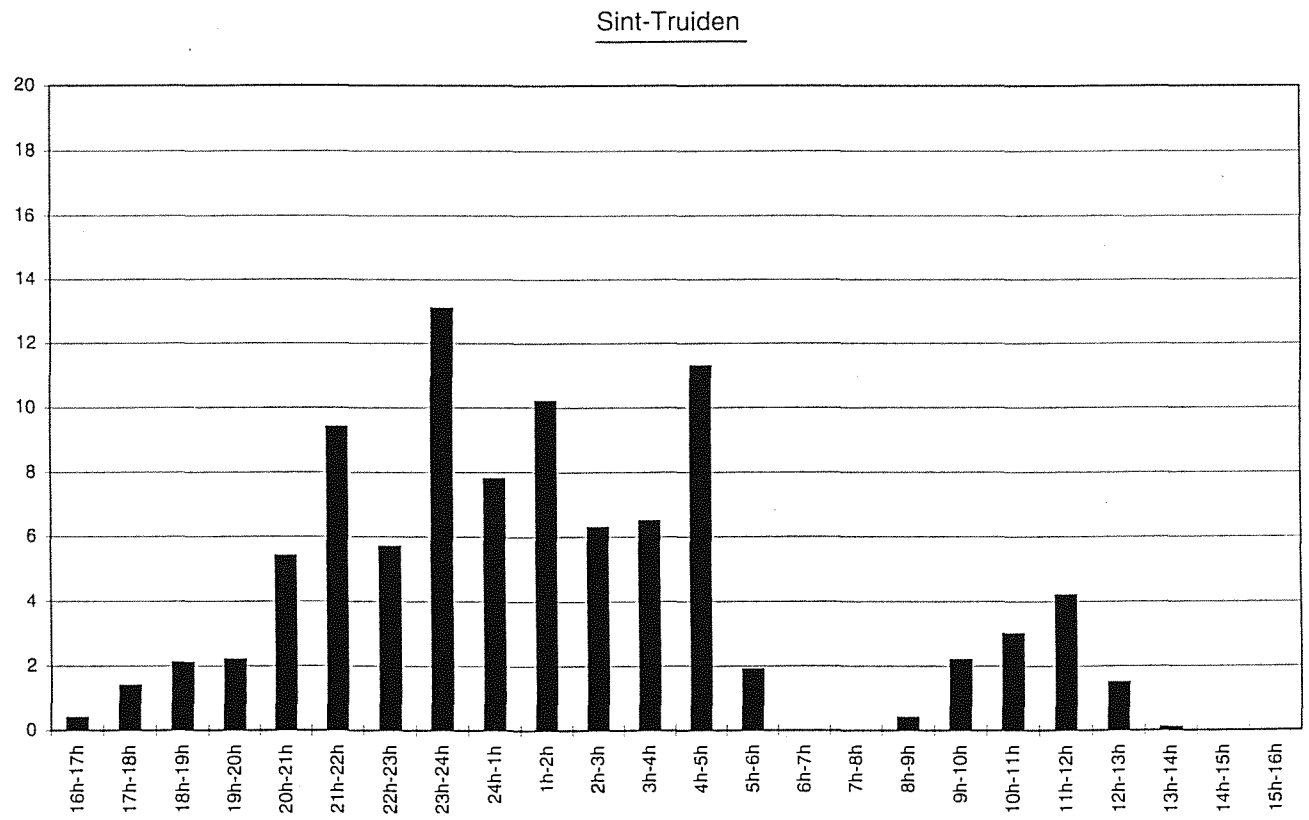
VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 2c

Pluviograaf SINT - TRUIDEN

Neerslag van de periode 13 Sep 98/16h00 - 14 Sep 98/16h00

Neerslag in mm/h

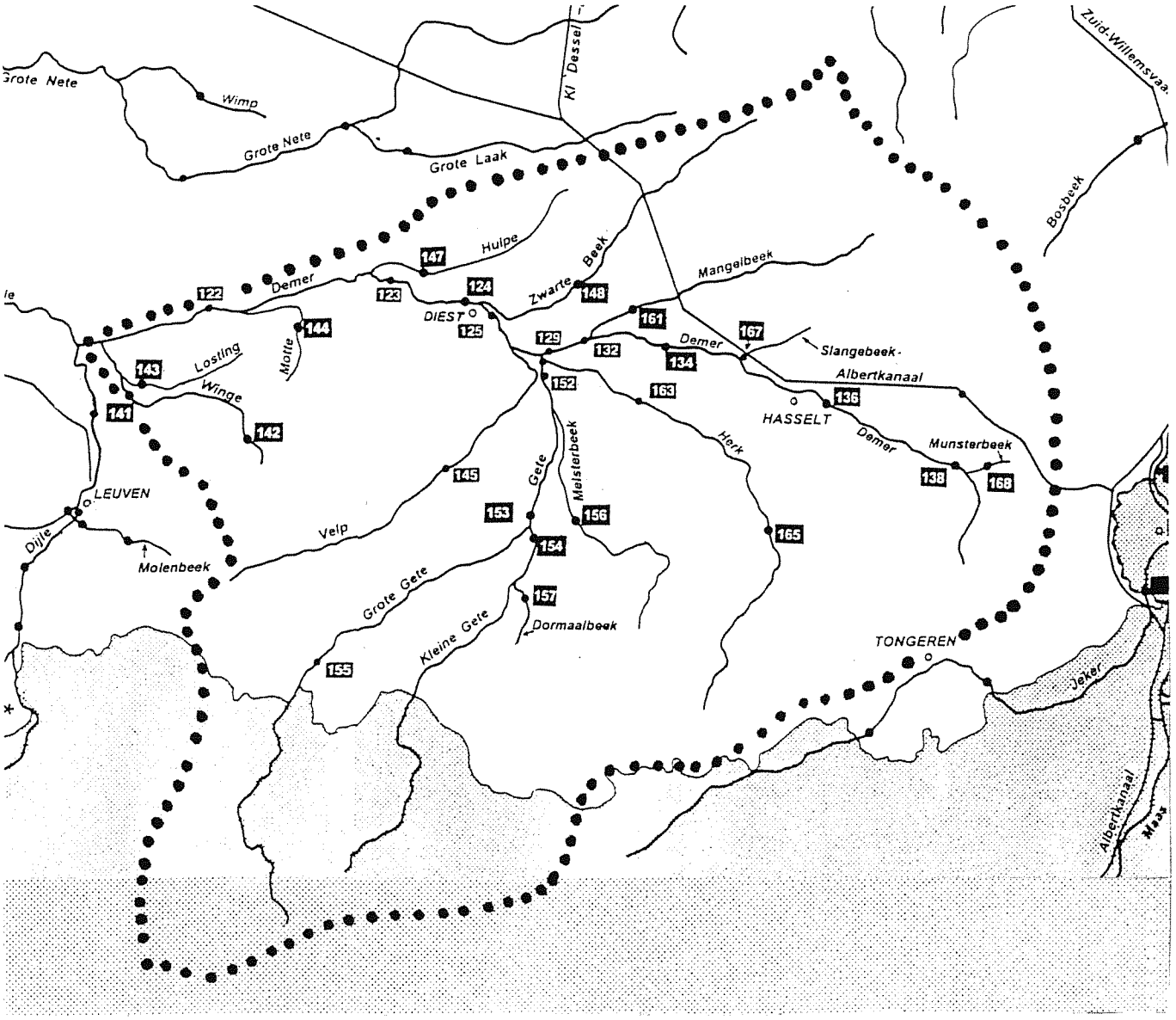


DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 3

Hydrografisch bekken van de Demer met inplanting van de hydrometrische stations



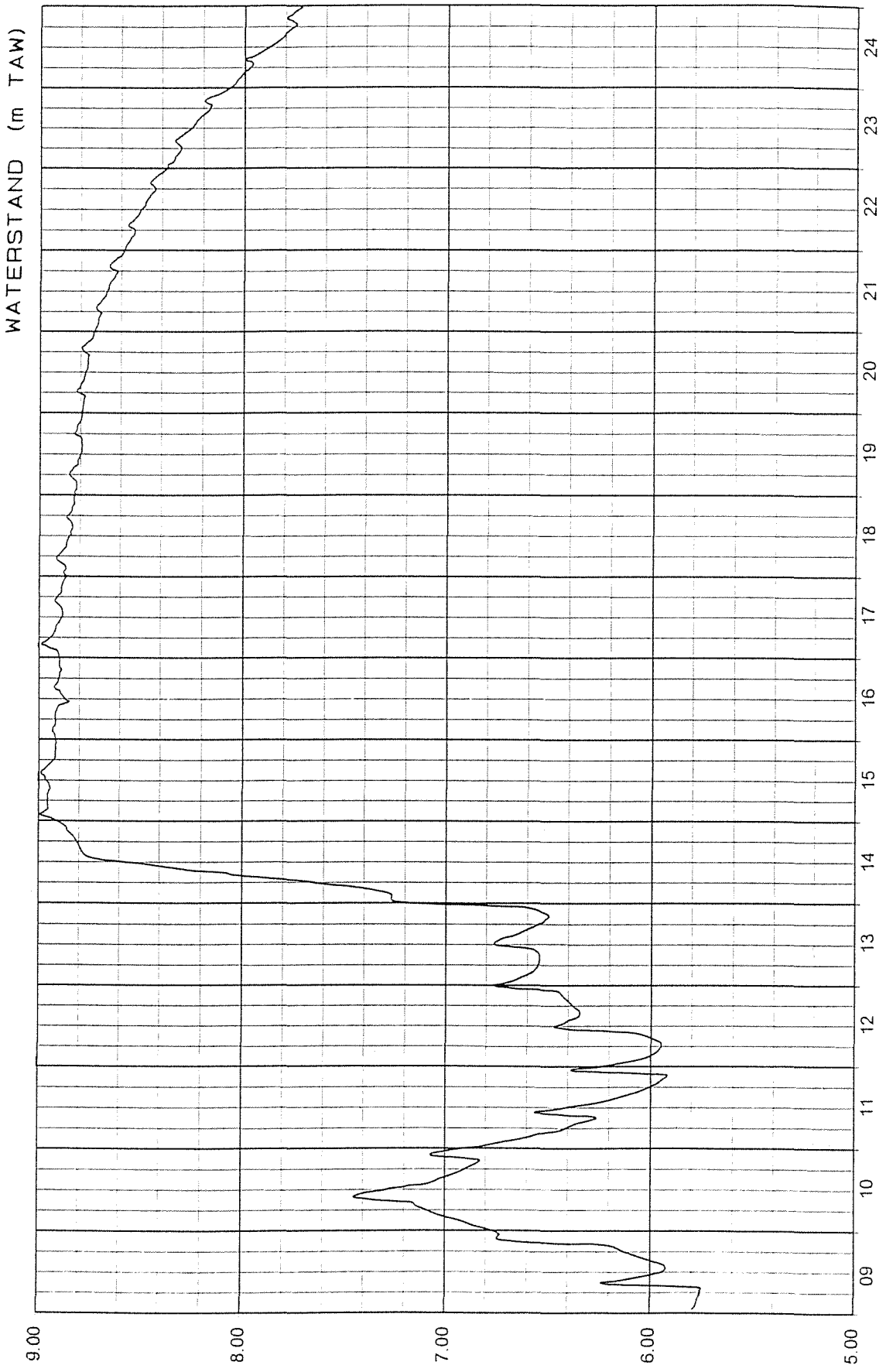
122	Demer / Aarschot
123	Demer / Zichem
124	Demer / Diest-afw. monding Zwarte Beek
125	Demer / Diest–250m opw. monding Zwarte Beek
129	Demer / Halen-200m opw. monding Gete-Herk
132	Demer / Linkhout
134	Demer / Kermt
136	Demer / Hasselt
138	Demer / Bilzen
141	Winge / Wezemaal
142	Winge / St.-Pieters-Rode
143	Losting / Wezemaal
144	Motte / Rillaar
145	Velp / Ransberg
147	Hulpe / Molenstede
148	Zwarte Beek / Zelem
152	Gete / Halen
153	Gete / Budingen
154	Kleine Gete / Budingen
155	Grote Gete / Hoegaarden
156	Melsterbeek / Rummen
157	Dormaalbeek / Zoutleeuw
161	Mangelbeek / Lummen
163	Herk / Kermt
165	Herk / Wellen
167	Slangebeek / Kuringen
168	Munsterbeek / Munsterbilzen

DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 4

DIJLE / HAACHT
waterstand 09 - 24 Sep 98



Bron: afd. Maritieme Schelde (adm. Waterwegen en Zeewezen)

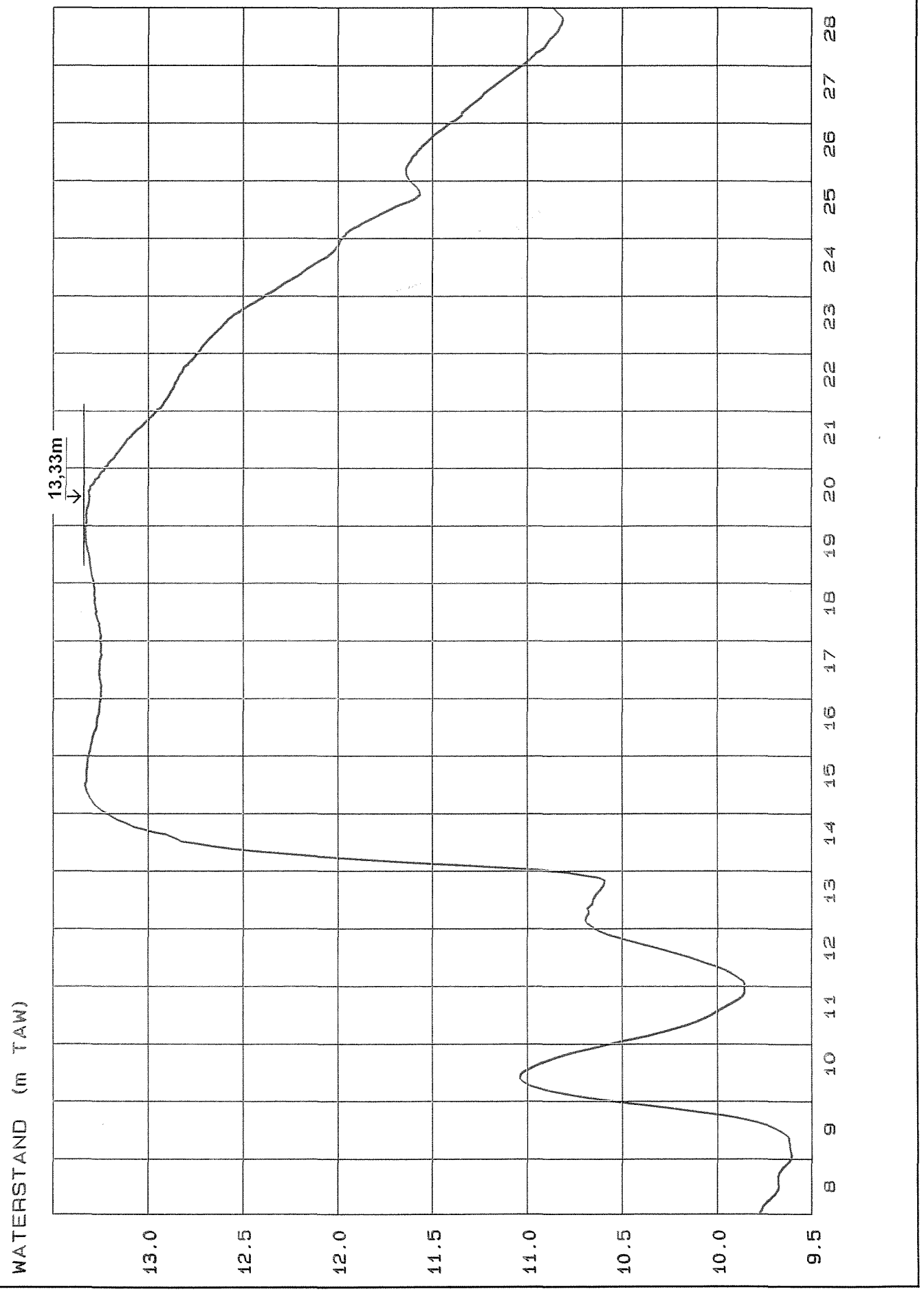
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 5

DEMER / AARSCHOT

waterstand 08 - 28 Sep 98



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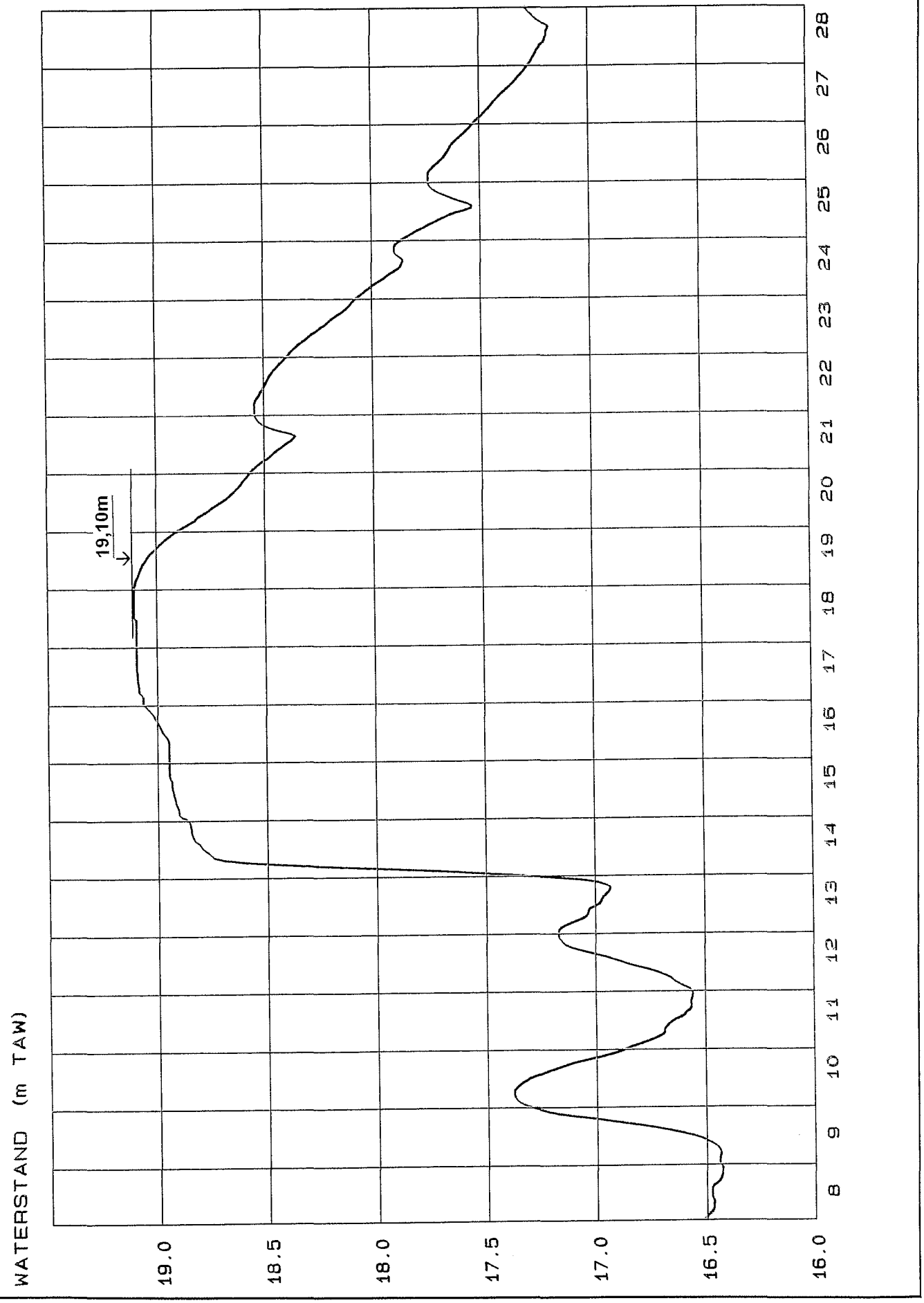
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 6

DEMER / ZICHEM
waterstand 08 - 28 Sep 98

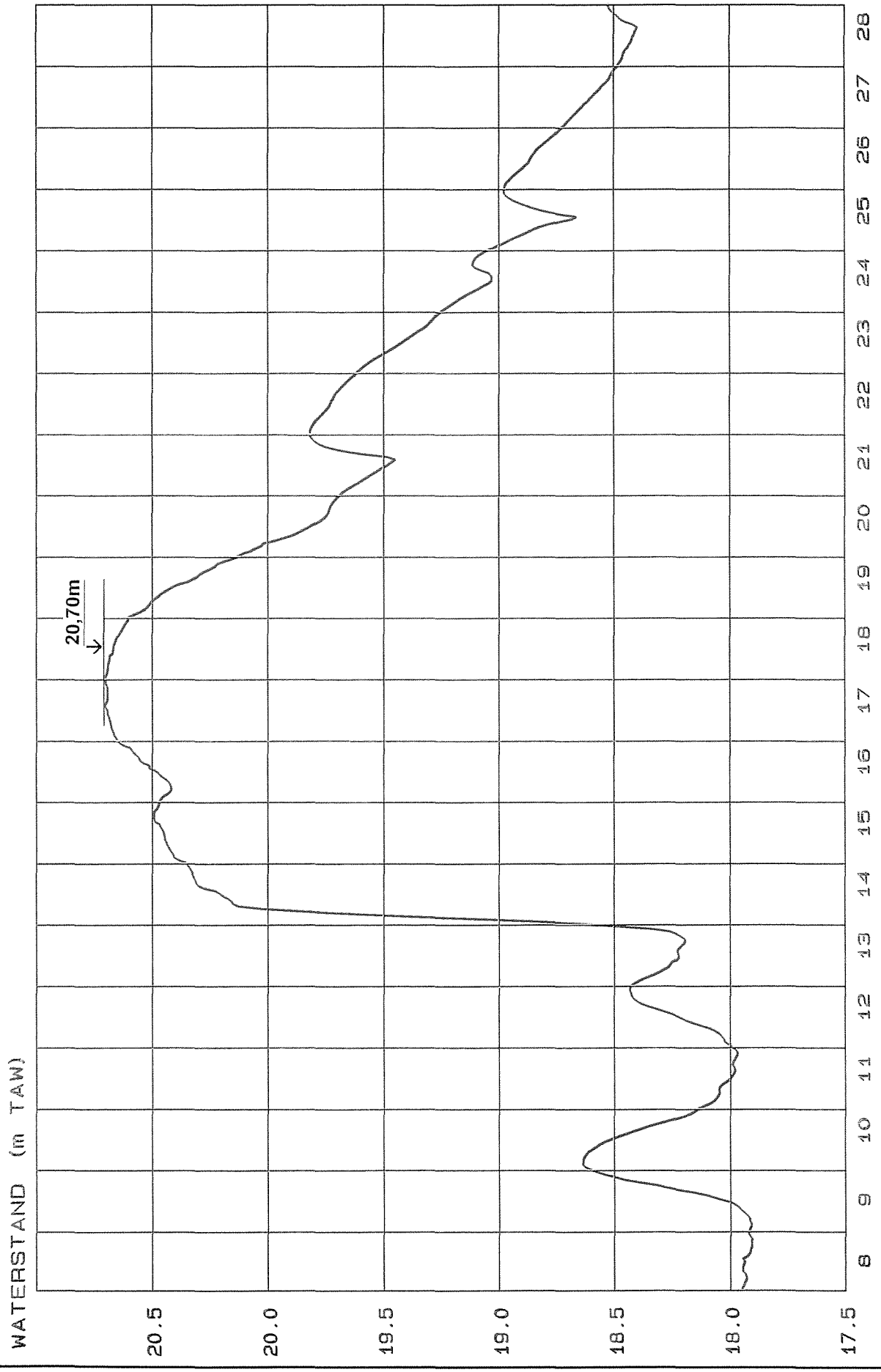


DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 7

DEMER / DIEST (250m opwaarts monding Zwarte beek)
waterstand 08 - 28 Sep 98

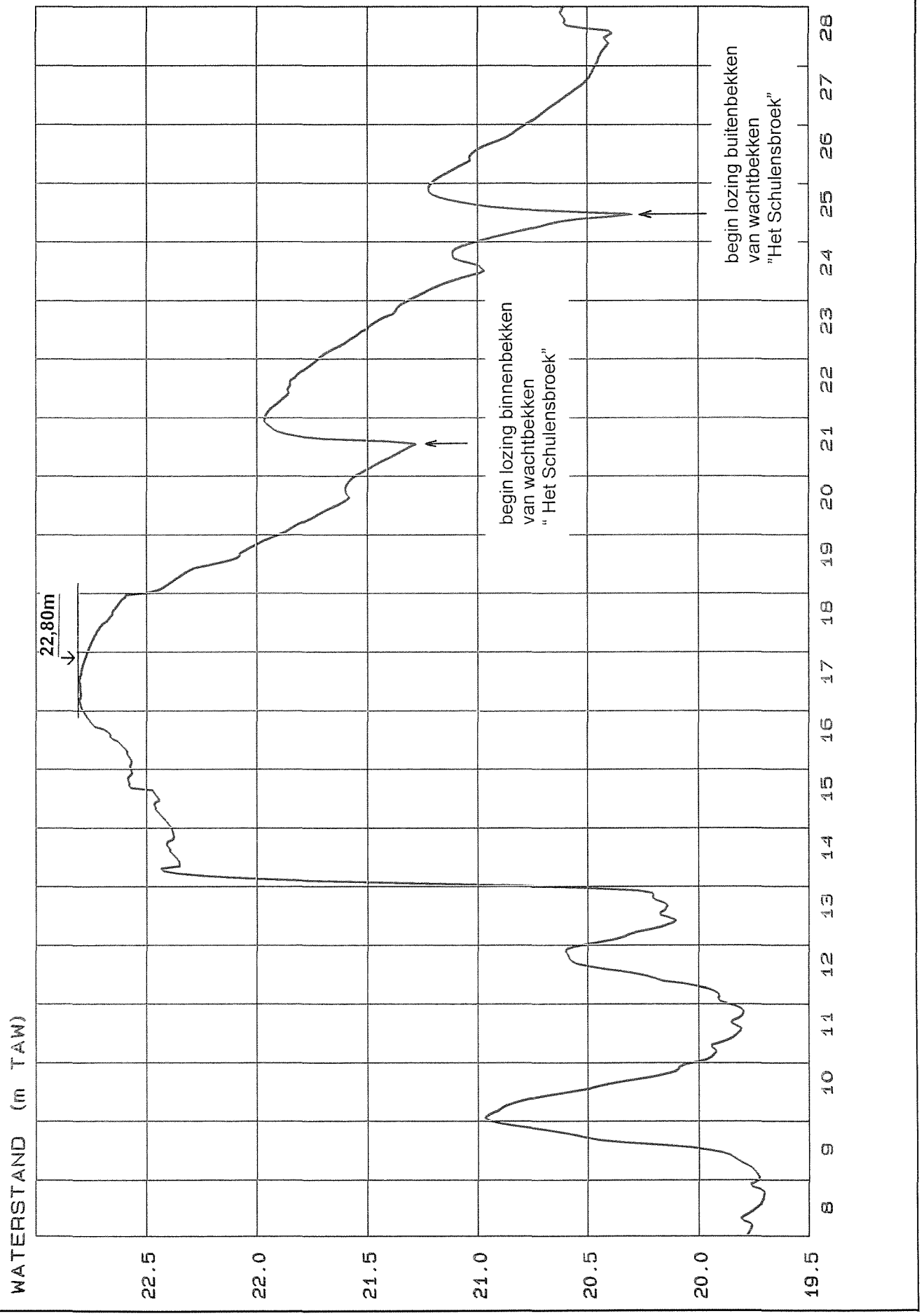


DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 8

DEMER / HALEN (200m opwaarts monding Gete - Herk)
waterstand 08 - 28 Sep 98



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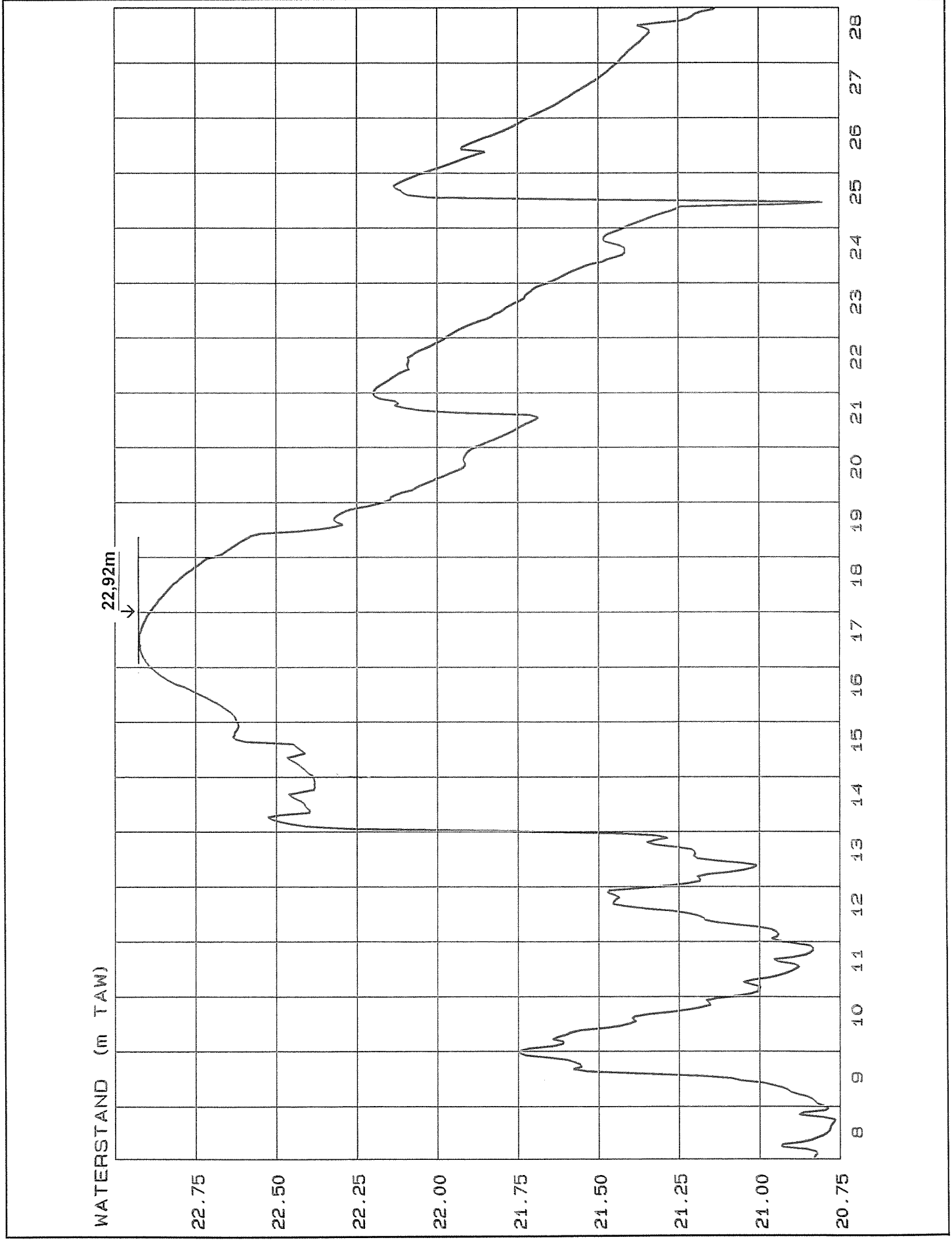
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 9

DEMER / LINKHOUT

waterstand 08 - 28 Sep 98



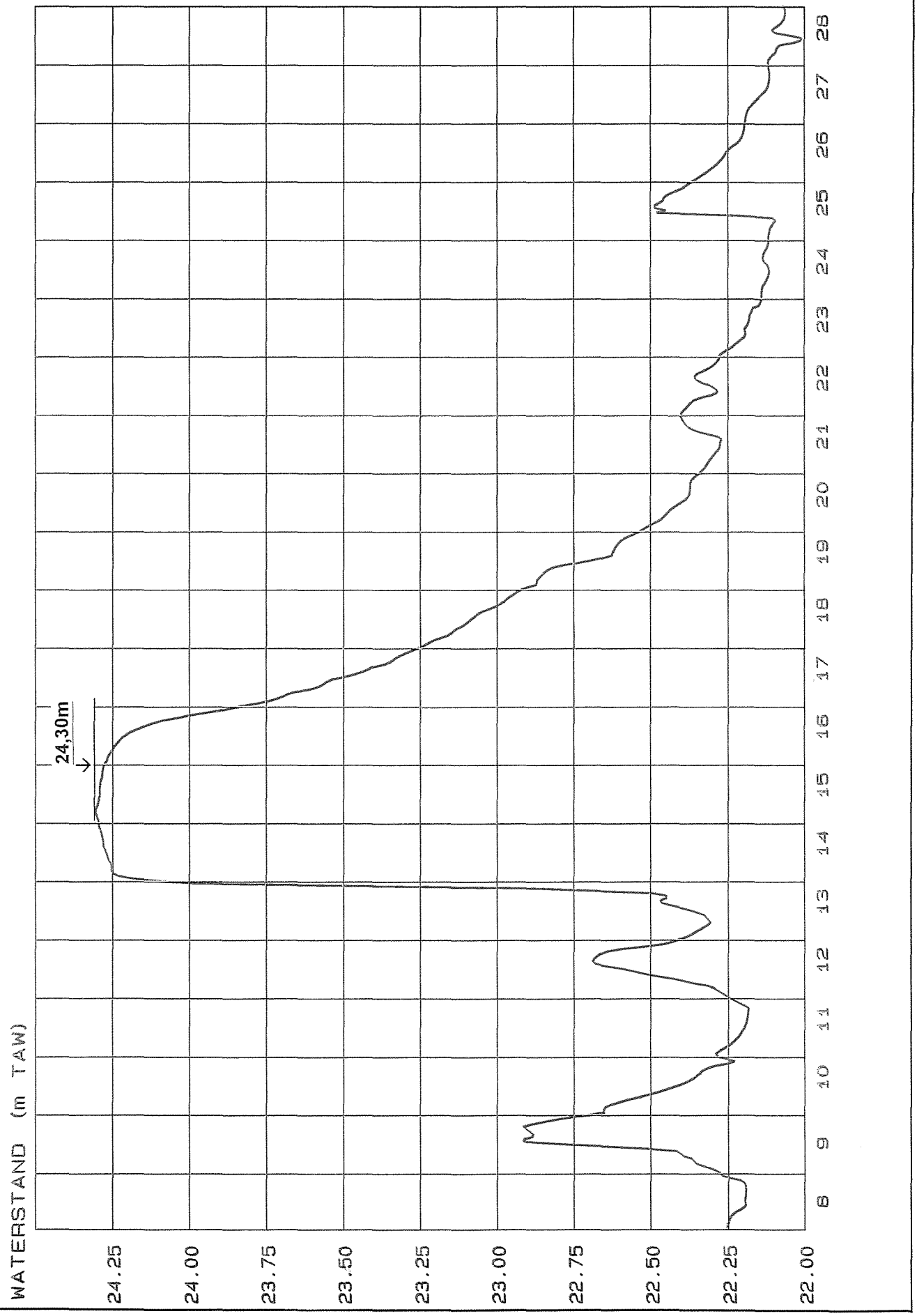
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 10

DEMER / KERMT

waterstand 08 - 28 Sep 98



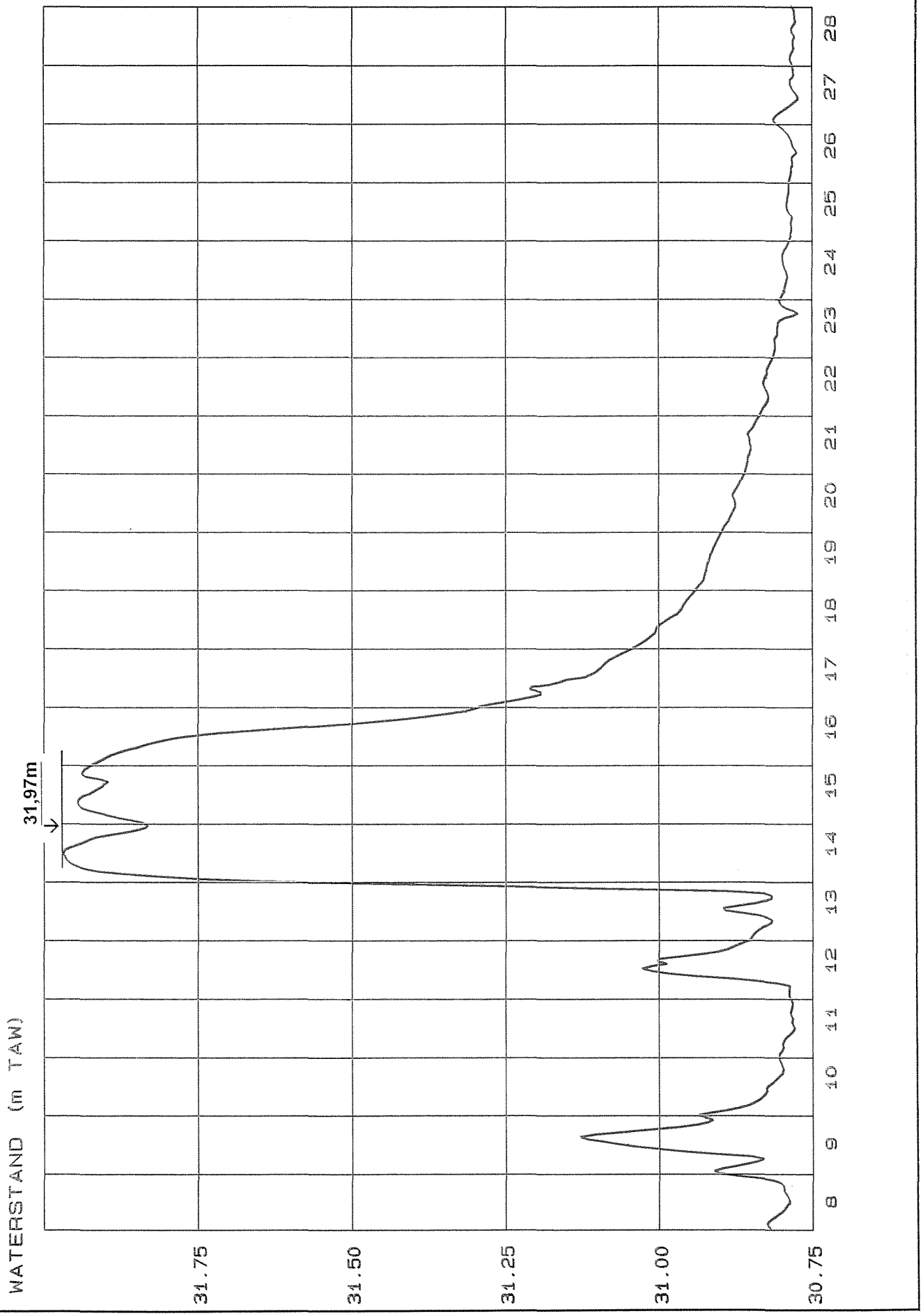
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 11

DEMER / HASSELT

waterstand 08 - 28 Sep 98



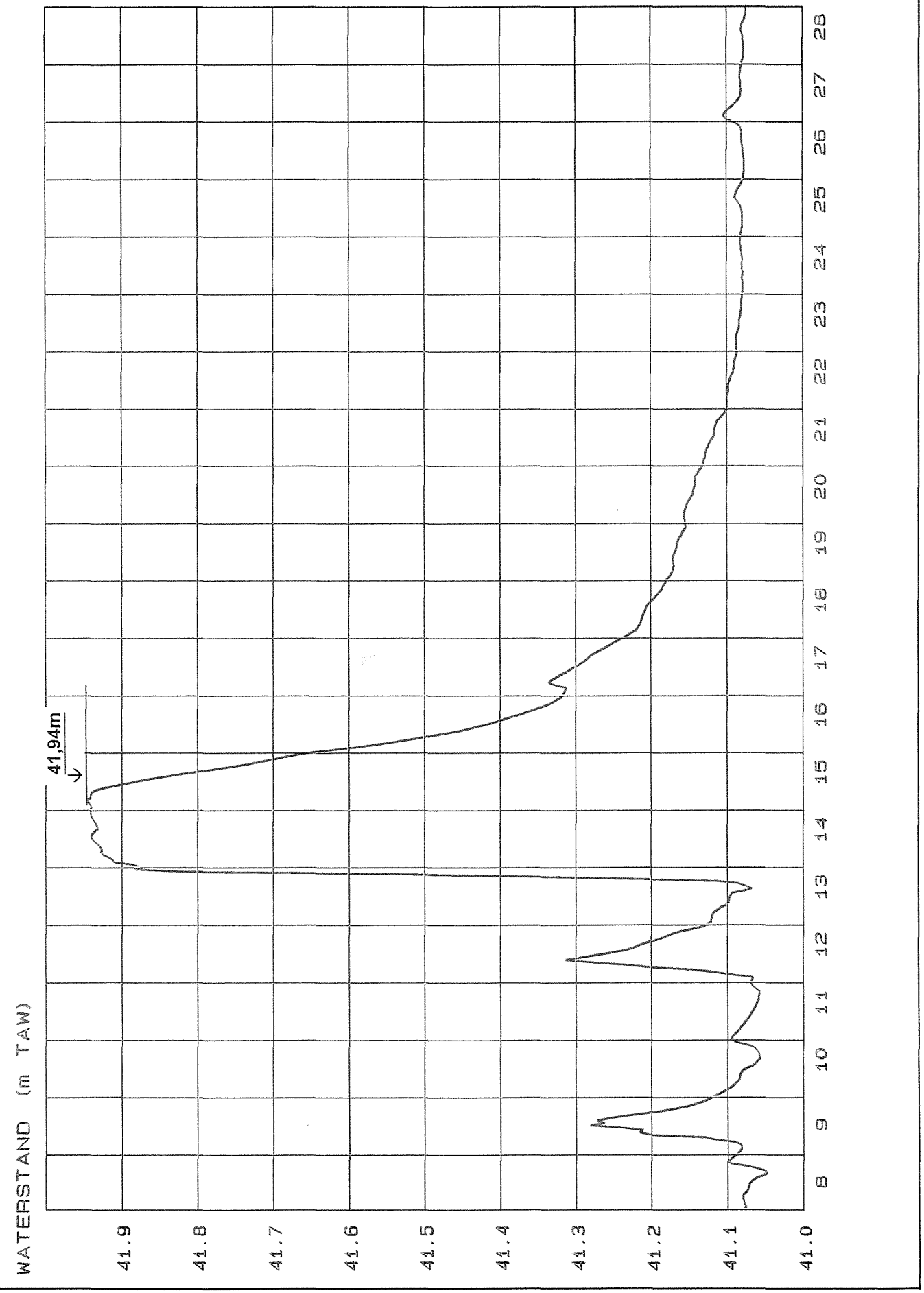
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 12

DEMER / BILZEN

waterstand 08 - 28 Sep 98



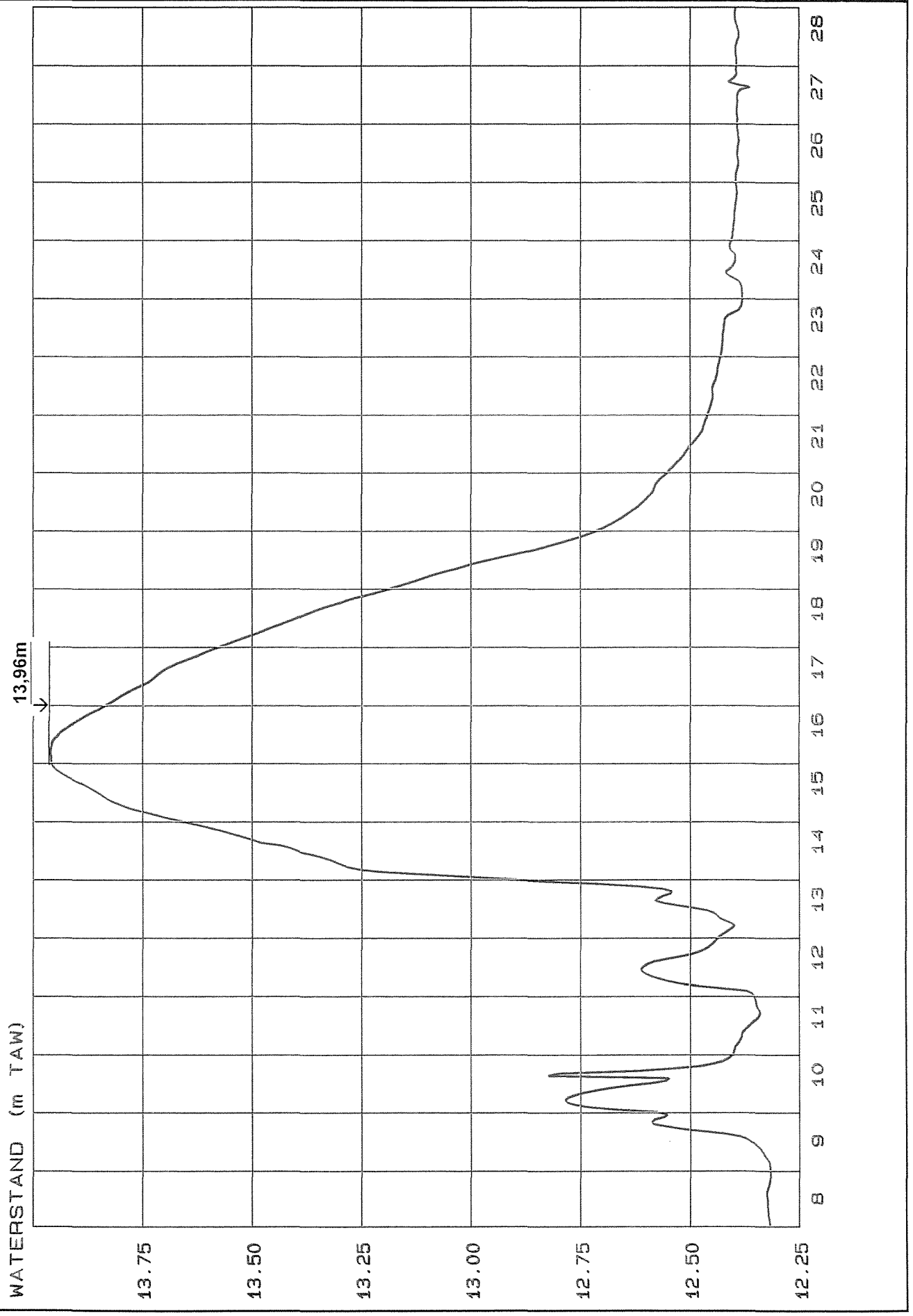
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 13

WINGE / WEZEMAAL

waterstand 08 - 28 Sep 98



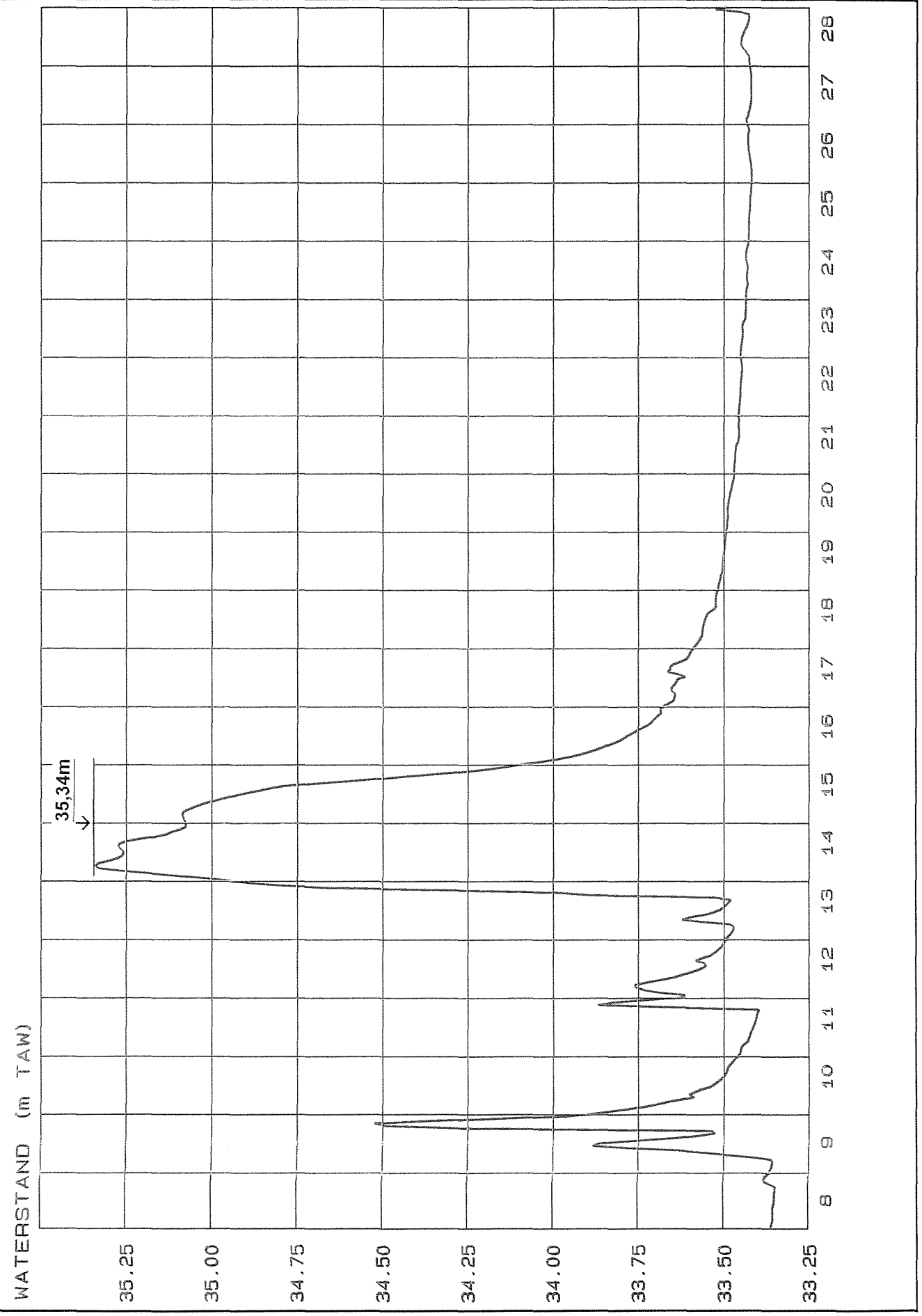
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 14

WINGE / SINT - PIETERS - RODE

waterstand 08 - 28 Sep 98



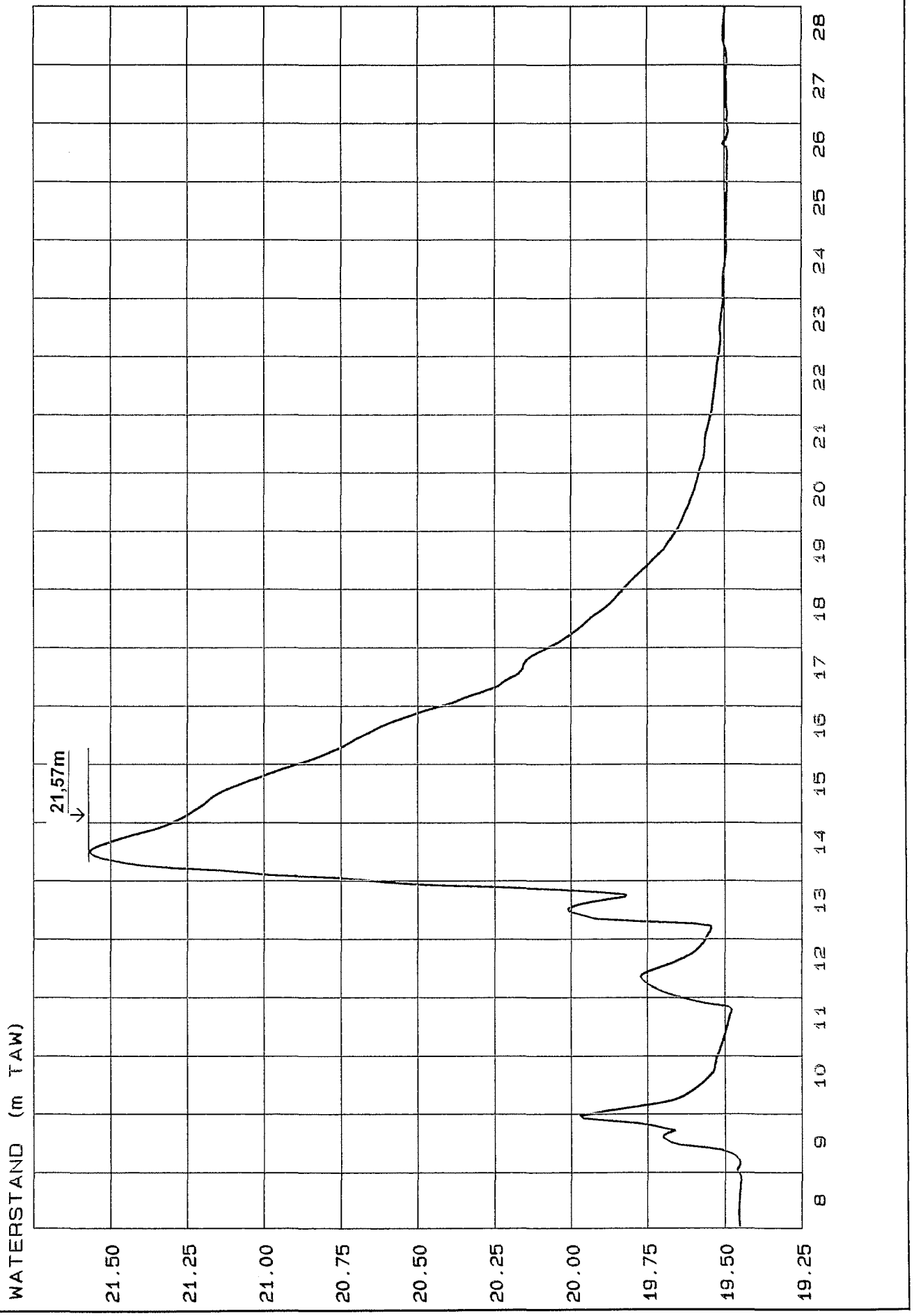
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 15

MOTTE / RILLAAR

waterstand 08 - 28 Sep 98



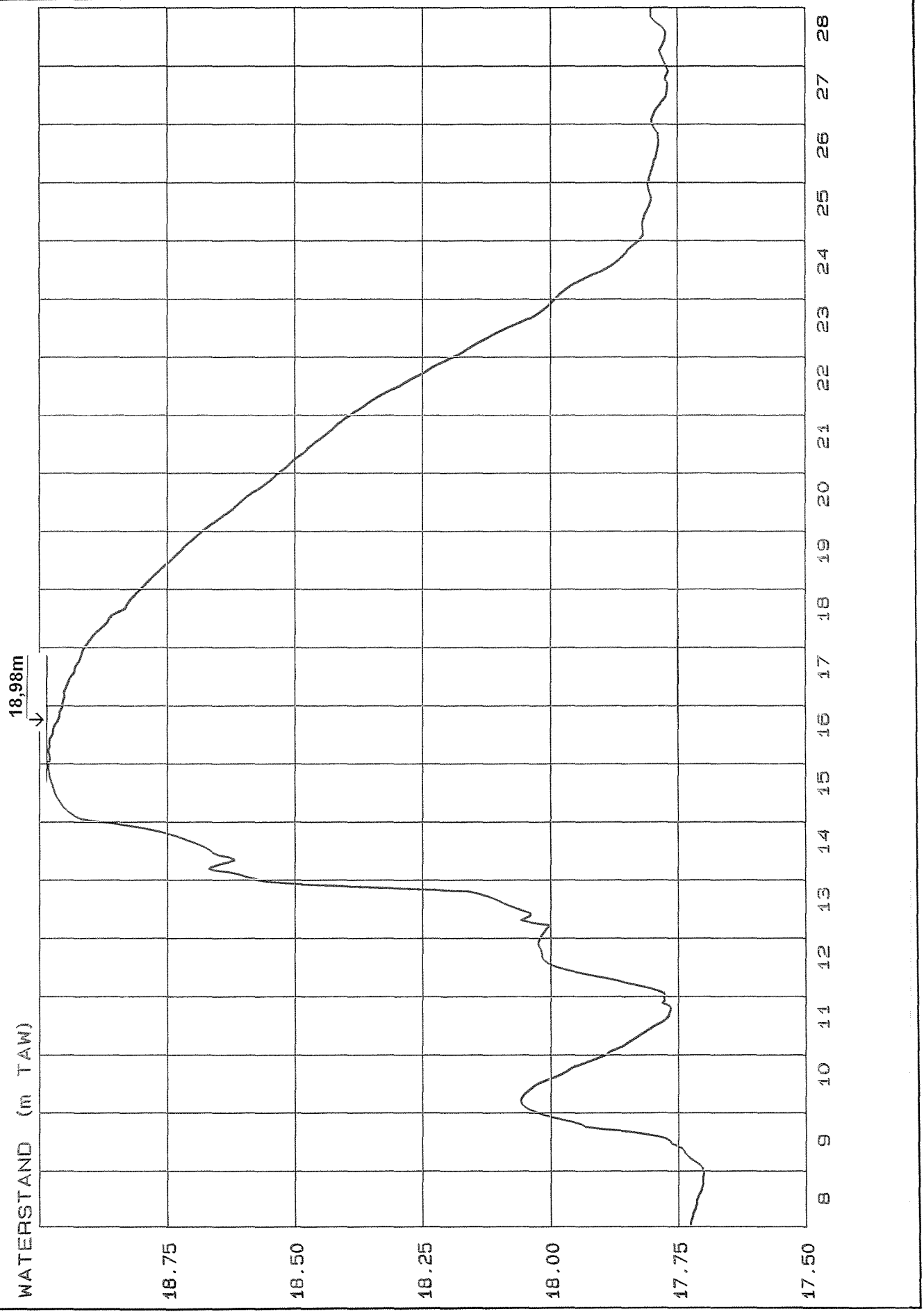
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 16

HULPE / MOLENSTEDE

waterstand 08 - 28 Sep 98



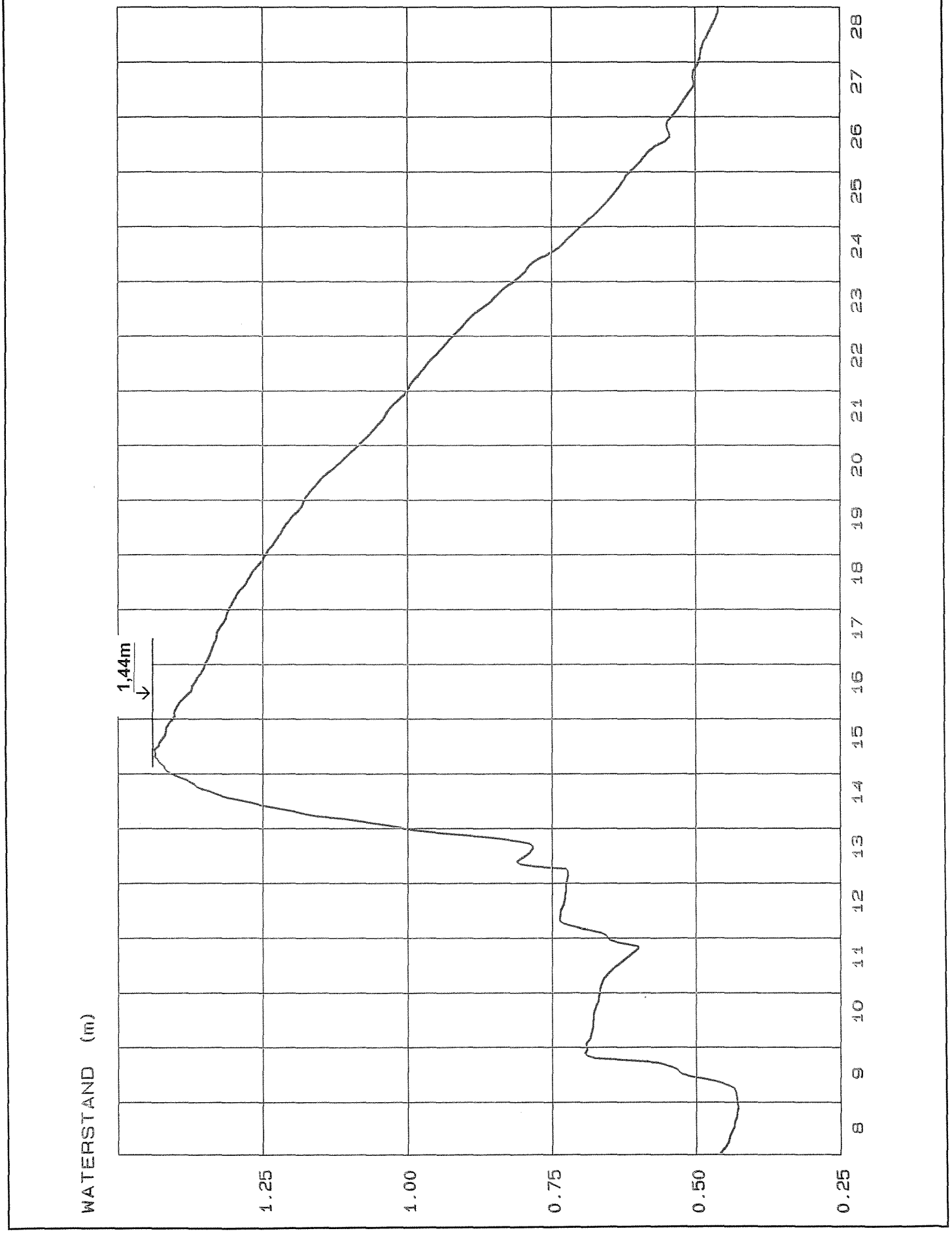
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 17

ZWARTE BEEK / ZELEM

waterstand 08 - 28 Sep 98



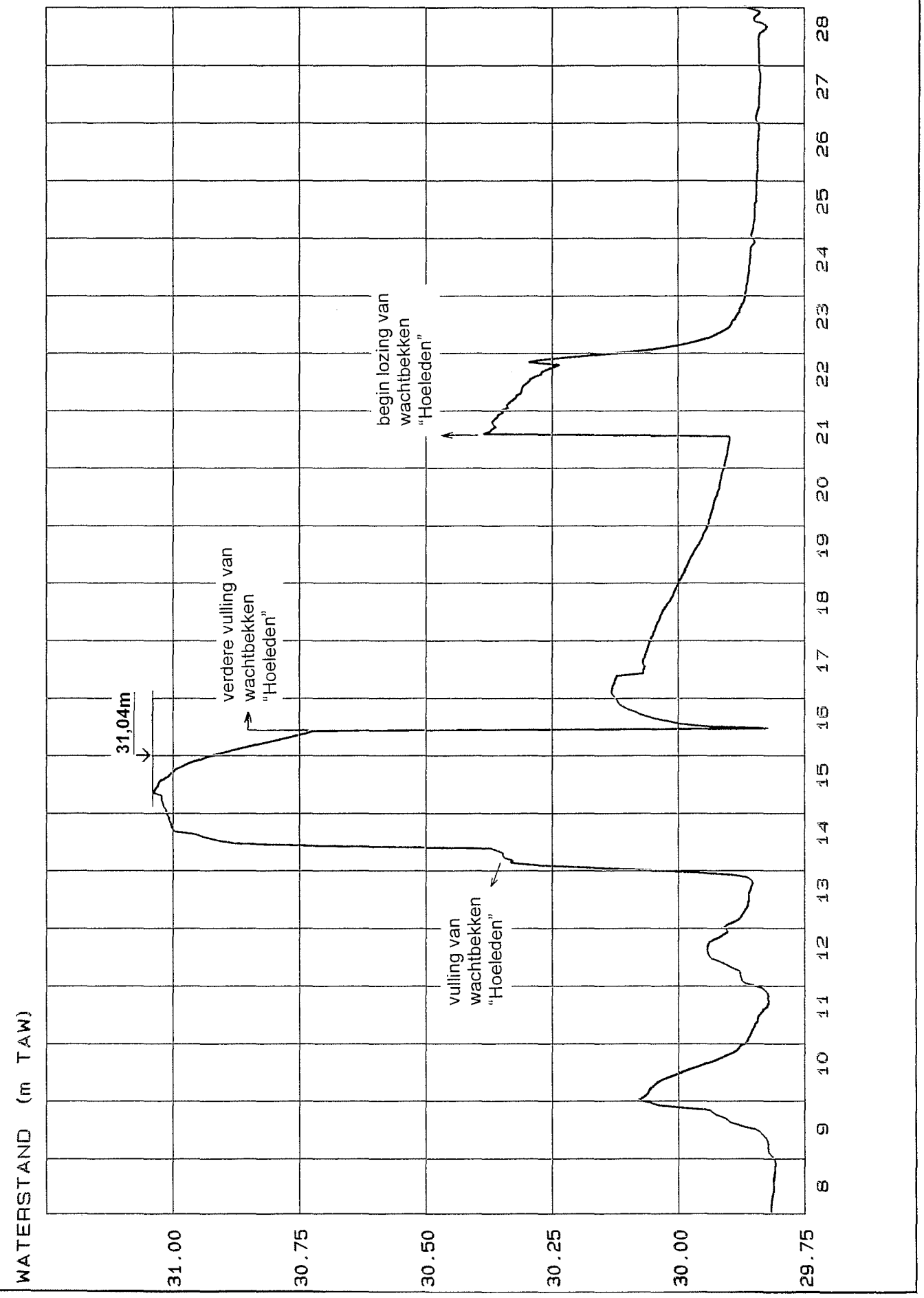
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 18

VELP / RANSBERG

waterstand 08 - 28 Sep 98



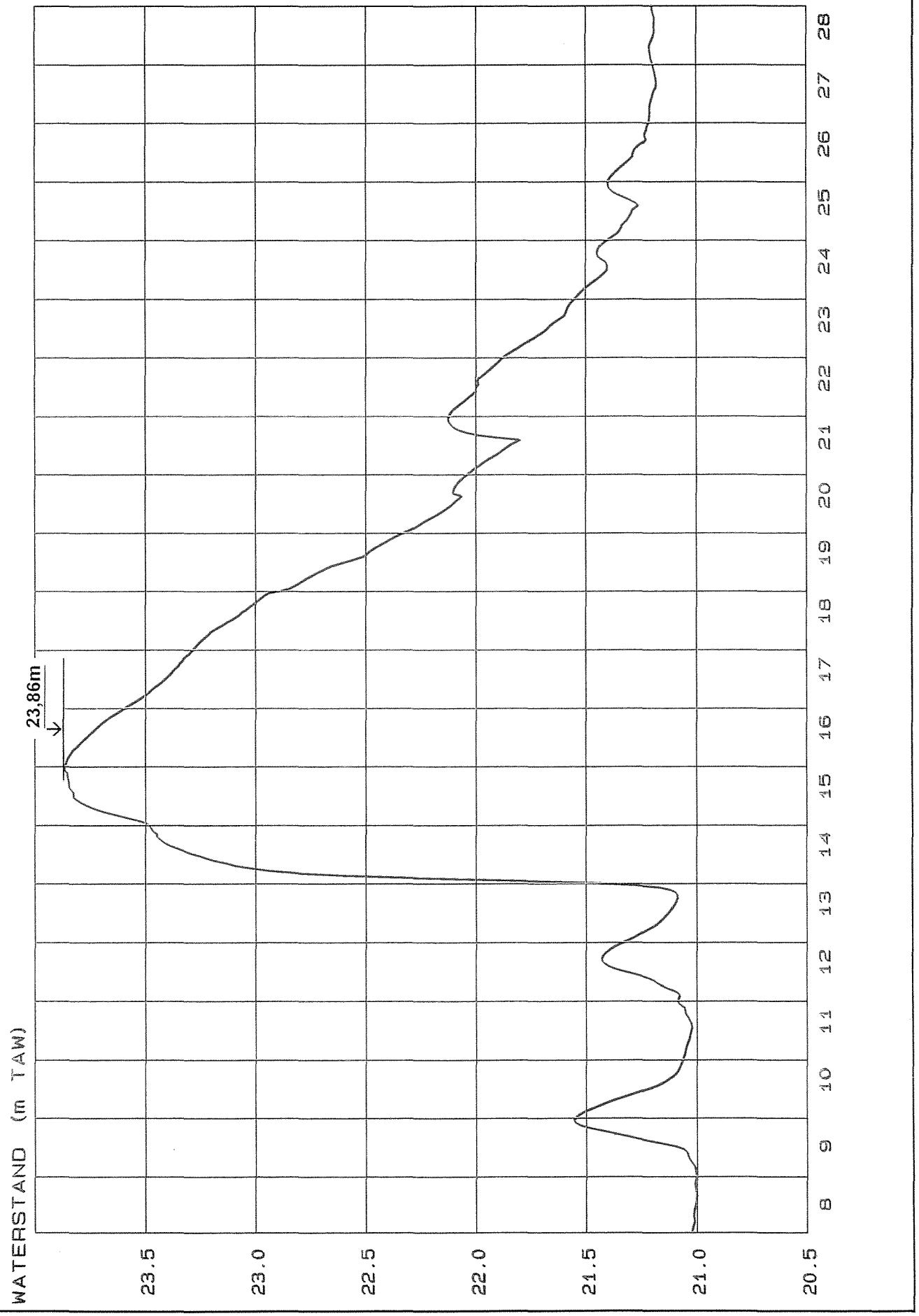
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 19

GETE / HALEN

waterstand 08 - 28 Sep 98



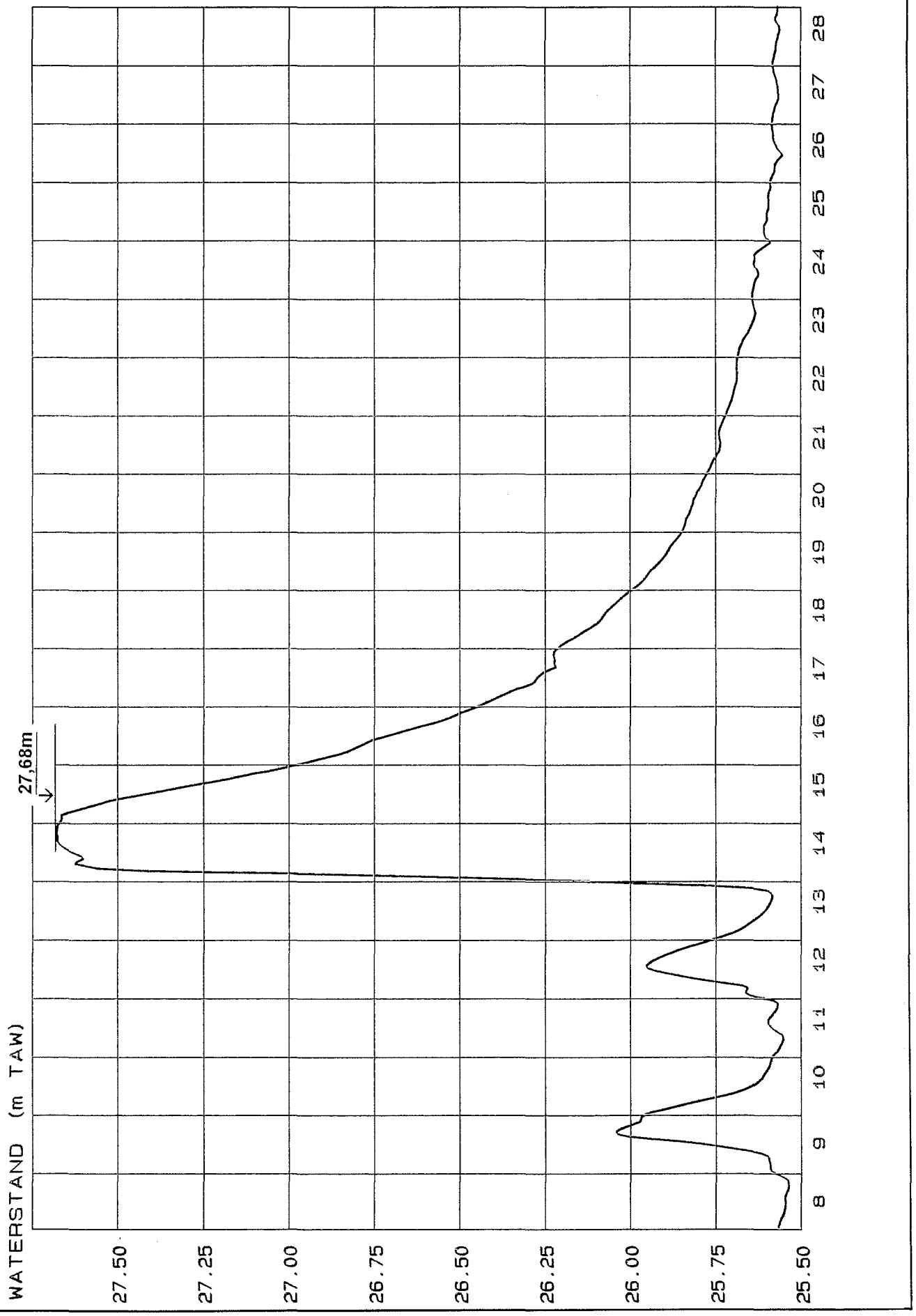
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 20

GETE / BUDINGEN

waterstand 08 - 28 Sep 98



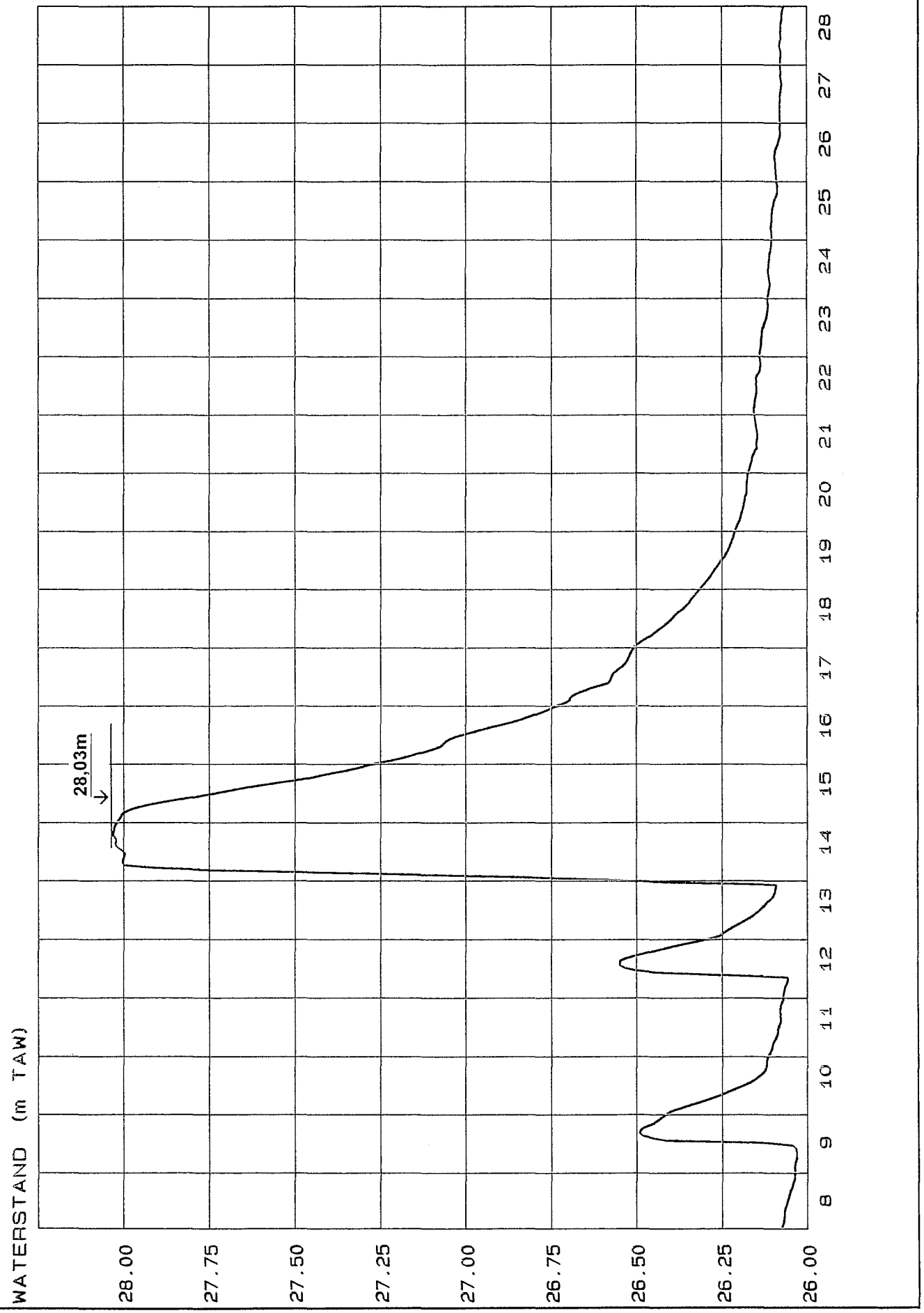
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 21

KLEINE GETE / BUDINGEN

waterstand 08 - 28 Sep 98



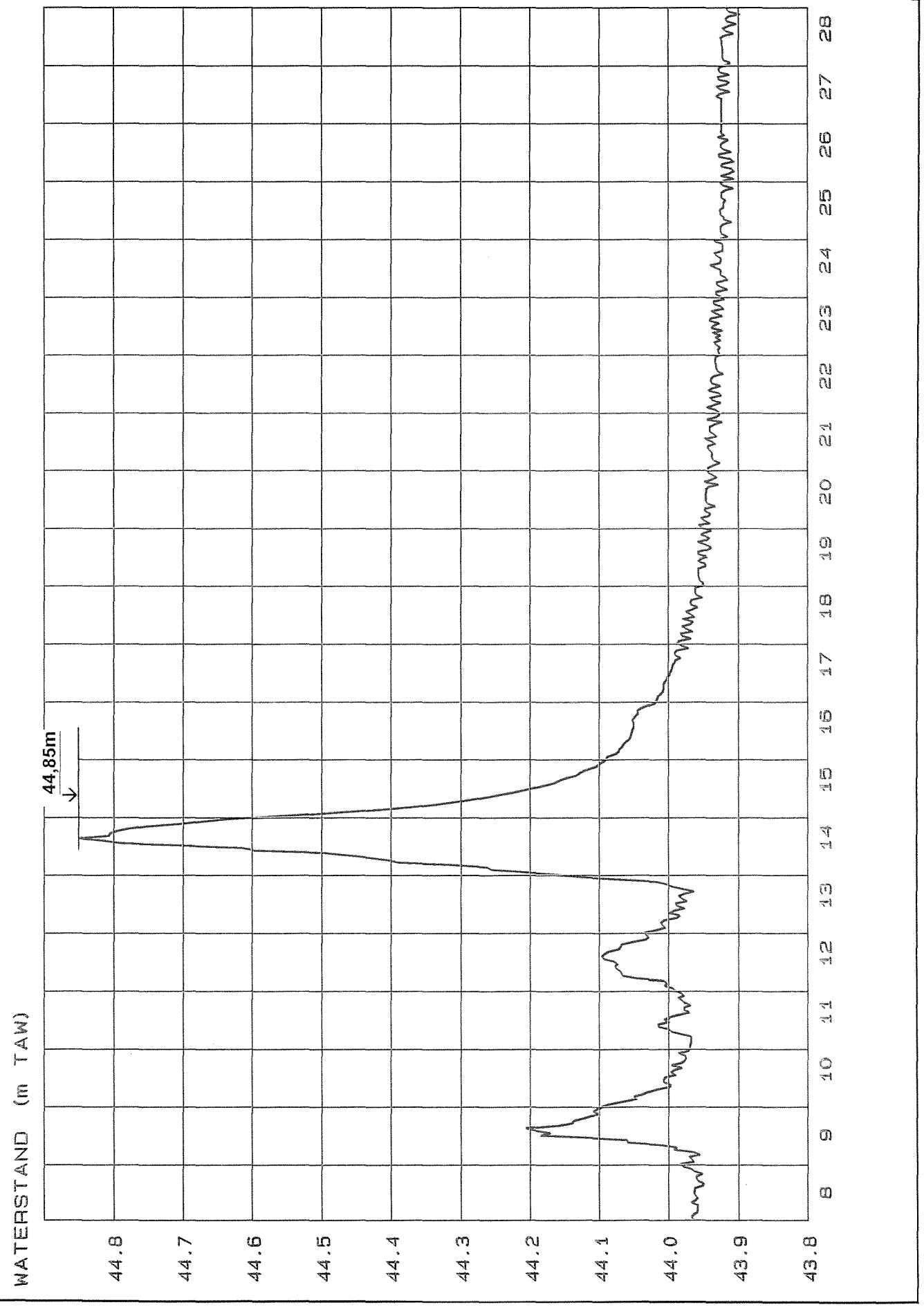
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 22

GROTE GETE / HOEGAARDEN

waterstand 08 - 28 Sep 98



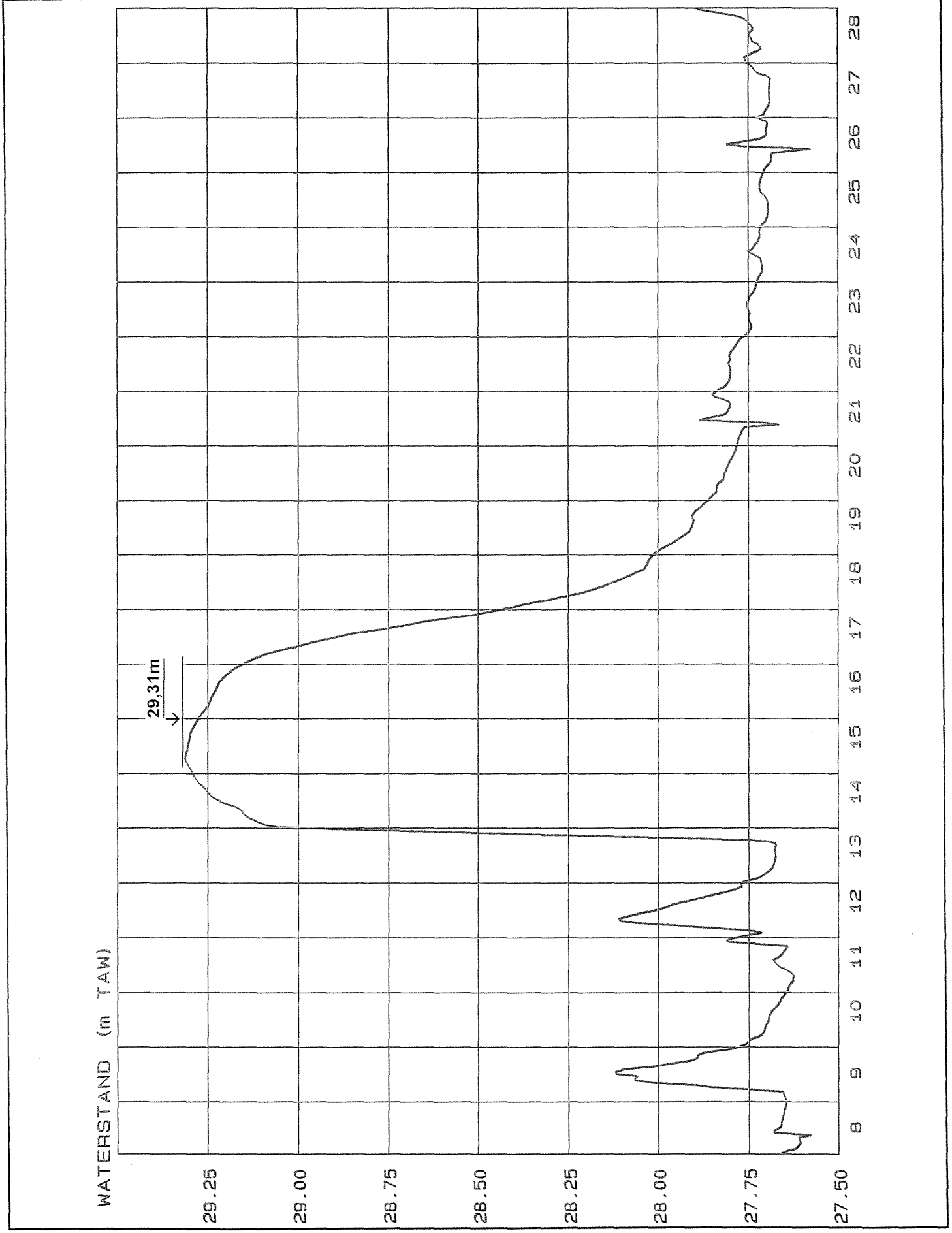
DIHO dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 23

MELSTERBEEK / RUMMEN

waterstand 08 - 28 Sep 98



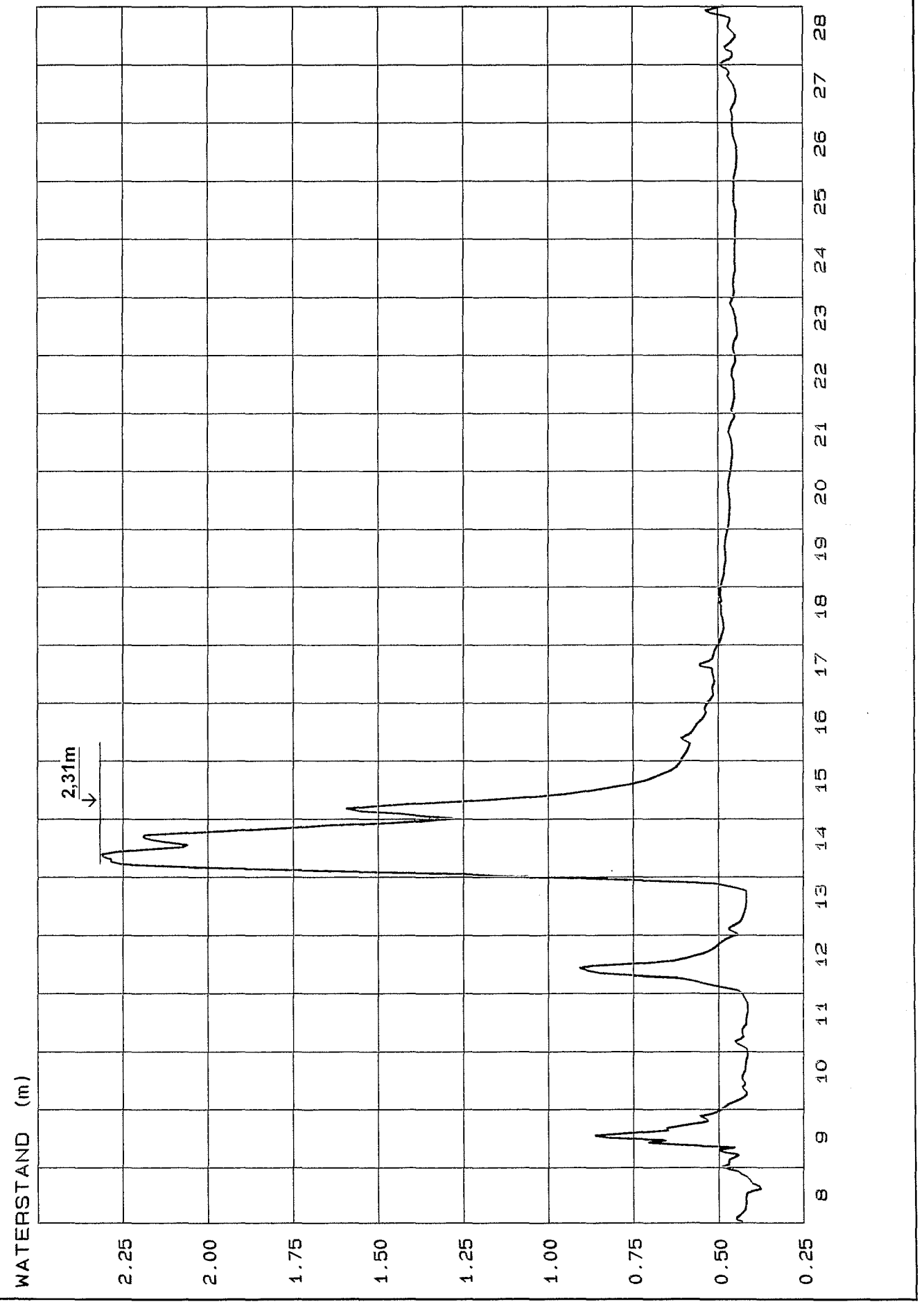
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 24

DORMAALBEEK / ZOUTLEEUW

waterstand 08 - 28 Sep 98



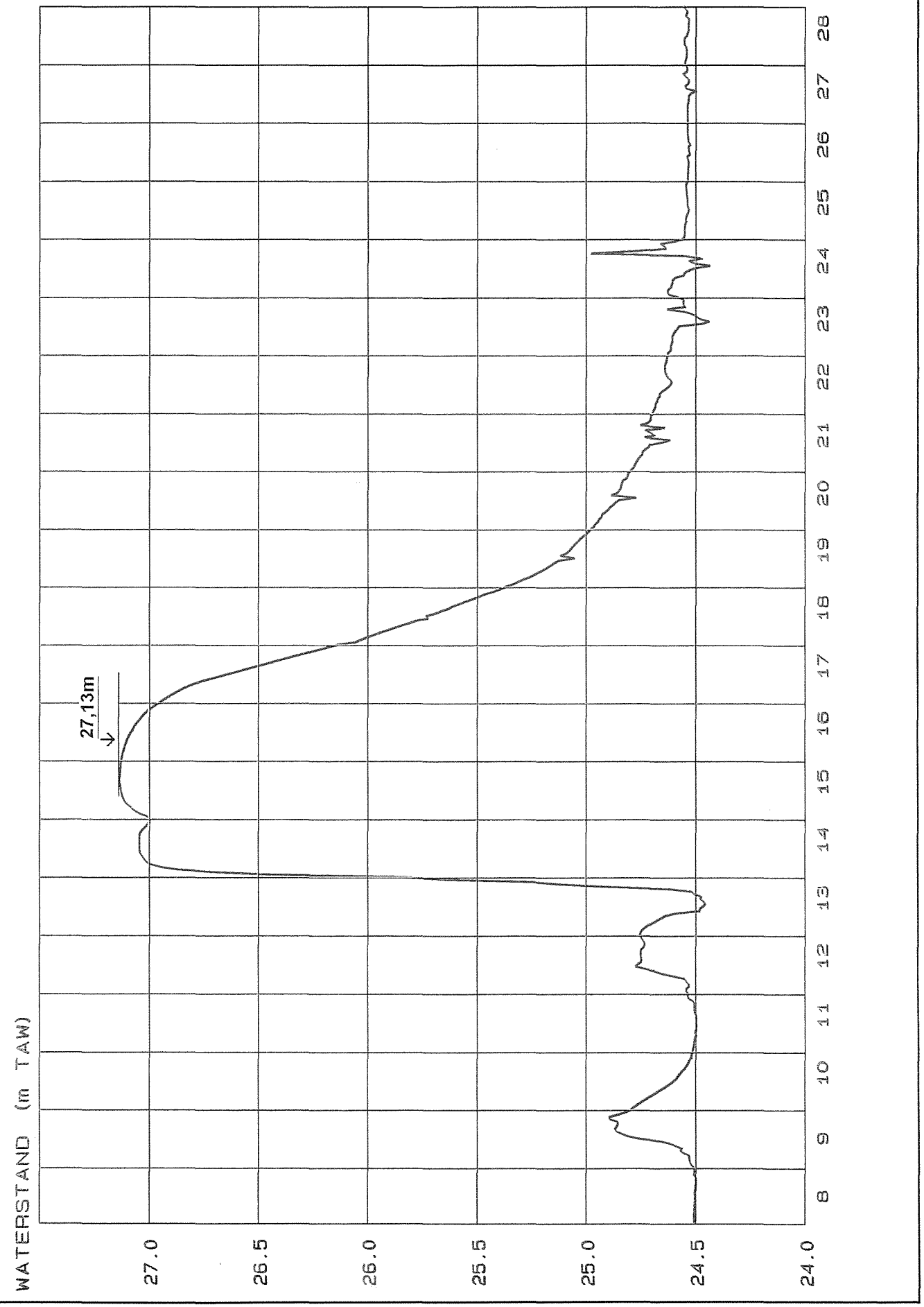
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 25

HERK / KERMT

waterstand 08 - 28 Sep 98

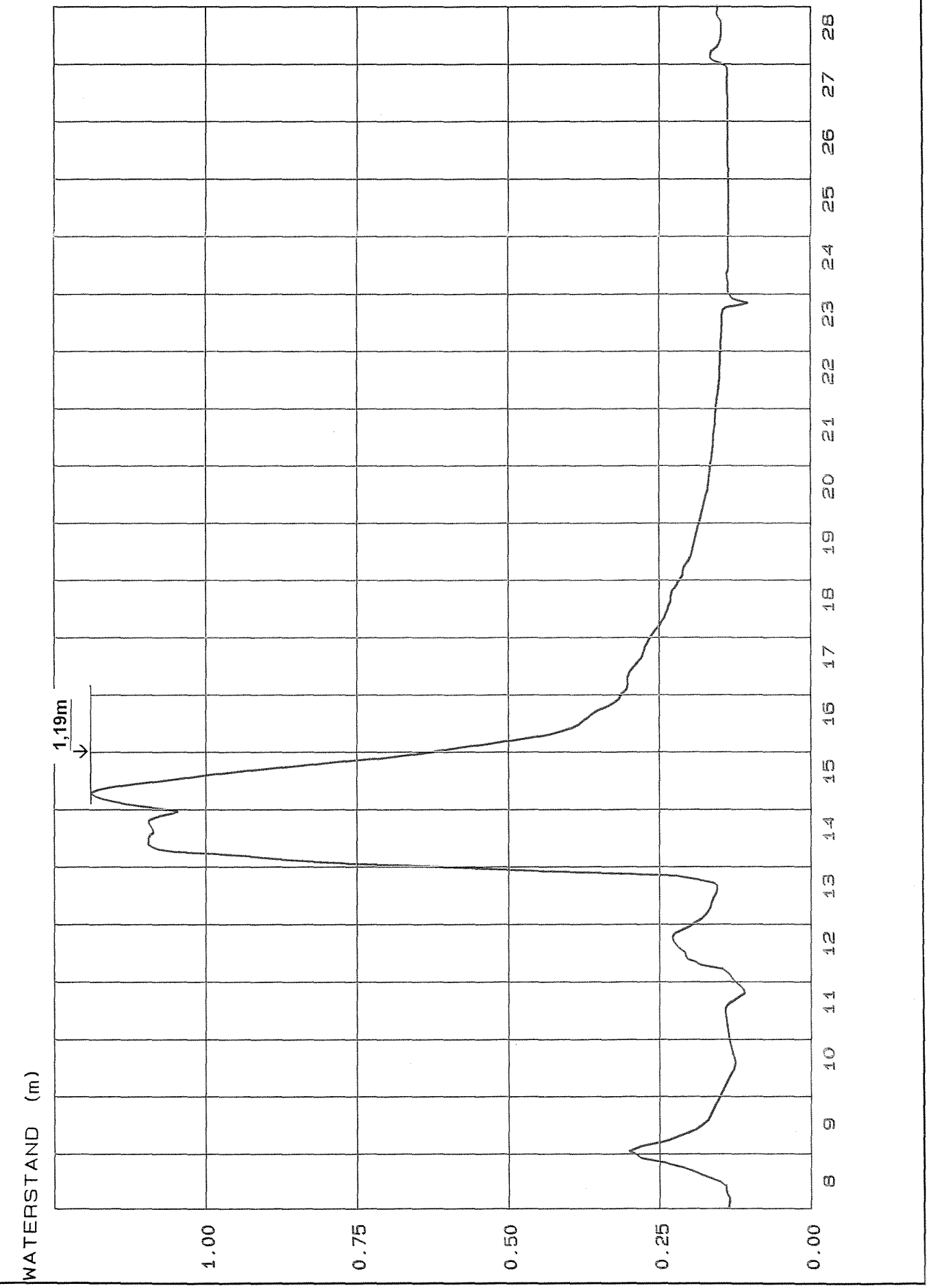


DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 26

HERK / WELLEN
waterstand 08 - 28 Sep 98



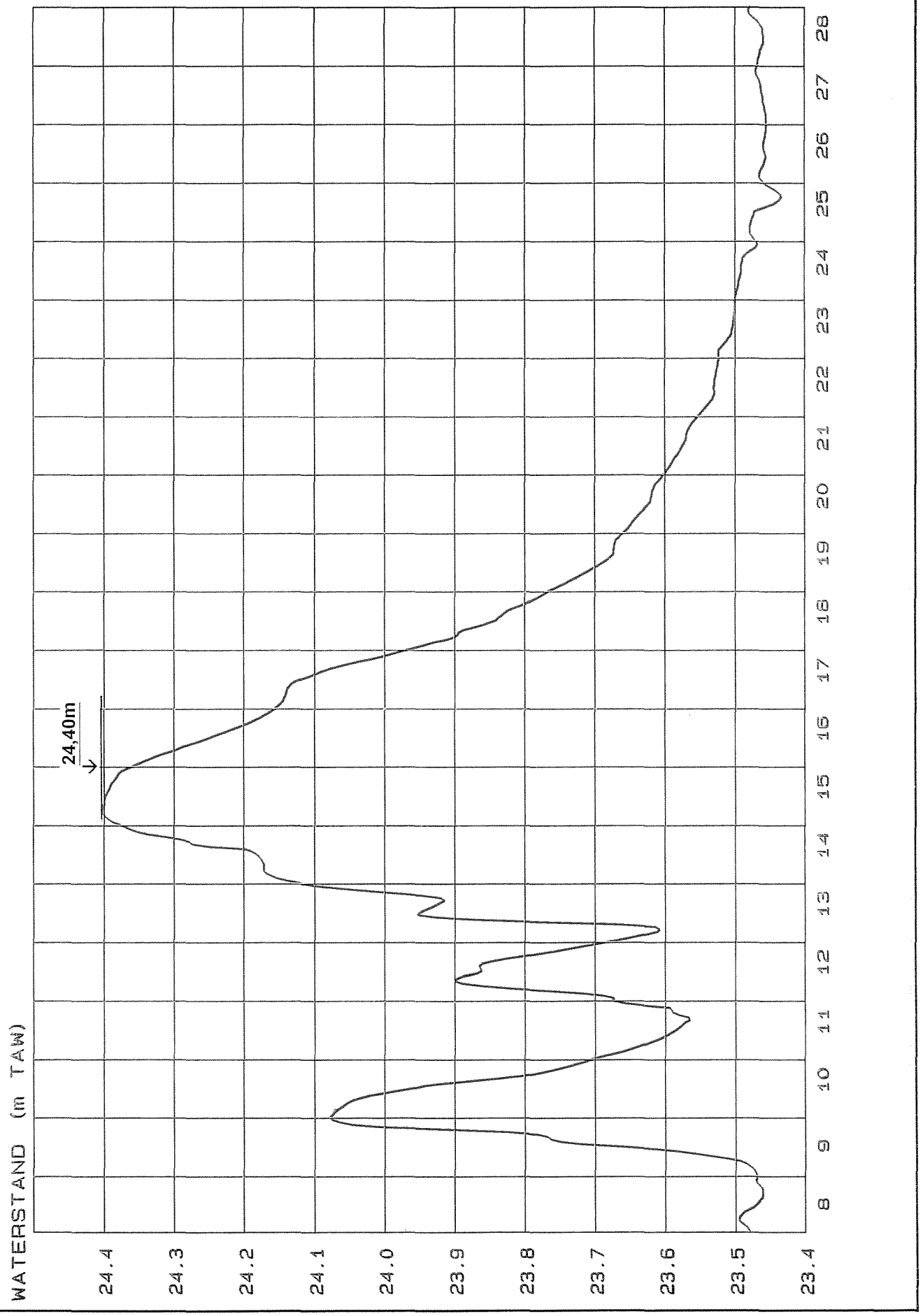
DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 27

MANGELBEEK / LUMMEN

waterstand 08 - 28 Sep 98



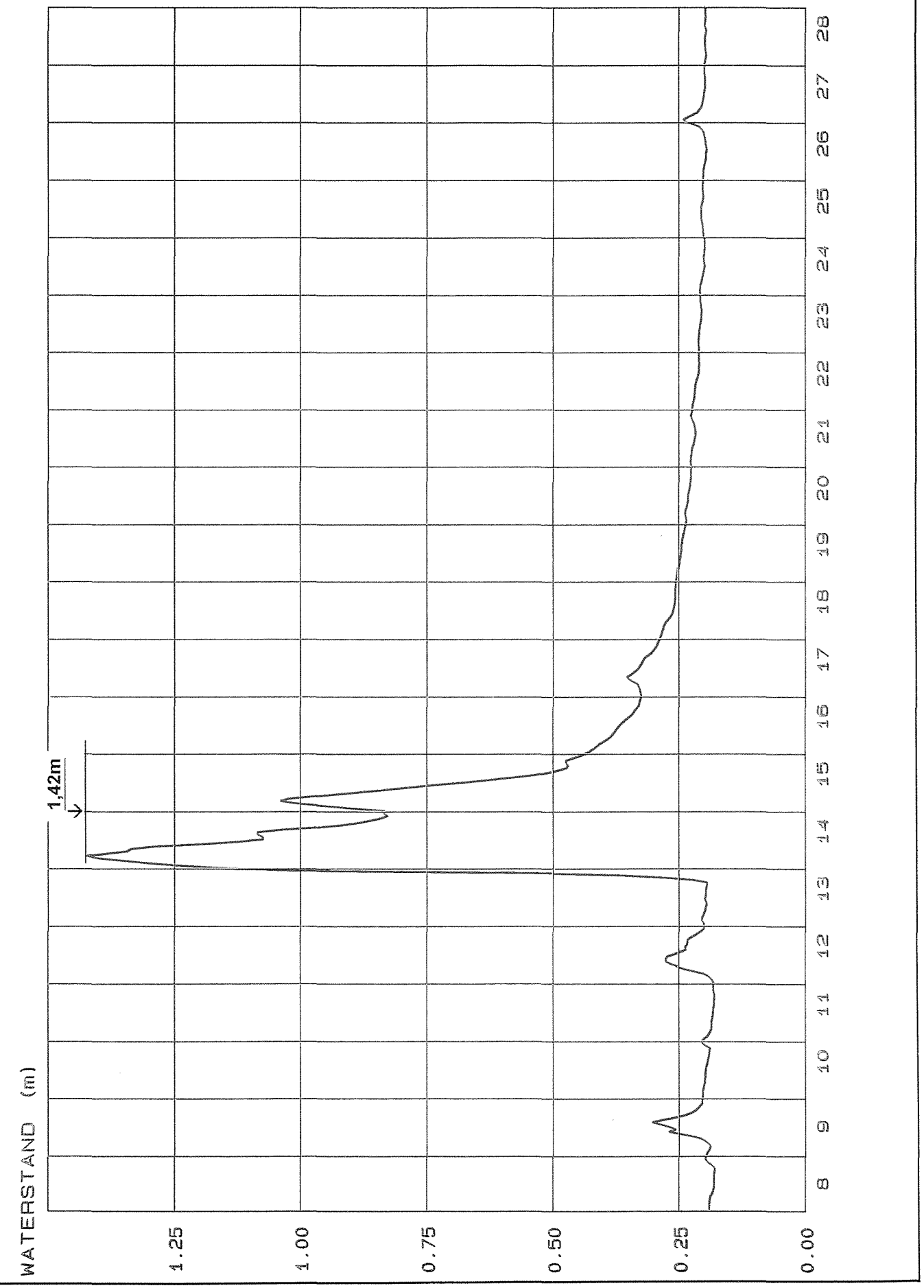
DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 28

MUNSTERBEEK / MUNSTERBILZEN

waterstand 08 - 28 Sep 98



DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 29a

DEMER / vak WERCHTER - DIEST
Geïnundeerd gebied

Herselt
Begijnendijk
Tremelo
Aarschot
Diest
Scherpenheuvel
Rotselaar
Tielt-Winge
Bekkevoort
Holsbeek
DEMER
GROTE LAAK
MUGGENBERGLOOP
VENNELOOP
LAARBEEK
OSSEBEEK
VOSSEKOTHOL
WIJNPUTHOL
LEIGRACHT
DE HULPE
ZWART
OUDE MOTTE
NIEUWE MOTTE
WIELANTSVLIET
MOUTLAAK
HEILAAKBEEK
LEIBEEK
VENNEBEEK
WINGE
IJSBEEK
WOLFSEIKLOOP
HOMMELSE BEEK
TIELTSE MOTTE
BEURTSEBEEK
WINTERBEEK
HEUVELSPANSEEL
HAZEHOEKLOOP
VIJVERSLOOP
BEGIJNE(N)BEEK
GROTE LOSTING
KLEINE LOSTING
BROEKWATERLOOP
WATERLOOP
LOSSINGSBEEK
DROGE BEEK
GROTE LEIBEEK
SLUISBEEK
PUNBEEK

Geïnundeerd gebied :

Schaal : 1 / 60.000

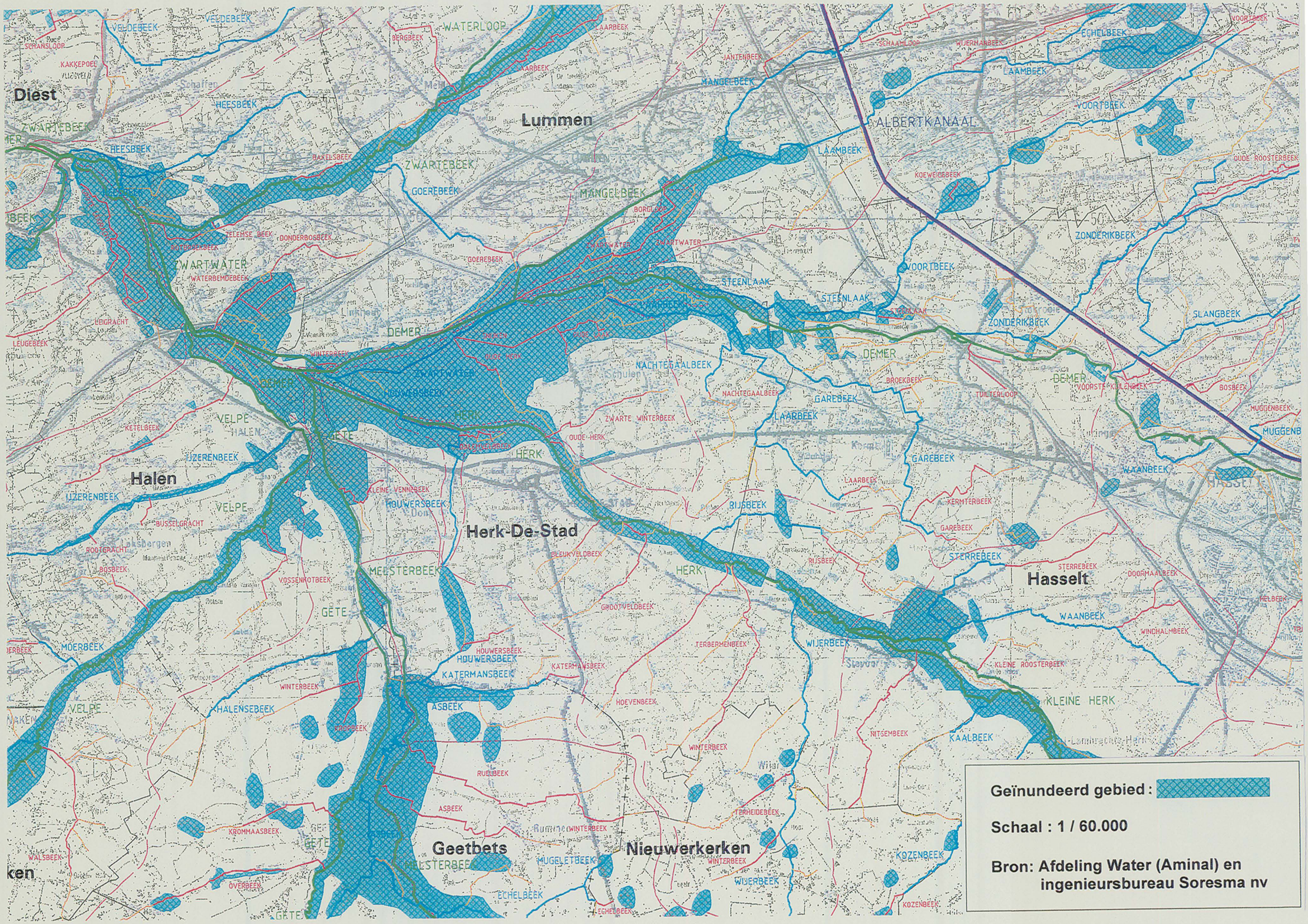
Bron: Afdeling Water (Aminal) en ingenieursbureau Soresma nv

DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 29b

DEMER / vak DIEST – KERMT
Geïnundeerd gebied

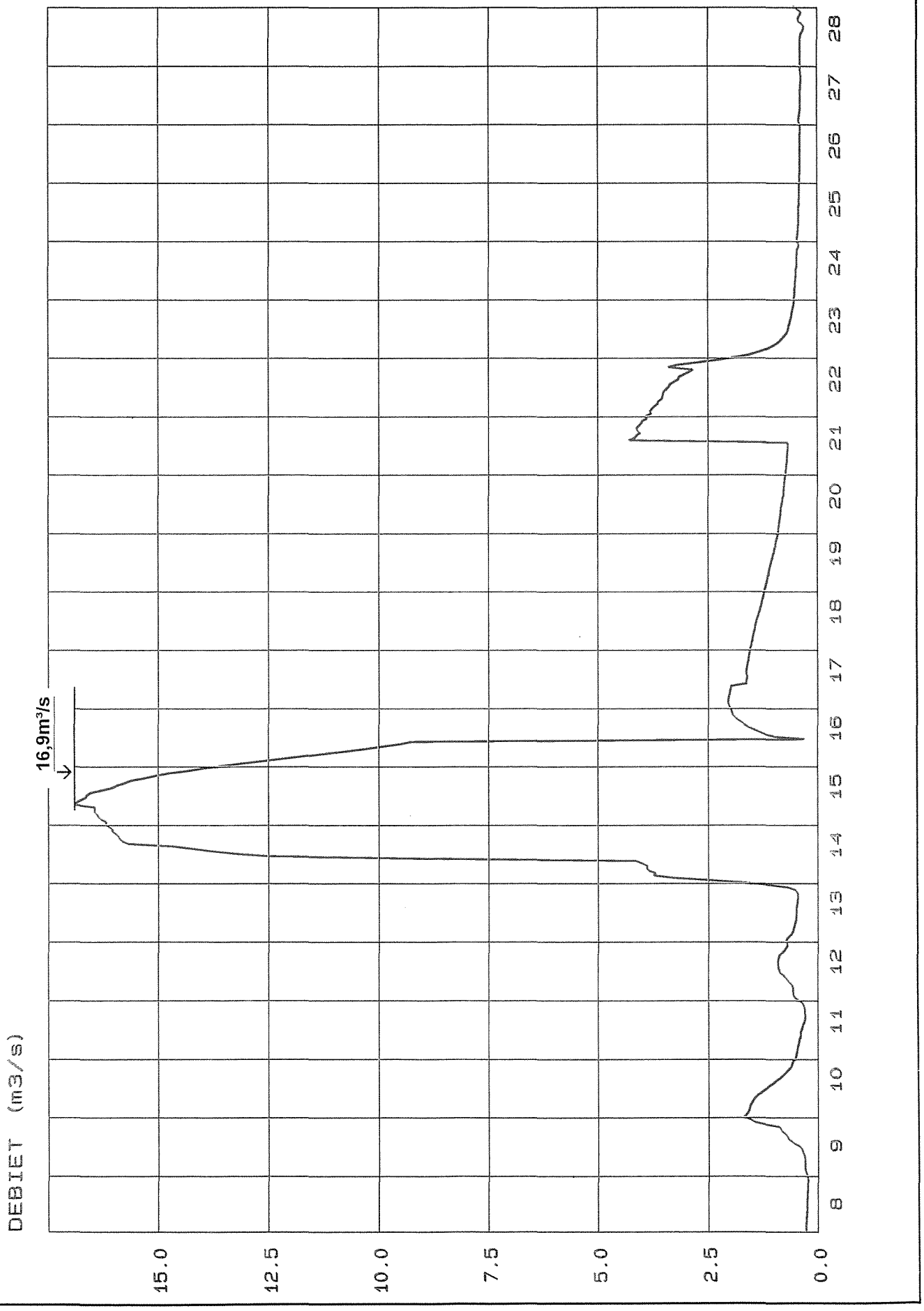


DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 30

VELP / RANSBERG
debiet 08 - 28 Sep 98

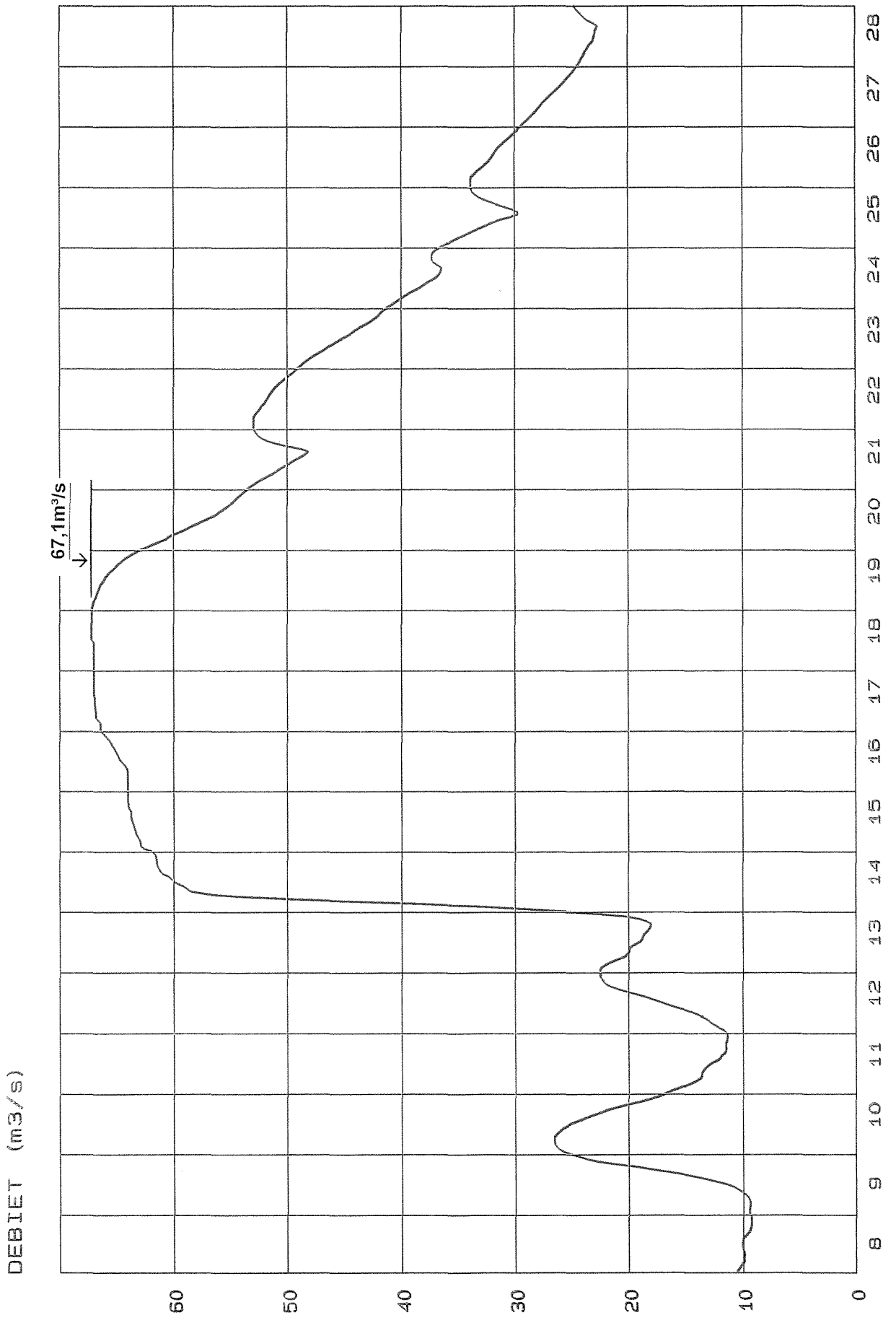


DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 31

DEMER / ZICHEM
debiet 08 - 28 Sep 98

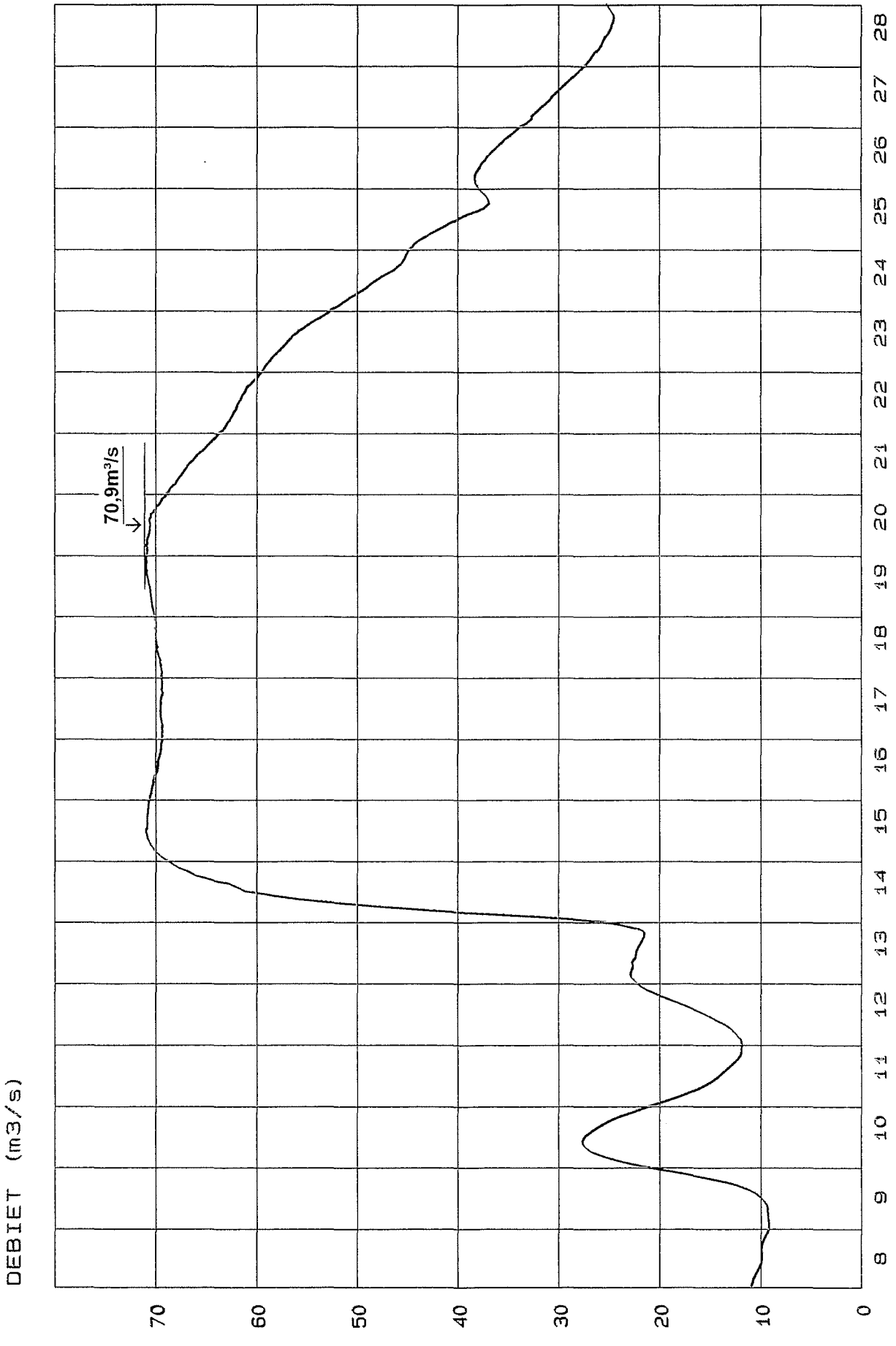


DIHO
dienst
HYDROLOGISCH
ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

Bijlage 32

DEMER / AARSCHOT
debiet 08 - 28 Sep 98

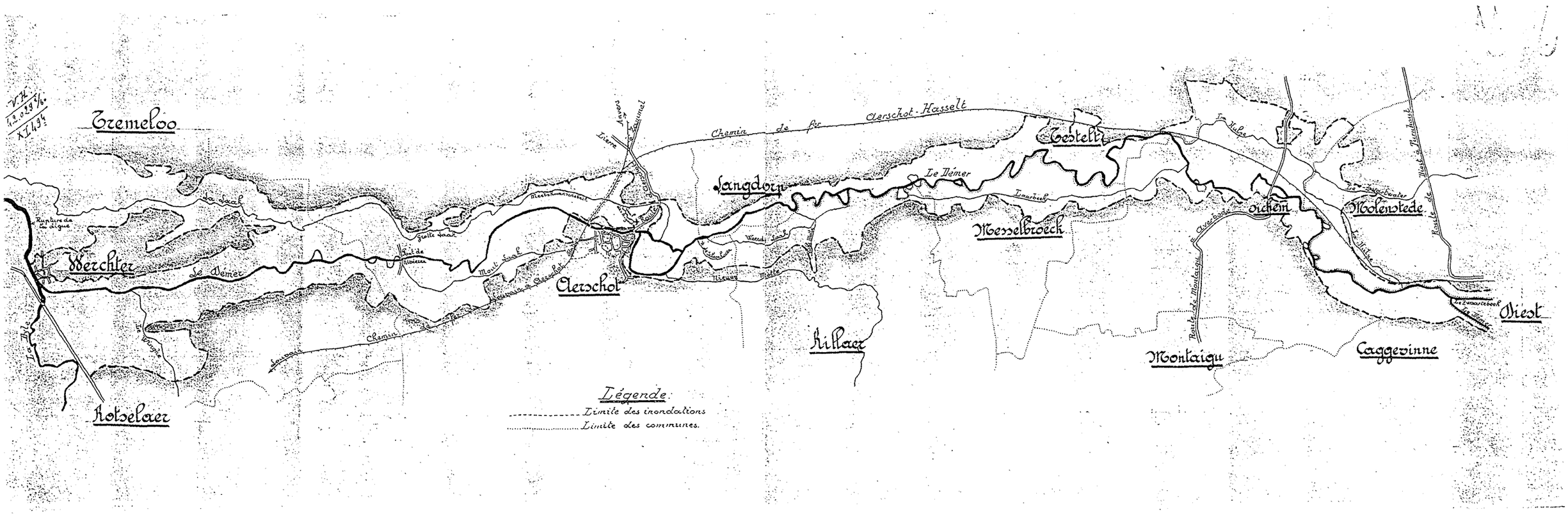


DIHO
dienst HYDROLOGISCH ONDERZOEK

VERSLAG HOGE WATERSTANDEN DEMERBEKKEN - SEP 98

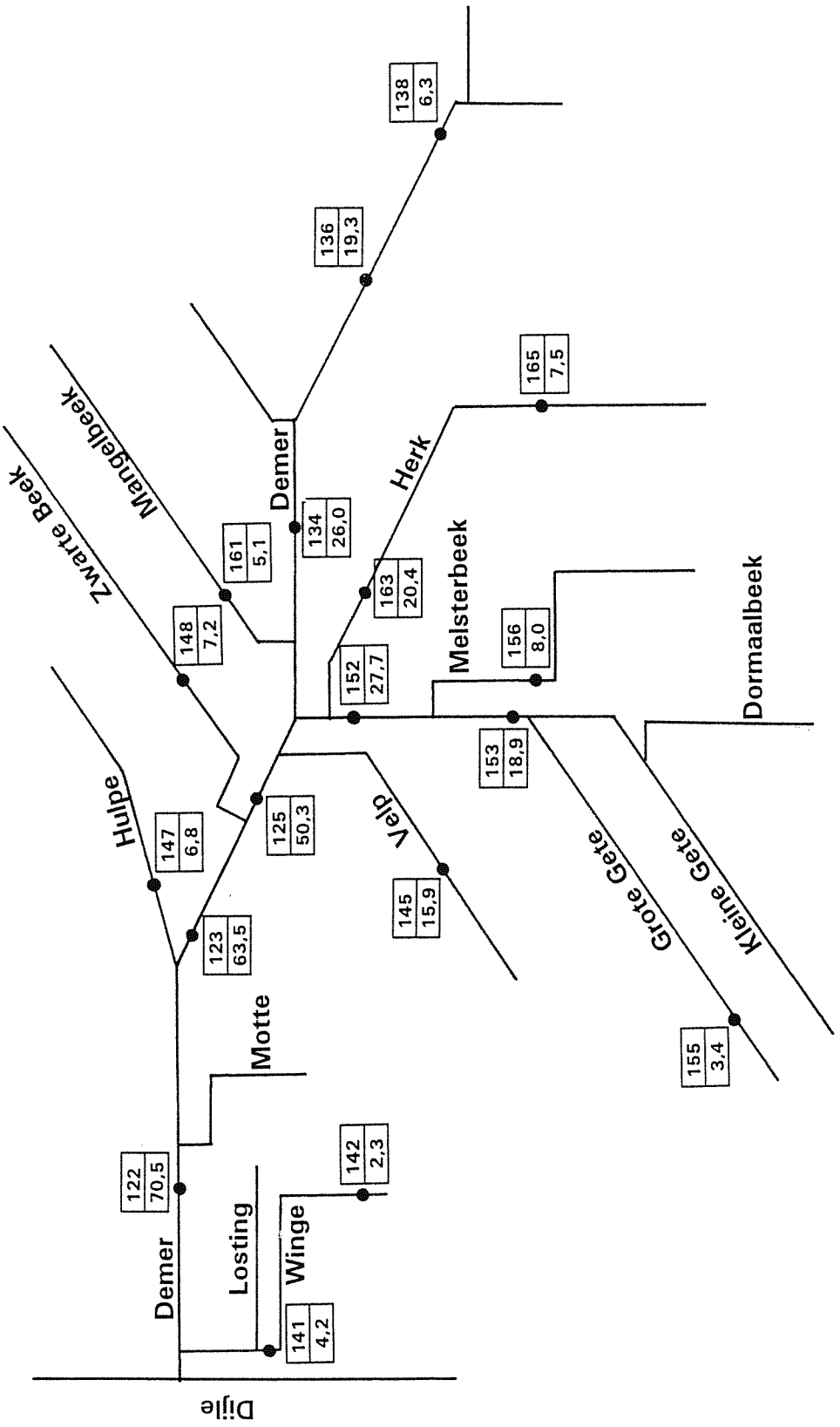
Bijlage 34

DEMER / vak WERCHTER-DIEST
geïnundeerd gebied bij hoge waterstand Jan 1926



kaartje uit archief DIHO

OVERZICHT VAN DE DEBIETEN OP 15 SEP 98



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