

# DNMI - RAPPORT

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TITTEL

**THE NEDSTRANDSFJORD  
SUPPLEMENTARY WAVE CALCULATIONS**

UTARBEIDET AV

SVEIN M. FIKKE  
HELLE TØNNESEN  
JAN A. BØRRESEN

OPPDRAGSGIVER

NORWEGIAN CONTRACTORS

OPPDRAGSNR.

SAMMENDRAG

This report is a supplement to DNMI report 26/85 KLIMA: "Nedstrandsfjorden. Extreme wind and waves". The grid of the fjord area is expanded to the coast and the maximum significant wave height along the towing route is calculated to 1.5 m.

UNDERSKRIFT

*Svein M. Fikke*

Svein M. Fikke

SAKSBEHANDLER

*Bjørn Aune*

Bjørn Aune

FAGSJEF

THE NEDSTRANDSFJORD  
SUPPLEMENTARY WAVE CALCULATIONS

1. INTRODUCTION

The wind and wave conditions in the Nedstrandsfjord are previously evaluated in (1). Later discussions and examinations of data have shown that the wind speeds given in (1) should be maintained, while the waves should be examined for the case that wave energy from the mouth of the North Sea could be transported into the Nedstrandsfjord (Appendices 1 and 2). It was also found that boarder effects of the "land and sea" grid in the FJORDSEA model might have affected the wave height calculations. For these reasons the wave calculations are repeated with a grid covering the whole fjord area from outside the coast line to the inner parts of the Nedstrandsfjord as shown in figure 1. When evaluating the wave heights it is also taken into account the actual towing route (figure 2) and that the operation will take place within the months May or June. For the last reason the probable maximum wave generating wind speed and the corresponding duration are discussed in chapter 2.

2. WAVE GENERATING WINDS IN THE NEDSTRANDSFJORD

The 10 min. mean wind speed from the SW direction with return period 100 years is set to 20 m/s for the summer months May-August (1). For the calculation of waves, averages of at least 3-6 hours should be selected, or about 17-18 m/s for open areas. For such long averaging periods, the wind direction will also vary.

The directional variability will reduce the effective fetch significantly for the Nedstrandsfjord. As the FJORDSEA model operates with a steady wind, it is found more realistic with a little stronger reduction of the wind speed. Therefore the maximum wave generating wind speed for the Nedstrandsfjord is set to 15 m/s (100 year return period for summer conditions).

In order to study the frequency of wind situations generating waves into the Boknafjord and the Nedstrandsfjord, the climatological records from Utsira lighthouse and Stavanger airport, Sola, have been examined. The wind records are homogenous from 1963 on both stations. To ensure that the wind field is extended enough, the data are tested for the case that there are southwesterly winds of at least 15 m/s on both stations at the same time. (There were no anemometer stations within the fjord area.) Only one case is found during the summer months for the period 1963-85, namely on 13 June 1973 at 1200 GMT. The wind speed at Sola was then 15 m/s (7 Beaufort) and the wind direction 220

As this examination was based on 6 hourly observations, the duration of the above situation have probably been less than 6 hours. To be on the conservative side, 9 hours are chosen as the maximum duration for this wind situation. For comparison, the model is run up to 24 hours for this direction.

3. WAVE CALCULATIONS

In order to check the diffraction of wave energy from the outer part of the Boknafjord into the Nedstrandsfjord, the FJORDSEA model is also run for 180 and 315 with 30 knots up to 24 hours.

The results of the model runs are shown in figures 3-11. (Because of the readability of the numbers, only the eastern part is shown in the most cases.) Table 1 shows the calculated waves outside the coastline and the maximum value for the towing route.

Table 1. Calculated significant wave heights from the FJORDSEA model.

Wind direction (degrees)	Wind speed (m/s)	Time (hours)	Wave heights (H) in m		Fig. no.
			Off the coastline	Maximum along the route	
225	15	3	1.9	1.2	3
225	15	6	3.0	1.3	4
225	15	9	4.0	1.5	5
225	15	12	5.1	1.7	6
225	15	24	6.5	2.3	7
180	15	12	4.7	0.9	8
180	15	24	6.0	0.9	9
315	15	12	5.1	0.8	10
315	15	24	6.5	0.8	11

Recommended set for 100 years return period for the inner part of the Nedstrandsfjord is underlined.

#### 4. RESULTS AND CONCLUSIONS

The results and discussion are limited to the case of wind generated waves as calculated by DNMI's FJORDSEA wave model.

Following the conclusions of chapter 2 the maximum significant wave height for the towing route across the inner part of the Nedstrandsfjord is calculated to 1.5 m (15 m/s from 225° after 9 hours). The corresponding wave height at the coastline of Western Norway with the same condition is 4.0 m as shown in table 1. Figure 5 shows the sidtribution of wave heights in the Nedstrandsfjord. Figures 6 and 7 show that the wind waves are not fully developed after 9 hours, but as discussed above, it is not likely that a wind speed of 15 m/s (30 knots) will be steady along the fjord direction for more than 9 hours.

Figures 8-11 show the results with winds from south (180°) and northwest (315°) after 12 and 24 hours. The wave heights outside the coast line reach 6.0 m and 6.5 m respectively in the two cases, while the waves along the towing route are less than 1 m. Thus, the FJORDSEA Model does not indicate any significant transport of wave energy into the inner part of the Nedstrandsfjord due to diffraction.

From the above discussion the highest (independent) significant wave height with 100 years return period for the towing route across the Nedstrandsfjord is set to 1.5 m for the months May to August.

#### REFERENCE.

- (1) Fikke, S.M. and K. Johansen: Nedstrandsfjorden. Extreme Winds and Waves. DNMI Report 26/85 KLIMA, Oslo 1985.

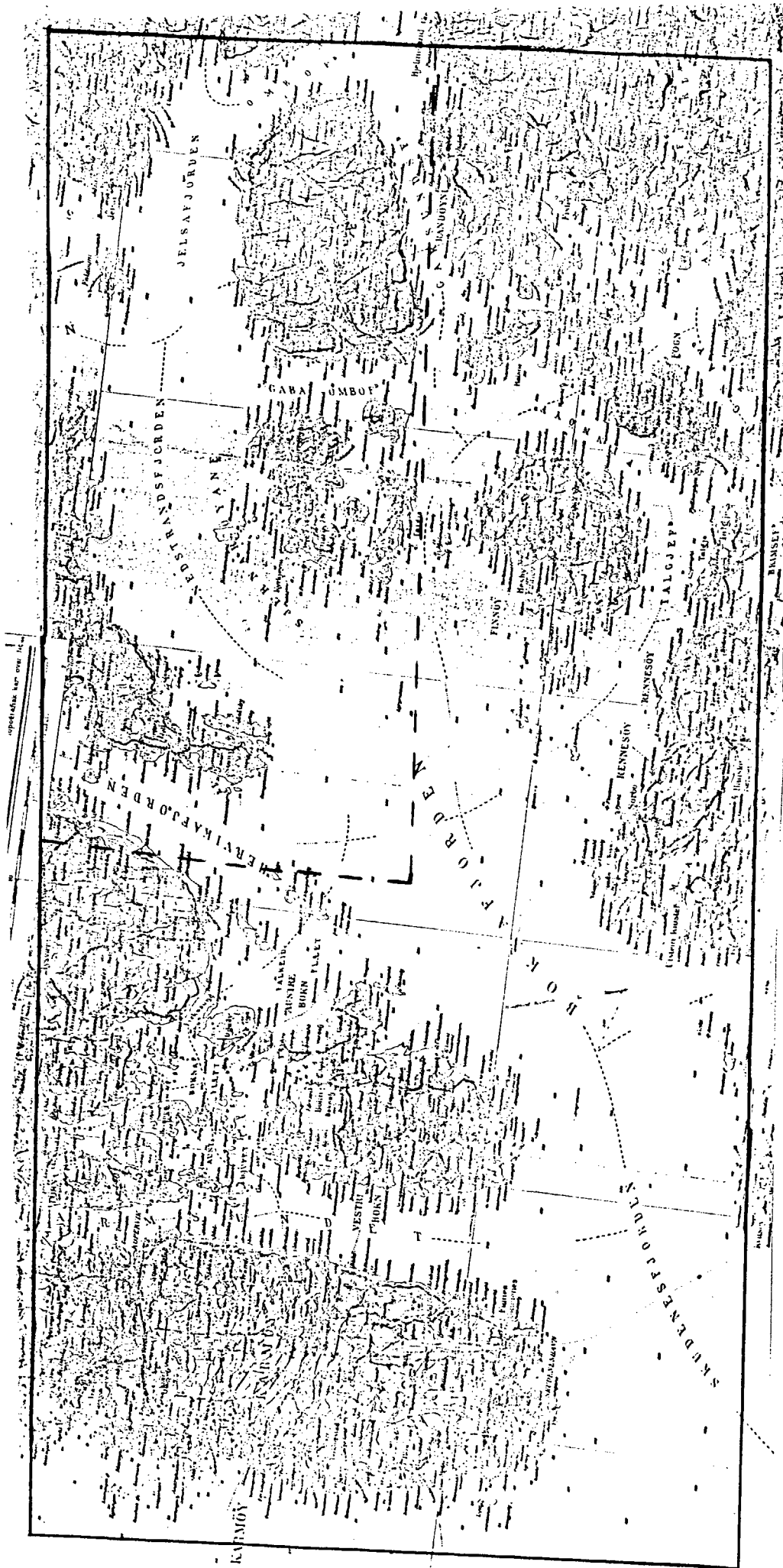


Figure 1. Area covered by the FJORDSEA wave model calculations. Grid size: 1 km. Small and shallow fjords and sounds are closes in the model. The area shown on figures 3 - 11 is east and north of broken line.

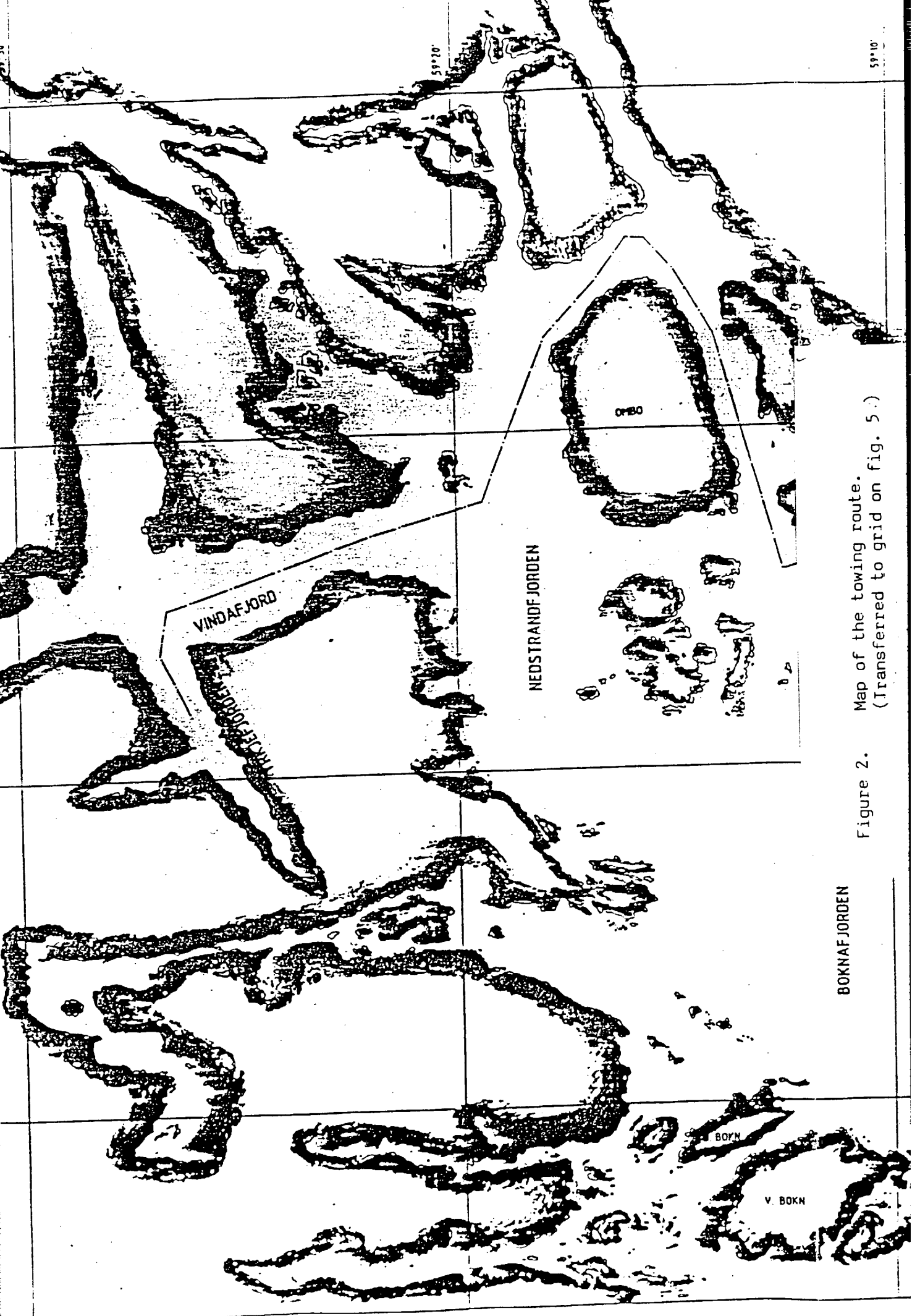


Figure 2. Map of the towing route.  
(Transferred to grid on fig. 5.)





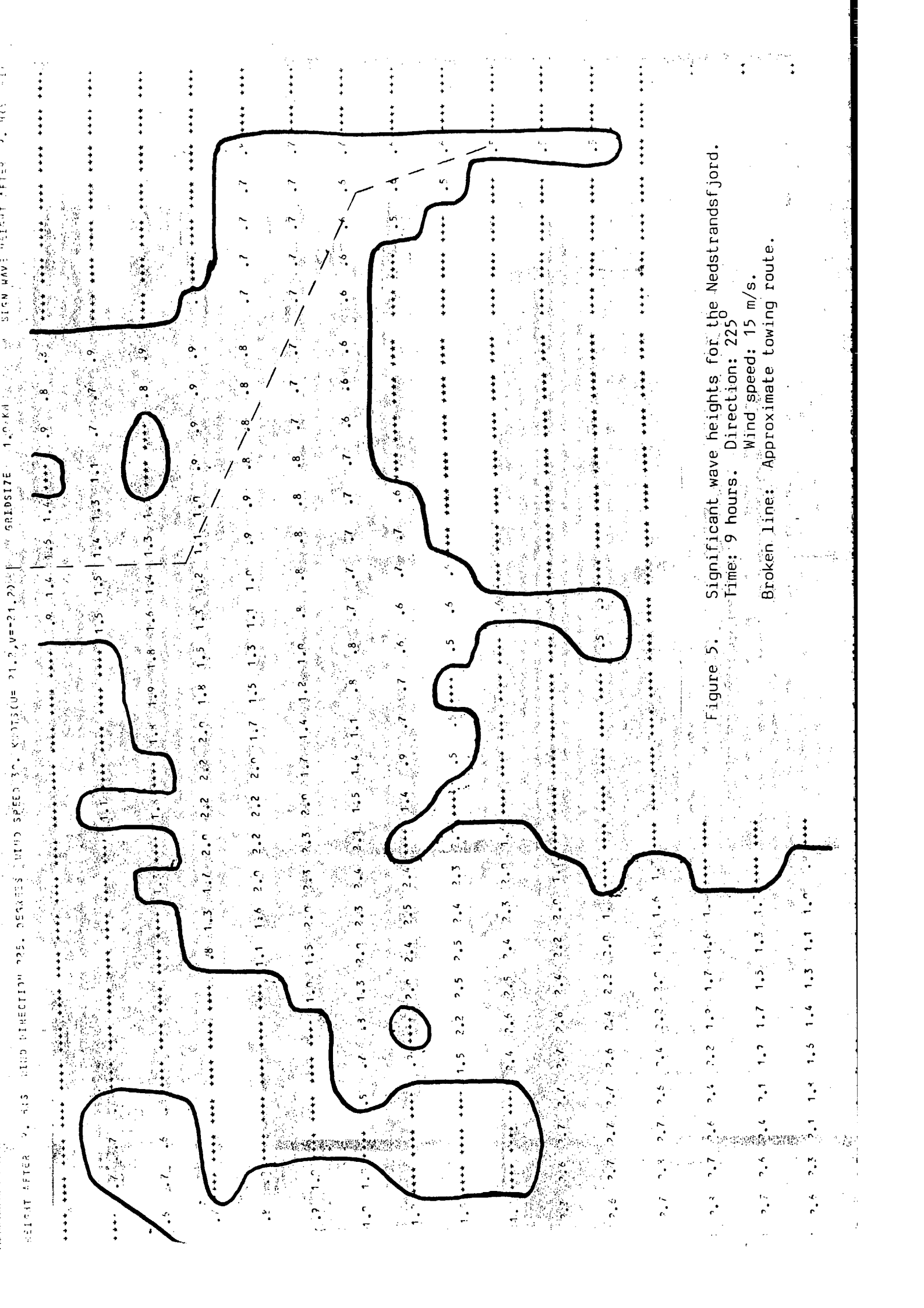
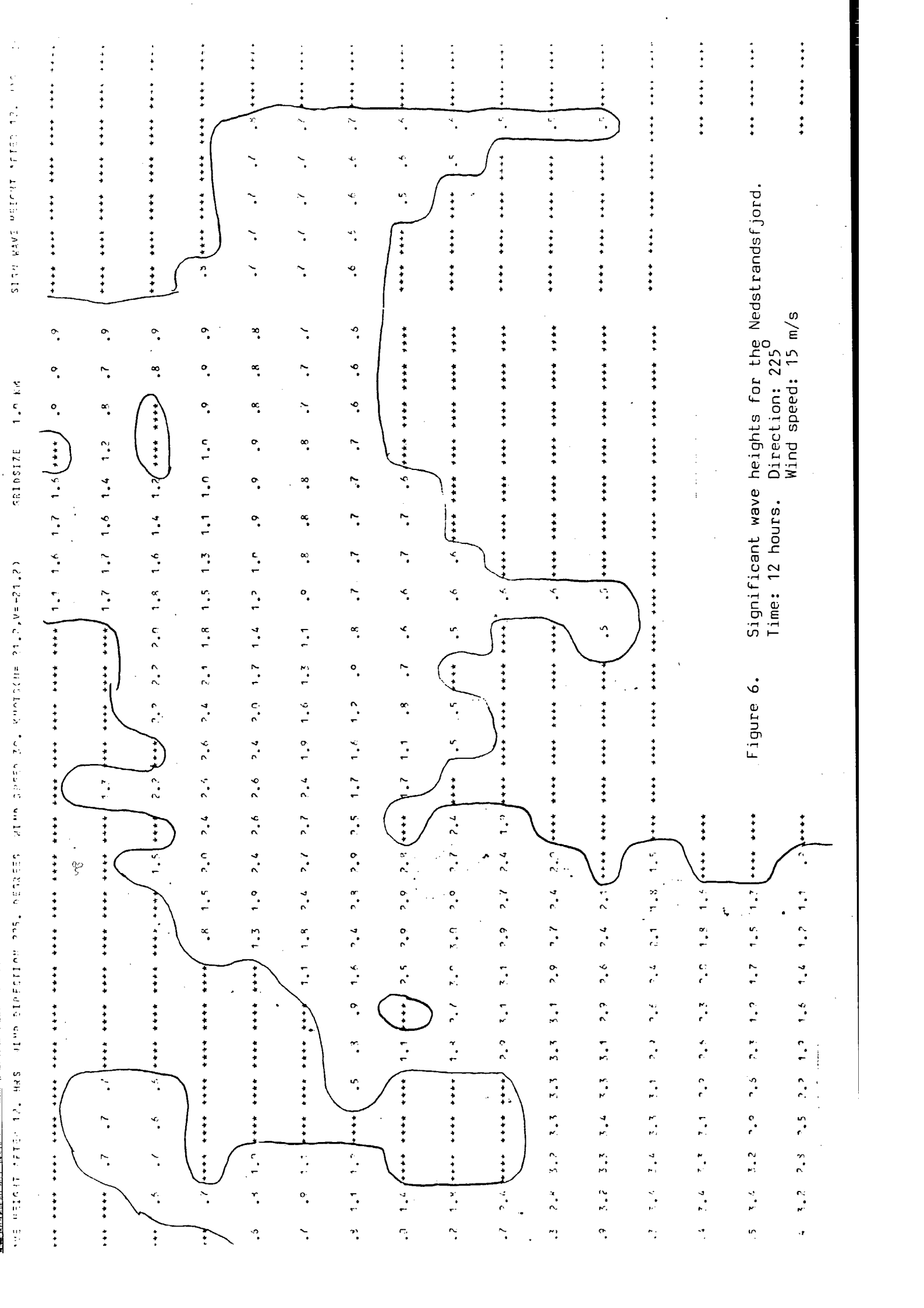


Figure 5. Significant wave heights for the Nedstrandsfjord.  
 Time: 9 hours. Direction: 225°  
 Wind speed: 15 m/s.  
 Broken line: Approximate towing route.







AVERAGE HEIGHT AFTER 12 HRS WIND DIRECTION 130. DEGREES WIND SPEED 30. KNOTS(U= .0,V=30.0) GRIDSIZE 1.0 KM

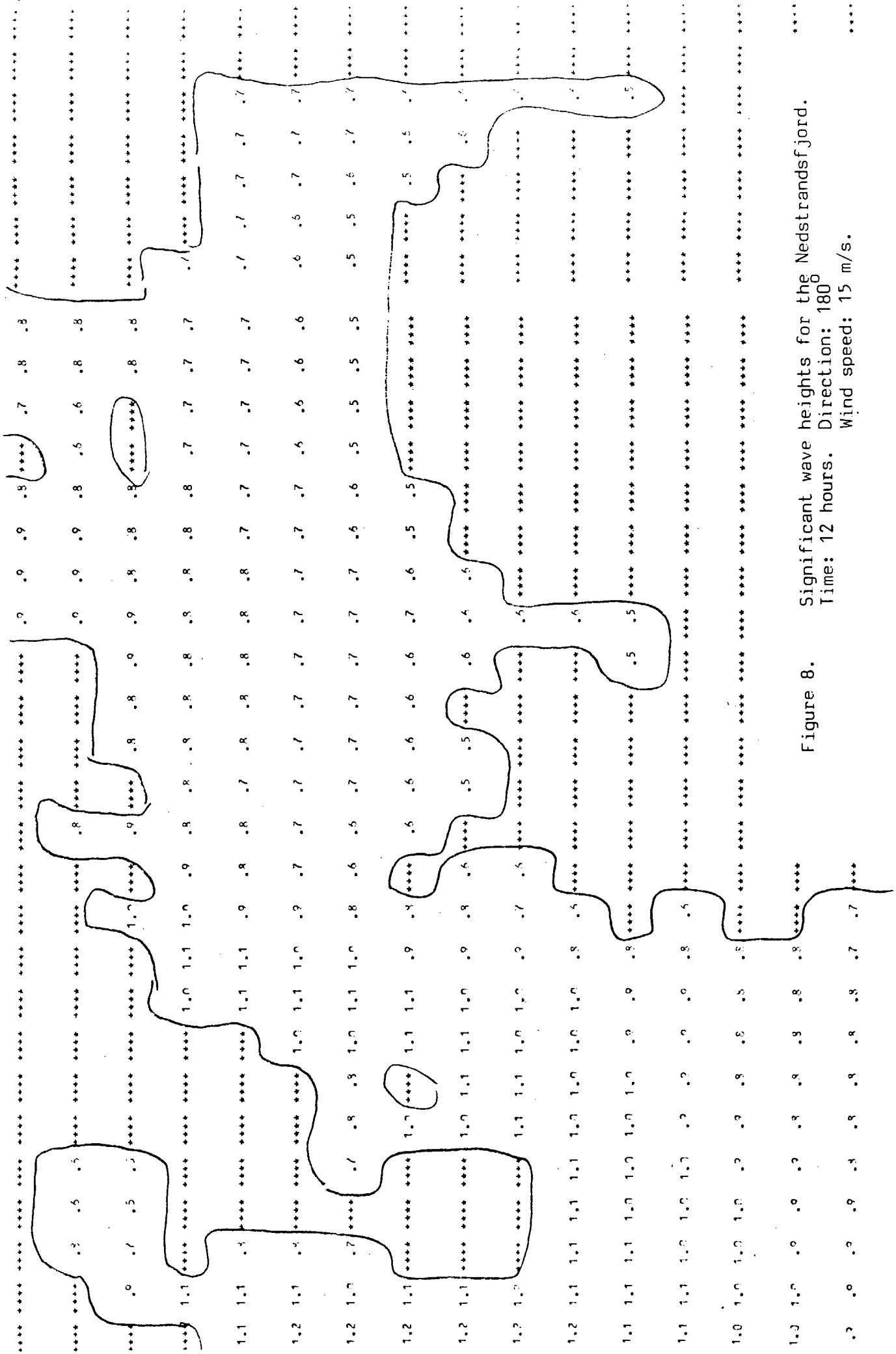


Figure 8. Significant wave heights for the Nedstrandsfjord.  
Time: 12 hours. Direction: 180°  
Wind speed: 15 m/s.

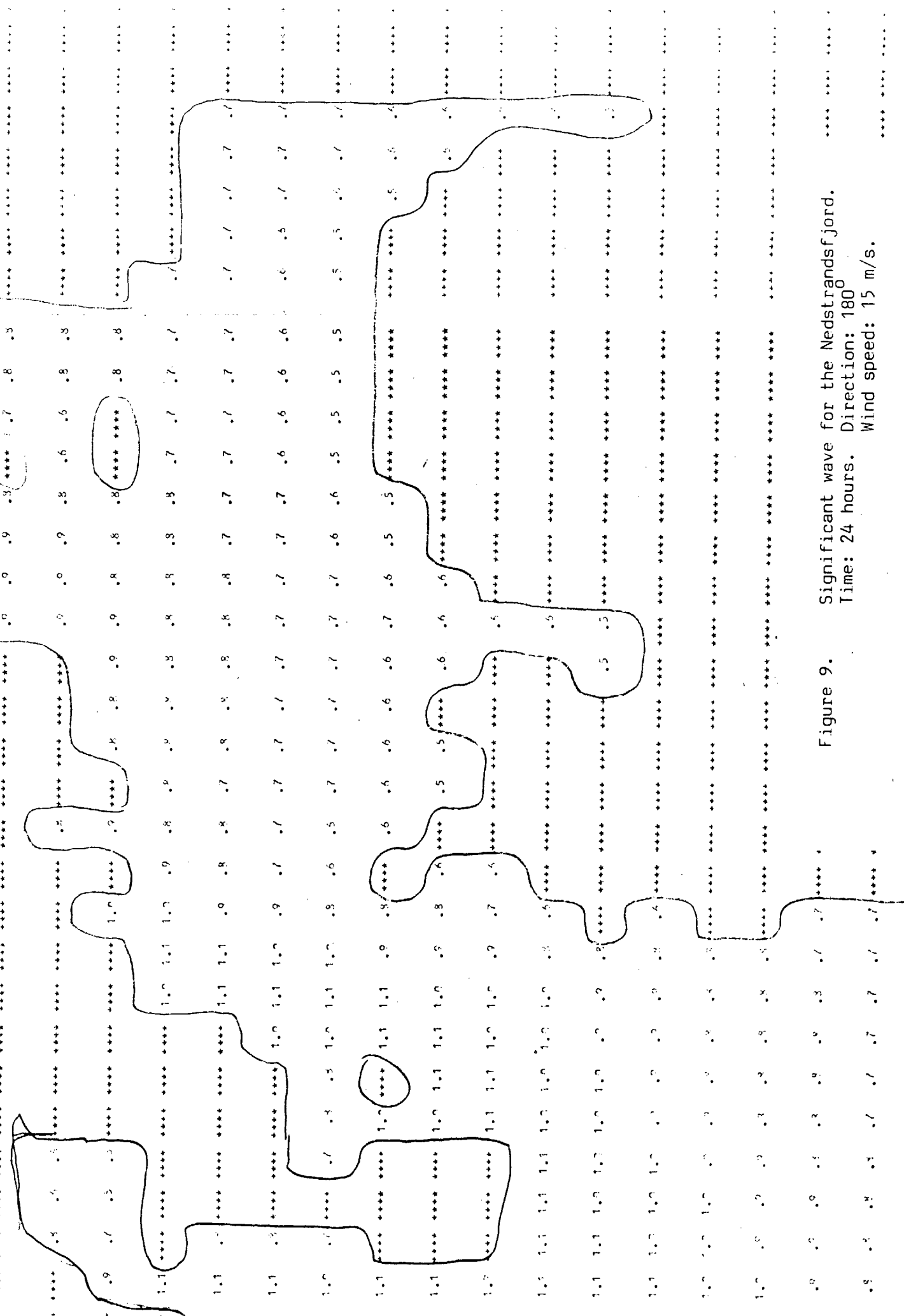
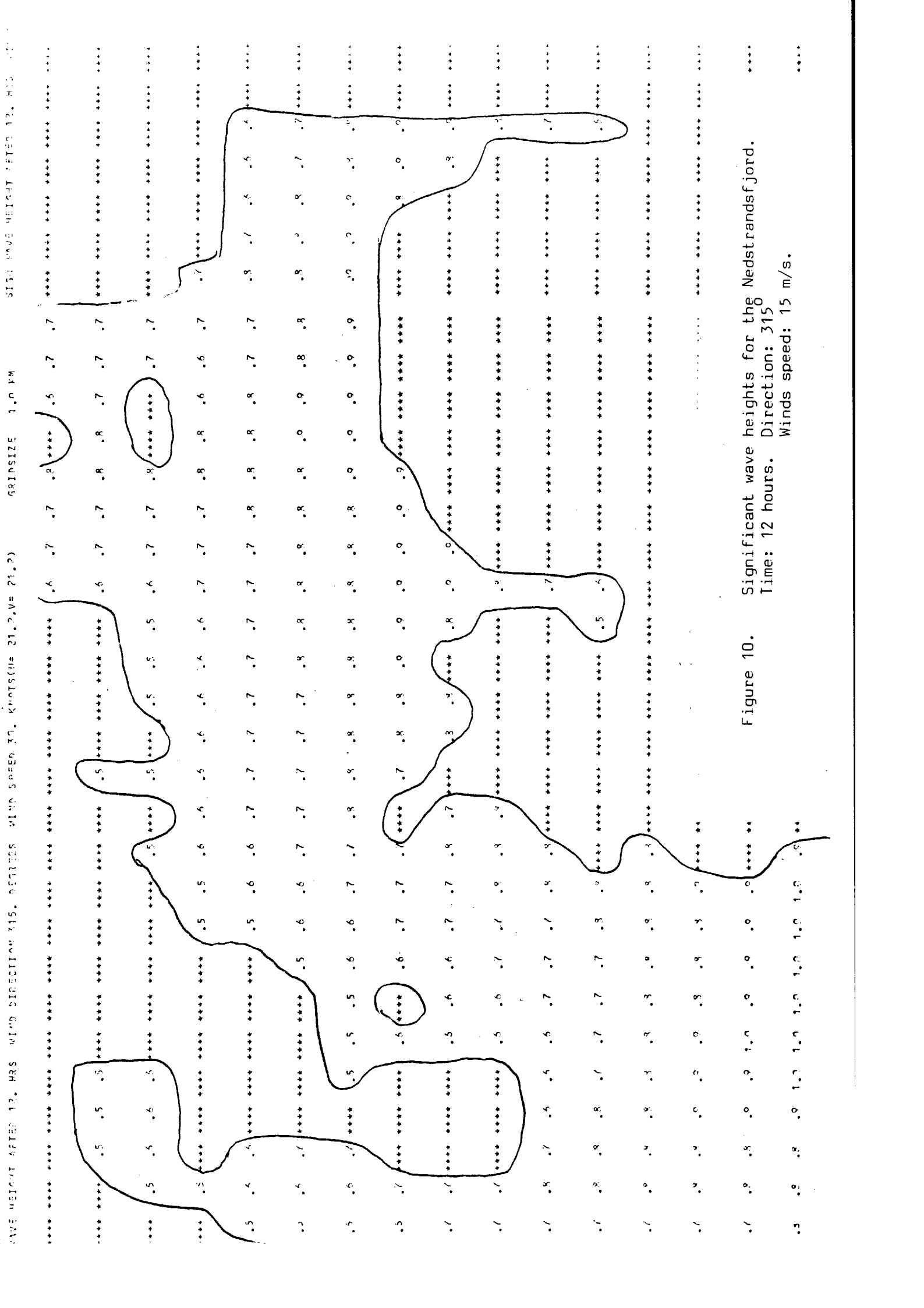


Figure 9. Significant wave for the Nedstrandsfjord.  
 Time: 24 hours. Direction: 180°  
 Wind speed: 15 m/s.





14.49 7  
 10001 METEC A  
 767600 CONDE N  
 FROM: NORWEGIAN CONTRACTORS, STAPEKK  
 TO: METEOROLOGISK INSTITUTT  
 ATT.: S. FLYKE

METEOROLOGISK INSTITUTT	
JR 00182	13. JAN. 86
Rsh/llc	
Ark nr. 322.4	ksp

DATE: 10.1.1986 KAN/LEH TLY.NO. 0716

ENVIRONMENTAL DATA FOR GANDBEJORD AND NESTSTRANDBEJORD

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WITH REFERENCE TO TELEPHONE CALL TODAY WE HEREBY TRANSMIT STATOILS COMMENTS TO THE PROPOSED CRITERIA. AS THE DIFFERENCE BETWEEN NDA'S AND YOUR RESULTS IS CONSIDERABLE, THE REASON FOR THE DIFFERENCES SHOULD BE LOOKED INTO:

- WE HAVE REVIEWED DMMI NET REPORTS 2/85 KLIMA AND 26/85 KLIMA WITH NO LETTER NO/S-L-267 AND PRESENT THE FOLLOWING FOR YOUR INFORMATION:

FOR GANDBEJORD

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	DMMI	NO	NDA
RETURN PERIOD-(YEARS)	10 100	-	10 100
1 MIN MEAN WIND (M/S)	21.0 20.0	-	20.0 20.0
10 MIN MEAN WIND (M/S)	25.0 20.0	-	24.0 20.0
H <sub>0</sub> (M)	1.0 1.00	1.40	1.50 1.60
H <sub>1</sub> MAX (M)	-	2.30	2.0 2.6
PERIOD RANGE TR (SEC)	-	4.0-6.0	4.4-6.1 4.2-6.7

FOR NESTSTRANDBEJORD

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1 MIN MEAN WIND (M/S)	-	-	20.0 20.0
10 MIN MEAN WIND (M/S)	20.0 25.0	-	25.0 31.0
H <sub>0</sub> (M)	-	1.00	1.40 1.00
H <sub>1</sub> MAX (M)	-	1.00	2.00 2.00
PERIOD RANGE TR (SEC)	-	4.0-6.0	4.5-6.0 5.0-6.0

- WITH REFERENCE TO THE H<sub>00</sub>/SAG EFFECT OF LONG PERIOD WAVES DURING THE BASE TOY TO VATS, IT HAS BEEN ESTIMATED THAT THE COMBINATION OF WIND SPEED AND DIRECTION NECESSARY TO PRODUCE SWELL ALONG THE TOY ROUTE IN NESTSTRANDBEJORD WOULD BE A VERY RARE EVENT. THE MAXIMUM POSSIBLE PERIOD, CONSIDERING AVAILABLE FETCH, IS ABOUT 11.0 SECONDS CORRESPONDING TO A WAVE LENGTH OF 100 METRES. THE MAXIMUM SWELL WAVE HEIGHT WOULD BE LESS THAN 0.50 METRE.

Sendt 29/1-86  
15<sup>30</sup>

TELEX

76760B CONDE N

19931 METEO N

Norwegian Contractors

Att.: Kjell A. Nyhus

Environmental data for Gandsfjord and Nedstrandsfjord.

With reference to your telex no 2716, date 10.1.1986 KAN/LEH, we have rereviewed the wind and wave data given for the Gandsfjord and the Nedstrandsfjord by DNMI and NDA.

Gandsfjord:

The NDA and DNMI wind speeds are almost identical. The differences in wave heights may be due to different methods.

Nedstrandsfjord:

The wind speeds used by NDA are identical with the extremes calculated for Sola airport (see table 1 DNMI report 26/85). Due to the distance from the coast line and the topographical effects on big and medium scale around the fjord, the reductions of wind speeds given in our report 26/85 are considered to be relevant.

As agreed on telephone 27.1.86, the wave heights will be checked for the case that high waves produced in the North Sea will be transmitted into the Nedstrandsfjord.

Regards,

Bjørn Aune

*Svein M. Fikke*  
Svein M. Fikke