MONITORING OF THE "FOUL AREA" DUMPING AREA IN MASSACHUSETTS BAY: THE EFFECTS OF DREDGE SPOIL DISPOSAL ON PHYTOPLANKTON GROWTH

Final Report to the U.S. Army Corps of Engineers
under Contract #DACW33-74-M-0190

SR-31

C. Martin and C.S. Yentsch

November, 1973

Cape Ann Society for Marine Science, Inc.
P.O. Box 128, Lanesville Station
Gloucester, Massachusetts 01930

C.S. Yentsch
Executive Officer
Cape Ann Society for Marine
Science, Inc.

CONTENTS

1. Introduction

2. Fluorometry of "foul area" and adjacent surface waters

3. Light and temperature

4. Composition of phytoplankton populations

5. Summary

6. Figures

MONITORING OF THE "FOUL AREA" DUMPING AREA IN MASSACHUSETTS BAY FOR EFFECTS OF DREDGE SPOIL DISPOSAL ON PHYTOPLANKTON GROWTH

1. Introduction

Increased concern has currently been expressed over the possibility that dumping of river and harbor dredge spoils may result in enrichment of coastal waters. Such enrichment, it is feared, might stimulate phytoplankton growth causing undesireable effects upon population dynamics. One such adverse effect would be the explosive growth of toxic organisms such as Gonyaulax tamarensis, a dinoflagellate whose sporadic occurrence is believed to be somehow tied to nutrients derived from land runoff and a changed nutrient chemistry of its habitat.

In order to evaluate the nature and extent of such effects, it has seemed prudent to monitor dumping operations, the aim being to look for changes in physical, chemical or biological characteristics of the receiving waters which could be attributed directly to the dumping activities.

Such a monitoring program was recently completed in connection with the maintenance dredging of the Annisquam River Waterway in eastern Massachusetts (Martin and Yentsch).[1]

The present report concerns a similar examination of dredge spoil dumping at the so-called "foul area" approximately 15 miles due east of Nahant (42° 25' N Lat. 70° 35' W. Long.)

This dumping area is circular in outline with a diameter of approximately 2 miles. The bottom contours describe a shallow depression roughly 7 meters deeper at the center than at the periphery. The center lies in water of about 100 meters depth. To the east lies the northwestern terminus of the Stellwagen Bank (Figures 1-6). The area in question has been used as the site for disposal of containerized wastes and other sunken objects for many years, getting its name from the presence there of objects which might "foul" fishing gear.

---

1. Martin C., and C.S. Yentsch, 1973. Evaluation of the effect of dredging in the Annisquam River Waterway on nutrient chemistry seawater and sediments and on phytoplankton growth. Final Report, U.S. Army Corps of Engineers Contract #DACW33-73-M-0944, Cape Ann Society for Marine Science, Inc.

During the spring and summer of 1973 between 50,000 and 60,000 cubic yards of polluted dredge spoil taken from the L(r Basin of the Charles River were deposited at this location. Two stations were selected for study, one called the "foul area" Center Station located at the buoy which marks the center of the disposal area, and a second one mile due north of the northern margin. The latter is referred to as the "foul area" Reference Station (see Figure 1). These stations were occupied by the R/V Bigelow on two separate occasions: 30 August 1973 between 1000 and 1300 hours and 27 September 1973 between 1100 and 1400 hours.

The monitoring program included the following components:

a. fluorescence of surface waters
b. surface chlorophyll
c. bathythermograph and thermistor temperature profiles
d. light transmission profiles
e. bathymetric survey
f. qualitative phytoplankton examination with special attention to the occurrence of red tide dinoflagellates such as Gonyaulax tamarensis
g. bottom sediment sampling.

2. Fluorometry of "foul area" and adjacent surface waters

Fluorescence measurements (total chlorophyll) were continuously recorded on two occasions on two transects across the north-south and east-west axes of the "foul area" using a Turner Model 111 Fluorometer with flow-through cuvette. Measurements were also made on two additional transects, one directed toward the coast (Boston Harbor) and a second running roughly north to Cape Ann. The surface chlorophyll measurements are indicated on Fig. 7 for the August 30th and September 27th visits to the study areas.

These data can be summarized as follows: chlorophyll concentrations as a measure of phytoplankton population size in the study area showed characteristic uniformity with minor variations in local patches. Overall, the values reflected t concentrations of chlorophyll present in Massachusetts and Ipswich Bays, generally. As expected, there was an

increased level of chlorophyll in late September over that observed in August which coincided with the normal and regularly occurring autumnal bloom of phytoplankton in the Gulf of Maine waters. There was no evidence that the dumping of dredge spoils influenced this characteristic bloom. It may be worth noting that chlorophyll levels were found to be highest inshore from the "foul area" (Point F, Fig. 7).

Surface chlorophyll concentrations were found to be quite low in August at both "Foul Area" stations. Similar levels were seen at Station "X" in Ipswich Bay and at Hodgkin's Cove, Cape Ann. This points to a general area-wide situation with respect to phytoplankton population size. In late September, levels rose somewhat consistent with a general rise in phytoplankton in Massachusetts and Ipswich Bays. See Table 1.

Table 1. Surface Chlorophyll (mg/m^3)

	30 August 73	27 Sept 73
"Foul Area" Center Station	0.402	4.42
"Foul Area" Reference Station	0.340	4.47
	28 August 73	**20 Sept 73**
Station "X", Ipswich Bay, N.E. of Cape Ann	0.465	0.612

3. Light and Temperature

Figures 8 and 9 show vertical distribution of light and temperature at the foul area Center and Reference Stations, respectively. Data from the site visits in August and September are shown.

The August profiles at both stations reflect the relatively stable summer conditions. At this time of year, the water becomes

quite transparent owing to the diminished populations of phytoplankton and to relatively low concentrations of other articulates. Fifty percent transmission was located at 15 meters. Stratification in temperature distribution is likewise characteristic of this period of the late summer. A pronounced thermocline existed at 15-20 meters with overlying water reaching a maximum of 20°C in the top 5 meters. From 50 meters to the bottom (90 meters), temperatures were uniform at about 6.5°C.

One month later, this stratification was partially disrupted. Surface waters had cooled off and increased mixing was evident. The thermocline had shifted downward slightly and surface water measured 14°C. Light transmission was much reduced, falling below 50% in the first 10 meters. These changes again reflect the seasonal pattern for this region, namely, surface cooling with resultant instability and mixing stimulated by renewed supplies of essential nutrients from deeper waters. Again, this fall bloom of algae is characteristic of the Gulf of Maine waters. Related studies during this same period in Ipswich Bay and Hodgkin's Cove confirm the widespread occurrence a minor bloom at this time.

4. Composition of phytoplankton populations

Microscopic examination of samples of phytoplankton taken in the study areas in August and September revealed no unexpected patterns. The dinoflagellate *Gonyaulax tamarensis* was conspicuously absent in the samples examined. This troublesome species was not seen in Massachusetts waters at any time during the summer of 1973.

The populations of planktonic algae changed radically between the August and September study period. In August, surface waters were low in phytoplankton with almost no diatoms and small numbers of unarmoured dinoflagellates with green flagellates. This condition was widespread and existed at both the "Foul Area" Center and Reference Stations as well as at other points studied. Chlorophyll levels were correspondingly low (Table 1).

In September, the surface phytoplankton reflected the characteristic upward shift regularly observed in Massachusetts

and Ipswich Bays at this time of year. As pointed out earlier, this autumnal bloom is stimulated by increased nutrient levels at a time when temperatures and solar radiation are still adequate to support good photosynthetic activity.

A list of dominant species observed is shown in Table 2.

Table 2. Dominant species of phytoplankton in the "Foul Area" September 27, 1973

DIATOMS

Skeletonema costatum (≃ 90% of population)
Chaetoceras decipiens
Chaetoceras diadema
Nitschia longissima
Rhizoselenia alata
Asterionella japonica
Licmophora sp.

DINOFLAGELLATES

Peridinium sp.
Prorocentrum micans

5. Summary

In general, then, the pattern of phytoplankton population change in the "foul area" seemed to reflect natural seasonal oscillations in the chemistry of local waters rather than any specific human disruptive activities. We found no evidence to suggest that these natural fluctuations were disturbed by the release in these waters of dredge spoils during the period studied. However, since the study was performed over a relatively brief period, it is of course not possible to predict accurately the effect of continuous dumping of similar dredge spoil in such an area. It is worth noting that sediment samples taken in the "foul area" were clearly different in character from those recovered at our Reference Station north of the "foul area".

The grayish-green mud characteristic at depths greater than 80 meters in this region was found to be covered to a depth of about [illegible] mm with a fine deposit of black mud. This surface layer was absent at the "Reference Station" and has not been observed at our other Ipswich Bay stations. It would appear to represent an accumulation of fine dark sediment derived from inshore deposits. It was not within the scope of our studies to examine this sediment distribution in any detail, but we feel that it would be useful to understand the origin, distribution and diagenesis of this material in relation to the chemistry of overlying water. Samples of these sediments are to be examined for heavy metal content at the New England Aquarium (Dr. Gilbert).

In conclusion, we feel that limited as the scope of monitoring efforts such as the present one may be, there is considerable logic and merit in performing studies of this kind in connection with offshore disposal operations. Predictive models of probable effects are not presently available, primarily because so few supporting data have been amassed. This is particularly true of the complexities of the dynamic equilibria which characterize coastal waters generally. The ultimate goal of such efforts should be to provide a sound basis for estimating the extent and nature of the effect of disposal activities upon the basic chemistry and thus on the biochemistry of primary components of the food webs and chains involved. Limitations of resources and time will continue to govern the rate at which these problems can be examined.

osci
specif
suggest
release
However
period.
effect c
area. It

recovered

List of Figures

Figure 1. Part of Coast and Geodetic Survey Chart No. 1207 showing location of "Foul Area" and adjacent waters.

Figure 2. Part of Coast and Geodetic Survey Chart No. 1207 showing approximate bottom contours and track of R/V Bigelow

Figure 3. Bathymetric transect A-B (north-south) in "Foul Area" on 30.viii.73.

Figure 4. Bathymetry transect B-C adjacent to "Foul Area".

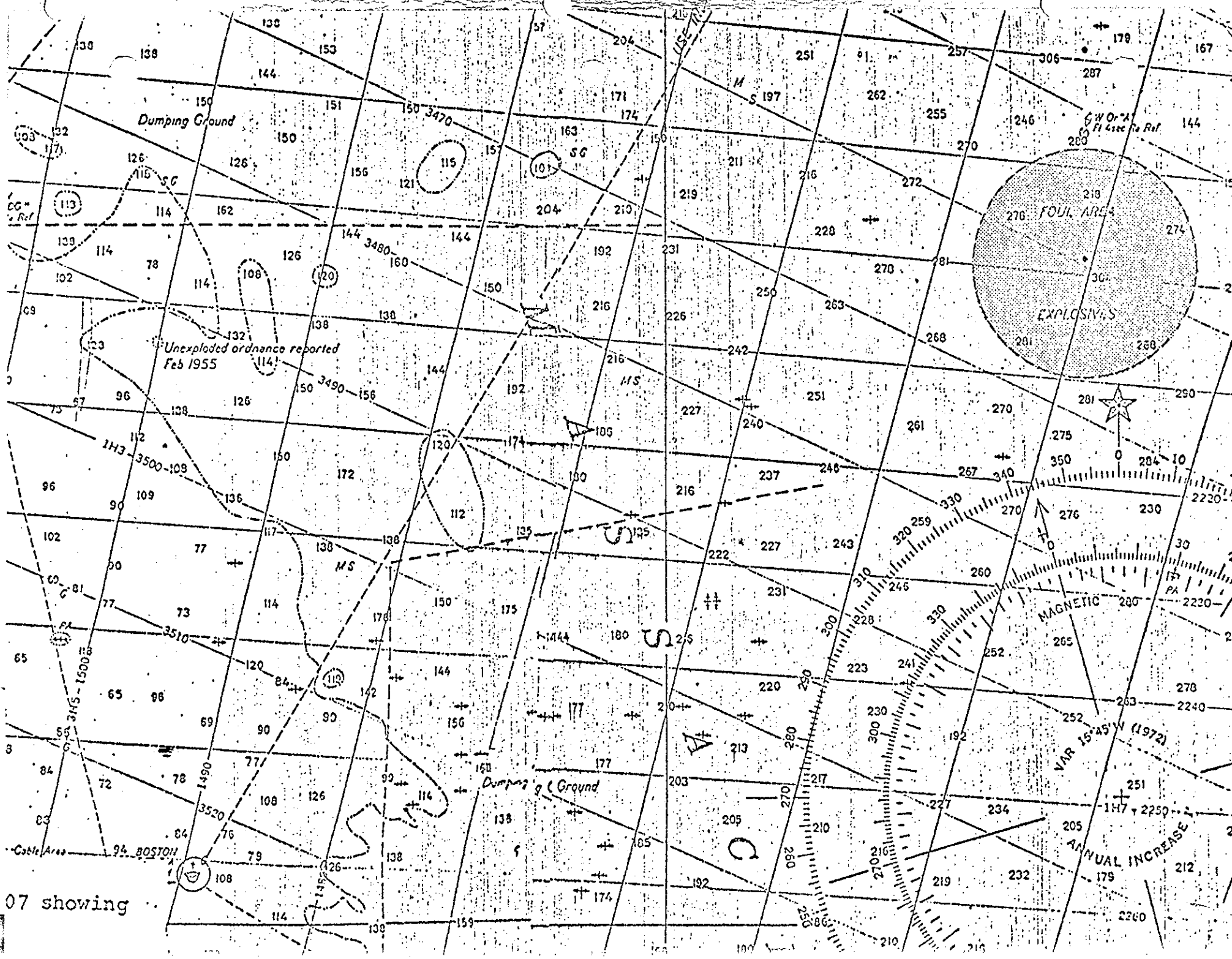
Figure 5. Bathymetry transect C-D (east-west) across "Foul Area".

Figure 6. Bathymetry transect D-E adjacent to "Foul Area".

Figure 7. Tracks of R/V Bigelow. Relative intensity of surface fluorescence is indicated by numbers in parentheses for 30.viii.73 and in brackets for 27.ix.73.

Figure 8. Temperature and light distribution at "Foul Area" Center and Reference Stations on 30.viii.73.

Figure 9. Temperature and light distribution at "Foul Area" Center and Reference Stations on 27.ix.73.


Dumping Ground
Unexploded ordnance reported
Feb 1955
FOUL AREA
EXPLOSIVES
MAGNETIC
VAR 15°45'W (1972)
ANNUAL INCREASE
Dumping Ground
Cable Area
BOSTON

07 showing

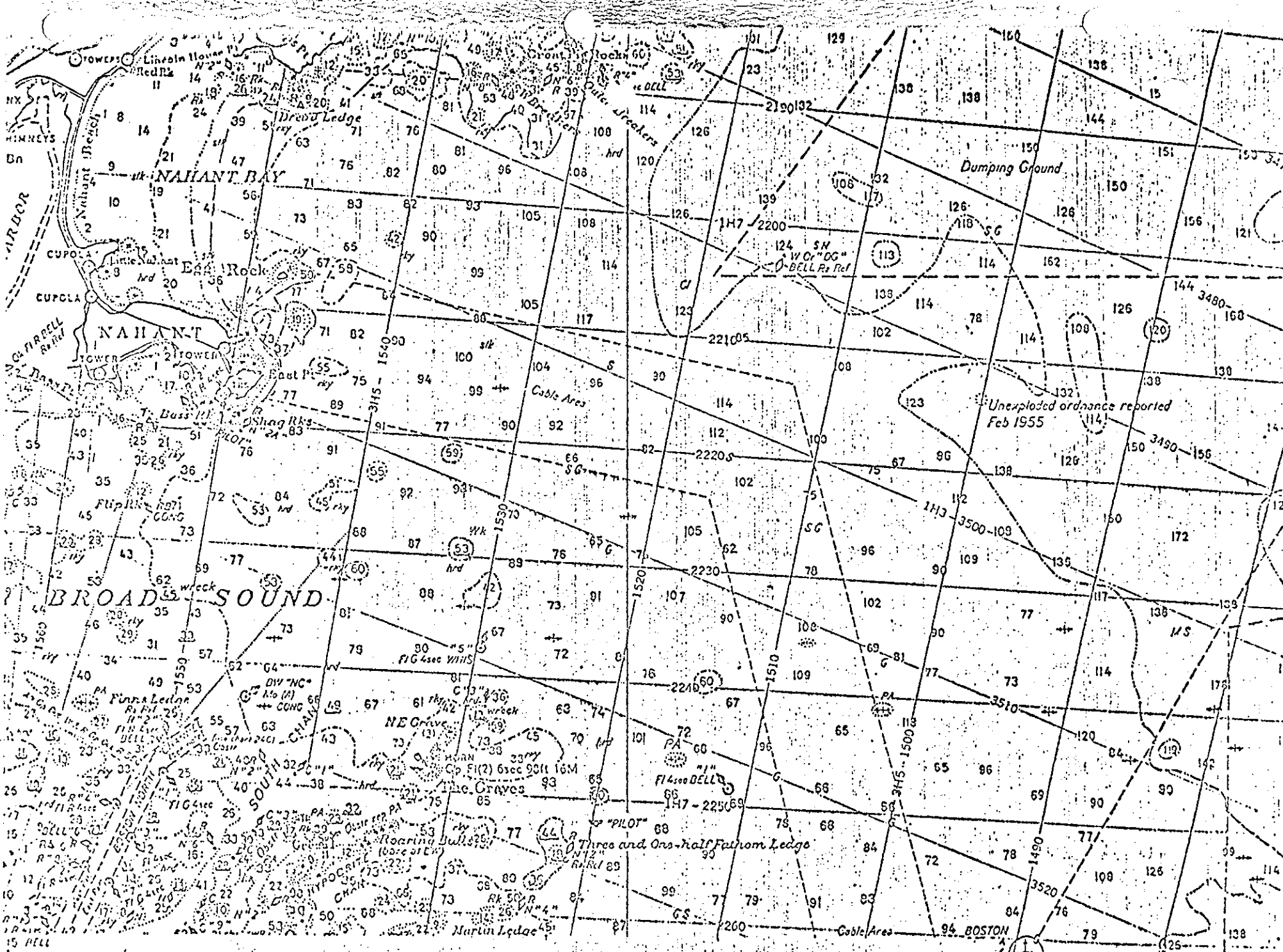


Figure 1. Part of Coast and Geodetic Survey Chart No. 1207 showing location of "Foul Area" and adjacent waters.

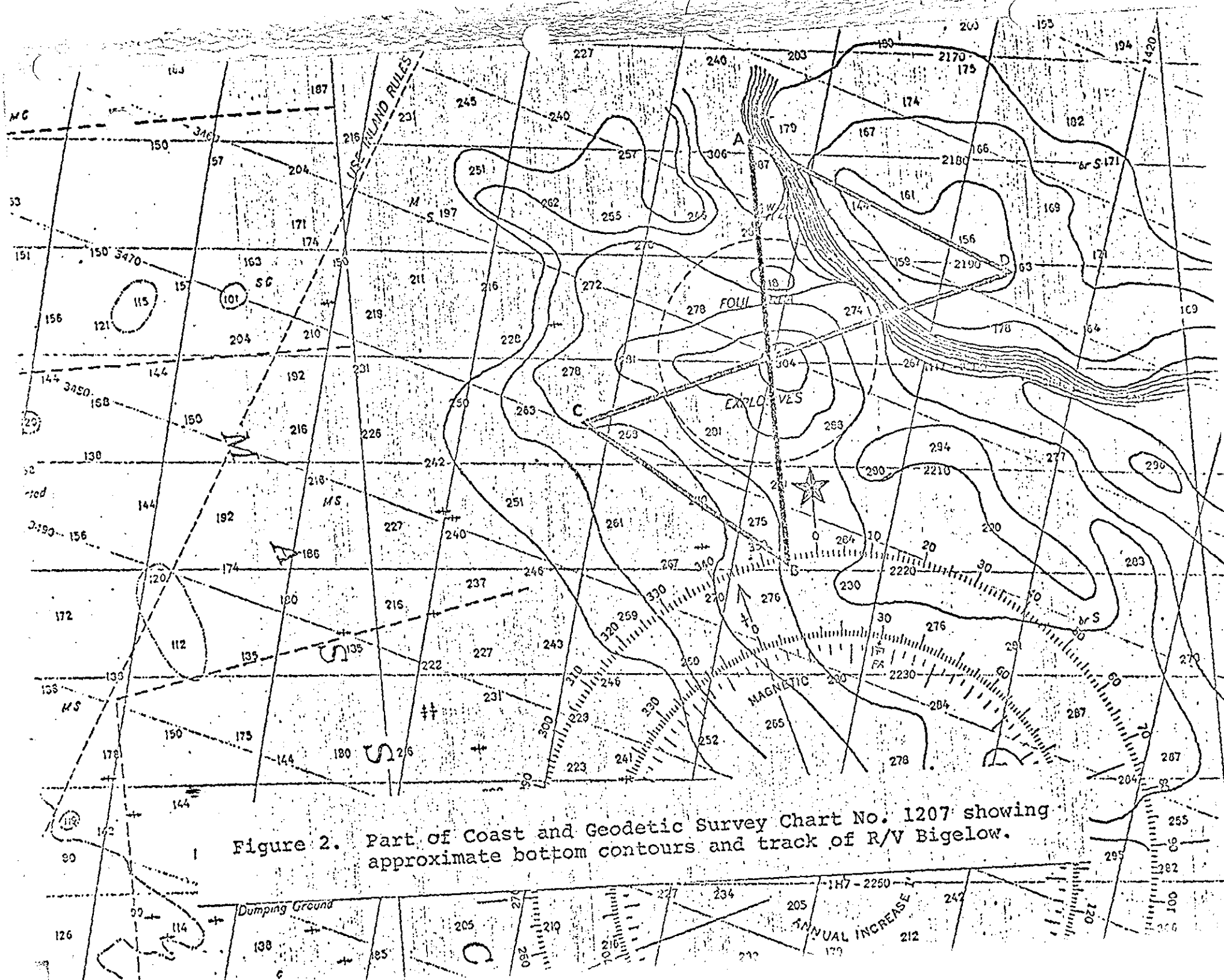


Figure 2. Part of Coast and Geodetic Survey Chart No. 1207 showing approximate bottom contours and track of R/V Bigelow.

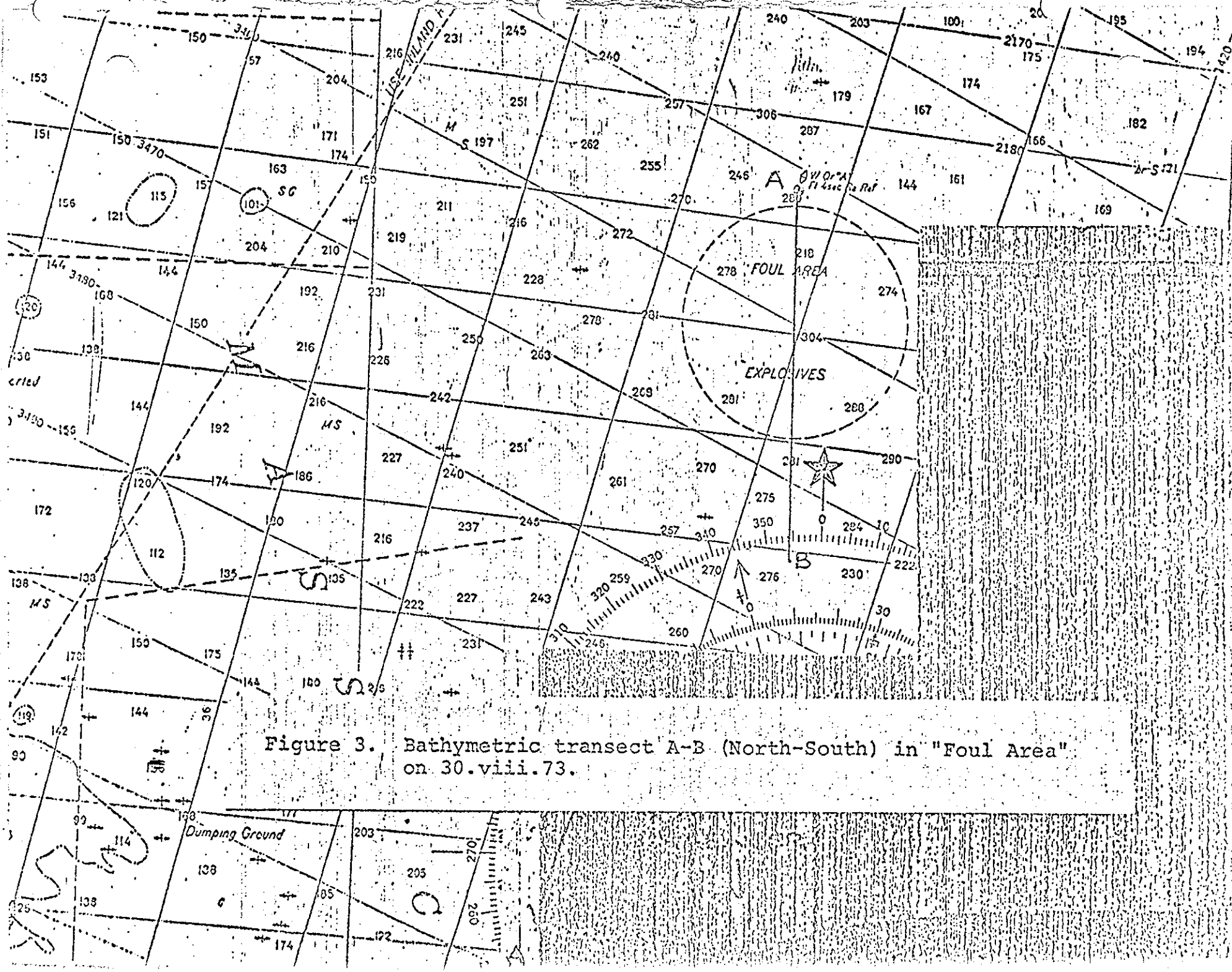


Figure 3. Bathymetric transect A-B (North-South) in "Foul Area" on 30.viii.73.

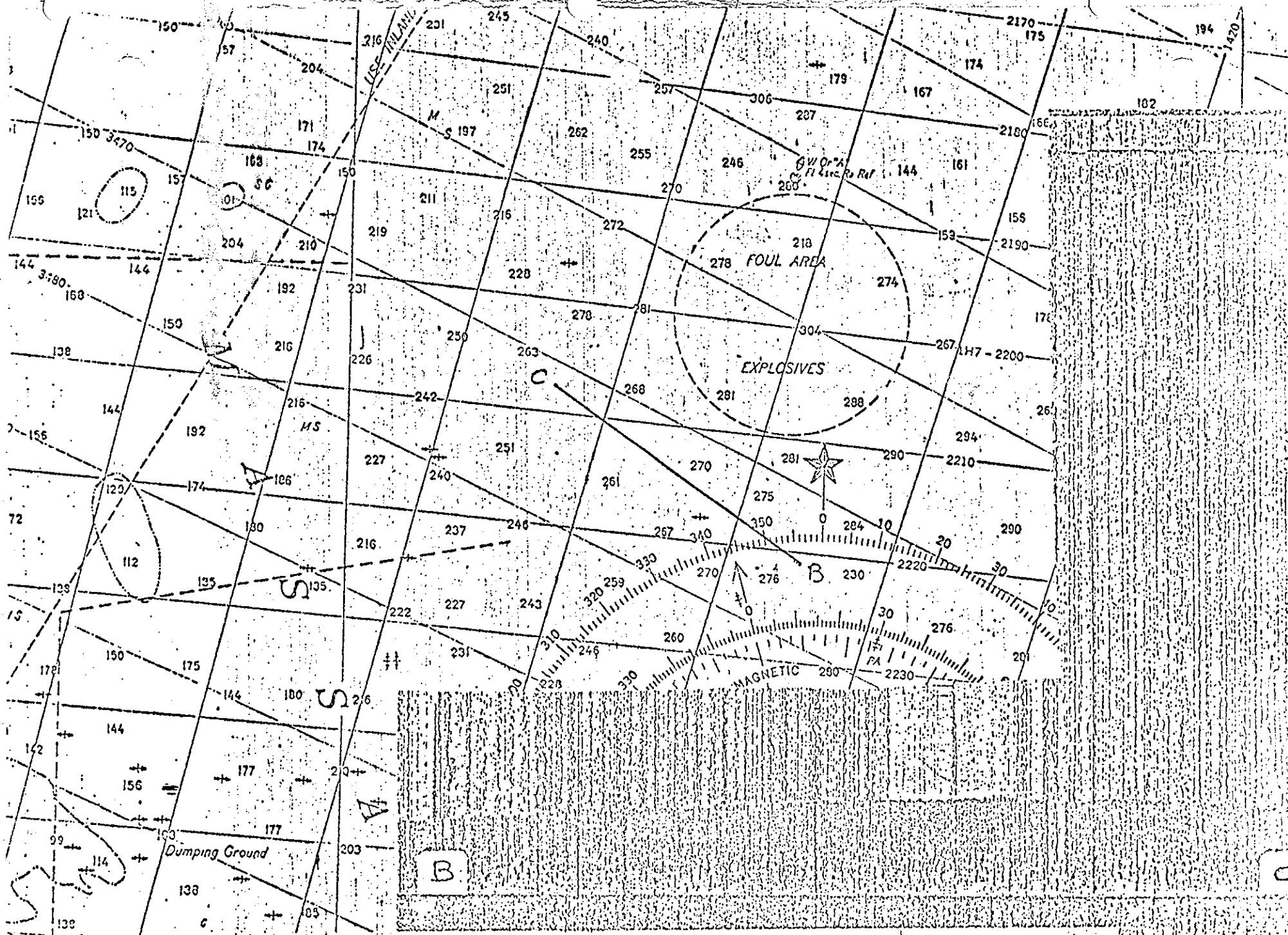


Figure 4. Bathymetry transect B-C adjacent to "Foul Area".

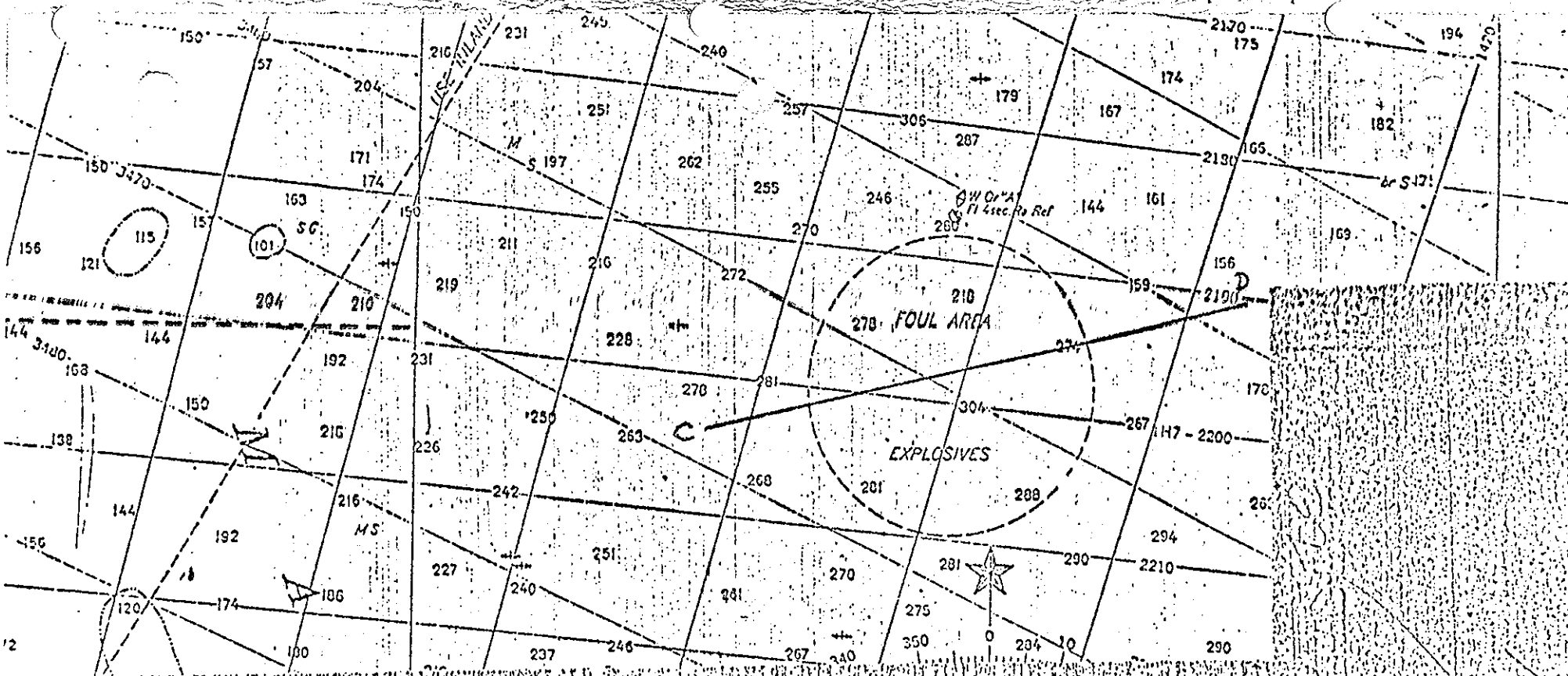


Figure 5. Bathymetry transect C-D (East-West) across "Foul Area".

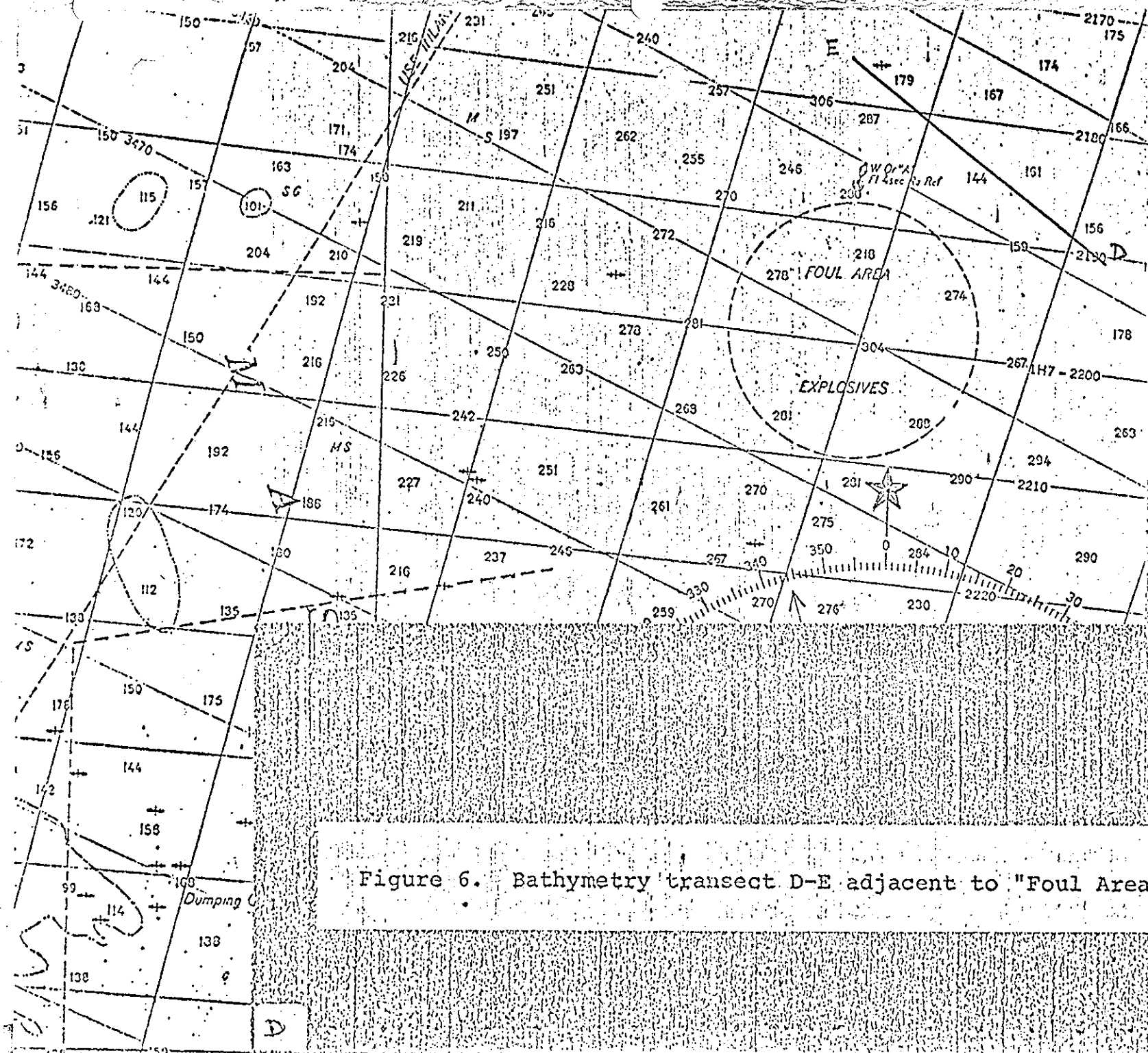
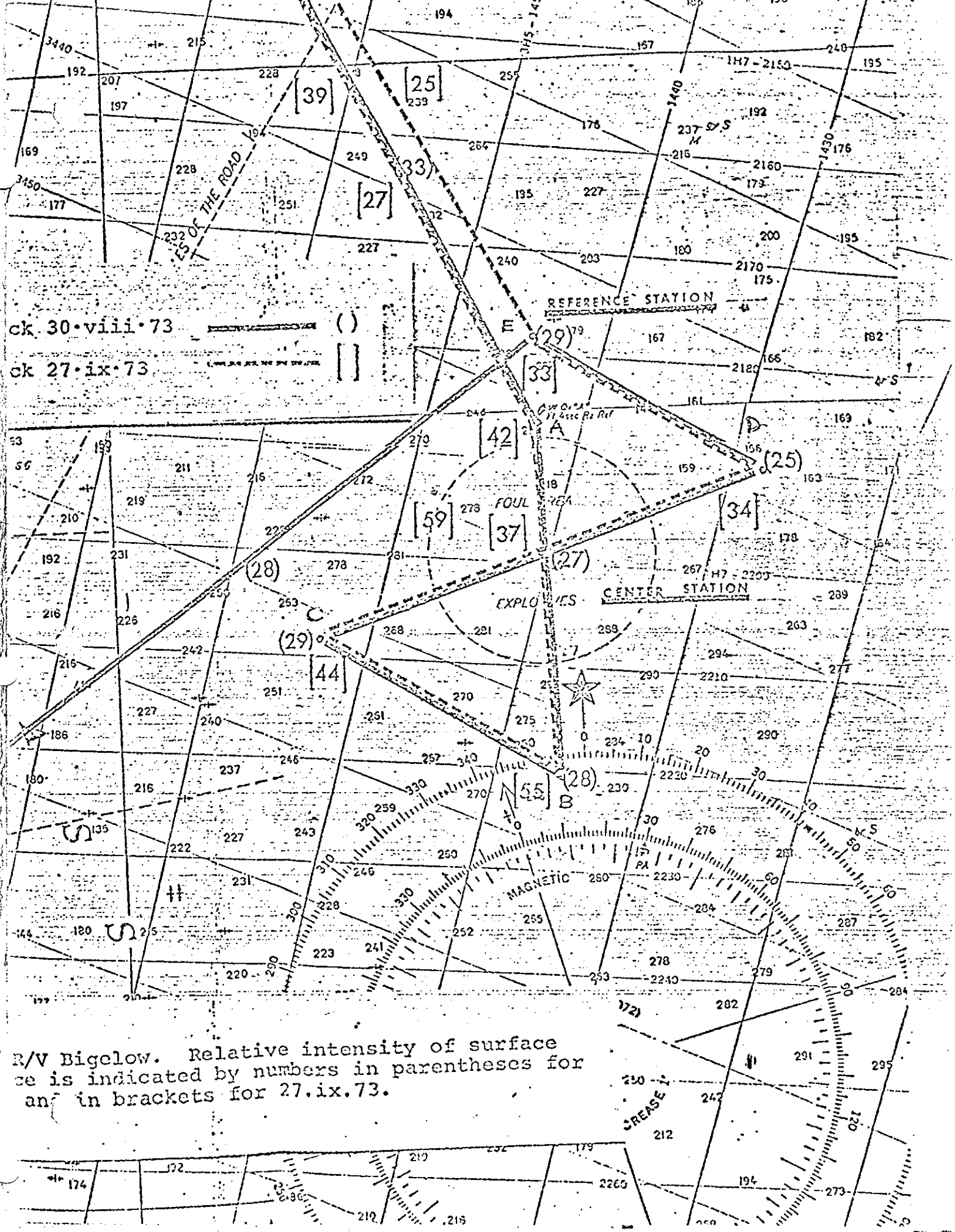


Figure 6. Bathymetry transect D-E adjacent to "Foul Area".



R/V Bigelow. Relative intensity of surface
ce is indicated by numbers in parentheses for
and in brackets for 27.ix.73.

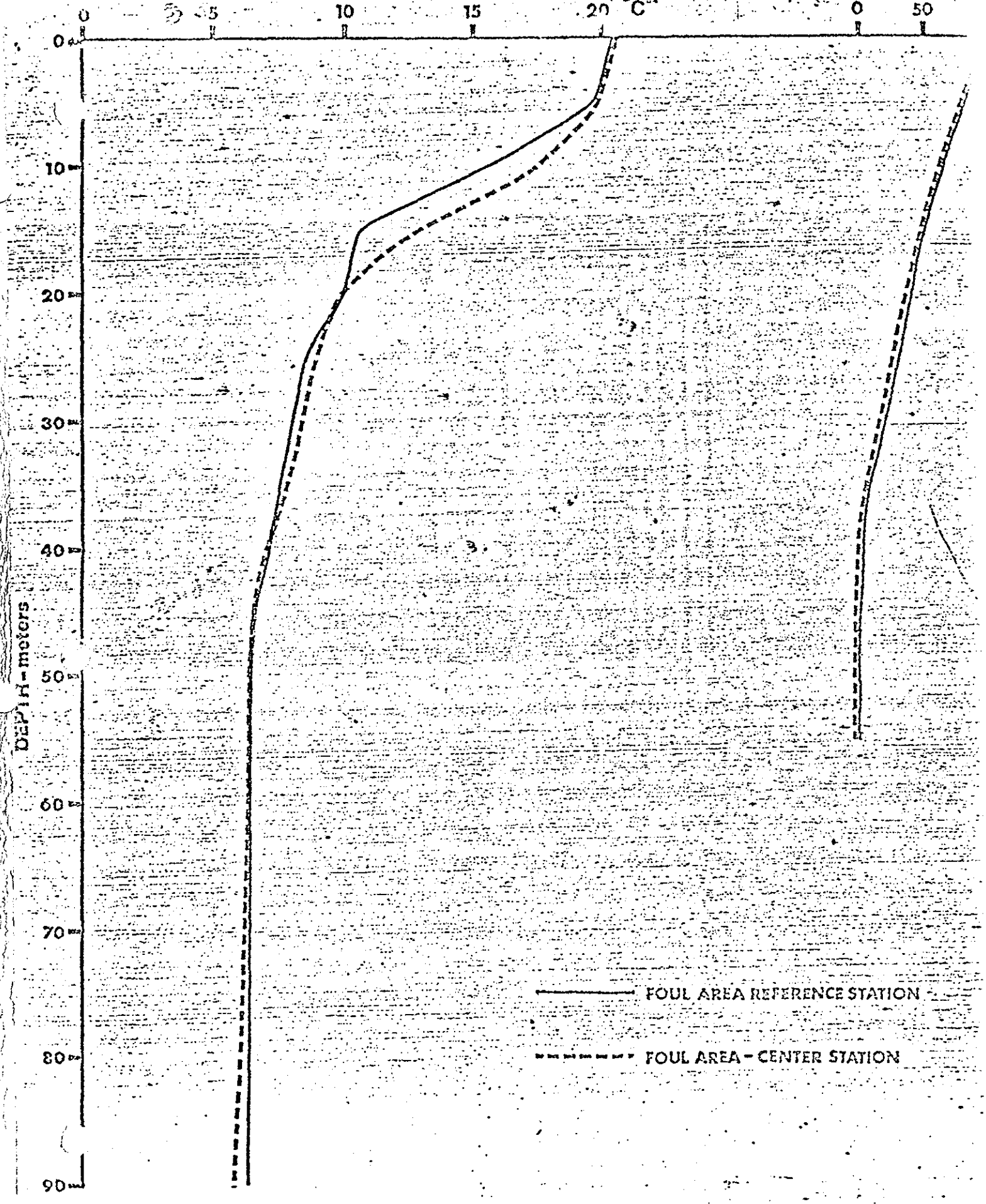


FIG. 8. Temperature and light distribution at "Foul Area-Center Station" and "Foul Area Reference Station" on August 20, 1973

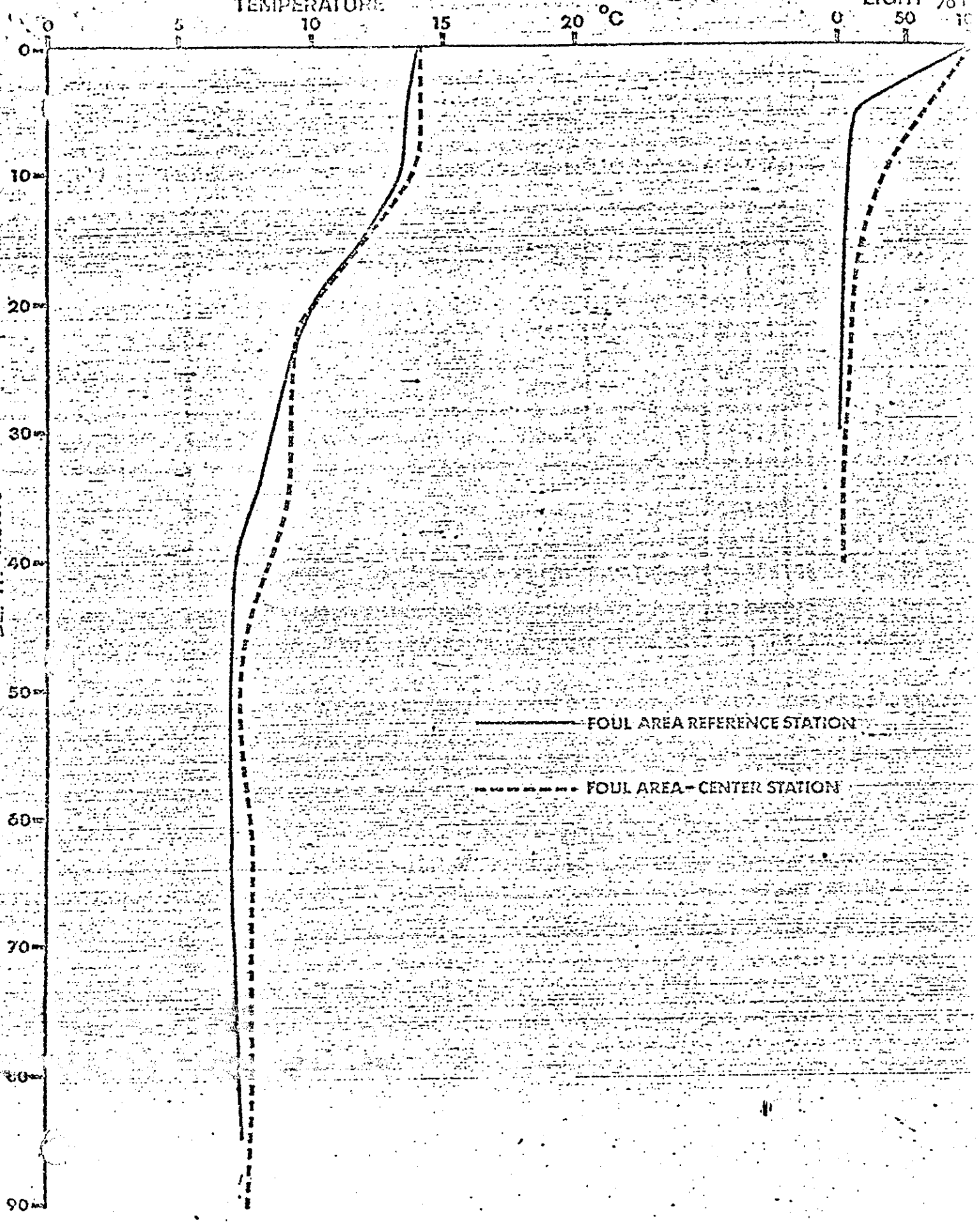


FIG. 9. Temperature and light distribution at "Foul Area-Center Station" and