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May 1990

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This document presents data collected from a monitoring survey at the Cape Arundel Disposal Site (CADS) on May 15 and 16, 1990 as part of the DAMOS (Disposal Area Monitoring System) program. The objectives of the May 1990 field operations were to replace a small temporary buoy with a permanent buoy and to determine the remaining site capacity. It was predicted that the central portion of the trough would have a maximum decrease in depth of 2 meters with only 10 to 30% of the disposed material detected by comparing the sequential bathymetric plots because of the highly irregular topography of the site. Both objectives were accomplished by conducting a precision bathymetric survey.

As of 1987, site capacity at CADS, based on a 36 meter minimum depth, was approximately 600,000 m^3 within the disposal site boundary. Since the 1987 survey, 480,000 m^3 of dredged material has been deposited at CADS. Based on the scow release points, 384,000 m^3 (80%) was deposited in >36 m depth. The 129,260 m^3 detected acoustically for the 300 X 300 m area accounted for 27% of the material recorded by the scow logs since 1987, or for 33% of the material that was deposited in deep water. This is within the prediction of a 10 to 30% detection rate based on earlier surveys at this site.

Poor agreement between disposal estimates and survey estimates are expected at this site because of the highly irregular topography. Some improvement may be possible by repeating the perpendicular bathymetric surveys in future cruises, but the degree of improvement is unpredictable. Based on the stability of the sediment in the trough, as inferred by bathymetry and REMOTS and previous erosion predictions it is reasonable to conclude that the undetected sediments are being placed into and remaining within the site among the rocky outcroppings.

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EXECUTIVE SUMMARY

This document presents data collected from a monitoring survey at the Cape Arundel Disposal Site (CADS) on May 15 and 16, 1990 as part of the DAMOS (Disposal Area Monitoring System) program. The objectives of the May 1990 field operations were to replace a small temporary buoy with a permanent buoy and to determine the remaining site capacity. It was predicted that the central portion of the trough would have a maximum decrease in depth of 2 meters with only 10 to 30% of the disposed material detected by comparing the sequential bathymetric plots because of the highly irregular topography of the site. Both objectives were accomplished by conducting a precision bathymetric survey.

A small temporary buoy had been deployed at CADS in April 1990. The results of the bathymetric survey in May indicated that the buoy did not need to be repositioned. The new permanent buoy was deployed at 43° 17.775' N, 70° 27.194' W, and the temporary buoy was removed.

The initial site capacity at CADS, estimated in 1987, based on a 36 m minimum depth, was approximately 600,000 m^3 within the disposal site boundaries. The area of the disposal site > 36 m depth was mostly confined to a 300 X 300 m area around the disposal buoy location. Since 1987, 480,000 m^3 of dredged material has been deposited at CADS. Based on scow release points, 80% of the material disposed by the scows, 384,000 m^3, actually was released in areas >36 m depth. The volume measured for the 300 X 300 m area between 1990 and 1987 was 129,260 m^3 (± 2117 m^3, 95% confidence interval). This volume represents 27% of the total dredged material released by scows in the vicinity of CADS from 1987 to 1990. Because of the highly irregular topography at this site it is uncertain whether improvements in estimating these volume changes are possible.

The 384,000 m^3 of dredged material released by the scows over the trough is adjusted to approximately 226,600 m^3 when a 41% correction factor is applied (Tavolaro, 1984). This corrected volume of dredged material would reduce the site capacity from 600,000 m^3 to 373,400 m^3. If only 129,260 m^3 (the amount detected by bathymetry) actually accumulated in the trough, the remaining site capacity would be 470,740 m^3. These translate to a capacity to handle future uncorrected scow log volumes of approximately 633,000 m^3, if all the material accumulated in the site, and 798,000 m^3 if actual detectable amounts only averaged out to a similar 27% of the total recorded volume.

MONITORING CRUISE
AT THE CAPE ARUNDEL DISPOSAL SITE
MAY 1990

1.0 INTRODUCTION

The Cape Arundel Disposal Site (CADS) is located approximately 2.75 nautical miles southeast of Cape Arundel, Maine. The site consists of a 500 yard diameter circle centered at 43° 17.800' N and 70° 27.200' W. Its bottom topography is characterized by a north-south trending trough running 1 km in length and 50 to 250 meters wide. This trough has a maximum depth of 43 meters and a silt/clay bottom admixed with fine sand. It is flanked by hard rock ridges shoaling up to 30 to 32 meters in depth. The practical capacity of the trough is estimated to be approximately 1.5 x 10^6 m^3 of dredged material based on a 36 meter minimum depth. The capacity for the section of trough within the disposal site boundary is 0.6 X 10^6 m^3 (SAIC, 1987).

Near-bottom currents at CADS are generally less than 10 cm/sec and northerly in direction, while near-surface currents are dominated by a southerly net drift moving at rates less than 15 cm/sec (SAIC, 1987). Although there is unlimited fetch to the northeast, near-surface currents have little effect on bottom currents due to the highly variable topography of the area which disrupts the coherence of near-bottom currents.

Previous REMOTS® and precision bathymetric surveys were conducted at CADS between 28 May and 2 June 1985 and between 16 and 17 October 1987. Disposal activities were minimal prior to the 1985 survey; scow logs indicate that 17,320 m^3 of dredged material were deposited at the site from February to May 1985. Disposal activities increased between 1985 and 1987; scow logs indicate 195,646 m^3 of dredged material were deposited at CADS by the 1987 survey (SAIC, 1990). Since the 1987 survey, approximately 480,000 m^3 of material have been disposed at the Cape Arundel Disposal Site.

Field operations were conducted at the Cape Arundel Disposal Site on 15 and 16 May 1990. The objectives of the cruise were to:

- Survey the Cape Arundel Disposal Site and determine the remaining site capacity by mapping that portion of the dredged material mound that is greater than 0.3 meters thick. It was predicted that the central portion of the trough would have a maximum decrease in depth of 2 meters. It was also expected that because of the complex topography of the site, only 10 to 30% of the disposed material would be detected by comparing the sequential bathymetric plots.

- Assess whether running a second bathymetric survey perpendicular to the first would improve resolution.

- Remove a temporary buoy that had been installed 26 days earlier when the permanent buoy was lost from its mooring. Also, based on the bathymetry, determine whether the new permanent buoy needed to be repositioned.

2.0 BATHYMETRIC AND NAVIGATION PROCEDURES

The precision navigation required for bathymetry was carried out utilizing the SAIC Integrated Navigation and Data Acquisition System (INDAS). This system used a Hewlett-Packard 9920 series computer to collect position, depth, and time data for subsequent analysis, as well as provide real-time navigation. Positions were determined to an accuracy of ±3 meters from ranges provided by a Del Norte Trisponder® System. Shore stations were established at previously used benchmarks at the Wells Beach Fire Control Tower (located at 43° 17.198' N, 70° 34.321' W) and the Kennebunk River Breakwater Light (located at 43° 20.756' N and 70° 28.590' W) in Maine (SAIC, 1985).

Individual depth measurements were determined to a resolution of 3.0 cm (0.1 feet) using an ODOM Echotrac® survey fathometer, Model DF 3200, with a 208 kHz transducer as described in DAMOS contribution #48 (SAIC, 1985). The speed of sound through the water column was determined from the temperature and salinity data obtained using an Applied Microsystems CTD probe.

Two precision bathymetric surveys were conducted at the Cape Arundel Disposal Site in May 1990. The first survey, conducted on 15 May 1990, consisted of fifty-seven lanes spaced 25 meters apart and covered an area 600 meters (east to west) by 1400 meters (north to south). This exceeded the 1987 survey boundaries by 200 meters to the south. The survey lanes were run east and west (perpendicular to the trough) to insure maximum detection of depth changes over the bottom. The survey included the area in the vicinity of the disposal buoy and the trough to the north of the buoy. The second survey, conducted on 16 May 1990, covered the southern portion of the first survey, with survey lanes running perpendicular to those of the first survey. Perpendicular survey lanes were used in an attempt to improve the resolution of the complex bathymetry found at CADS. This survey consisted of twenty-five lanes spaced 25 meters apart and covered an area 600 meters by 600 meters square. The bathymetric data from the two surveys were combined to produce the final depth contour plots of the Cape Arundel Disposal Site. During analysis of the bathymetric data, the raw depth data were corrected to Mean Low Water by adjusting for ship draft, for changes in tide heights during the survey, and for the speed of sound in the water column. A more detailed

description of the bathymetric analysis procedure is provided in DAMOS Contribution #60 (SAIC, 1989).

Prior to the second survey, the new disposal buoy was deployed at 43° 17.775' N, 70° 27.194' W. The results of the bathymetric survey did not indicate that the buoy required repositioning.

3.0 RESULTS

Approximately 480,000 m^3 of dredged material have been deposited at CADS since October 1987. A comparison of October 1987 and May 1990 bathymetry (Figures 3-1 and 3-2, respectively) shows reductions in depth up to 3 meters near the center of the disposal site and up to 1 meter in the trough to the north. A volume calculation was performed comparing the 1987 survey, 600 meters (east to west) by 1200 meters (north to south), and the corresponding areas of the 1990 surveys. The rapidly changing topography outside the trough at CADS introduced errors in the volume. To remove these errors, the volume of accumulated material between 1987 and 1990 was calculated using the center 525 meters (east to west) and the southern 400 meters (north to south) common to both surveys (Figures 3-1 and 3-2). A volume of 206,334 m^3 of dredged material was calculated for that area. Depth changes occurred north of this area; however, errors introduced by very irregular topography negate any attempt to quantify these changes.

The 525 X 400 m^2 area used in the previous volume calculation included the disposal site and the hard rock ridges around the trough (Figures 3-1 and 3-2). The hard rock ridges introduced errors into the bathymetric comparison and were also less than the 36 m depth used to determine site capacity. A more accurate volume for the disposal site was calculated by using the 300 X 300 m area centered at the disposal buoy which excluded these ridges. A visual comparison of the bathymetry of this area in 1987 and 1990 (Figures 3-3 and 3-4), showed depth reductions on the slopes and on the floor of the trough near the disposal buoy. The volume reduction calculated over this area was 129,260 m^3. The isopach map of the changes in depth shows up to 3.75 meters of material on the slopes surrounding the area of the disposal buoy and 1 to 2 meters of material on the floor of the trough north of the buoy (Figure 3-5).

4.0 DISCUSSION

A comparison of the precision bathymetric surveys conducted at CADS in 1987 and 1990 indicated an accumulation of dredged material in the vicinity of the disposal buoy since 1987. Maximum dredged material thickness occurred on the slopes of the trough northwest of the buoy and followed the northwest-southeast trend of the bathymetric contours. Less accumulation occurred in

the trough or low points to the north and southeast. This follows the prediction of a minimum 2 meter depth reduction in the central portion of the trough in the disposal site.

The uneven distribution of dredged material over the disposal site is due to the spatial dispersion of the scow release points (Figure 4-1). A majority of the release points were in the trough, within 100 m of the disposal buoy. Many release points, however, occurred north and west of the buoy. These outlying disposal locations caused the deposition of dredged material on the hard rock ridges where it was not as easily detectable acoustically. The material released over the ridges did not decrease the estimated capacity of the trough because it was deposited above the 36 m depth.

The bathymetry for CADS shows depth changes of one meter or less in the trough north of 43° 17.9' N and over three meters near the buoy. The volume reduction calculation for the 300 m X 300 m area centered on the buoy (Figure 3-2) was 129,260 m^3 (95% confidence limits; 127,143 m^3 to 131,377 m^3).

Tavolaro (1984) showed that volume estimates based on scow log records considerably overestimate the amount of dredged material because of the significant amount of interstitial water associated with the dredged material in the scows. He calculated that "depth difference" volume estimates based on successive bathymetric surveys will be as much as 41% less than the scow log volume estimates. The discrepancy was attributed not only to the scow log inaccuracies but also to the compaction of dredged material on the bottom following disposal and the significant volume of material deposited at the flanks of the mounds in layers too thin to be detected acoustically.

Scow logs reported that 480,000 m^3 of dredged material were deposited at CADS between October 1987 and May 1990. Applying the 41% factor, a corrected volume of 283,200 m^3 of dredged material may be detected acoustically. The calculated volume of 129,260 m^3 accounted for 46%, +/- 2%, of the corrected scow volume. Previous recommendations to conduct a perpendicular survey at CADS were followed during this study and were expected to increase the accuracy of the 1990 results. The comparison of the 1990 and the 1987 bathymetry did not show a significant improvement, because the perpendicular survey was conducted only in 1990. Comparison to a subsequent survey conducted the same way should determine if increased resolution is obtained.

5.0 CONCLUSIONS

As of 1987, site capacity at CADS, based on a 36 meter minimum depth, was approximately 600,000 m^3 within the disposal site boundary (SAIC, 1987). Since the 1987 survey, 480,000 m^3 of dredged material has been deposited at CADS. Based on the scow

release points (Figure 4-1), 384,000 m^3 (80%) was deposited in >36 m depth. The 129,260 m^3 detected acoustically for the 300 X 300 m area accounted for 27% of the material recorded by the scow logs since 1987, or for 33% of the material that was deposited in deep water. This is within the prediction of a 10 to 30% detection rate based on earlier surveys at this site.

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Poor agreement between disposal estimates and survey estimates are expected at this site because of the highly irregular topography (SAIC,1990). Some improvement may be possible by repeating the perpendicular bathymetric surveys in future cruises, but the degree of improvement is unpredictable. Based on the stability of the sediment in the trough, as inferred by bathymetry and REMOTS and previous erosion predictions (SAIC,1987), it is reasonable to conclude that the undetected sediments are being placed into and remaining within the site among the rocky outcroppings.

6.0 REFERENCES

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SAIC. 1990. Monitoring Cruise at the Cape Arundel Disposal Site, October 1987. DAMOS Contribution #67 (SAIC Report 87/7513&C67). U.S. Army Corps of Engineers, New England Division, Waltham, MA.

Tavolaro, J.F. 1984. Sediment Budget Study for Clamshell Dredging and Ocean Disposal Activities in the New York Bight. Environ. Geol. Water Sci. 6 (3): 133-140.

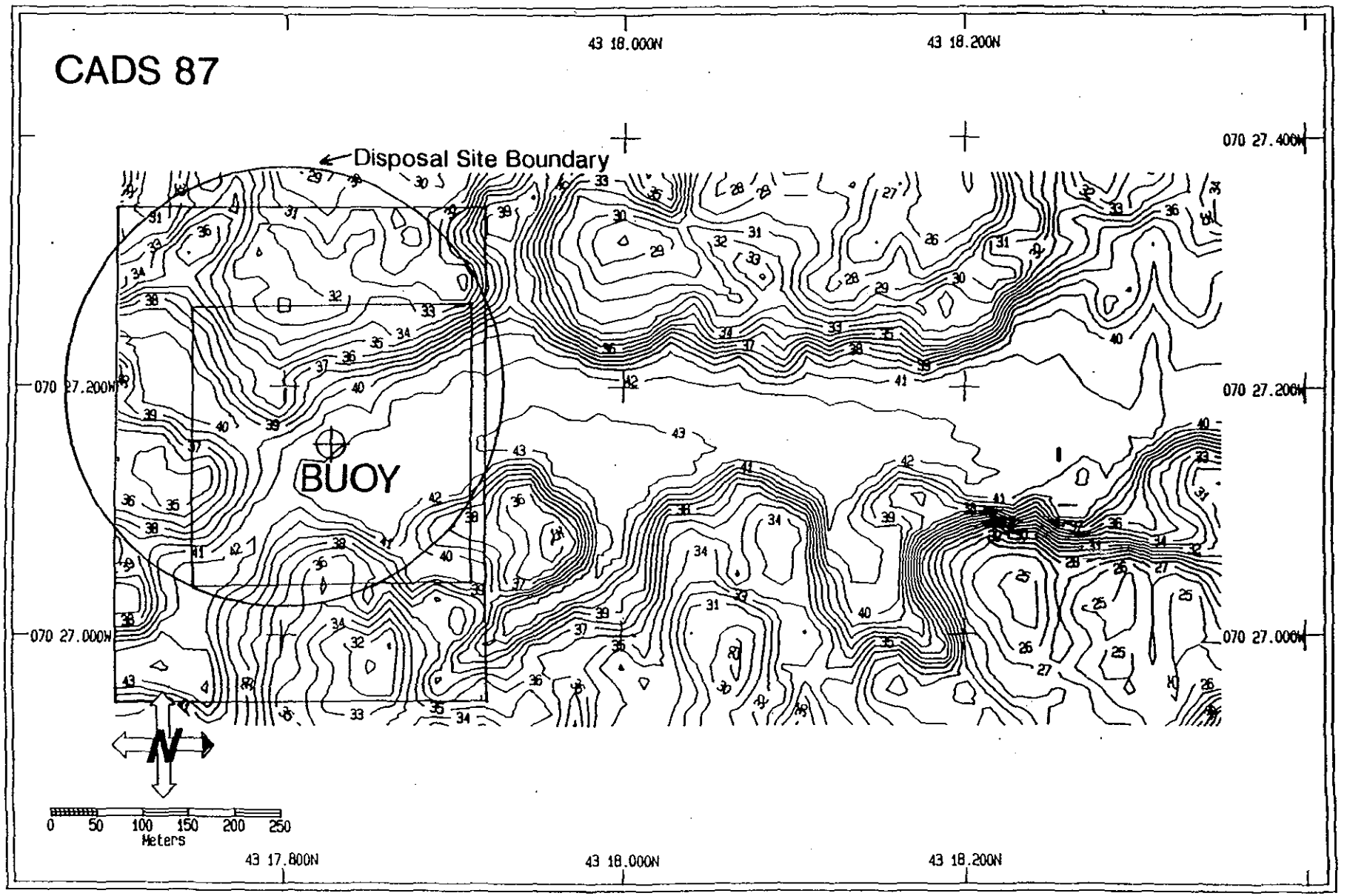

Figure 3-1. Contoured bathymetric chart (depth in meters) of CADS, 17 October 1987. The contour interval is 1 meter. The large rectangle indicates the area of the preliminary volume difference calculation. The square around the buoy delimits the area which has been enlarged in Figure 3-3.

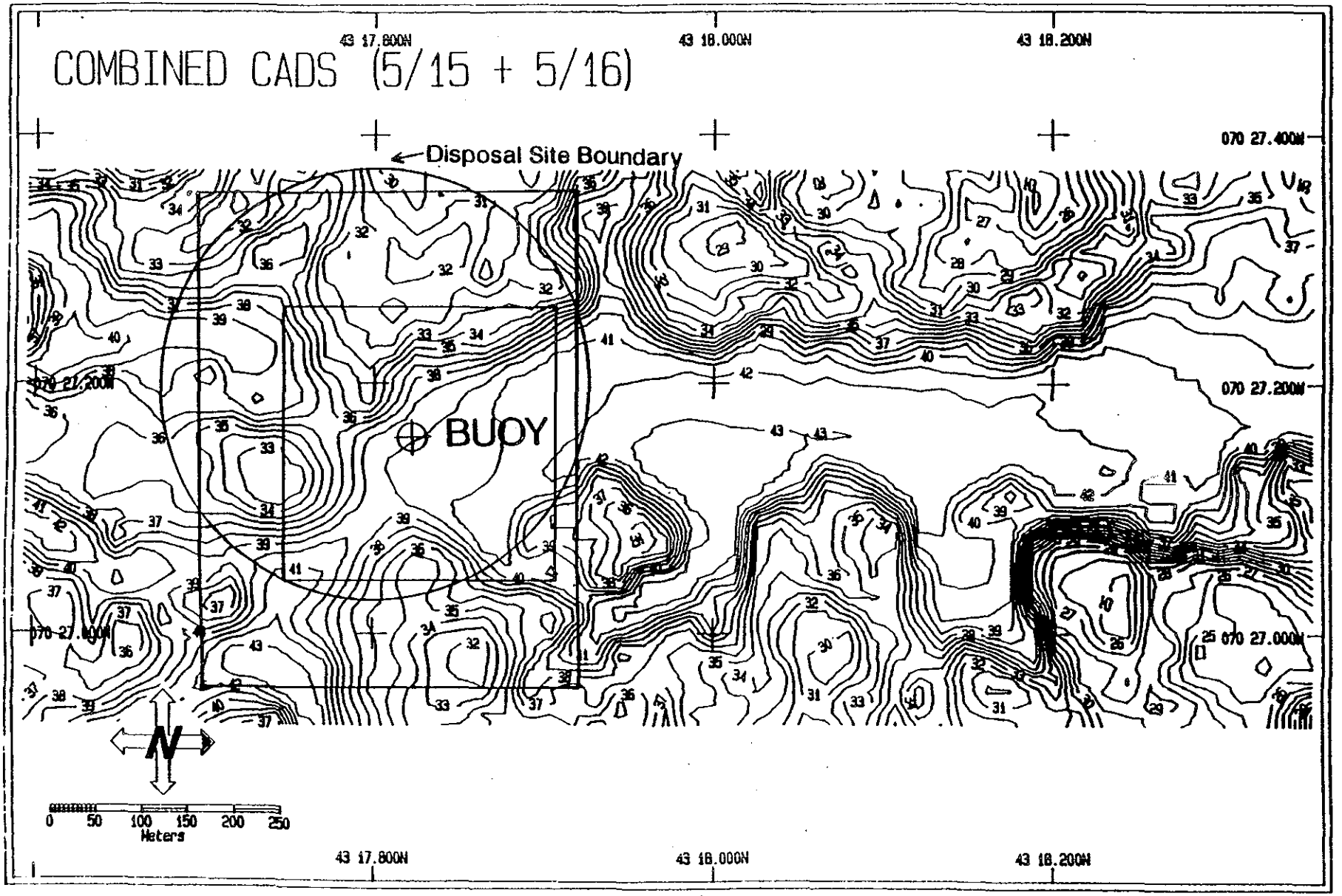

Figure 3-2. Contoured bathymetric chart (depth in meters) of CADS, 15 and 16 May 1990. The contour interval is 1 meter. The large rectangle indicates the area of the preliminary volume difference calculation. The square around the buoy delimits the area which has been enlarged in Figure 3-4.

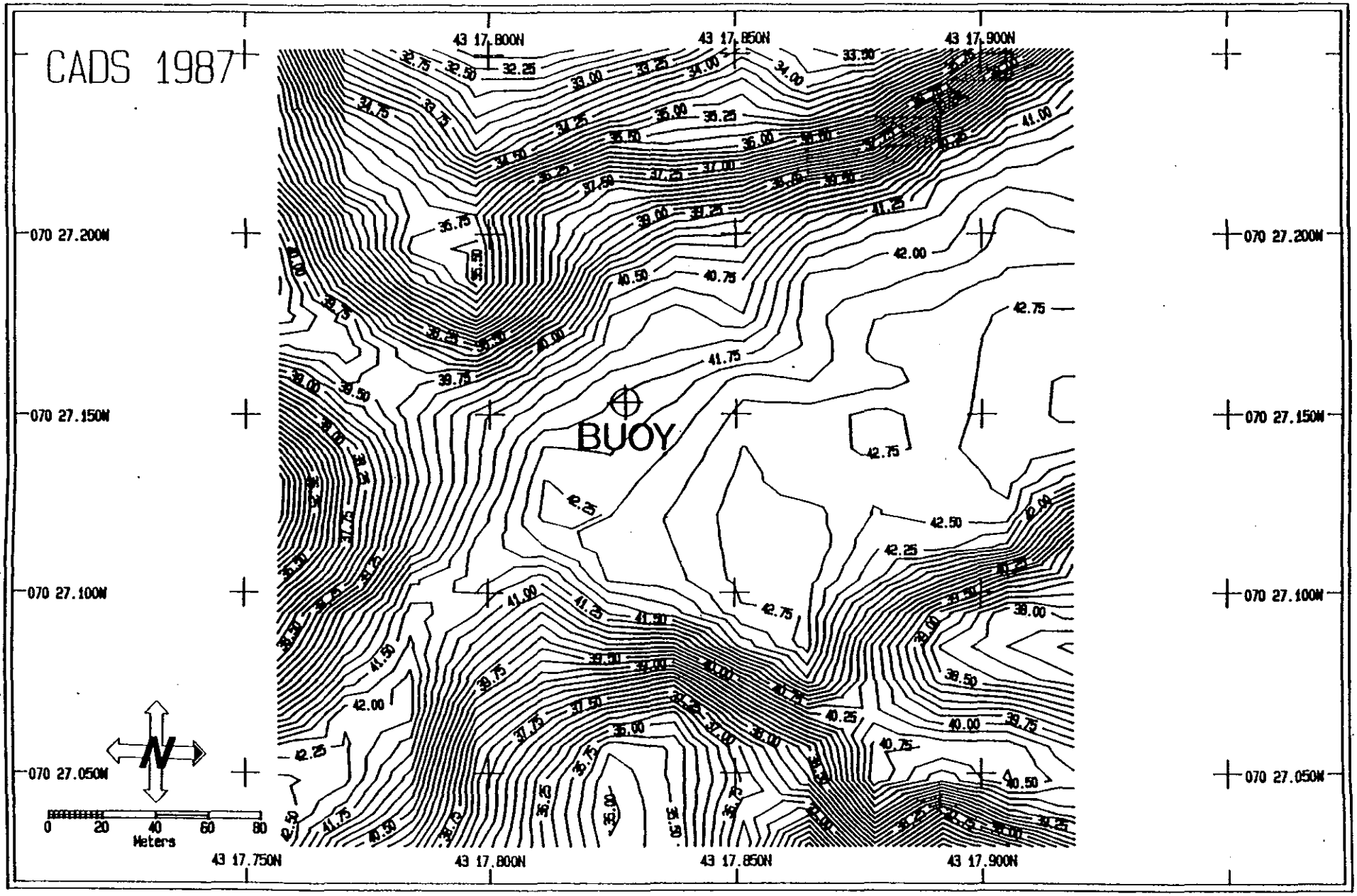

Figure 3-3. Contoured bathymetric chart (depth in meters) of the area surrounding the buoy at CADS, 17 October 1987. The contour interval is 0.25 meters. This chart is an enlargement of the area outlined in Figure 3-1.

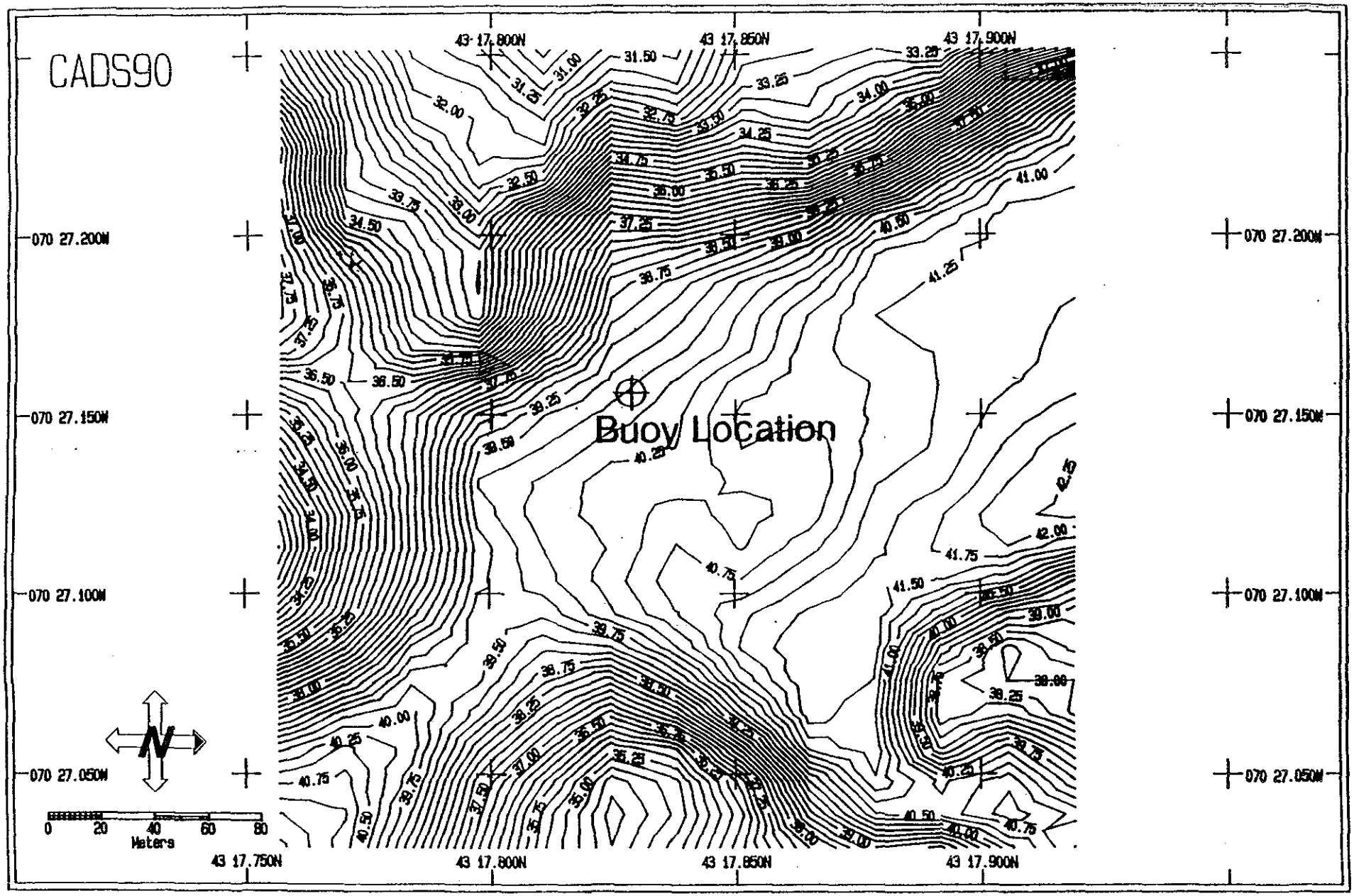

Figure 3-4. Contoured bathymetric chart (depth in meters) of the area surrounding the buoy at CADS, 15 and 16 May 1990. The contour interval is 0.25 meters. This chart is an enlargement of the area outlined in Figure 3-2.

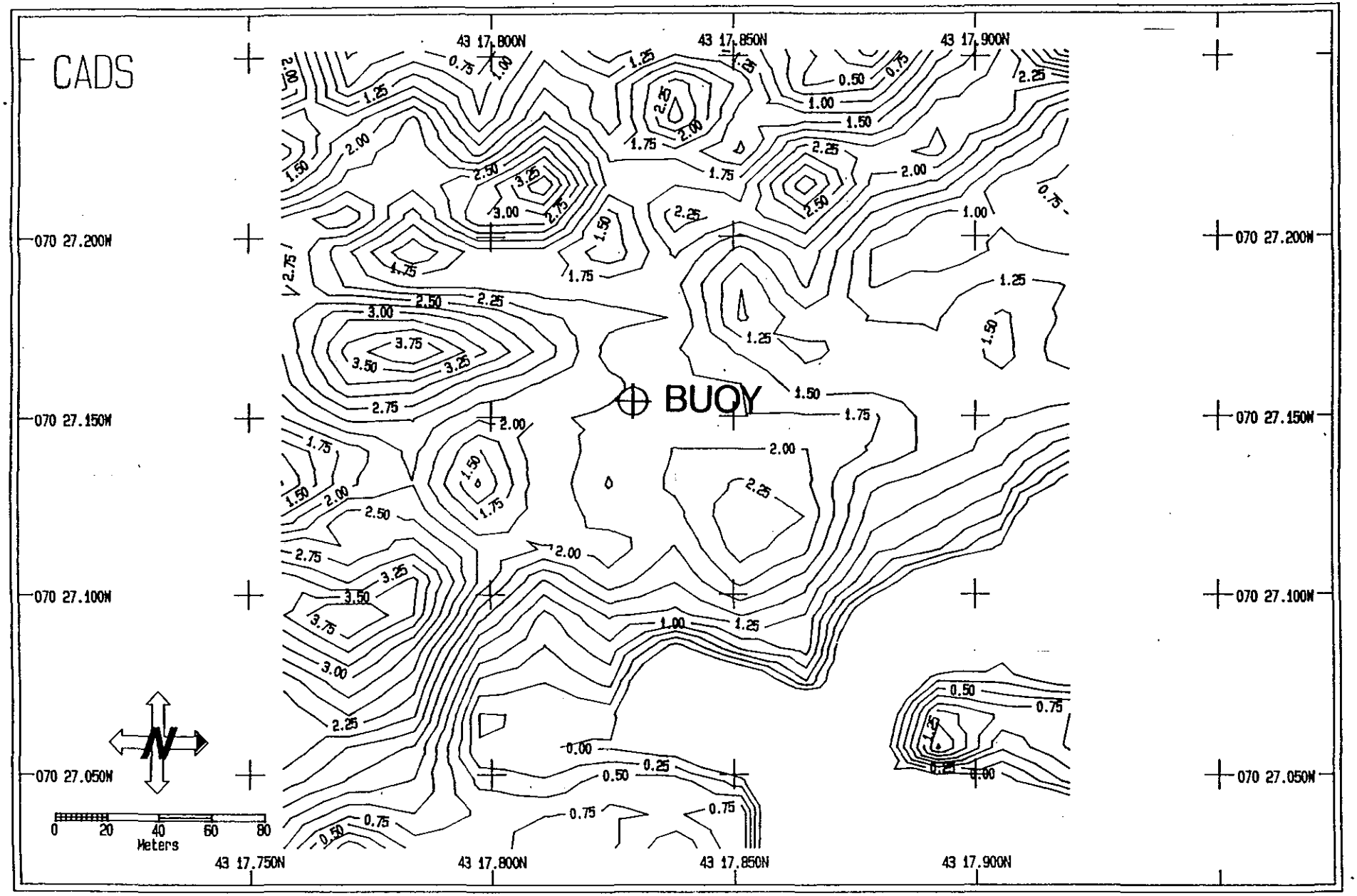

Figure 3-5. Contoured isopach chart of changes in depth surrounding the buoy at CADS, 15 and 16 May 1990. The contour interval is 0.25 meter. The areas that were compared to produce this chart are outlined in Figures 3-3 and 3-4.

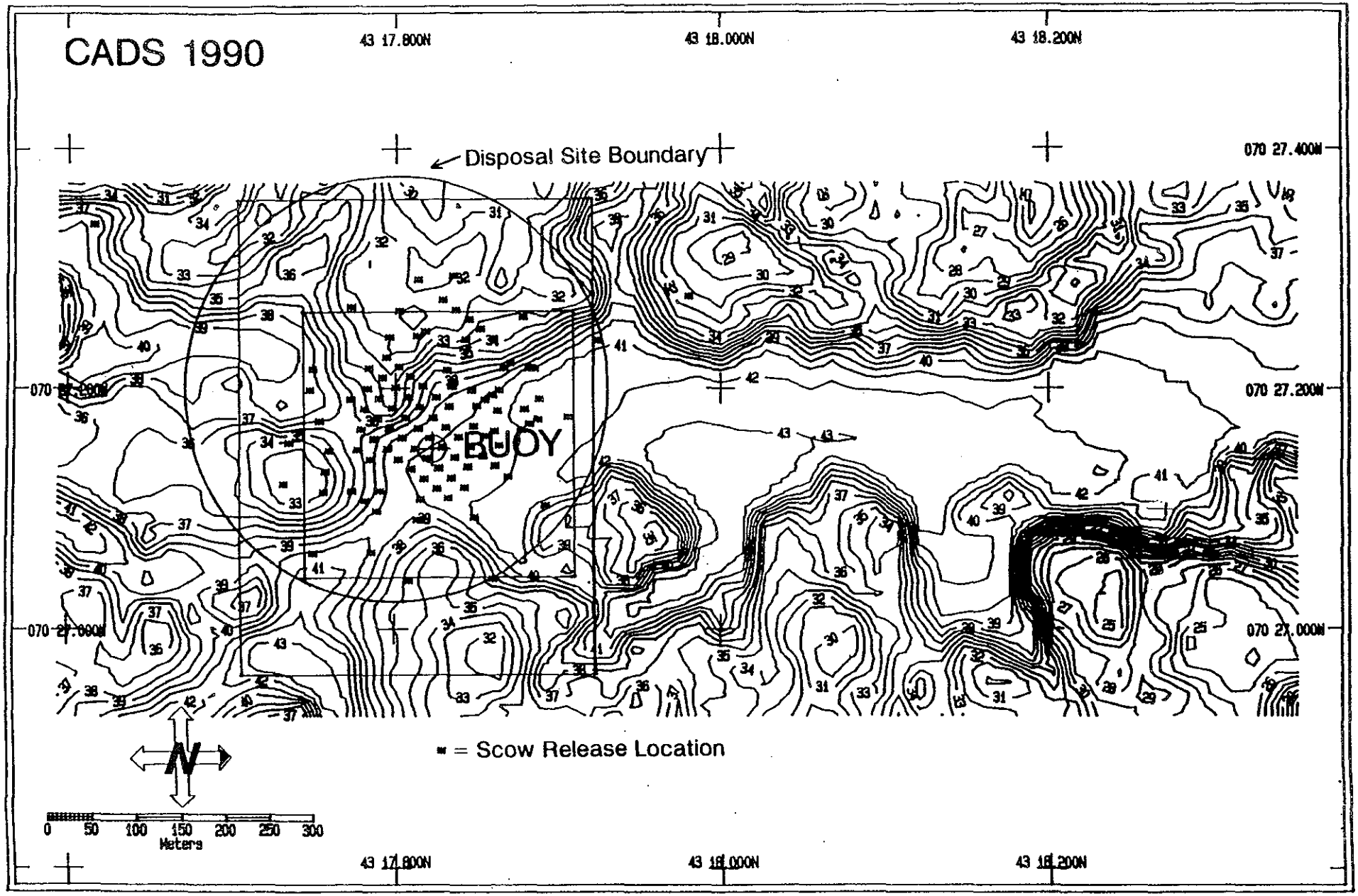

Figure 4-1. The location of scow release points at CADS from October 1987 to May 1990.

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