1977

Task 1 evaluation on the thickness of the mobile surface layer, Dam Neck, Virginia : final report to Malcolm Pirnie Engineers, Inc.

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FINAL REPORT

to

Malcolm Pirnie Engineers, Inc.

TASK 1 EVALUATION OF THE THICKNESS OF THE MOBILE SURFACE LAYER, DAM NECK, VIRGINIA

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by

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Introduction

Our objective under Task 1 was to make an assessment of the sedimentary features (sediment texture and structures) present in cores (obtained by vibratory method) at the project site in order to express an opinion as to the thickness of the "surface mobile sand layer". The mobile sand layer is that surficial sediment layer undergoing cut and fill episodes due to present day wave and current induced sediment transport. In addition, this report contains information extracted from existing literature on recent (1859 to 1968) shoreline behavior in the vicinity of the proposed outfall and on some aspects of surface sediment movement at a nearby site in 35 to 45 ft. water depths. Finally, this report incorporates the results of a later VIMS study of the shallow water depth characteristics and bottom sediments landward of the earlier core hole sites. The results of latter study are fully presented in Appendix A.

The Surficial Mobile Layer

Studies in nearshore environments elsewhere have shown that a surficial mobile layer of varying thickness may exist. The surficial layer may represent a cut and fill response to episodic storm events or to longer term encroachment of slowly moving sand bedforms responding to a net current circulation. Depending upon the frequency of occurrence and the intensity of storms, the depth profile and the type of sediments present, such cut and fill sequences leave their sedimentary signatures in mobile layers of a few inches to several feet in thickness.

Our examination of the core sections obtained on a transect along the project site revealed no clear cut evidence that the mobile layer is anywhere more than one to four inches thick at the time the transect was cored. The inshore survey, using diver operated "can cores", showed a mobile layer at positions of BH 19 and BH 18 a few inches thicker than that reflected in the vibracores. The innermost can core, taken at a position about 150 feet seaward of the nearshore bar, indicated that the mobile layer is greater than 6 inches deep (the depth of the can core). This is to be fully expected however since the bar itself, with relief of a few feet, is a mobile layer feature.

Our interpretation from the core sequence is that the sediment horizon underlying the thin mobile layer represent an erosional surface cut by waves and currents into a sediment sequence characteristic of a coastal lagoon depositional environment. The twenty-one offshore cores taken in water depths ranging from 21 to 33 feet contain on the order of 20 feet of homogenous dark gray, fine to very fine-grained sands and silts broken by isolated layers of coarse shell and gravel between one and twelve inches thick and by clay horizons varying in thickness between fractions of an inch to two feet or greater. Penetrometer tests by Mueser, Rutledge, Wentworth and Johnston show that these clays experienced an overburden exceeding the existing overburden. In itself, the deposition of clay horizons would not be expected in an open ocean nearshore environment. The high percentage of fines and the preservation of large, highly angular shell fragments (including nearly whole, articulated pelecypod valves) in thin layers suggests a low-energy depositional environment more in keeping with a coastal lagoon having intertidal channels rather than the present wave-dominated nearshore environment. This interpretation is further reinforced by the presence of a five-foot core section containing peat and other vegetative material at the top of the landward most core (Core B-0-19) taken in a water depth of 12 feet some 600 to 700 ft. seaward of the present shoreline. The peat indicates that marshes were, more than likely, a part of the inferred lagoonal environment.

It is of interest to note that two pieces of rusty iron were obtained approximately 17 inches below the top of core BH 24 which was located about 5,000 feet from shore in a water depth of 31 feet. The iron fragments were found within a 3 inch layer of coarse shell fragments. One piece of iron about two inches in length was found to have a diamond shaped cross-section after scraping off the oxide cemented sediments. The second piece was not scraped. We speculate that these are tip fragments of clam harvest equipment which broke after encountering the dense shell layer in which they were found. Another hypothesis is that the shell horizon represents a shell concentrate of a recent erosion event and that the overlying fine sand is recent deposition, a mobile layer sequence. However, BH 11, which is located about 250 feet shoreward of BH 24, contains, at comparable elevations, interfingering layers of fine sand and clay which are interpreted as part of the "lagoonal" sequence. Thus, even if the alternate hypothesis were accepted it would appear that this "mobile layer" depth was localized.

Shoreline Position Changes

Historical highwater shoreline positions are shown in documents of the U.S. Corps of Engineers (1970). The shoreline positions were plotted from surveys performed by the Coast and Geodetec Survey (now NOS of NOAA) and the Corps of Engineers. The maps with composite traces from the various surveys (1859 to 1968) are on file and available from the Corps' Norfolk District Office.

At the immediate vicinity of the outfall (Corps Sheet 5) shoreline positions are shown for the years 1859, 1905, 1925 and 1939. Adjacent nearby areas also have the 1968 shoreline. The results of the comparisons are shown in Table 1 as extracted from the above mentioned report. For the cases of Sheet 5 and Sheet 6 the information was taken directly from the Corp report. The rate of retreat or advance is shown as the average over the entire shore length shown on the sheets. At the outfall site the rate is a point measurement.

The plots of shoreline position and the rates of change shown in Table 1 indicate that in the general area of the outfall intersection the shoreline has undergone episodes of advance and retreat. Between 1905 and 1925 the averaged retreat rate was about 21 ft/yr at the outfall site. The surveys 1925 and 1939 indicate essentially the same shoreline position. Although the 1968 shoreline position is not shown at the outfall site, the area to the immediate south (Sheet 6) retreated between 1925 and 1968 at 1.4 ft/yr.

Movement of the Nearshore Sands

As previously mentioned the evidence from the transect of vibracore borings indicates a sediment sequence of relict coastal lagoon deposits undergoing erosion at the surface (over the long term) as the shoreline retreats. There is no quantitative evidence on the magnitude of nearshore sand movement at the transect or in the general area. However, there is qualitative evidence (Saumsiegle, 1976) on sediment movement in a region within two miles (ENE) of the diffuser section in water depths ranging from 35 to 45 feet. Saumsiegle was concerned with the stability of a mound of approximately 18 X 10^6 cu. yds. of sand (dredge spoil) deposited as a reservoir source for beach nourishment. The study consisted of repetitive bathymetric surveys and sediment sampling to determine whether the mound, which amounted about 8 feet positive relative relief, was stable.

The exotic sands were generally poorly sorted with the modal size between 0.5 and 0.25 mm whereas the indigenous sediment was better sorted and had a modal size between 0.125 and 0.088 mm. Sequential sediment sampling between 1973 and 1975 indicated that there was some transport of the exotic material to the south and that indigenous sand moved unto the mound resulting in admixtures, particularly on the flanks of the mound. Saumsiegle concluded that the principal mode of mixture was due to the movement of indigenous sediment into the mound zone. The grain size characteristics of the "indigenous" sediment reported by Saumsiegle correspond very closely with those measured from samples taken from the top one foot of the offshore cores. Saumsiegle's study demonstrates that the surface sediments in the area do respond to wave and current transport forces. However, the study does not provide the basis for predicting the magnitude of transport.

Table 1: Shoreline Position Changes

<table>
<tr><th></th><th>Shoreline length</th><th>1859–1905</th><th>1905–1925</th><th>1925–1939</th><th>1939–1968</th></tr>
<tr><td>Rudee Inlet to N. Sandbridge (Sheet 5)</td><td>4.44 miles</td><td>+1.6 ft/yr</td><td>-16.7 ft/yr</td><td>+1.5 ft/yr</td><td>ND</td></tr>
<tr><td>Outfall site</td><td></td><td>+3.2</td><td>-21.0</td><td>0.0</td><td>ND</td></tr>
<tr><td>N. Sandbridge to S. Sandbridge (Sheet 6)</td><td>6.07 miles</td><td>+0.1</td><td>-19.2</td><td colspan="2">-1.4 ft/yr</td></tr>
</table>

ND = no data

References Cited

U.S. Army Corps of Engineers, 1970, "Feasibility Report for Beach Erosion Control and Hurricane Protection, Virginia Beach, Virginia: Technical Report, Appendix 1, September, Norfolk District, Norfolk, Virginia.

Saumsiegle, William J., 1976, "Stability and Local Effects of an Offshore Sand Storage Mound, Dam Neck Disposal Site, Virginia Inner Continental Shelf", Unpublished M.S. Thesis, Old Dominion University, Norfolk, Virginia.

APPENDIX A

Report on Nearshore Surficial Sediment Characteristics and Bottom Depth Profile at the Atlantic Plant Outfall Transect, Dam Neck, Virginia, February 14-15, 1977.

Purpose of Sampling

The purpose of the work described in this appendix was to supplement information on surface and near surface sediments obtained by a series of vibracores along the proposed transect and to extend the water depth profile information closer to the shoreline.

Examination of the uppermost portions of the cores recovered by the vibrating method disclosed that sediments interpreted as a relict coastal lagoon sequence existed within inches of the top of the cores in many cases. The inference gained from the core evidence alone was that the surface "mobile layer" was very thin. However, since it is possible for the surface sediments to be displaced as the coring apparatus contacts the bottom or during removal of the core and liner at the surface, the decision was made to augment the vibracore information to obtain further information on the surficial sediments. The sampling was restricted to the zone within the first few hundred feet seaward of the breaker zone where we deemed that a mobile layer would be most pronounced (aside from the breaker and beach zone itself).

Horizontal Control

The position of the transect line and the location of four vibracores (BH 18, 19, 22, and 23) are shown on a 1:2400 scale horizontal control sheet constructed by Malcolm Pirnie Engineers, Inc. which accompanies this report. Three horizontal control points were established at the positions shown by ground survey methods. The two outer control points were selected to coincide with highly visible land objects, the third or central control point coincides with station 51 + 10.65 of the outfall transect. The central control point and a point approximately 250 feet landward along the transect were marked by signal banners so that a range visible from seaward was formed to establish the transect. Sampling positions along the transect were then determined by the three-point fix method using horizontal sextant angles plotted with a three-arm protractor aboard the RV CAPTAIN JOHN SMITH. Coring positions were marked with a surface buoy attached by line to a concrete weight placed on the bottom. These and other sample positions are shown on the accompanying control sheet.

Sampling Methods

Undisturbed bottom samples were collected by a diver using a "can core" device. The latter consists of a one-gallon rectangular can with the bottom cut away. The diver inserted the can into the bottom with the cap removed, then sealed the can by replacing the cap and digging from the sides to insert a small board beneath the core. The core container was then extracted from the bottom and carried to the surface where the diver's tender bound the container with large rubber bands before transfer to the deck of the RV CAPTAIN JOHN SMITH. The cores were held in a vertical position at all times.

Due to varying sea states and extremely low water temperatures, only three can cores were obtained by the diver. Disturbed samples or bottom grabs of the surficial sediment were also taken using a miniturized van Ween-type sampler. This sampler penetrates only about 1 inch below the bottom and collects several cubic inches of sediment. Following a preliminary description, the latter samples were placed in sample jars.

The three can cores obtained were allowed to stand for several days so that slow dewatering could take place before opening the cores in the laboratory. The opened cores were transferred to support frames in which the outer layers of sediment were trimmed away to permit an examination of internal structures. Color photographs of each of the finished cores were taken and are included with this report.

<u>Description of Samples</u>

<u>Core 1A (near BH 18)</u> - This core contains approximately 4½ inches of dark gray to light brown, fine to very fine sand (63-125

microns). The upper 1½ inches of the core consists of light brown sand containing numerous parallel laminations in the form of dark, very thin heavy mineral layers. The layered section lies unconformably above structureless mottled gray sand with inclusions of occasional pea-sized rock fragments (well-rounded) and shells. The latter include 1/2-3/4 inch unbroken pelecypod valves. The gray color of the sand in the lower section is due to a homogenous admixture of silt-sized and predominantly black heavy mineral grains; it is very similar in appearance to the top 8 inches of sediment recovered in BH 18 which likewise contained no structures. The upper surface of core 1A is covered by a thin yellowish-gray layer of fine silt broken by worm tracks. Otherwise the surface is smooth with no evidence of wave-induced bedforms. Much of the material in the silt cap is probably of organic origin; the diver reported that the water 3½ feet above the bottom was very turbid and contained an unusual amount of inch-long mucoid filaments floating in suspension.

Core 2A (near BH 19) - Nearly 6 inches of light brown fine sand (~125 microns) was recovered in core 2A; unfortunately a crater developed within the core during the initial dewatering stage which severely disrupted its internal structure. However, it is clear that the core originally possessed well-developed parallel laminations throughout most of its length in similar fashion to the top 1½ inches of core 1A. Numerous small broken shell fragments are also dispersed throughout the core. The sediment column in BH 19, on the other hand, contained only 4 inches of structureless fine sand lying above a 2-inch layer of gray clay grading into a layer of black peat.

Core 3A (inshore) - Core 3A consists of 4½ inches of brownish-gray fine sand (~125 microns). The entire length of the core contains a striking amount of very thin parallel laminations. There is a single cut and fill structure near the top of the core as evidenced by cross bedding cutting across some of the laminations. The core also contains a number of small broken shell fragments and a few pea-sized pieces of gravel such as the ¼-inch quartz pebble seen protruding at the extreme right side in the photograph. On the upper surface of the core are a series of low-amplitude ripples having a wave length of about ½ inch. These were the only bedforms visible in any of the cores although the diver reported seeing sand ripples on the bottom at all three sites. An extremely thin yellowish film covers the surface of core 3A.

Bottom Grab 4A (near BH 23) - A small sample of fine to very fine gray sand was recovered.

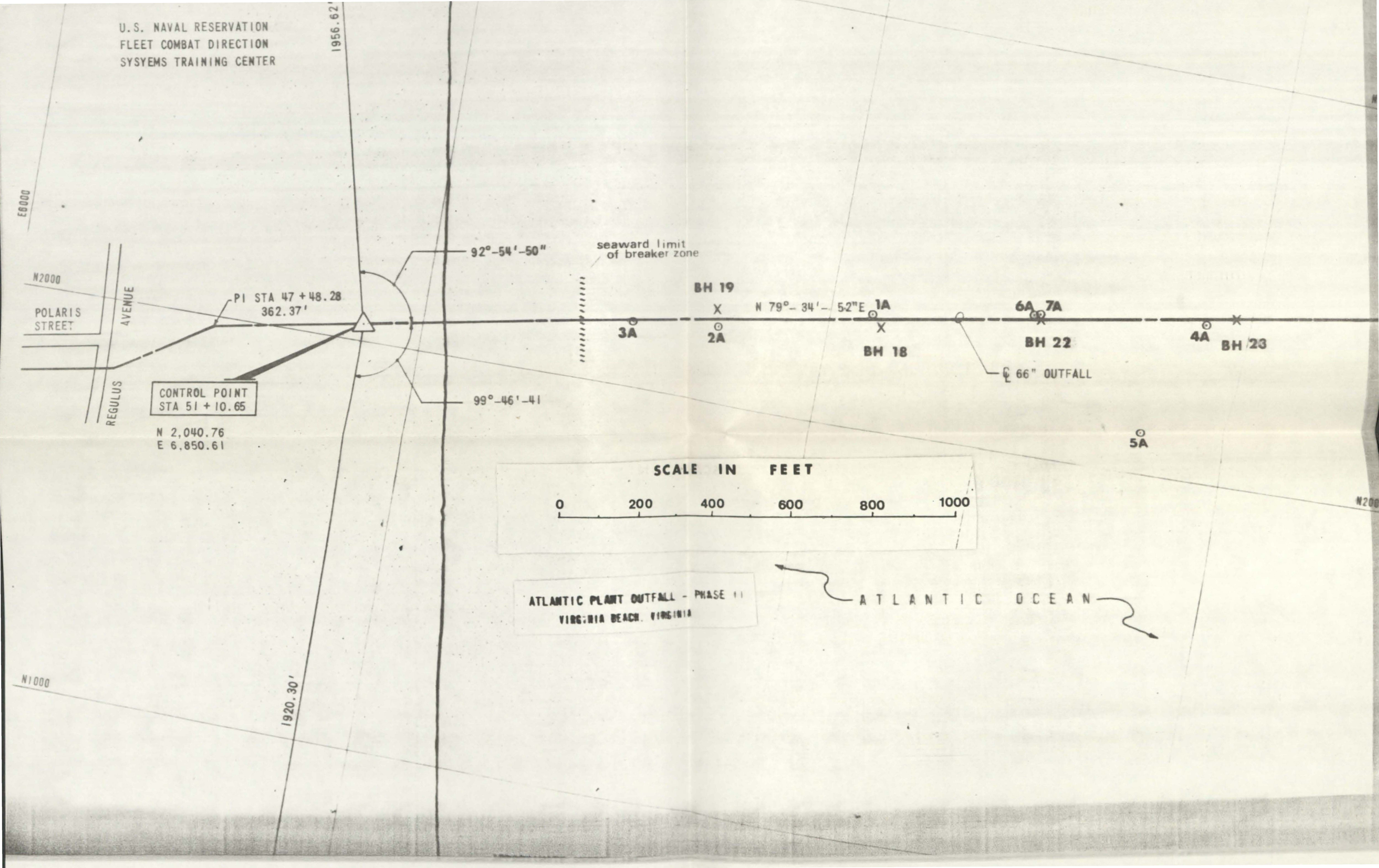
Bottom Grab 5A (off transect) - While drifting away from the transect line, several quick grabs were obtained with the sampler. One consisted almost entirely of soft, greenish-gray mud, a combination we did not find in any of the other surface samples As a note of possible interest, its position has been included on the control sheet.

Bottom Grab 6A (near BH 22) - This sample contained fine gray sand and silty mud. It appears that the silty mud was part of a thin layer on top of the sand. At the time this sample was taken and while approaching low tide, the surface water was highly turbid due to the presence of numerous mucoid filaments of the type described in the bottom layer above core 1A. These filaments appeared to contain a small but perhaps significant amount of silt in organically bound aggregates. The source of this floating material is unknown.

Bottom Grab 7A (near BH 22) - Essentially a repeat of sample 6A except that the sand contained no silt and tended to be brownish in color. The distribution of silty layers at the top of the sediment column thus appears to be patchy.

Depth Profile Along the Transect

Three separate fathometer runs were made along the outfall transect line using a Raytheon Model DE-719 precision fathometer system mounted in a 14-foot rubber boat. The depth of the transducer was set at 1.0 foot and the indicated depths were checked by lead line comparisons. Horizontal control was achieved by



U.S. NAVAL RESERVATION
FLEET COMBAT DIRECTION
SYSYEMS TRAINING CENTER
1956.62'
E6000
N2000
POLARIS STREET
AVENUE
REGULUS
PI STA 47 + 48.28
362.37'
92°-54'-50"
99°-46'-41
CONTROL POINT
STA 51 + 10.65
N 2,040.76
E 6,850.61
seaward limit
of breaker zone
BH 19
N 79°- 34'- 52"E
1A
3A
2A
BH 18
6A
7A
BH 22
4A
BH 23
℄ 66" OUTFALL
5A
SCALE IN FEET
0
200
400
600
800
1000
ATLANTIC PLANT OUTFALL - PHASE II
VIRGINIA BEACH, VIRGINIA
ATLANTIC OCEAN
N1000
1920.30'

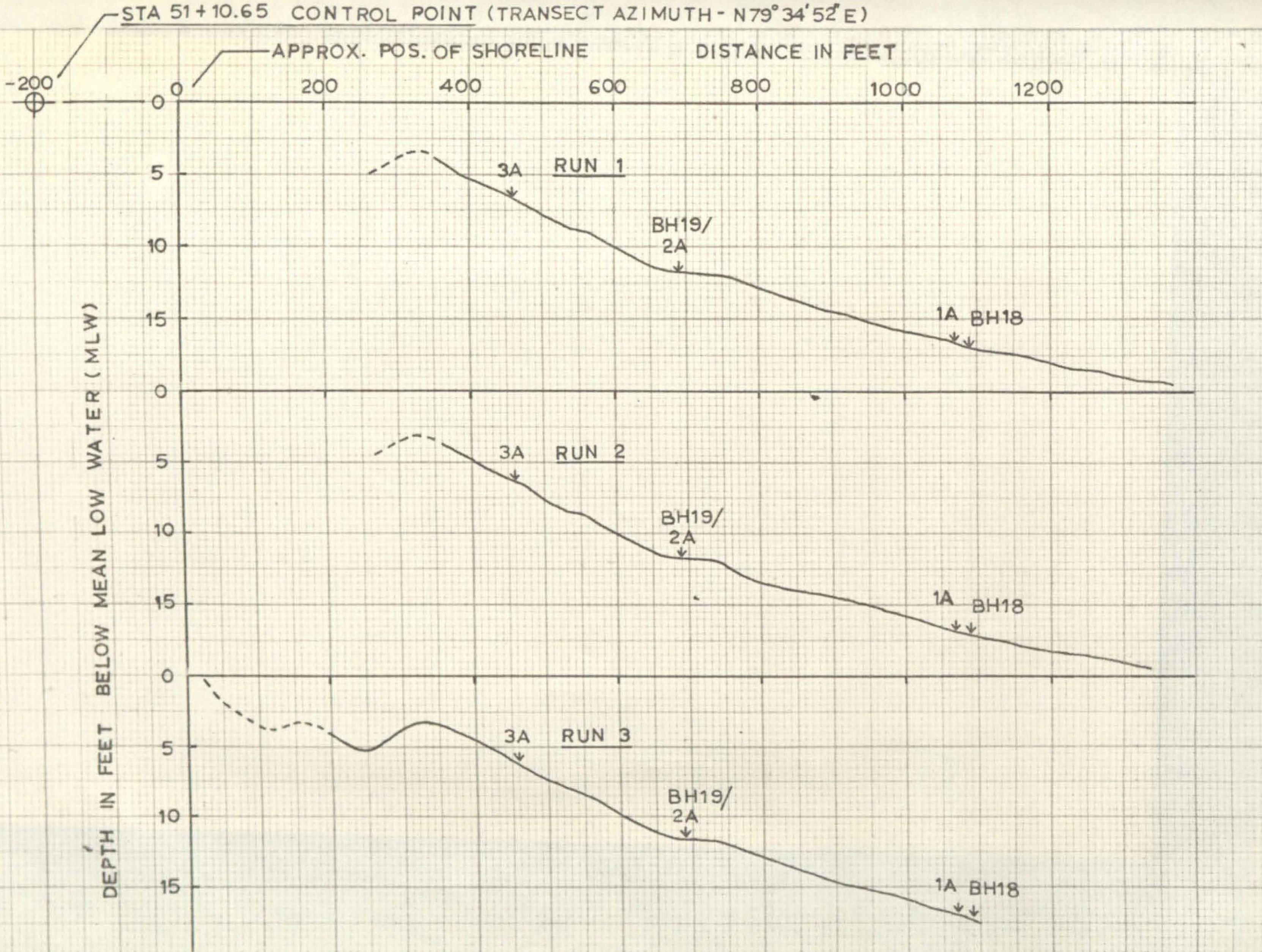
sextant angles taken at the beginning and end of each fathometer run over a distance of approximately 1000 feet on range with the transect line.

The enclosed graph shows the bottom profiles plotted from the fathograms after applying a depth correction based on the predicted tide level at Virginia Beach during the runs. Each profile consists of a smooth curve drawn through plotted points transferred from the fathogram using a set of ten-point proportional dividers between the beginning and ending fix marks. The boat was run at a constant power setting along the sounding line so that the assumption of equal distances over equal time intervals should be valid between fixes.

Although the sea state was not high, swells generated frequent spilling waves over the longshore bar system making this area difficult to pass over while maintaining continuity of soundings. Nevertheless, run 3 contained sufficient information to delineate both the outer bar and the trough inside this bar. The inferred position of the second bar and trough was made after observing a crew member who waded ashore at the conclusion of run 3.

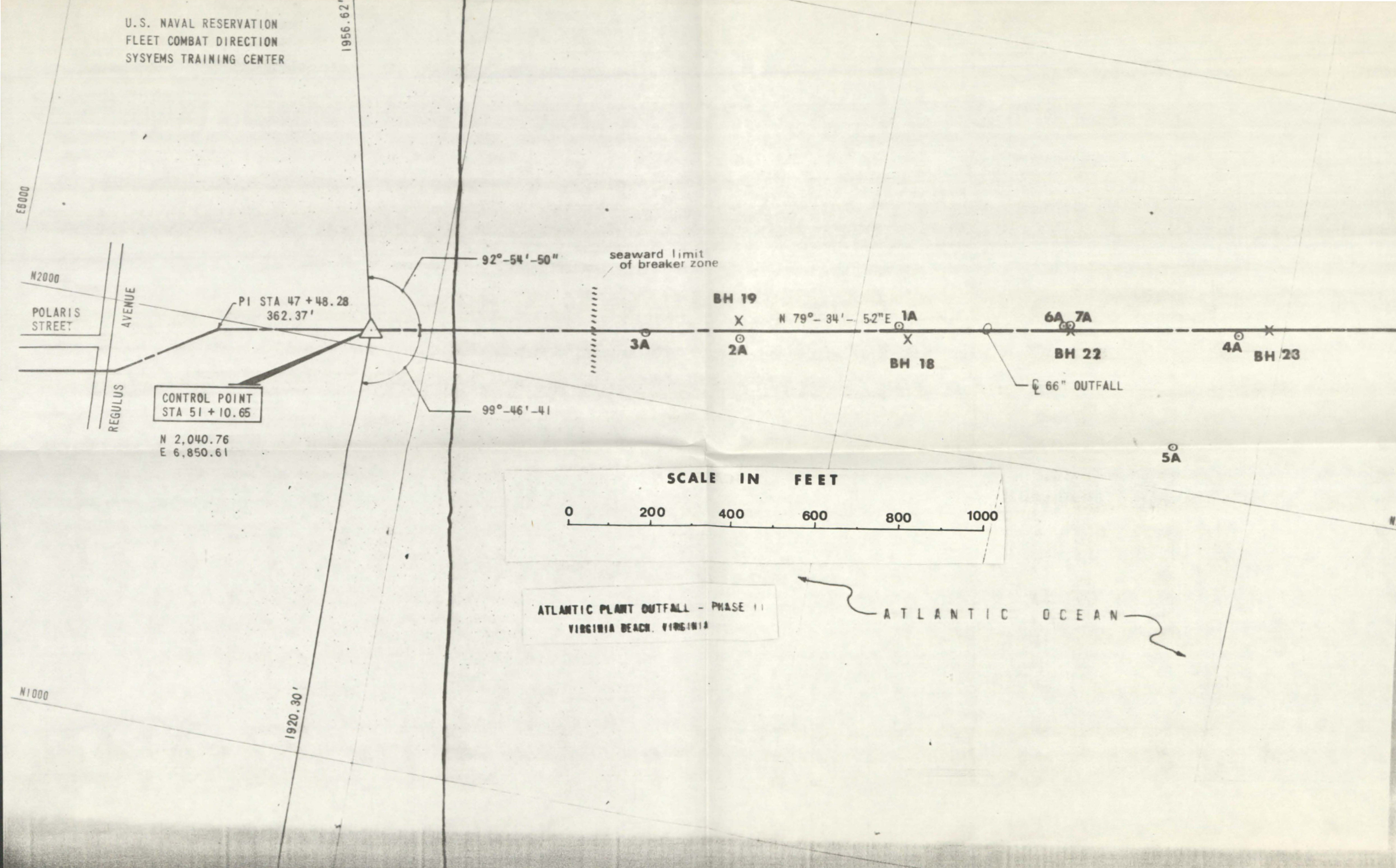
The agreement between the three profiles indicates that a fairly high level of precision was achieved in the three runs . It is interesting to note that each profile is slightly flattened at the position of core 2A and BH19. A thick layer of peat found beneath several inches of sand in BH19 suggests that the flattening may be associated with an outcrop of the peat offering slightly increased resistance to erosion in comparison to other bottom sediments (muds, fine sand and shell layers) lying below the peat.

Viewing the crest of the outer bar in relation to the present shoreline position, it has been noted in surveys conducted by Ocean Systems, Inc., in July of 1976 that the outer bar lay nearly 100 feet closer to shore at that time. This amount of change would not be unusual in many areas due to seasonal migrations in which longshore bar systems move closer inshore with the onset of summer wave conditions and retreat farther seaward during winter when a different wave regime induced by local coastal storms is extant. The beach face itself often mirrors this change by developing a steeper foreshore slope in summer, then changing to a flatter profile as sand moves seaward during winter.



FATHOMETER DEPTH PROFILES, RUNS 1-3, ATLANTIC PLANT OUTFALL TRANSECT

VIMS, FEB. 15, 1977 (ARROWS INDICATE POSITIONS OF CORE SAMPLES)



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1A
BH 18
6A
7A
BH 22
4A
BH 23
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5A
SCALE IN FEET
0
200
400
600
800
1000
N1000
1920.30'
N200
ATLANTIC PLANT OUTFALL - PHASE II
VIRGINIA BEACH, VIRGINIA
ATLANTIC OCEAN