ASSESSMENT OF THE ENVIRONMENTAL IMPACTS OF CONSTRUCTION AND OPERATION OF THE HART AND MILLER ISLANDS CONTAINMENT FACILITY

Third Annual Interpretive Report
August 1983 - August 1984

October, 1985

Submitted to

Maryland Water Resources Administration

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PREFACE

This report represents the results of the third year environmental monitoring of the Hart & Miller Islands containment facility. This project reflects the state of Maryland's monitoring activities related to determination of possible negative impacts from the operation of the facility. The results reported in this document reflect the state's approach for conducting interdisciplinary monitoring. This data will be available for future comparisons of the habitat quality in the vicinity of the dike. To date no significant detrimental impacts have been observed based upon the observations described within this report. This report is submitted to Maryland Port Administration for partial fulfillment of MPA contract number 384001.

Jim Peck, Director
Maryland Water Resources Administration

Charles Bostater
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INTRODUCTION

This report reflects the results of environmental monitoring of the Hart and Miller Islands Diked Dredge Spoil containment facility conducted from September 1, 1983 through June, 1984. This report includes final reports of third year monitoring efforts by each of the the principal investigators.

The purpose of this monitoring program is to collect data necessary for determining any negative impacts upon the habitat quality surrounding the diked facility. To achieve the above purpose several projects were funded and the results discussed. The background, goals and objectives for each project are listed below.

DESCRIPTION OF THE CONTAINMENT FACILITY

The State of Maryland has contracted to construct, in 1981 - 1983, a diked area at Hart and Miller Islands to receive bottom sediments dredged from Baltimore Harbor and its approaches. The facility is designed to receive 53 million cubic yards of material, most of which will be produced in deepening channels to 50 feet, and its long-term use will be as a permanent wildlife and recreation area.

This will be an 1,100 acre enclosure behind a dike 18 feet above mean low water constructed from sand deposits within and underlying the enclosure site. Typical side slopes will be 3:1 (three horizontal to one vertical) on the exposed outside face, 5:1 on the inside and 10:1 on the Back River side. The Bayside face will be riprapped with stone over filter cloth. The completed dike will be about 29,000 feet long and contain 5,800,000 cubic yards of stone.

The site is of environmental and economic significance to the State of Maryland and the Chesapeake Bay region. The State has therefore determined, as prescribed in authorizing permits for the facility, that there is need for "a comprehensive environmental monitoring program for the Hart and Miller Islands containment facility prior, during and following commencement of operations," and assigned the responsibility for the development and coordination of the monitoring with the Water Resources Administration.[1] Subsequent discussion

[1]Memorandum of Understanding on Dredging and Spoil Disposal and the Hart and Miller Islands Containment Facility between the Departments of Transportation, Natural Resources, and Health and Mental Hygiene, May 7, 1979. Approved by the Board of Public Works, June 6, 1979.

led to the division of the monitoring program into two complementary portions - (a) monitoring related to assurance of compliance with state and federal laws, regulations and permit requirements (compliance monitoring is being conducted by the Office of Environmental Programs (OEP) of Maryland Department of Health and Mental Hygiene and the Water Resources Administration (WRA) of the Department of Natural Resources); and (b) studies to determine the environmental impacts of construction and operation - the subject of this report.

Effective liaison and coordination is maintained with all agencies having roles in site management, operations, monitoring, sampling and oversight programs related to the Hart and Miller Islands Facility.

To provide continuing and needed assessment of the environmental effects of this facility, studies were conducted by institutions with expertise in research on the components, processes and environmental resources of the region, and interpretation of the environmental impacts with recommendations for further observations. The overall goals of the monitoring program are listed below:

GOALS

(A) To provide coordination, integration and timely reporting of investigations related to the determination and evaluation of environmental impacts resulting from construction and operation of the Hart and Miller Islands facility.

(B) To provide notification to the sponsor (Maryland Port Administration) of any observed undesired or suspected effects and respond to such other environmental problems relating to facility operations and observed impacts as may be mutually agreed.

(C) To add to existing background data concerning conditions and detect and evaluate any significant short-term and long-term effects of the facility through a specially designed and coordinated set of physical, chemical and biological studies of local water, sediments and biotic populations.

(D) To provide annual interpretive report on accumulated knowledge of the environmental effects and recommendations for future monitoring.

OBJECTIVES

Four projects were implemented to achieve the above goals. The title and objective of each project are listed below:

PROJECT I : COORDINATION AND DATA MANAGEMENT - OBJECTIVES

1. To arrange competent design, conduct, coordination and timely reporting of specific studies required to assess the environmental effects of the facility.

PROJECT III : FISH POPULATIONS - OBJECTIVES

1. To survey the species, abundance and distribution of crabs and fish in the vicinity of Hart and Miller Islands following construction and during operation of the diked containment facility.

2. To determine the effects of the facility on these components of the biota.

3. To provide samples of selected species for chemical analysis.

PROJECT IV : SEDIMENTARY ENVIRONMENT - OBJECTIVES

1. To identify the sedimentological, geochemical and biological conditions of the near-surface sedimentary column in the project area;

2. To provide information to assess gross environmental changes that may occur during the project life.

ANALYTICAL SERVICES

A fifth project, Analytical Services, was proposed but not implemented for the fourth year of monitoring. Laboratories operated by the Environmental Protection Agency and Maryland State agencies were unable to commit the necessary facilities and manpower to perform the proposed comprehensive analyses of trace organic and inorganic substances in water, sediments and aquatic organisms in the vicinity of the containment facility.

An attempt to award a contract for this work through the competitive bidding process was made, but contract negotiations involving many technical details of analysis and reimbursement were so lengthy that sample integrity was compromised by long storage. The decision was made, finally, to cancel most of the analyses, rather than accept questionable data for so critical a monitoring program. Arrangements have now been concluded so that timely and accurate analyses of trace contaminants can be made during subsequent years.

HISTORY OF THE MONITORING PROGRAM

Year 1 Monitoring Program (August 1981 - August 1982)

The Chesapeake Research Consortium provided coordinating services for the first year of investigations. The assessment program had two primary purposes:

1. To provide reliable background of environmental information through summary of available pre-construction information on the aquatic environment around the islands.

2. To establish baseline conditions and detect and evaluate any significant short and long term efforts on the aquatic environment and resources.

* Tidal exchange through Pleasure Island Channel after recent dredging to a nominal depth of 8 feet is about the same as the exchange between Hawk Cove and the Chesapeake Bay. Wind substantially affects both.

* Properly designed dye studies, in combination with continuation of two long-term current meters, can be of exceptional value in examination of future water movement from dike spillways and in other long-term analyses.

The long-term current meter measurements show that, although the wind and high Susquehanna River flows can dominate the circulation in the Hart and Miller Island region over one-month time scales, the countercurrent or eddy revealed by the October 1981 intense spatial array of instruments is, in the mean, a steady and stable feature of the circulation pattern near the islands.

Both the spatial arrays and the long-term moorings provide evidence that the containment dike does not significantly alter the flows in the region. Clearly, the dike will produce locally increased currents within a scale of 100m from the islands, but these flows are not sufficient to generate significant scour or to affect the far-field.

Pleasure Island Channel provides a greater potential for exchange between the Back River - Hawk Cove waters and the Bay proper than had been expected at the outset of the experiments. The amount of exchange could be controlled by controlloing the depth of the dredged navigation channel. The closing of the opening between Hart and Miller Islands will not, however, produce a significant alteration in the exchange of Hawk Cove with the Bay proper.

Water Column Nutrients and Productivity--

This study describes light extinction, nutrient characteristics and primary production rates in the vicinity of Hart and Miller Islands.

* Intensive sampling provided data on light extinction, nutrients and the rates of primary production near the facility with good statistical characterization.

* The observed components vary widely over the annual cycle and between years.

* These components were normal for low salinity areas affected by river flow.

* The effects of construction activities were pronounced in June and September 1982 when the total suspended material in the water (seston) was consistently higher near dredging and plant pigments (chlorophyll a) were somewhat lower.

* No other detectable and consistent differences were observed between near-dike stations and the more distant reference area.

* There was no consistent pattern of surface to bottom differences in this shallow region which is affected by wind and tides and usually unstratified.

* Two years of study has provided a useful basis for future comparison.

Sedimentary Environment--

These study objectives are twofold.

To identify the sedimentological, geochemical and biological conditions of the near-surface sedimentary column in the proposed project area; and

To provide information to assess gross environmental changes that may occur during the project life.

* Detailed description has documented particle size, water content and sedimentary structure of surface samples and cores around the facility over the two year period.

* The biological content and metals content of selected samples were determined.

* In early summer of 1982, new deposits of light gray fluid mud were seen at several stations near the dike structure on the Bay side.

* More intensive sampling in November of 1982 disclosed that the fluid mud extended 525 yards to the east and 1,090 yards to the south of the dike and ranged in thickness from 3.9 -15 inches. Approximately 641,000 cubic yards had been desposited between March and November.

* The fluid mud was very probably from dike construction, and apparently resulted from comparatively fast deposition.

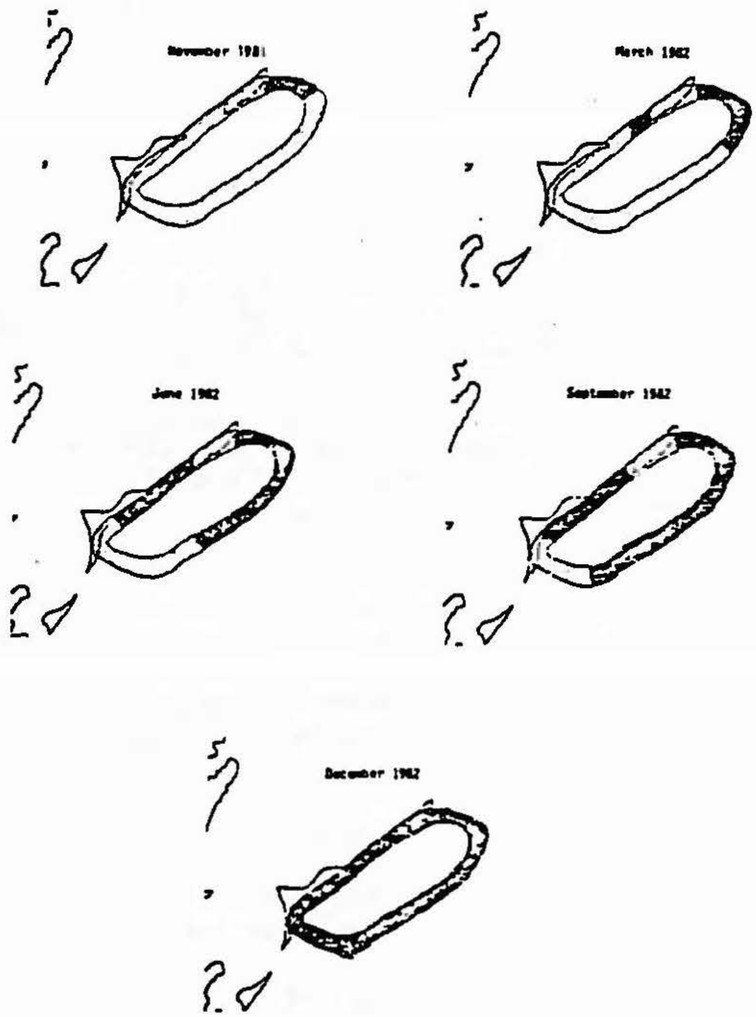
* The new mud changed little through May 1983 and contained very few indications that the area was recolonized by animals, and those were in the surface sediments.

* Extensive data on the sediments, associated living organisms and chemical content are now available for future comparisons.

Deposition of Fluid Mud--

Maryland Geological Survey indicated there were two periods when material from dike construction was misplaced. The first spill occurred June 7, 1982 and the second took place September 15, 1982, both along the Bay side of the

Extent of Completion of the dike on the sampling dates shown.



* Most of the invading animals were juveniles, and the total biomass may lag behind other areas for about two years.

* Detailed descriptions and analyses are now available for comparison in future years and after any significant change.

Fish and Crabs

Objectives of this study were to describe the communities and populations of fish and crabs in the vicinity of the islands and to assess the impact of construction of the containment facility on these populations.

* Quarterly collections at six inshore stations yielded 25 species, and 20 species were caught at ten offshore sites. Many were common to both areas.

* At inshore stations, the community was dominated by silversides and anchovies, with the largest number of fish and greatest variety in May and the smallest in February.

* Crabs reached highest abundance in August.

* Both fish and crabs were much less abundant in August 1982-May 1983 than during the same period in 1981-82.

* No effects from the construction of the containment facility were detected.

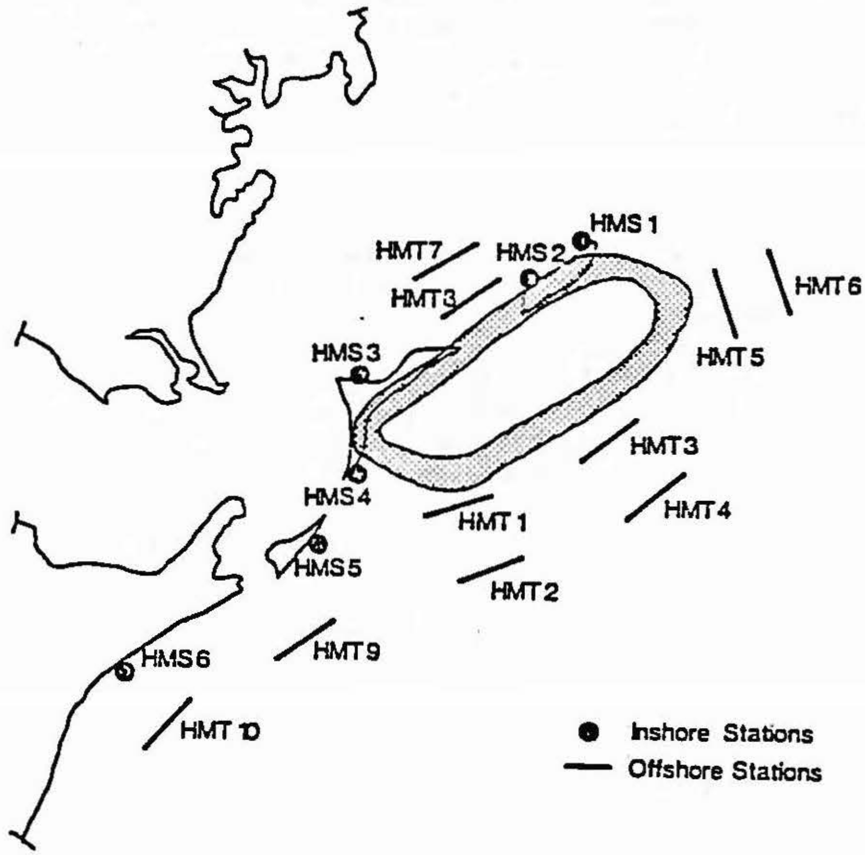
* Extensive data on the quantity and composition of the catch over the two-year period provides detailed description for this period and a basis for future comparisons.

Submerged Aquatic Vegetation

Recent scientific literature emphasizes the importance of submerged vegetation communities in estuarine systems. Low level aerial surveillance was utilized to search for submerged aquatic vegetation in the vicinity of Hart and Miller Islands during the period August 1981-August 1983. No submerged vegetation were observed during the pre-construction period. The absence of submerged vegetation in the vicinity is consistent with the decade-long general decline of submerged aquatic vegetation in the upper Chesapeake Bay.

* Photographic aerial surveillance and the benthic sampling program did not detect any submerged aquatic plants during this period.

* Plants might have been present early in the season and disappeared before the summer surveys.



Locations of fish and macro-epibenthos sampling stations.

* Highly useful reference data are now available for the two-year period and the requirements of an effective and efficient annual monitoring program are established.

In order to investigate the variability in trace metal concentrations found in these species, a number of animal collections were made which comprised several individuals (20-30) from the same site. Individuals from these collections were analyzed, the results computed as a cumulative mean and this was expressed in terms of its percentage deviation from the collection mean. This procedure was adopted to determine the minimum number of specimens required to reach a representative mean concentration for any one metal and for any one species. In most cases it was determined that a sample number of between fifteen and twenty individuals provided a metal concentration having a likely error of less than 10%. An examination of seasonal data showed marked variation of metal concentration in the same species at different times of the year.

It seems likely that trace metals in Macoma may better reflect levels in the physical environment. However, any future monitoring effort must be better focused in this regard. For example, it would be more meaningful if Macoma collections and analyses were made concomitantly with sediment collection and analysis.

Many of the conclusions reached at the end of the first year remain largely unchanged. Problems arising from the effect of extraneous variables such as salinity will be resolved with a greater monitoring effort on the Chesapeake system in general. Meaningful results from a focused monitoring program such as this can only really be gained from a long-term program.

Organic Contaminants--

The sampling of water, sediment and biota in the Hart-Miller Island area was performed on seven dates: August 23-25, 1982, September 8-9, 1982, November 15-17, 1982, February 21-23, 1983, May 16-18, 1983, June 21-22, 1983 and July 14-15, 1983. The sampling design was established to obtain information on several critical questions which need to be assessed in order to accurately identify changes occurring as the result of construction and operation of the Hart-Miller dredge disposal containment facility. These questions were:

1. What are the levels of organic contaminants, likely to be found in the dredge spoils, currently found in the water, sediments and biota in the Hart-Miller Islands area during the construction phase?

2. What is the variability of observed levels of these contaminants in various media sampled?

3. What are the best indicator organisms to monitor changes in contaminant levels in the region?

List of 44 compounds analyzed.

Compound
alpha-BHC
lindane
beta-BHC
aldrin
heptachlor
heptachlor epoxide
dieldrin
naphthalene
fluorene
phenanthrene
anthracene
fluoranthene
pyrene
benzo(a)pyrene
benzo(a)anthracene
benzo(k)fluoranthrene
3,4 benzofluoranthene
chrysene
acenaphthylene
benzo(ghi)perylene
dibenz(a,h)anthracene
indeno(1,2,3-cd)pyrene
acenaphthene
PCBs, total
kepone
dimethyl phthalate
diethyl phthalate
dibutyl phthalate
di-2-ethyl hexyl phthalate
di octyl phthalate
atrazine
simazine
trifluraline
chlordane
diazinon
DDE
DDD
DDT
linuron
butyl benzyl phthalate
endrin
malathion
methyl parathion
ethyl parathion

Sedimentary Environment--

Coastal and Estuarine personnel within the Maryland Geological Survey are conducting three investigations: a high resolution bathymetric survey; sediments survey; and a beach and dune erosion study. The first two surveys continue investigations based on information and utilizing designs of the prior two years of monitoring. As in other investigations conducted during the third year, the same general array of sampling stations is maintained; however, the number of sampling periods is reduced from 4 to 2. The beach and dune erosion study is to evaluate the stability and forces acting upon the public beach created between Hart and Miller Islands. Definition of the beach erosion problems and remedial actions are to be planned.

Biota - (Bottom Organism Studies)--

University of Maryland Center for Environmental and Estuarine Studies personnel continue their studies of near field infaunal and epifaunal bottom dwelling communities. Continuity with the previous 2 years of benthic monitoring is maintained; however, sampling locations are shifted to concentrate on potential operational impacts at the unloading piers and primary sluice gate.

Biota - (Fish and Crab Studies)--

Tidal Fisheries personnel within the Maryland Tidewater Administration are assessing any changes in fish populations. New sampling techniques are being used to augment those methods previously used for fish studies at the site. Otter trawls, beach seine, anchored gill nets, eel pots and fish traps are enabling refinement of fisheries population information to determine any increased habitat diversity around the diked facility.

Trace Metals and Organic Contaminants--

EPA assisted investigations are configured on the background information obtained during the previous two years of study. The sampling locations, parameters and analysis methods are revised to provide information appropriate to operations and potential discharge locations at the facility. Approximately 20 trace metals in water, sediments and select organisms and an array of organic contaminants in sediments and organisms are being analyzed.

PROJECT I

SCIENTIFIC COORDINATION AND DATA MANAGEMENT

by

Charles Bostater, Cynthia Stenger, Peter Lidiak, Stephen J. Jordan

ABSTRACT

All data collected under this year's project are stored in the Resource Monitoring Data Storage System for archiving and future interpretive analysis. Appendix A of this report shows all data collected under this year's monitoring by principal investigators. Scientific coordination for this project continued to provide oversight of study design and report preparation, including internal and external peer review. A brief synopsis of monitoring results is provided.

METHODS

Data Management

All data is stored in the Resource Monitoring Data Storage System. Standard format data sheets were completed by the individual investigators and sent to the Tidewater Administration for data entry, verification and storage. All data submitted have been stored; Appendix A is a printout of the data sets as stored.

Scientific Coordination

All projects and associated surveys were conducted as scheduled, except for the analytical services project. Substantial staff time was committed to developing a request for proposals for the analytical services of this monitoring project. This was necessary since the U.S. EPA, Central Regional Laboratory was not able to perform the number of analyses originally scheduled.

A Request for Proposals was produced and a laboratory audit evaluation process was developed to assess potential laboratories. Unfortunately, contract negotiations were so lengthy that sample shelf life was exceeded. Therefore, a decision was made to cancel this project for the monitoring year, and to establish a reliable, long-term source of analytical services for future years. This has been accomplished through the combined resources of the U. S. EPA, Maryland Water Resources Administration, and Maryland Geological Survey.

contents of sediments. A discussion of zinc enrichment factors demonstrates how the origin of sediments can be assessed, and how contaminant concentrations and correlations can be used as signatures of sediment sources.

A beach erosion study documents changes in elevation profiles of the recreational beach constructed on the western side of the facility. Two separate erosional processes (runoff and wave/tidal) were identified and recommendations made for the amelioration of each. A supplement to this report details measurements of bathymetric changes in the Hart and Miller Islands vicinity. The only observed significant changes since 1981 were associated with local dredging, although the sensitivity of the survey was rather low ($\pm$30 cm).

Finally, appended to the interpretive report is a data report showing the actual data submitted by investigators for the monitoring year in Resource Monitoring Data Storage System formats. Data entry, verification, and applications programming were performed by the Monitoring and Data Management Section, Maryland Department of Natural Resources, as a part of the Scientific Coordination and Data Management Project. Permanent storage of the data in readily accessible form provides a continuous, documented record of baselines and trends in biota, sediments, and contaminant levels. In future reports, year-to-year comparisons will form the basis for assessment of changes, either positive or negative, associated with the containment facility and its operation.

Recommendations were for continued monitoring of the benthic fauna at the reference stations; concentrated nearfield studies at the rehandling pier and sluice gate; and a more detailed study of the riprap epifaunal populations by sampling at various depths, and taking replicate samples at each station.

METHODS

The sampling station locations for this year's study were arranged as illustrated in Figure 2. Four of the station locations were retained from the previous year's study to serve as reference sites. They were HM16, a soft-bottom station located about 1.9 km southeast of the containment island; HM9, located on oyster shell bottom about 360 m northeast of the island; HM22, a soft-bottom station located about 3.7 km north of the island; and HM26 at the mouth of Back River (to serve as an indicator of any influences to the fauna from this tributary). It was believed that these locations and distances from the containment island were sufficient to be outside any operational influences of the facility. Nearfield infaunal stations were located about 90 m from the dike along the side of greatest activity, the rehandling piers. Also, this was the area of a fluid mud spill during dike construction in July 1982, and these stations serve to monitor repopulation in this area. Four epifaunal stations were located in the stone riprap in the areas of the rehandling piers. One depth, the shallow subtidal zone, was sampled at each of these stations.

Samples at all locations were taken September 27 and 28, 1983, and March 19 and 20, 1984. With the exception of the riprap stations triplicate samples were taken by means of a .1m^2 van Veen benthic grab. Each sample was washed separately on a 1mm screen, and the contents preserved in formalin. On the stone riprap a sample approximately 10cm^2 was scraped from a flat stone surface and preserved for later analysis. The number of each species was counted and recorded separately for each replicate grab. An estimate of abundance was made for the colonial epifaunal species.

Water temperatures and salinities were taken by means of an induction salinometer near the bottom of the water column at selected stations. Depths were recorded from a recording fathometer and stations were located by means of radar and Loran C.

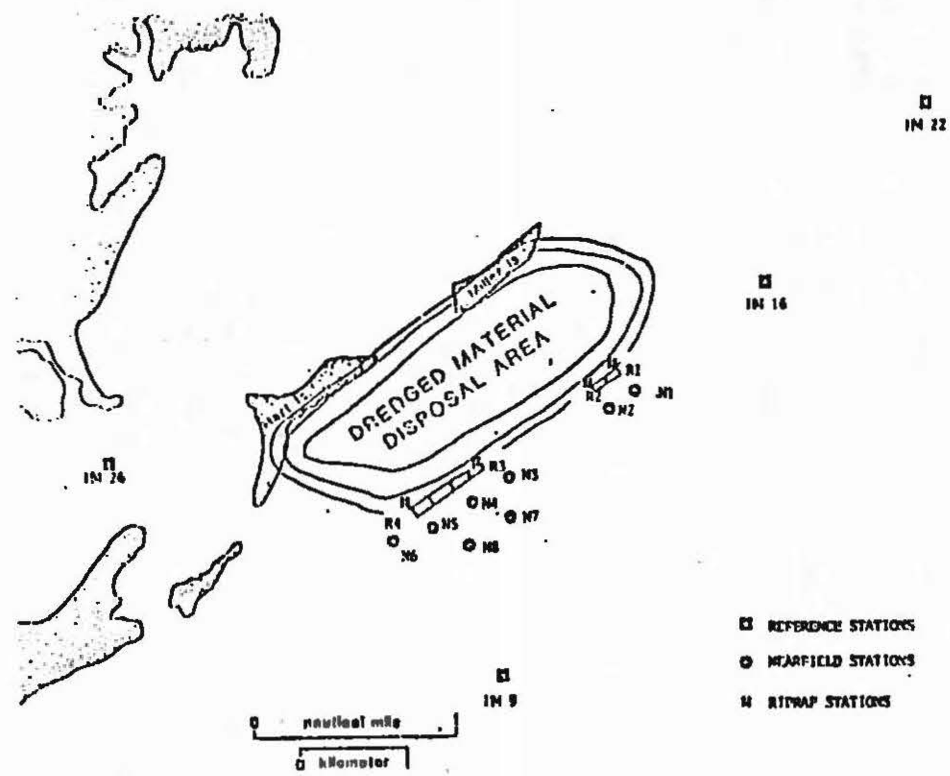


Figure 2. Approximate benthic sampling locations.

where concentrated boat and barge activity stirred the bottom. Because of this shallowness, dredging was performed after September 1983 to facilitate boat operation. In March 1984 the water depth at N5 was 6.3 m as opposed to 4.2 m during the previous sampling period in September. While the bottom at N6 was not dredged, it was influenced enough by the dredging activity to cause major faunal adjustments. An examination of the samples also revealed a reduction in numbers of most species with the exception of Leptochierus, which increased markedly at (N5) and also at neighboring station N6. As was expected Rangia and other sedentary forms were removed with the dredged sediments while motile species such as Leptochierus and the annelid Scolecolepides increased in numbers. The newly exposed sediments or the depression caused by dredging appeared to attract these motile species.

INFAUNAL REFERENCE STATIONS

Three stations were retained from past studies as typically soft-bottom communities whose fauna could serve as reference for the 8 nearfield stations as well as checks for effects from extraneous sources. They were located at the mouth of Back River (HM26), at Spry Island about 3.7 km NE of the containment island (HM22), and about 1.9 km SE of the facility (HM16).

At these stations, located an adequate distance from the influences of the containment facility, the fauna exhibited trends of a natural transition from a higher to a lower saline environment. The number of species remained about the same or increased slightly while the complete dominance of a single species became reduced in density. Low salinity species such as the mollusks Congeria and Rangia, increased in number while the amphipods Leptochierus and Melita decreased. A similar trend was shown in the data presented by Allison and Butler (1981) for the years 1972 to 1978. For the years immediately following Agnes in 1972, Rangia increased dramatically while Leptochierus was scarce. After 1976 Rangia decreased sharply and Leptochierus increased. The annelid Scolecolepides appeared to parallel the abundance of Leptochierus also for the years 1972 to 1978. Other less abundant species were affected by these changes in salinity; however, their trend was difficult to establish because of the wide sample variability.

Between September 1983 and March 1984 Rangia had at least a 50% mortality. This mortality was probably greater since many other clams were dead but had not gaped because of the cold water temperatures in March. It is estimated the actual mortality was closer to 75%. The annelid Scolecolepides increased more than any other species during this same period with the exception of the minor amphipod species Monoculodes which increased from 0 to 9 individuals.

All of these changes in species abundance were natural for an area located in the upper reaches of an estuary. Reductions from a saline to fresh water environment can occur suddenly (Fig. 1) at the expense of many species and benefit of others. Even at constant salinity species and numbers constantly are changing. Predation, competition, food availability, temporary ice formation, and aging are a few of the factors besides salinity that contribute to species variability.

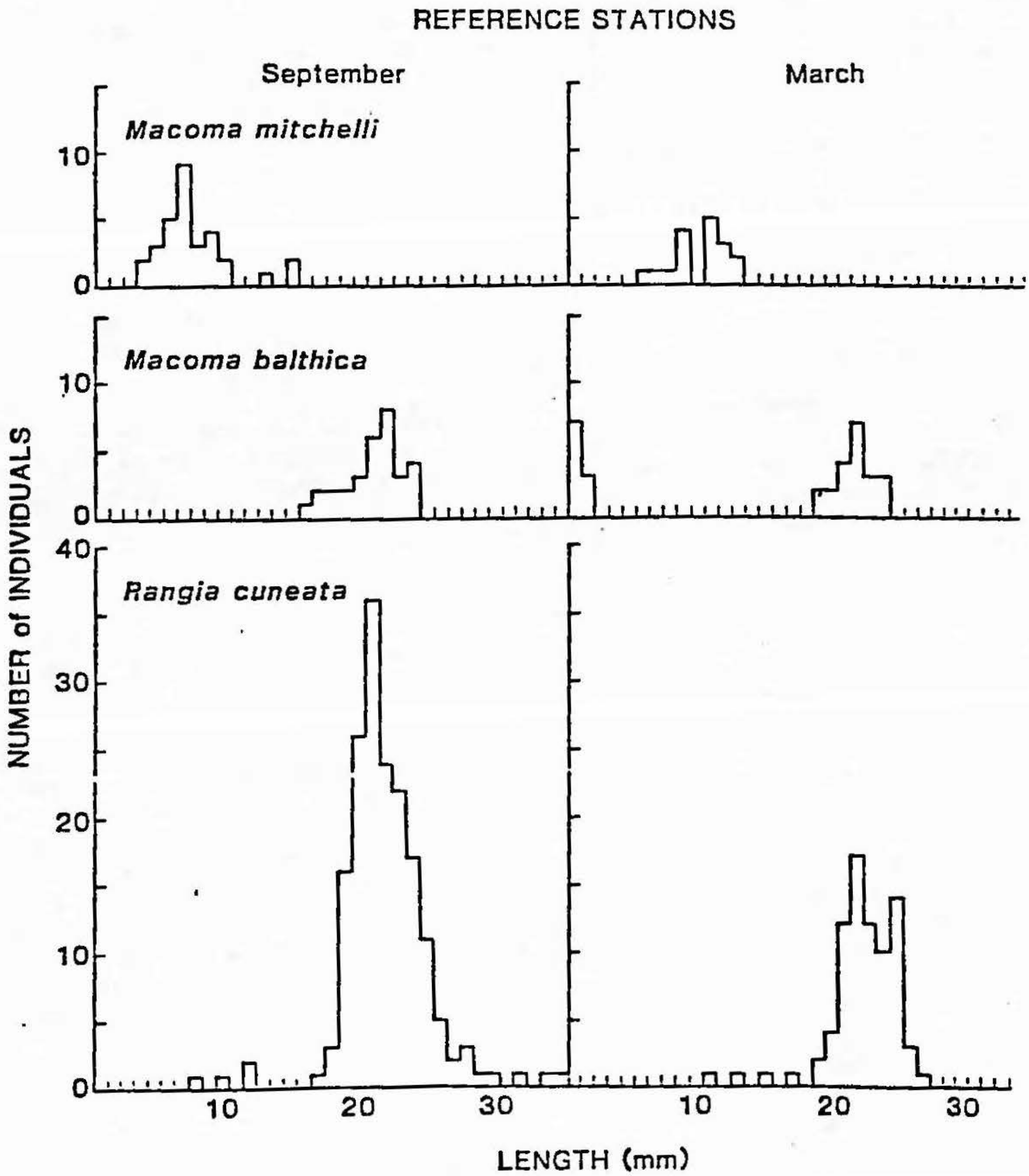


Figure 4. Length frequency diagrams of the three major species at the reference stations.

The area between shells and around their bases provides a place for finer silts and clays to collect. Therefore, a benthic sample collected on the oyster bar should also contain species from the soft-bottom community which live in the sediment-trap areas. More than half of the animals found at station HM9 were common in the soft-bottom stations. Only seven species collected were inhabitants which depended upon or preferred oyster shells. This is typical of an oyster shell community from a low and variable salinity. Four of these species require hard surfaces for attachment. They are the two species of barnacles, Balanus, the false mussel Congeria, and the mussel Ischadium. The isopod Cassidinidea clings to the shell surface and the worm Nereis and the crab Rithropanopeus live among the shell crevices.

The most abundant species were the barnacles, B. improvisus, and B. subalbidus. In September 1983 B. improvisus was about eight times more abundant than B. subalbidus. By March 1984 it was only about three times more abundant. This was probably a reflection of lower than normal salinity between these sampling periods. Other reports have shown that B. subalbidus can withstand low salinities, less than 1 o/oo, or even short periods of fresh water while B. improvisus is not as tolerant of low salinities (Poirrier and Partridge, 1979; Kennedy and DiCosimo, 1983). Congeria, which attaches itself to hard surfaces such as oyster shells, increased since August 1982 but decreased between the two present sampling periods. The remaining epifaunal species, the worm Nereis, the mussel Ischadium, the isopod Cassidinidea, and the crab Rithropanopeus, were much less abundant in March 1984.

IMPORTANT DOMINANT SPECIES (Table 1)

Cyathura polita

This crab-like animal, which spends its entire life on the bottom, reaches a maximum length of about 25 mm. In late summer the most recent cohort dominates the population in the area with a mean length of about 9.5 mm. Because it is tolerant of wide salinity changes, and even fresh water for several hours, it maintains a relatively even population density (Table 1).It is reported that this species lives in unlined tubes which it builds in the sediment but frequently can be commonly distributed by passive means (Burbanck 1961). It has been seen in this and past studies that large specimens rapidly inhabit recently deposited spoil areas in the upper Chesapeake. A local reduction in numbers was found at the nearfield Station 5 in March presumably because of dredging. Comparatively, the numbers at all other nearfield locations remained about the same as at the reference stations. This is considered an important species in this area because of its relatively constant numbers and its importance as food for fish, crabs, and probably waterfowl.

Scolecolepides viridis

On soft-bottom substrates this small worm is the most abundant annelid in this area of the bay. Its numbers are seasonally variable presumably because of its sensitivity to salinity changes and its availability to predation. It

TABLE 1. DOMINANT SPECIES AND MEAN NUMBER PER STATION

September 1983	March 1984
Nearfield (.3m^2)	
1. Rangia (170)	1. Scolecolepides (96)
2. Cyathura (38)	2. Rangia (78)
3. Lepthochierus (44)	3. Leptochierus (85)
Reference (.3m^2)	
1. Leptochierus (65)	1. Scolecolepides (85)
2. Cyathura (36)	2. Cyathura (45)
3. Scolecolepides (23)	3. Leptochierus (59)
Oyster Shell (Non-quant)	
1. Balanus (2033)	1. Balanus (597)
2. Congeria (1401)	2. Congeria (387)
3. Nereis (187)	3. Nereis (75)
Riprap (10cm^2)	
1. Balanus sp. (45)	1. --
2. Chironomid (4)	2. --
3. Nereis (3)	3. --

* (--) Dashes indicate no species found

Leptochierus plumulosus

This small (less than 13 mm) shrimp-like crustacean has been the most abundant species in soft bottoms since the beginning of our monitoring program. However, this year during both sampling periods, in September 1983 and March 1984, the numbers were at their lowest (Fig. 5). It is postulated that lower salinity during critical periods kept repopulation in check after the annual summer depression from predation.

This species appears to be primarily a deposit feeder inhabiting fragile tubes constructed at the water-sediment interface. In this study and past dredge and spoil disposal studies it was found to rapidly inhabit recently deposited or disturbed sediments. It was more abundant at stations 5 and 6 prior to dredging probably because of the disruption of the bottom by frequent boat activity. The area was then dredged and in March the samples indicated

TABLE 2.0 SPECIES DIVERSITY INDICES (H') SINCE THE CURRENT MONITORING PROGRAM BEGAN

NO.	Sampling Date Aug 81	Nov 81	Feb 82	May 82	Aug 82	Nov 82	Feb 83	May 83	Sep 83	Mar 84
Reference (16,22,26)		1.484	1.175	1.608	2.437	1.235	1.153	1.139	2.837	2.889
Shell (9)	2.493	2.188	3.038	2.946	1.523	1.721	2.211	2.104	1.925	2.315
R1									.818	0
R2									.266	0
R3									1.521	0
R4									1.214	0

1983 and through our current study, the dominant species became reduced in numbers resulting in an increase in diversity. Super imposed upon this scenario was a disturbance dredging which took place at stations N5 and N6, an resulting in increase of one species (Leptochierus) and diversity values which were reduced to a level of average years. (Table 2.1) It may be concluded from this that the area around Hart and Miller Islands normally has low species diversity values (less than 2) and when disturbances to the population occur such as predation, dredging, or lowered salinity, then the diversity value increases. If sustained periods of high fresh water flow (low salinity) occur and the diversity values increase above 2, then such outside disturbances to the population result in a lowered diversity value. That is, either a single source of distrubance,or decreased saltiny tends to increase diversity, but when these influences are combined, diversity decreases. Oyster shell bottoms normally have a higher diversity of fauna than soft bottoms because of the additional hard shell surfaces intermixed with muds. Diversity values dropped with an increase in barnacles in August 1982. The recognition of an additional species of barnacle in February 1983 added a second high-count species which increased the diversity values. The reduction in density of both species in March 1984 was presumably freshwater-related and again increased diversities.

Diversity values on the stone riprap surfaces should not be as great as an oyster shell bottom because only the stone surface substrate is available for species to inhabit. Results of only the September 1983 samples indicated a more diverse fauna at the southern end of the island. Because of the ice formation and its scour action, all species in the shallow water zone were eliminated by the March 1984 sampling period. Further work is needed to characterize this new habitat to the area.

Friedman's Non-Parametric Test

Friedman's non-parametric two-way analysis of variance by rank (Elliott, 1977) was used to determine if a difference between the nearfield stations and the soft bottom reference station could be found. For each of the sampling periods the nearfield stations were first tested to determine if any statistical difference existed and then the reference stations were added to them and the test was repeated. The numbers of the four dominant species (Scolecolepides, Leptocheirus, Cyathura and Rangia) collected at each station were ranked, and the rank totals compared across stations. The results of these tests are given in Table 3. At the generally accepted 5% level of significance, no difference was found in any of the four tests.

On visual examination of Table 4, one may see similar percentages of organisms at the groups of stations. Increases or decreases between sampling periods also are similar within the nearfield, soft-bottom reference, and shell bottom stations. The major increase in percentage of Leptochierus at the nearfield stations was a result of the dredging at Station 5 and 6. This same species slightly decreased during the same period at the reference station.

TABLE 3. RESULTS OF FRIEDMAN'S NON-PARAMETRIC TEST

Source	D/F	X^2	.05%	Sig. Diff.
September				
Nearfield	3	6.3	7.8	No
All Stations	3	4.9	7.8	No
March				
Nearfield	3	6.0	7.8	No
All Stations	3	5.5	7.8	No

TABLE 4 (continued) LIST OF COLLECTED SPECIES AND PERCENTAGE OF EACH SPECIES AND PHYLUM

	Containment Facility Area				Reference Areas			
	Nearfield (8)		Riprap (4)		Soft Bottom (3)		Shell Bottom (1)	
	Sept 83	Mar 84	Sept 83	Mar 84	Sept 83	Mar 84	Sept 83	Mar 84
ARTHROPODA (Crustaceans)								
Balanus improvisus			6.0				45.4	37.6
Balanus subalbidus			78.4				7.2	13.2
Cyathura polita	11.4	9.6			15.2	16.4	.2	.1
Cassidinidea lunifrons							1.4	1.4
Edotea triloba	1.4	.4			.7	1.8		
Leptocherius plumulosus	13.4	26.6			27.8	21.5		.8
Corophium lacustre	.5	.2	1.9		.1	.5		.1
Gammarus tigrinus		.4			.4	1.0		1.1
Melita nitida							.5	.3
Chirodotea almyra					.1	.2		.1
Monoculodes edwardsi	.1	.4				1.1		
Chironomid sp.		.3	7.5			.2		.1
Rithropanopeus harrisi	.1		.5				3.1	2.5
% Crustaceans	26.4	37.8	93.9	0	44.4	42.7	57.8	57.3
Total Number Individuals	2640	2561	213	0	702	825	3862	1177

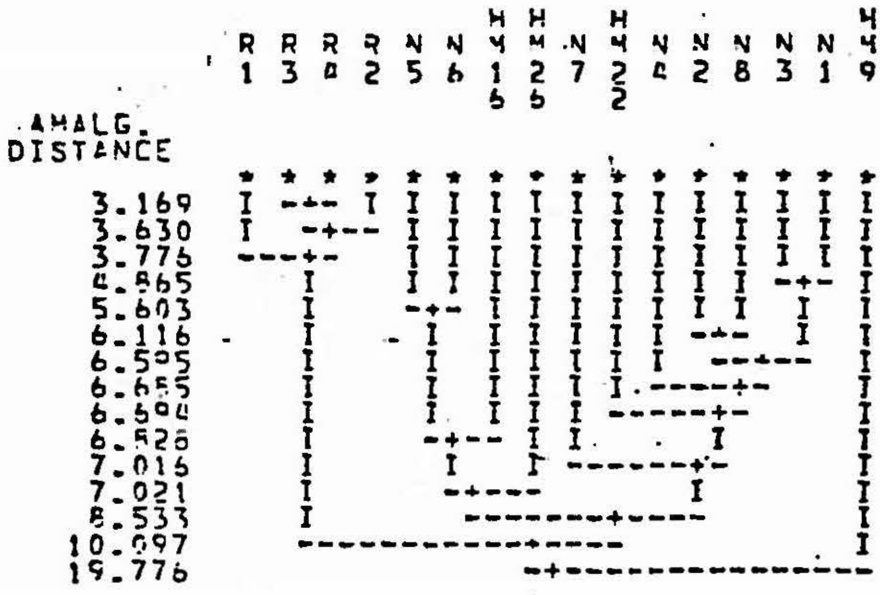


Fig. 6. Cluster analysis of September 1983 station data. Stations and groups of stations most similar have horizontal connections and smaller amalgamation distance.

CONCLUSIONS AND RECOMMENDATIONS

Salinity in this area during the current year's study averaged lower than the preceding two years. This resulted in a depression and reallocation of species dominance.

The interpretation of benthic species diversity values for Hart and Miller Islands is contrary to most other areas. Here, low values are indications of normal unstable environmental conditions while high values reflect a more unusual stable environment.

The area adjacent to the dike where fluid mud was deposited in July 1982 continued to recover in number of species and individuals. Two longer-lived mollusks, Macoma, still lagged behind those at the reference areas. There was no significant difference between the nearfield stations and the reference areas.

No major effects on the benthic fauna from construction were found but limited dredging, which increased the water depth from 14 to 21 feet, took place at the primary rehandling pier. Sedentary species such as mollusks were reduced in numbers while more motile opportunists such as worms and crustaceans increased.

Relatively few species had become established on the stone riprap surfaces in shallow water in September. By March all species had disappeared, presumably scoured from the surfaces by ice movement. The value of the recently placed riprap as a new ecotone for fish and crabs should be investigated more thoroughly.

Future benthic studies should retain sampling stations at the reference areas and the primary rehandling zone. Stations should be established at the sluice gate and at various depths on the stone riprap. Monitoring should be continued because of the variable environment which has a profound effect on faunal composition of the area.

PROJECT III

FISH POPULATION STUDIES
1983 - 1984

by

Jim Casey
Fisheries Division, Tidewater Administration

INTRODUCTION

Major engineering projects in both non-tidal and tidal waters can alter considerably the natural ecosystems over a wide area. Such projects can have both negative and positive influences on local biota, thereby necessitating comprehensive data collection to provide information which can help to minimize the former and optimize the latter. The data collected both prior to and during construction has been reported (Ritchie, 1977; Tsai & Millsaps, 1982) with present data covering the completed structure and initial operation as a containment facility. Use of the structure area by finfish and crabs appears considerable and tends to indicate that it may function like an artificial reef, although currents along the south and east faces may reduce use by some desirable species. The intensive semiannual survey, while duplicating some of the previous sampling techniques, has also included additional techniques to augment and refine population information.

The Hart - Miller's Island Containment Facility

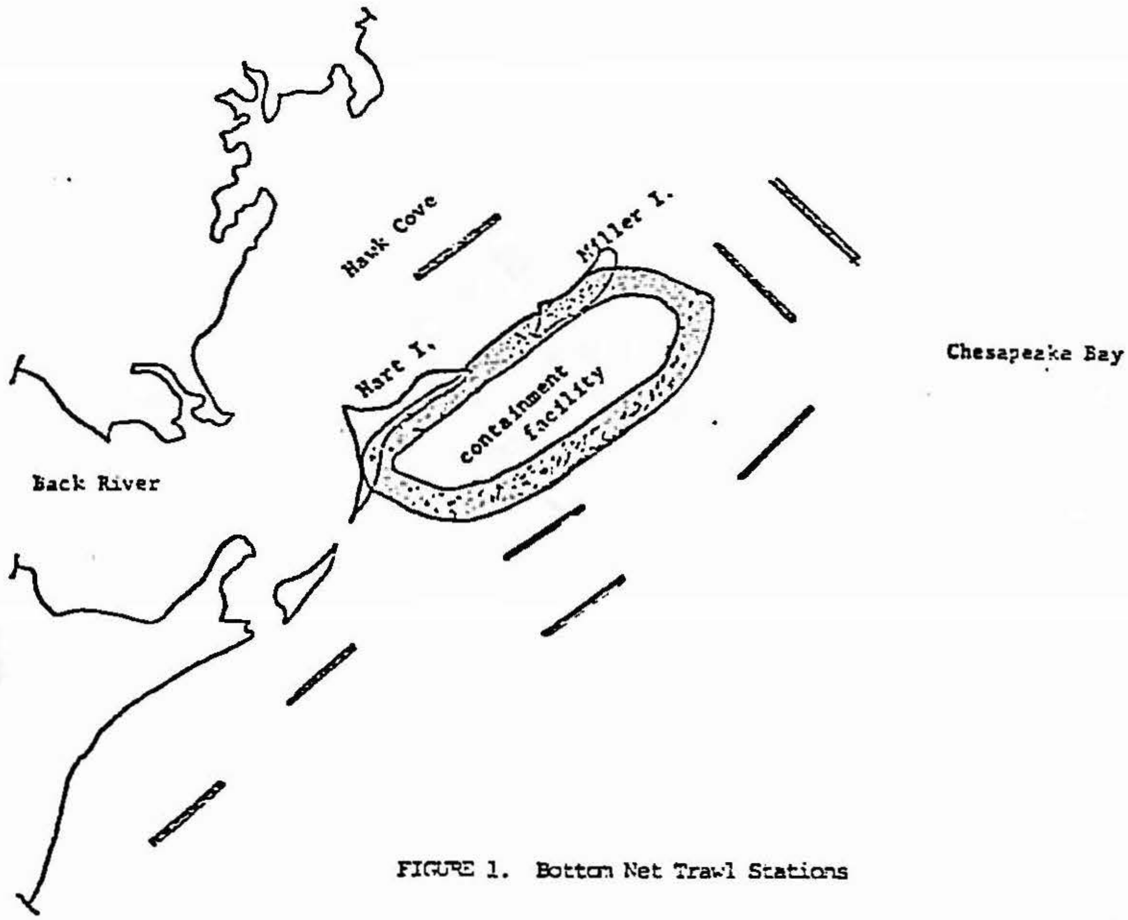


FIGURE 1. Bottom Net Trawl Stations

Seine Hauls

Construction of the facility apparently caused alterations in the remaining seine stations of Tsai & Millsaps (1982) which had the effect of rendering two of the three unworkable. These two sites were relocated to a suitable site as close as possible to the original. The third station has undergone severe shore erosion with resultant shoaling and unstable bottom conditions. It was, however, used. During the first sample period, the 15.2 m long seine used by Tsai & Millsaps (1982) was compared with the 60 m long seine as used by Tidal Fisheries Administration. A replicate sample was taken with each net. As the 60 m long net proved more suitable to the depth and less likely to spook fish in the shallows, it was the only seine used in the second sample period.

To operate, one end of the net was held ashore while the other was paid out of a net box on the boat. The net was set in a semicircle with the other end being brought ashore by the end of its 60 m reach. The net, covering an area of 1,640 sq. ft., was brought in by hand and the species caught were recorded according to the data outline below. A replicate sample was also taken at each site and this catch recorded. The following data were recorded when possible:

1. Number of species and aggregate weight of catch, by species. For target species, a subsample will be measured for length and weight by age class.
2. Effort - the area swept by the gear for each station
3. CPUE for each species and station
4. Diversity Index for each station
5. A comparison of the two seine types

Figure 2 indicates the location of the seine hauls.

Gill Nets

Experimental gill net arrays consisting of eight mesh sizes: 3.81 mm (1 1/2 in.); 6.35 mm (2 1/2 in.); 7.62 mm (3 in.); 7.92 mm (3 1/8 in.); 8.89 mm (3 1/2 in.); 9.52 mm (3 3/4 in.); 10.16 mm (4 in.); and 11.43 mm (4 1/2 in.) were utilized and fished for times/depths/mesh sizes to capture typical age group representatives of important species in the general areas of abandoned beach seine stations. Each panel was 31 m long by 2.5 m deep and worked as 4 panels per net for a total of two nets. The typical setover period was 24 hours with the nets pulled for data on three consecutive days. Occasionally, weather conditions precluded work, resulting in a 48 hour setover period. The following data were recorded:

The Hart - Miller's Island Containment Facility

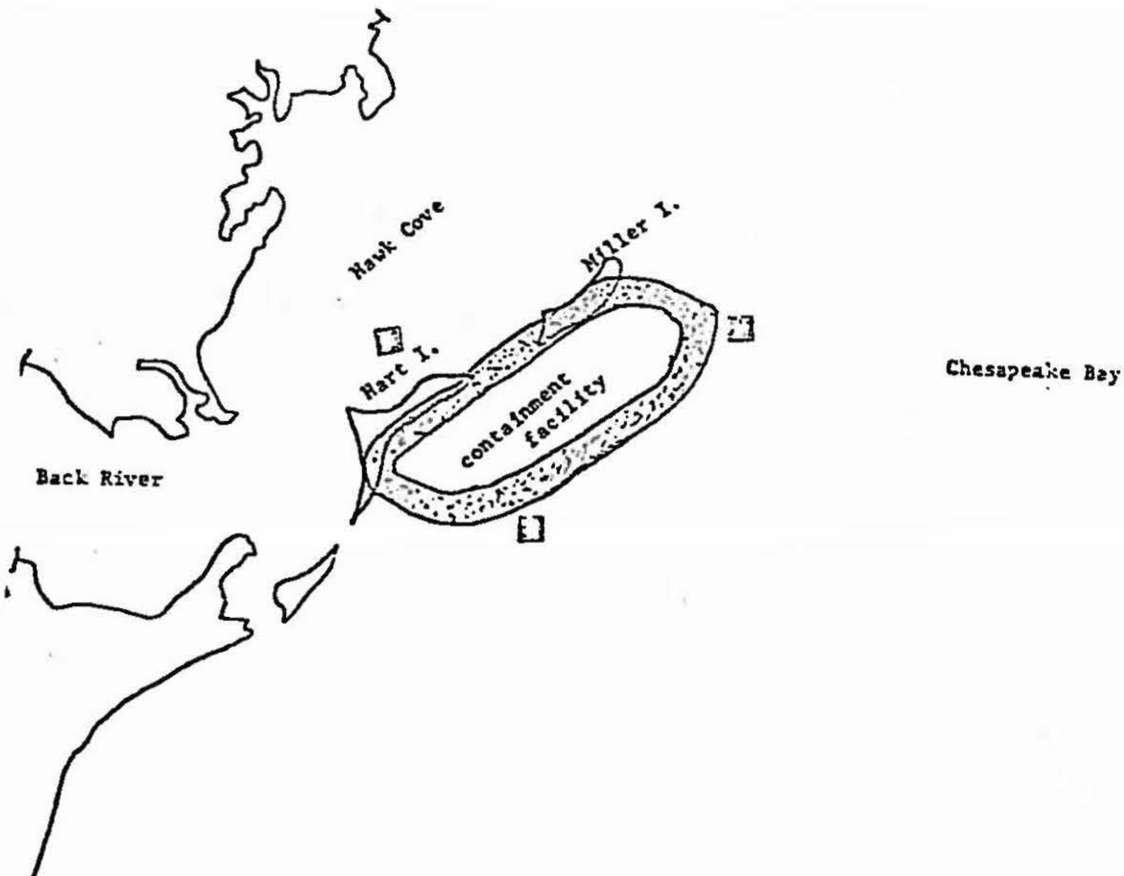


FIGURE 3. Gill Net Stations = ▢

The data collected for each trap included:

1. Catch, by species with weight/length for target species
2. Effort in trap days
3. CPUE by species
4. Diversity index by station

Figure 5 indicates the location of fish trap stations.

RESULTS

The additional sampling gear used during this phase was not completely suitable to the area for a variety of reasons. Lack of suitablilty was not primarily due to the gear itself but to conditions encountered in the sampling process. Gill nets functioned admirably, catching a considerable variety of local fish species. However, exposure of the containment facility to rough open bay seas made retrieval of nets difficult at best and hazardous at worst. Strong currents and rough seas tended to blow the nets down and twist them. Vessel traffic, always a hazard, resulted in a considerable loss of gear by anchoring over it or running through it. Water depth did not permit much clearance for heavy draft tugs and barges. While a drift gill net may have been more successful than the anchor gill net used, its use would have proved too hazardous given the intensity of both recreational and commercial boat traffic.

Fish traps, commonly called hoop nets, are generally used in protected waters of approximately 3m depth. Current and sea conditions caused them to roll and undoubtedly affected their function. Their sheer size made handling difficult, particularly under the commonly encountered rough seas. A different variety of fish trap, called the Morton trap, could function more successfully under these conditions. Because of its smaller base, weighted with a floating mesh frame, this trap would easily withstand local conditions.

Eel pots functioned quite well, particularly when placed on the rocky slopes or toe. While they did tend to snag on the rocks, catch was much improved over an open bottom set.

Sampling by bottom trawl appeared to be the most successful method, particularly when carried-out close to the rock slope. It is more workable during poor sea conditions (up to a point), is not seriously affected by currents, and can be worked around vessel traffic.

Beach Seine Gear Comparison

Earlier seine studies had utilized the 15.5 m x 1.8 m beach seine of 0.6 cm mesh while Tidal Fisheries personnel had commonly used the 61 m x 1.8 m beach seine of similar mesh size for the same purpose. To compare catch rates and effort of each net, both were used simultaneously at each station with one replicate/net/station following a 30 minute wait.

As expected, the 61 m seine did catch larger numbers of individuals as well as 33% to 50% more species per station than the 15.5 m seine. It must be noted that station HMS-2 was exceptionally shallow (less than 30 cm) and

TABLE 1. 1983 COMPARISON, 50 FT. SEINE VS. 200 FT. SEINE

Species	Station											
	HMS-5				HMS-4				HMS-2			
	200'	200'	50'	50'	200'	200'	50'	50'	200'	200'	50'	50'
	*		*		*		*		*		*	
Menhaden	35	69										
White Perch		4			3	3	2				1	
Striped Bass		4	1		3		4					
Silverside	6	1	3		10	8	22	7	1	57	4	4
Anchovy		1			8	148		1				
Brown Bullhead	1											
Spot	1				4	7		1				
Pipefish			1									
Gizzard Shad					36	1						
Striped Killifish					6	7	5	6		2		
Bluefish						2						
Naked Goby									1			
Blue Crab	2	1			1	8	1	1	1	3		2
Grass Shrimp				1							3	
Totals	45	80	5	1	71	188	30	16	3	62	8	6
Number Species	5	6	3	1	8	9	4	5	3	3	3	2
Combined Species	8		4		9		6		4		4	

* Replicate

TABLE 2. 1983 COMPARISON: 50 FT. VS 200 FT. SEINE (CPUE/HECTARE)

Species	Station HMS-5				Station HMS-4				Station HMS-2			
	200'	200'*	50'	50'*	200'	200'*	50'	50'*	200'	200'*	50'	50'*
Menhaden	592	1166										
White Perch		68			51	51	439				219.3	
Str. Bass		68	219		51	68						
Silverside	101	17	658		169	135	4864	1535	16.9	963.3	877.1	877.1
Anchovy		17			135	2501		219				
Brown Bullhead	17											
Spot	17				68	118		219				
Pipefish			219									
Gizzard Shad					608	17						
Str. Killifish					101	118	1096	1316		33.8		
Blue Fish							34					
Naked Goby									16.9			
Blue Crab	34	17			17	135	219	219	16.9	50.7		
Grass Shrimp				219							657.8	

* Replicate
Note-data rounded to nearest whole number

TABLE 6. CATCH BY STATION-BOTTOM TRAWL SEPTEMBER, 1983

Species	HMT-1	HMT-2	HMT-4	HMT-5	HMT-6	HMT-7	HMT-9	HMT-10	Total By Species
Spot	123	29	27	18		118	96	153	564
Bluefish	1	10				1	2		14
Croaker	9	9	2				33	25	78
Hogchoker	1		1	2			6		10
Anchovy	22	201	24			69	47	130	493
White Perch		1	8						9
Summer Flounder		2	3			2	1	3	11
Striped Bass						2	1	1	4
Gizzard Shad						2			2
Menhaden							2	6	8
Blue Crab	13	13	17	24	37	30	43	22	199
Totals By Station	169	265	82	44	37	224	231	340	1,392

TABLE 8. TOTAL CATCH BY SPECIES-BOTTOM TRAWL BY YEARLY SURVEYS (SIMILAR TIME PERIOD)

Species	August, 1981*	August, 1982+	September, 1983
Spot	6,480	697	564
Bluefish	1	4	7
Croaker	0	0	78
Hogchoker	311	25	13
Anchovy	366	72	493
White Perch	468	81	9
Summer Flounder	17	0	11
Striped Bass	1	3	4
Gizzard Shad	0	0	2
Menhaden	24	2	10
Blue Crab	(3)++	(3)	199
American Eel	118	0	
Channel Catfish	12	42	
Sea Trout	82	1	
Winter Flounder	3		
Pipefish	1		
Naked Goby		1	

* Tsai, 1982
\+ CRC Publ. #114, 1984
++ not recorded

TABLE 10. TOTAL SPECIES WEIGHT (gm); OFFSHORE STATIONS

Species	Station HMT-1	HMT-2	HMT-4	HMT-5	HMT-6	HMT-7	HMT-9	HMT-10	Total By Species
September, 1983									
Spot	8,600	2,500	2,900	1,450		8,200	8,600	15,700	47,950
Bluefish	90	1,100				105	253		1,548
Croaker	620	600	110				2,200	1,750	5,280
Hogchoker	25		20	35			185	65	330
Anchovy	210	440	20			115	50	250	1,085
White Perch		85	680						765
Summer Flounder		185	320			350	180	600	1,635
Striped Bass						110	60	200	370
Gizzard Shad						275			275
Menhaden							20	85	105
Channel Catfish									
Yellow Perch									
Blue Crab	2,500	2,600	3,300	4,100	6,250	4,900	8,000	4,200	35,850
March, 1984									
White Perch	2,690	3,705	2,670	1,390	2,175		2,210	420	15,260
Striped Bass	145	280	450						875
Channel Catfish	760		1,255			880			2,895
Yellow Perch	150	190				170	160		670
Blue Crab				38					38

BAY ANCHOVY
(Anchoa mitchilli)

This constituted the most abundant species at the inshore stations and accounted for 51% in number of the total catch (Table 13). It was most abundant at HMS-4 during both sample periods. This is in contrast to the Second Interpretive Report which listed this species as second behind the Atlantic silverside.

MENHADEN
(Brevoortia tyrannus)

This species was ranked second in abundance (33%). It was found only at HMS-5 during October, 1983 and at all stations during May, 1984, particularly HMS-4. The prior report indicated large swings in abundance of this species from one year to the next, so it was listed as a miscellaneous species.

ATLANTIC SILVERSIDE
(Menidia menidia)

Listed as most abundant in the prior report (33%), Altantic silverside was only 9% of catch during the present sampling period. They were found at all stations in nearly the same numbers at both sampling periods.

GIZZARD SHAD
(Dorosoma cepedianum)

With a total of 37 taken, this species made up 2% of the total catch, and were only present in the October sample of HMS-4. This number is up considerably from the previous study which with twice the samples, found only 8 specimens.

OTHER SPECIES

A total of 11 striped bass (Morone saxatilis) were taken compared to the 17 taken by the previous study. There was a considerable difference in white perch (Morone-americana) with only 22 taken. Similar time periods for the previous sampling period accounted for considerably more (12 taken in May samples as opposed to 31 in the same month a year earlier. Yellow perch (Perca flavescens) catches were only in the May samples and amounted to 10 individuals. Other species taken in minimal numbers were striped killifish, (Fundulus majalis), spot, (Leiostomus xanthurus), bluefish, (Pomatomus saltatrix), carp, (Cyprinus carpio), channel catfish, (Ictalurus punctatus), white catfish, (Ictalurus catus), naked goby, (Gobiosoma bosci), brown bullhead, (Ictalurus nebulosus), bluegill, (Lepomis macrochirus), and blue crab, (Callinectes sapidus).

TABLE 11 (continued)

Species	--- HMS-2 ---				--- HMS-4 ---				--- HMS-5 ---			
	200 A		200 B		200 A		200 B		200 A		200 B	
	No.	Wt.(g)	No.	Wt.(g)	No.	Wt.(g)	No.	Wt.(g)	No.	Wt.(g)	No.	Wt.(g)
Atlantic Silverside	11	54.0	7	36.0	37	155.0	24	110.0	5	25.0	17	70.0
Striped Killifish	1	2.0	0	.0	6	8.0	5	6.0	1	2.0	1	2.0
Menhaden	0	.0	2	123.0	379	21000.0	85	9000.0	17	1500.0	65	6200.0
White Perch	0	.0	0	.0	4	400.0	3	300.0	2	210.0	3	280.0
Yellow Perch	0	.0	0	.0	3	531.0	7	1300.0	0	.0	0	.0
Bluegill	0	.0	0	.0	1	95.0	0	.0	0	.0	0	.0
Anchovy	0	.0	0	.0	513	420.0	279	240.0	32	26.0	28	20.0
Carp	0	.0	0	.0	1	2600.0	0	.0	2	5800.0	0	.0
Channel Catfish	0	.o	0	.0	0	.0	1	280.0	0	.0	0	.0
White Catfish	0	.0	0	.0	0	.0	1	420.0	0	.0	0	.0
Blue Crab	0	.0	0	.0	0	.0	1	50.0	0	.0	0	.0
Totals	12	56.0	9	159.0	944	25209.0	406	11706.0	59	7797.0	114	6572.0

*A = Total number of individual 1,544
B = Biomass 51,499 g

TABLE 13. TOTAL CATCH OCTOBER, 1983 - MAY, 1984

Species	Total Catch	% Of Total Catch
Atlantic Silverside	184	9%
White Perch	22	1%
Striped Killifish	29	1%
Anchovy	1,009	51%
Menhaden	652	33%
Spot	12	1%
Gizzard Shad	37	2%
Striped Bass	11	1%
Bluefish	2	0%
Yellow Perch	10	0%
Carp	3	0%
Channel Catfish	1	0%
White Catfish	1	0%
Naked Goby	1	0%
Brown Bullhead	1	0%
Bluegill	1	0%
Blue Crab	17	1%
Total	1,993	

TABLE 14. TOTAL CATCH BY GILL NET, 1983

Species	Total Catch	% of Total
Menhaden	1,453	63.3%
Bluefish	268	11.7%
Gizzard Shad	160	7.0%
White Perch	26	1.1%
Hogchoker	20	0.9%
Summer Flounder	45	2.0%
Spot	22	1.0%
Striped Bass	26	1.0%
Channel Catfish	36	1.5%
White Catfish	4	0.2%
Hickory Shad	1	0%
Blue Crab	236	10.3%
Total	2,297	100%

TABLE 16. CATCH BY GILL NET, OCTOBER, 1983

Mesh Size (inches) Species	1 1/2"	2 1/2"	3"	3 1/8"	3 1/2"	3 3/4"	4 1/2"	Totals By Species
				HMG-1				
Menhaden		44	22	9	15	8	12	110
Bluefish		120	40	9	3	3	24	199
Gizzard Shad		11	33	24	14	4	5	91
White Perch		4	1	5	1			11
Hogchoker				2	3			5
Summer Flounder				4	6	6	10	26
Spot				3	4	2	5	14
Striped Bass		5	11	4	1			21
Channel Catfish		7	4	7	8	2	3	31
White Catfish			1	1				2
Hickory Shad		1						1
Blue Crab		1	1	12	22	8	31	75
Total By Mesh Size		193	113	80	77	33	90	586

Mesh Size (inches) Species	*1 1/2"	2 1/2"	3"	3 1/8"	3 1/2"	3 3/4"	4 1/2"	Total By Species
				HMG-2				
Menhaden	573	338	87	26	4	2	13	1,043
Bluefish	18	24	3		1			46
Gizzard Shad		2		7	1			10
White Perch				3	1			4
Hogchoker		1		5	1			7
Summer Flounder				9	1	1		11
Spot		1	1	1	2	2	1	8
Striped Bass			2	1				3
Blue Crab	2	4	7	41	26	13	24	117
Total By Mesh Size	593	370	100	93	37	18	38	1,249

*= 1 1/2" Gill Net lost on 2nd day of study, not replaced

TABLE 17. CATCH BY GILL NET, MAY, 1984

Mesh Size (inches) Species	1 1/2"	2 1/2"	3"	HMG-1 3 1/8"	3 1/2"	3 3/4"	4"	4 1/2"	Total By Species
Striped Bass	14		1						15
Yellow Perch	9	1	2						12
White Perch	219	21	8	2	4	5			259
Menhaden	5	48	41	68	34	51	47	58	352
Pumpkinseed	2								2
Hogchoker	4	8	4	7		1			24
Gizzard Shad		48	24	16	11	4	4		107
Channel Catfish		4	3	3	9	6	10	3	38
White Catfish									
Spot		4							4
Blueback Herring									
Blue Crab	2	8	1	4		1			16
Catch By Mesh Size	255	142	84	100	58	67	61	61	829

Species	1 1/2"	2 1/2"	3"	HMG-2 3 1/8"	3 1/2"	3 3/4"	4"	4 1/2	Total By Species
Striped Bass	2	2	3						7
Yellow Perch	2	8	3	1	3				17
White Perch	338	43	10	7		3			401
Menhaden	18	245	185	202	190	194	215	173	1,422
Pumpkinseed									
Hogchoker		28	16	6		2			52
Gizzard Shad			1						1
Channel Catfish	8	9	11	14	9	14	2	9	76
White Catfish	1								1
Spot									
Blueback Herring		5							5
Brown Bullhead			1						1
Blue Crab	6	5	10	11	13	6	4	5	60
Total By Mesh Size	375	345	240	241	215	219	221	187	2,093

FISH TRAP CATCH

As with eel pots, the catch by fish traps was poor, accounting for only 6 fish/pot day in May. Table 19 delineates the catch by sample area.

TABLE 19. CATCH BY FISH TRAP, OCTOBER 1983

Species	HMG-1	HMG-2	HMG-3
Spot	6	6	
Hogchoker		1	
White Perch	28	1	48
Blue Crab		2	
Eel	3		4
Menhaden	1		
Bluefish	5		1
White Catfish			1

Total = 107 Individuals

CATCH BY FISH TRAP, MAY, 1984

Species	HMG-1	HMG-2	HMG-3
White Perch		2	
Pumpkinseed			2
Blue Crab			3

Total = 8 Individuals

In the largest sample (October), white perch were 71% of the sample and ranged in size from 142 mm to 220 mm with 173 mm as the median size.

METHODOLOGY

Sediments

Field Methods

Field sampling for surficial sediments was conducted twice during the year: November, 1983 and June, 1984. The station locations, shown in Figure 1, differ somewhat from those sampled during the first two years of this project. Stations were relocated from the Hawk Cove side to the bay side. The box core station locations remained the same. The location coordinates for the stations are listed in Table 1.

The surficial sediments were collected using a Van Veen sampler which took an undisturbed sample of the top 8-10 cm of the sediments. The sampler is lined with zinc; however, great care was taken to subsample only material which had not been in contact with the walls of the sampler. Two sediment samples--one for textural analysis, the other for trace metals and organic contaminants analysis--were collected from each station except for three stations adjacent to the sluice gate located on the northeastern portion of the dike wall. At these three stations (#11, 21 and 24), duplicate grab samples were collected and two sediment samples were taken from each grab. The sediment samples were placed in 18 oz. Whirl-pac bags. The sample designated for textural analysis was stored out of direct sunlight at ambient temperature; the second sample, designated for trace metal and organic contaminant analysis, was refrigerated.

TABLE 1. RAYDIST COORDINATES, LORAN-C TD'S* AND LATITUDE AND LONGITUDE COORDINATES OF THE STATIONS VISITED DURING THIRD YEAR MONITORING

Station Number	Raydist Coordinates Red	Green	Loran C TD's		Latitude	Longitude
2	48.42	766.25	27640.8	42888.1	39°13.43'	76°23.80'
3	65.18	760.31	27636.5	42886.5	39°13.41'	76°23.03'
4	64.42	730.08	27637.3	42895.6	39°14.15'	76°22.16'
5	72.43	720.10	27635.4	42897.0	39°14.24'	76°22.19'
6	80.24	709.41	27633.4	42898.5	39°14.34'	76°21.72'
7	90.25	787.95	27631.0	42902.6	39°14.64'	76°21.00'
8A	85.54	675.29	27632.7	42907.5	39°15.04'	76°21.05'
9	94.57	675.92	27629.9	42905.2	39°14.83'	76°20.64'
10	95.56	659.95	27630.0	42909.7	39°15.19'	76°20.39'
11	96.23	657.02	27630.2	42913.4	39°15.48'	76°20.20'
12	86.75	641.22	27633.3	42917.4	38°15.83'	76°20.88'
13	80.18	639.57	27635.5	42919.7	39°16.04'	76°20.88'
14	79.97	626.34	27636.1	42924.0	39°16.38'	76°20.75'
16	59.71	672.81	27641.1	42914.9	39°15.72'	76°22.29'
19	82.47	739.98	27632.3	42889.0	39°13.58'	76°22.07'
20	57.33	782.81	27638.1	42881.4	39°13.05'	76°23.67'
21A	88.44	658.14	27631.5	42911.5	39°15'22"	76°20'37"
22	99.98	559.87	27631.7	42939.2	39°17'30"	76°18'54"
23	33.93	739.95	27646.8	42900.5	39°14'36"	76°24'14"
24	102.00	660.00	27629.8	42909.0	39°15'2"	76°20'1"
25	101.00	690.00	27629.7	42900.4	39°14'21"	76°20'29"
26	85.00	720.00	27633.6	42895.0	39°13'58"	76°21'35"
27	70.00	820.00	27637.4	42869.7	39°12'1"	76°23'48"
BC-1	70.00	730.00	27635.7	42894.5	39°14'2"	76°22'21"
BC-2	89.92	705.31	27630.7	42897.6	39°14'72"	76°21'11"
BC-3	80.80	697.07	27633.3	42901.9	39°14'36"	76°21'29"
BC-4	99.31	676.45	27628.5	42904.0	39°14'42"	76°20'20"
BC-5	72.44	637.41	27627.7	42920.1	39°16'16"	76°21'11"
BC-6	54.20	672.37	27643.4	42917.1	39°15'51"	76°22'32"
BC-7	41.30	719.97	27645.0	42904.6	39°14'56"	76°23'38"

*Between the November 1983 and June 1984 sampling periods, the State of Maryland abandoned the Teledyne Hastings-Raydist radionavigational system. The Loran-C navigational system will be used starting June 1984. The locational accuracy of the Loran-C navigational system is within 0.4 lanes (fluctuation of the Y-lane over the year) or approximately 66 yards (60 meters).

Radiographic Procedures

Radiographic processing of the gravity cores was done using techniques outlined in Howard and Frey, 1972. Each core was split and visibly described, noting textural changes, sedimentary and biogenic structures. Subsamples were taken for textural analyses. From each gravity core a 1.5 cm vertical slab was sectioned and X-rayed using a Torr 120 kV X-ray unit. Kodak AA-5 industrial film was used. The exposure data was as follows: focal distance, 95 cm; amperage, 3 ma; voltage, 50-65 kv; time, 60-180 sec. After exposure, the film was then processed through standard chemical solution baths utilizing X-ray developer and fixer. The negative transparencies were developed for 4.5-5.0 min. at 20°-21°C. Positive images were produced on Kodak Rapid Polycontrast print paper. In the resulting print, fine-grained sediments are represented by darker shades and coarser material by lighter tones.

Beach Erosional Study

Field Methods

The beach and nearshore profile lines were taken from the engineering site plan of the constructed dike and recreational beach area between Hart and Miller Island. The two end profiles were located along the fence line on Hart and Miller Islands respectively. The profile lines matched those of a hydrographic survey conducted by Waterway Improvement Division of Tidewater Administration during the summer of 1983. The origin of the profile lines were at the center line of the dike road and ran down the dike face (and/or beach) to the water interface. The profiles are spaced at 400 foot (121 m) intervals. Elevations of the origins of each profile were transferred from an established bench mark location at the origin of profile 30+00 (Figure 8).

Beach profiling measurements were taken three times during this first year of the beach study. The profiling measurements were made by the leveling method of surveying, using a self-leveling level, providing accuracy to 0.1 foot (3 cm). At changes in slope along the profiles one foot cores (30 cm) were collected. From the cores, sand samples were taken for textural analyses.

Oblique aerial photographs were taken prior to the beach profiling measurements.

Laboratory Methods

The beach samples collected along the profile runs were analyzed using the same methods as the surficial sediment samples. However, along with sand, silt and clay percentages, the sand and silt-clay fraction of each sample have been saved for complete grain size analysis by Rapid Sediment Analyzer and Coulter Counter.

Radiographic examination of the fluid mud accumulations revealed little or no bioturbation as opposed to the more bioturbated sediments observed in the fall of 1981. Only the upper few centimeters of the accumulations showed recent biogenic recolonization and biogenic activity.

Trace metal analyses of sediment samples were conducted in the fall of 1981 and spring of 1983. Based on enrichment factors calculated for Zn (for explanation of enrichment factors, see Kerhin et al., 1982; Wells et al., 1984), there was agreement between the sediments collected before and after dike construction except in the area where the light-colored fluid muds had accumulated; there the enrichment factor values for zinc dropped. Down core variations in cores analyzed for trace metals confirmed the lower enrichment factors for the light grey to pink fluid muds and higher enrichment factors for dark colored silty-clays.

Further monitoring after the completion of the dike structure revealed little additional change in the characteristics of the sediments.

Third Year Observations

Sediment Distribution - November 1983 -

Very little change was seen in the sediments since the June, 1983 period. Figure 3 illustrates a tertiary diagram plot of the sediments collected in November (the open circles represent sediments collected at the new station locations). As with the previous period, the trend of these sediments passes from the sand to sand-silt-clay to silty-clay/clayey-silt boundary. Although it appears that, at several stations, the classification of sediment type had changed (Figure 4), close examination reveals that these shifts were restricted mainly to those sediments that were on the border areas of that sediment classification. Slight changes in the sand-silt-clay ratios would result in reclassification of sediment type. Such is the case at Stations 4 and 5. In June 1983, the sediments collected at these two locations were classified as silty-clay; but in November, 1983, they were found to be clayey-silt. The same applies to Stations 8, 13 and 14. At the remaining locations, the sediments remain unchanged. Table 3 lists the sedimentological parameters of the sediments collected in November, 1983.

The field descriptions of the sediments indicate no obvious changes in physical appearances of the sediments since June, 1983 (Table 2). The new stations (25, 26, 27 and BC-6) were described as grey-brown, cohesive mud and Station 24 as lumpy muds (SSiCl). These sediments were consistent with the sediment characteristics observed during the first two years of monitoring (Wells et al., 1984).

- June, 1984 -

Based on visual descriptions and textural analyses (Tables 4 and 5), there were no major changes observed in the sediments collected in the summer of 1984 (Figure 5). North of the dike structure, at Stations 13, 16, 22 and 23 the

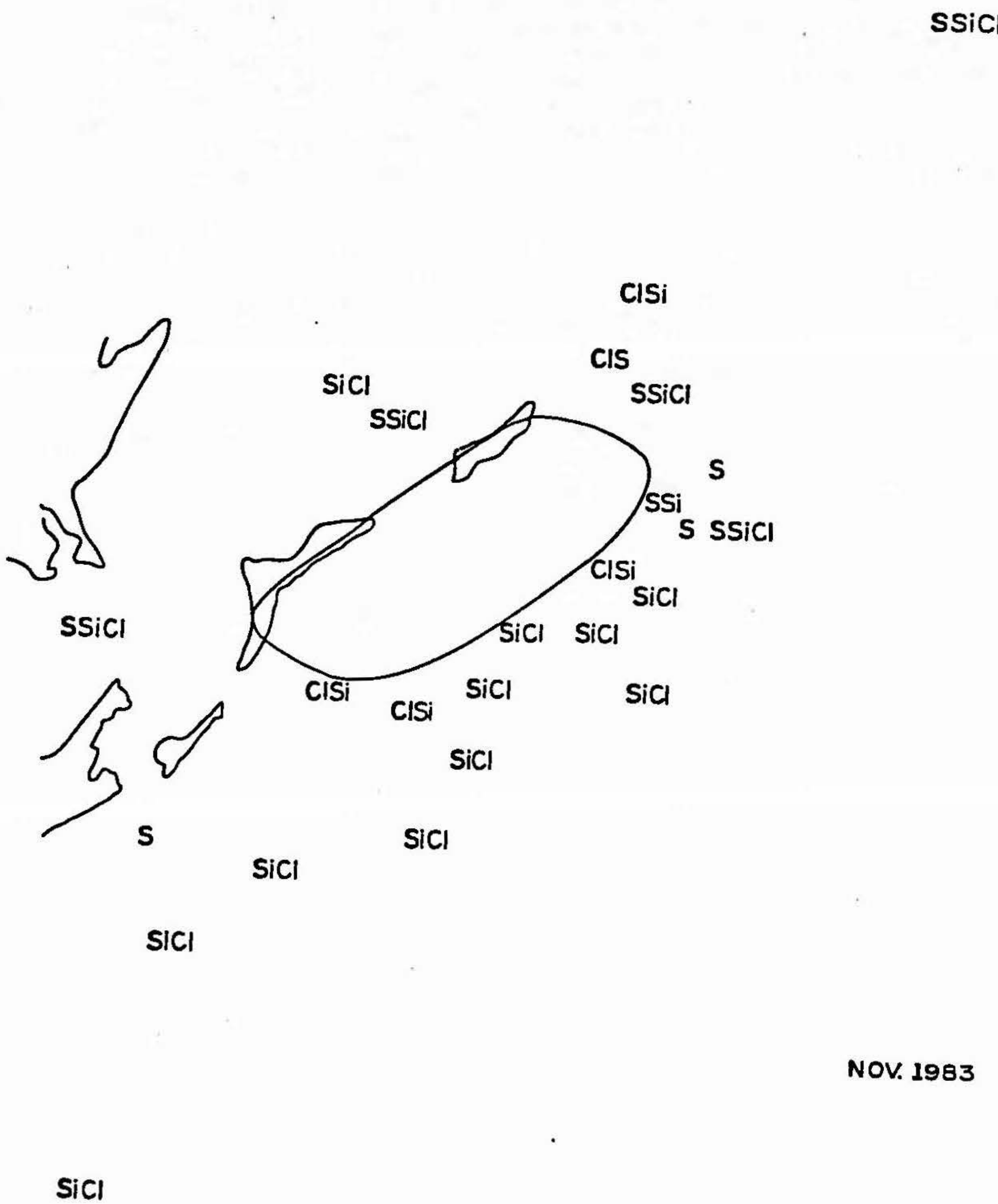


Figure 4. Areal distribution of sediment types around Hart and Miller Island dike facility based on November, 1983 samples.

TABLE 2. FIELD DESCRIPTIONS OF SURFICIAL SEDIMENT SAMPLES COLLECTED NOVEMBER 28 AND 30, 1983

Station Number	Water Depth	Description
2	-	Brown to grey medium-size sand.
3	15'	Overlying brown flocculent layer on greenish brown mud, very watery; live *Rangia*.
4	12'	Brown floc overlying light reddish-brown to brown mud; somewhat cohesive.
5	14'	Brown floc overlying light grey and brown to reddish-brown, cohesive mud; smooth texture.
6	16'	Brown floc overlying medium to light grey mud; somewhat cohesive; shells (*Rangia*).
7	18'	Brown floc layer with *Rangia* shells overlying medium to dark brown-grey cohesive mud.
8A	14'	Brown floc layer containing few shells overlying light to medium grey cohesive mud.
9	19'	Brown flocculent with *Rangia* shells overlying medium to dark brown-grey, lumpy mud, some plant fibers.
10	15'	Brown flocculent layer containing live *Rangia* overlying muddy sand.
11	14'	Floc overlying brown muddy sand; shells.
12	14'	Brown floc over gritty, medium to dark grey mud.
13	10.5'	Brown floc containing *Rangia* shells - some live, over brown muddy sand.
14	14'	Brown flocculent layer over meduim grey-brown cohesive mud; shells.
16	-	Cohesive, stiff, dark grey to black mud.
19	17'	Brown floc layer overlying greenish-grey, cohesive firm mud; *Rangia* shells.
20	-	Dark brown to brown grey, cohesive, somewhat gritty mud.
21A	13'	Brown flocculent layer containing shell fragments (including oyster "hash") overlying medium grey mud.
22	12'	Brown flocculent layer overlying muddy grey-brown sand.
23	-	Grey to grey-brown somewhat gritty, mud.
24	19'	Brown floc layer over medium grey-brown, lumpy mud.
25	19'	Brown floc containing lots of shells including *Rangia* overlying medium to dark brown-grey, lumpy mud.
26	17'	Brown floc over dark to medium grey mud, somewhat lumpy; also some shells, plant material; somewhat watery.
27	-	Grey-brown, very cohesive mud; containing some shells (*Rangia*).
BC-3	15'	Brown floc over steel-grey smooth mud.
BC-6	-	Dark brown to grey-brown mud; shells (*Rangia*).

TABLE 4. FIELD DESCRIPTIONS OF SURFICIAL SEDIMENT SAMPLES COLLECTED JUNE 6 AND 7, 1984

Station Number	Water Depth	Description
2	8.5'	Medium brown sand with shells.
3	17.5'	Grey-green, somewhat cohesive mud, shells and small copepods?
4	15'	Pink to reddish brown, smooth mud.
5	16'	Slightly gritty watery, greenish-brown mud and trace of pinkish/red mud and white mud mixed toward bottom of grab.
6	16.5'	Thin layer of brownish-red floc overlying smooth, steel grey mud; some streaks of lighter and darker grey throughout; _Rangia_ shells.
7	19'	Death assemblage of small _Rangia_ with floc overlying medium grey-brown, somewhat cohesive mud.
8A	16'	Death assemblage of _Rangia_, sandy mud; marbled white, light grey, and dark grey mud on bottom.
9	21'	Floc containing small _Rangia_ overlying medium grey-brown, somewhat cohesive mud, plant material and worms.
10	18'	Red to greenish-brown muddy sand with _Rangia_.
11	16'	Brown muddy sand with lenses of dark grey mud; _Rangia_ shells on top.
12	14.5'	Floc with shells over greenish-grey mud. Gradually gets sandier toward bottom (10cm).
13	11'	Red sand overlying lighter brown, muddy sand.
14	15.5'	Greenish-grey mud, very cohesive.
16	12'	Floc with shells overlying cohesive, light green-grey mud.
19	19'	Grey to greenish-grey, somewhat cohesive mud, copepods? and shells. Highly oxidized floc on top (intense red-brown color).
20	16'	Cohesive grey-brown mud with shells.
21A	16'	Oyster bed; mixed white-brown-grey smooth mud; lots of shells (only one grab out of eight yielded enough mud for sample).
22	14'	Medium grey, gritty mud with plant material and shells. Very watery floc.

TABLE 5. HART-MILLER ISLANDS - SEDIMENTOLOGICAL PARAMETERS OF SURFICIAL SAMPLES COLLECTED JUNE 6 AND 7, 1984

Station Number	Sand%	Silt%	Clay%	Shepard's Class	Water%	% Organics & Carbonates
2	96.87	2.62	0.51	S	22.51	0
3	59.00	18.85	22.16	ClS	46.97	5.57
4	0.39	46.58	53.03	SiCl	48.26	6.77
5	13.27	48.65	38.08	ClSi	51.13	8.68
6	0.19	43.91	55.90	SiCl	54.27	9.12
7	2.11	37.84	60.05	SiCl	59.97	24.21
8A	19.84	42.58	37.58	ClSi	38.36	10.32
9	3.26	37.57	59.18	SiCl	62.65	15.59
10	80.72	8.08	11.20	S	31.21	12.21
11	87.97	4.61	7.42	S	27.76	6.20
12	34.85	41.54	23.61	SSiCl	39.89	7.78
13	88.01*	6.60	5.39	S	20.58	4.49
14	1.94	47.20	50.86	SiCl	58.94	11.09
16	46.05	27.07	26.88	SSiCl	41.64	12.77
19	0.33	37.25	62.43	SiCl	61.48	13.20
20	1.35	39.08	59.56	SiCl	63.85	11.81
21	7.91	59.88	32.21	ClSi	46.48	6.69
22	66.35+	15.05	18.60	ClS	40.37	10.21
23	54.32	25.47	20.21	SSiCl	42.95	13.40
24	1.43	41.69	56.88	SiCl	59.69	17.24
25	0.56	42.35	57.09	SiCl	60.18	14.49
26	0.72	40.19	59.10	SiCl	59.01	23.03
27	2.92	36.91	60.17	SiCl	59.93	17.26
BC-3	3.09	49.16	47.75	ClSi	55.99	17.40
BC-6	2.22	39.87	57.91	SiCl	63.19	21.62

*Includes 0.95% gravel weight.
+Includes 1.56% gravel weight.

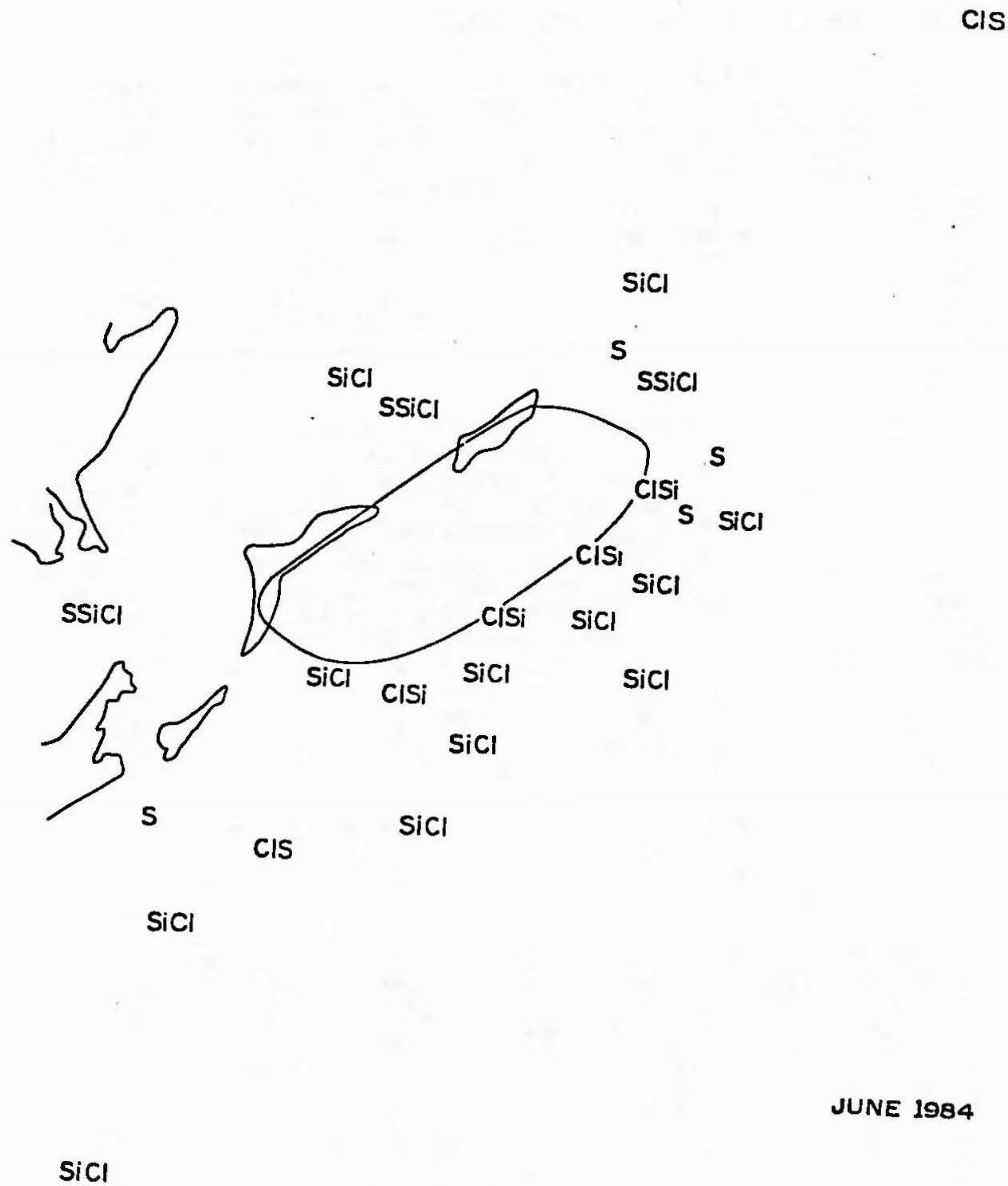


Figure 6. Areal distribution of sediment types around Hart and Miller Island dike facility based on June, 1984 samples.

TABLE 6. TRACE METAL ANALYSIS OF SURFICIAL SEDIMENT SAMPLES COLLECTED NOVEMBER, 1983

Sample #	Sample Date	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Sn*	Zn
		Metal Concentrations in ug/g											
2	11/28/83	<0.3	<1.0	2.1	2.1	2,800	7.1	390	<0.1	14	<0.5	-	32
3	11/28/83-triplicates	15	<1.0	25	23	20,000	37	2700	<0.1	40	<0.5	-	160
3	11/28/83-triplicates	<0.3	<1.0	2.5	<1.0	1,400	4.7	700	<0.1	15	<0.5	-	27
3	11/30/83-triplicates	17	<1.0	29	29	24,000	50	3000	<0.1	52	<0.5	-	240
4	11/28/83	21	<1.0	25	25	28,000	33	950	<0.1	38	<0.5	-	120
5	11/28/83	17	<1.0	21	20	25,000	19	830	<0.1	34	<0.5	-	100
6	11/28/83	24	<1.0	28	30	30,000	36	1200	<0.1	48	<0.5	-	160
7	11/28/83	23	<1.0	36	39	33,000	40	2100	<0.1	70	<0.5	-	260
8	11/28/83	16	<1.0	18	21	20,000	22	750	<0.1	30	<0.5	-	100
9	11/28/83	24	<1.0	34	37	31,000	59	1500	<0.1	62	<0.5	-	250
10	11/28/83	5.9	<1.0	11	10	8,900	17	530	0.1	20	<0.5	-	91
11	11/28/83-triplicates	3.6	<1.0	5.0	4.0	4,000	8.5	770	0.1	15	<0.5	-	40
11	11/30/83-triplicates	6.3	<1.0	6.5	5.2	5,800	12	1000	<0.1	16	<0.5	-	54
11	11/30/83-triplicates	3.9	<1.0	3.5	4.0	4,000	11	1000	<0.1	16	<0.5	-	42

Note: Less than values represent the detection limit of each parameter

* Samples were contaminated with tin during processing; therefore, tin was not measured.

\+ Values are highly suspect; concentrations reported are approximately 100 times lower than expected. Laboratory records are incomplete to resolve differences.

n.a. Not analyzed; insufficient sample volume.

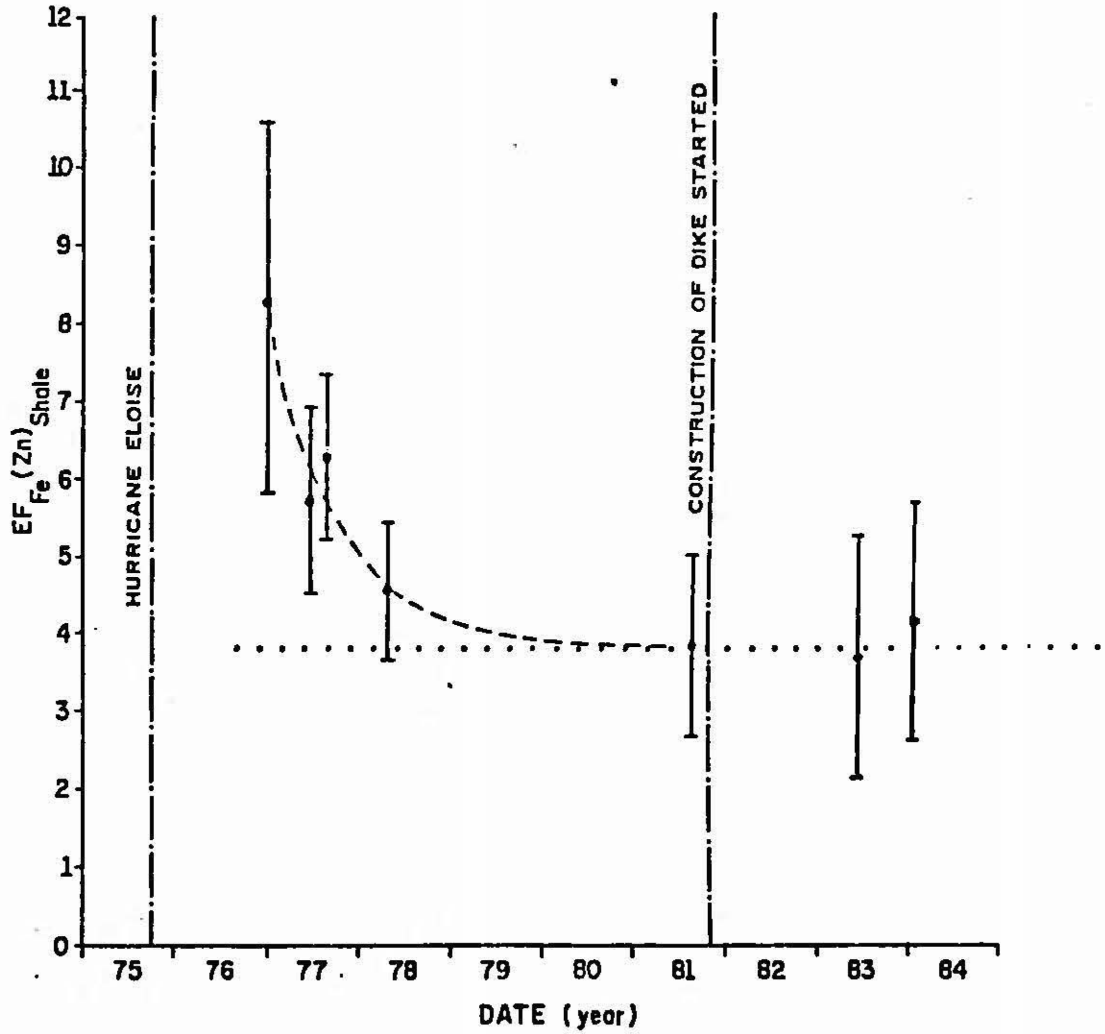


Figure 7. Average enrichment factors for Zn over a seven year period based on sediments collected around the Hart and Miller Islands complex.

TABLE 7. TEXTURAL PARAMETERS OF SEDIMENT SUBSAMPLES TAKEN FROM CORES COLLECTED IN JUNE, 1984, FOR RADIOGRAPHIC STUDIES

Station Number	Depth Interval(cm)	%Sand	%Silt	%Clay
BC-1	0-4	4.48	13.61	81.91
	6-10	0.88	26.33	72.78
	10-14	0.81	28.16	71.03
	14-18	1.65	26.22	72.13
	22-26*	14.33	66.37	19.31
	46-50	5.04	27.91	67.05
	80-84	10.10	27.39	62.61
	100-105	5.01	26.27	68.72
BC-2	0-4	2.23	30.01	67.76
	8-12	3.59	22.67	73.74
	16-20	3.19	27.08	69.73
	40-44	1.50	32.36	66.13
	76-80	2.28	21.20	76.52
BC-3	0-4	3.44	54.94	41.62
	4-8	1.44	8.68	89.88
	8-12	2.14	3.11	94.76
	24-28	3.55	38.27	58.18
	50-54	3.53	34.00	62.47
	76-80	3.87	34.46	61.66
	112-115	2.17	37.18	60.65
BC-4	0-4	3.41	35.87	60.72
	20-24	1.15	38.14	60.70
	40-44	1.99	35.73	62.28
	76-80	1.64	33.47	64.89
	116-120	1.97	34.82	63.20
BC-5	0-4	3.39	44.60	52.01
	6-10	0.91	43.69	55.41
	22-26	1.68	44.71	53.61
	30-34	0.72	35.29	63.99
	70-74	2.03	40.80	57.17
	90-94	1.68	39.85	58.47
	120-123	1.33	38.38	60.29

*Percentages are suspect.

BEACH EROSION STUDY

Recreational Beach

The recreational beach between Hart and Miller Islands was created during the early stages of construction of the diked disposal facility. Over 500,000 cubic yards (372,000 m^3) of sand were pumped between the islands in an overall configuration similar to the entire diked facility. The crest of the recreational beach is at +18.00 (5.44 m) feet mlw and slopes gently to the waters's edge. The width of the recreational beach is approximately 75 m (Figure 8).

An oblique aerial photograph (looking southward) taken soon after construction of the diked facility shows several distinct geomorphic features (Figure 9). The most obvious feature is the orientation of the shoreline with respect to Hart and Miller Island. Instead of a straight shoreline between the islands, the shoreline configuration is curvilinear. There is a westward offset of the shoreline at the Miller Island end curving eastward towards the Hart Island end. A secondary feature noticeable on the aerial photograph is the wave-cut(?) scalloped appearance of the natural beach area particularly at the Miller Island end. This is in contrast to the gently sloping upper section of the recreational beach. The contrast between the upper and lower sections of the recreational beach may signify a difference in geomorphic form and coastal processes. A third feature noticeable on the color rendition of the aerial photograph is the difference in color of the sediments of the recreational beach and diked face behind Miller Island. The sediments of the recreational beach are white (lighter shade) in appearance whereas the sediments behind Miller Island are yellowish (darker shade) in color. This yellowish appearance of the sediments suggests a different source than for the recreational beach sediments.

During a field trip taken in the spring with other Department of Natural Resources officials, it was observed that the recreational beach was undergoing erosional changes with the development of a wave-cut escarpment along the lower sections and the formation of sheetwash gullies between the upper and lower sections of the beach. It was evident at that time that at least two distinct geomorphic processes were in operation on the recreational beach; one set of processes operating on the lower section (near the water), and a second set of processes for the upper sections (near the roadway). This may preclude a single approach to erosion control measures.

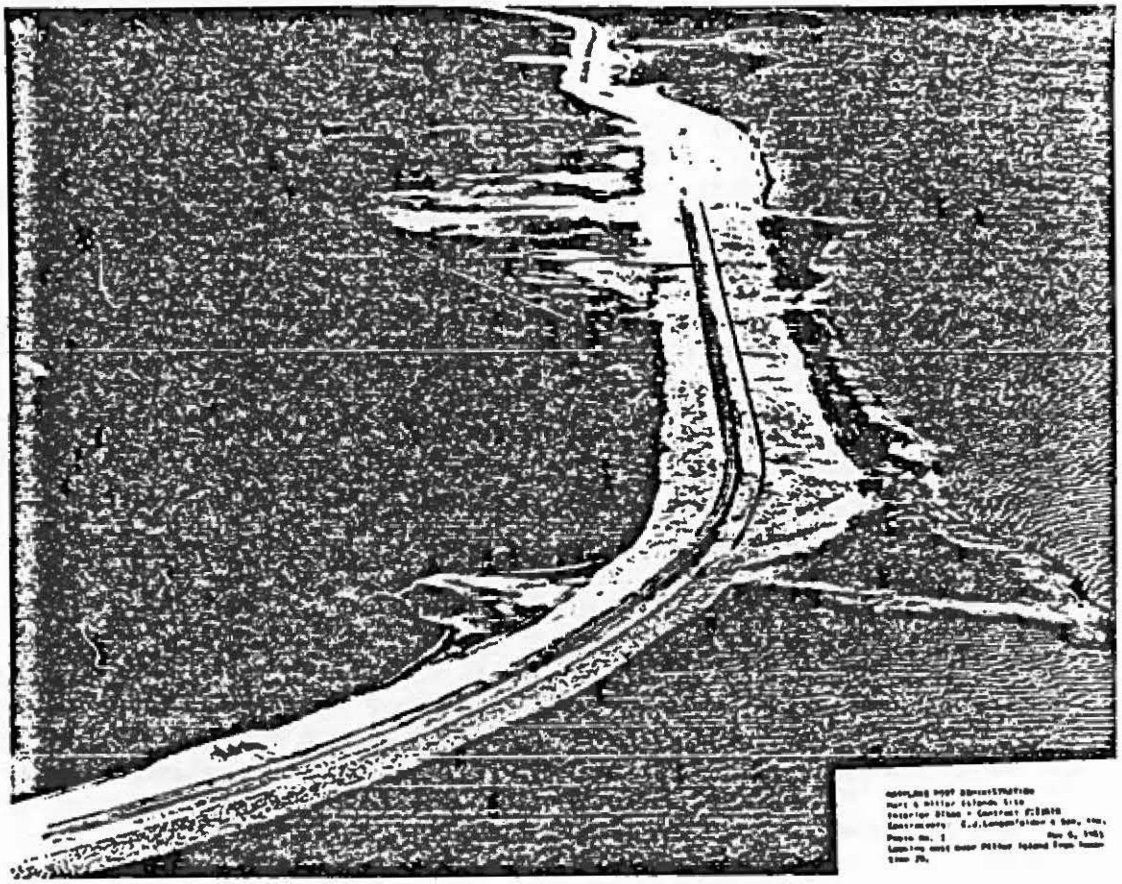


Figure 9. Oblique aerial photograph of recreational beach.

These changes in the recreational beach must be viewed as both natural and man-induced. Natural changes were a result of both wind and wave processes whereas the man-induced changes were a result of bulldozing during the early summer. Bulldozing of the upper sections modified any changes mapped between June and August but the changes in the July to August period were resultant of the natural coastal processes. The changes in both time periods showed the same pattern of change although the magnitude of changes was different. Therefore, it is still possible to evaluate the changes in terms of the natural processes along with the man-induced processes. Secondly, the bulldozing was confined to the upper sections of the recreational beach therefore allowing natural conditions to modify the lower sections of the beach area.

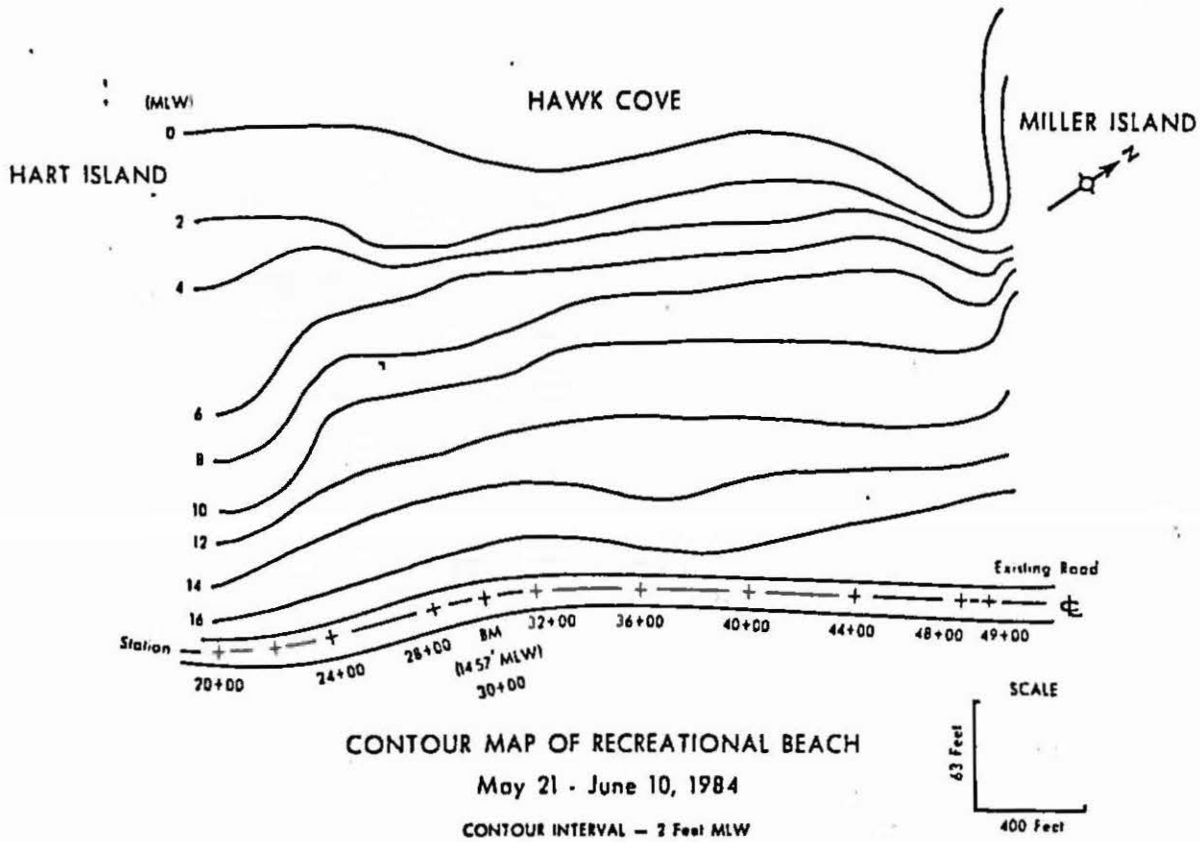


Figure 10. Contour map of recreational beach based on first profile survey (June 1984).

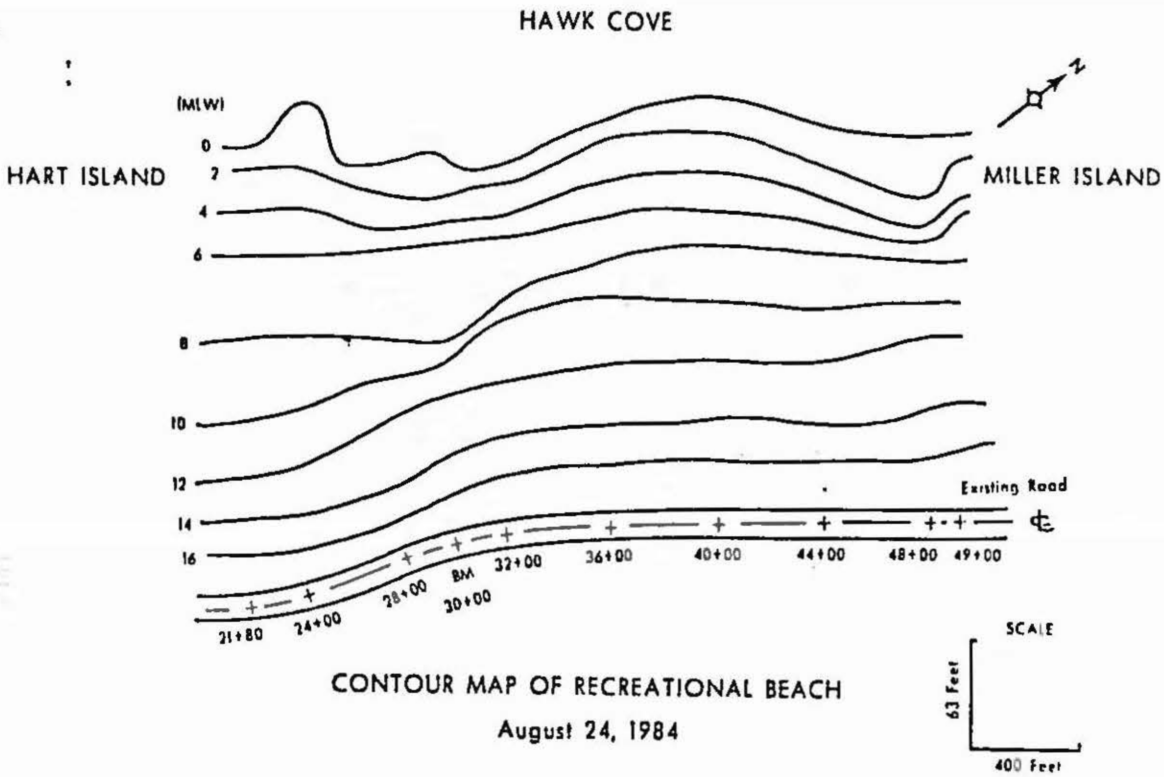


Figure 12. Contour map of recreational beach based on third profile survey (August 1984).

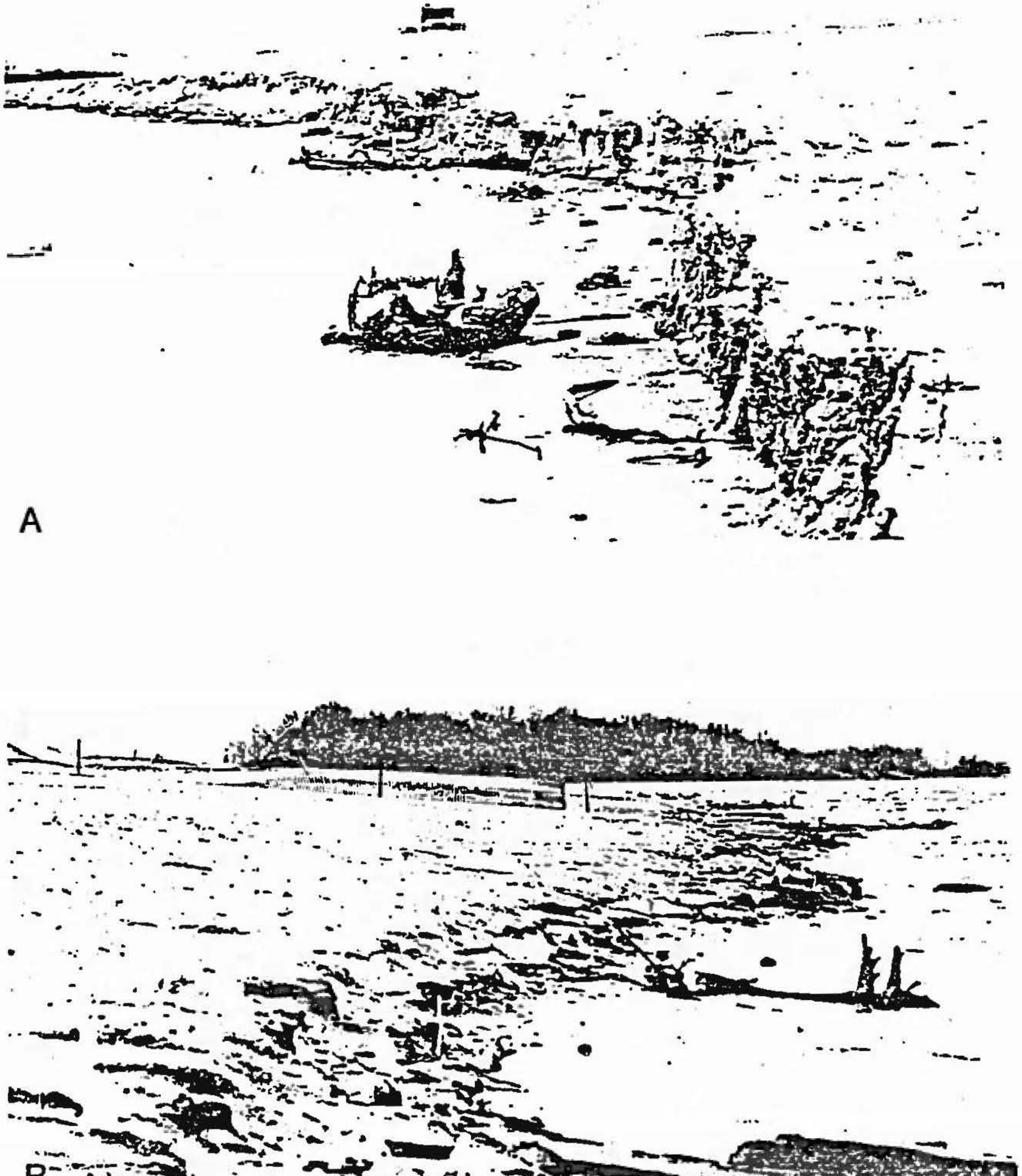


Figure 14. Ground photography of the wave-cut escarpment along the recreational beach; 14A is in early summer and 14B in late summer 1984.

TABLE 9. HART-MILLER ISLANDS BEACH STUDY SEDIMENT SAMPLES COLLECTED ON PROFILE LINES

Profile Number	Date Collected	Sample Number	Dist.+ (ft)	Elev.* (ft)	Percent Gravel	S	Si	Cl	Sand Description
22+00	6/29/84	1	33	15.59	0.08	92.30	4.93	2.69	Medium sand; blond
		2	88	11.05	3.80	89.72	4.17	2.31	Tan medium sand
		3	140	8.63	1.00	92.21	3.95	2.84	Medium sand; blond
		4	198	6.35	0.61	95.83	1.78	1.78	Blond medium sand
		5	230	2.85	0.51	94.85	3.04	1.60	Blond medium sand
		6	250	2.70	0	98.93	0.54	0.53	Blond medium sand
		7	260	1.65	1.01	97.46	0.77	0.76	Coarse to medium tan sand
24+00	6/29/84	1	30	15.73	6.09	88.49	2.71	2.71	Fine sand with some medium sand
		2	90	11.58	3.54	91.00	2.73	2.73	Fine blond sand
		3	144	8.04	0.77	92.23	3.50	3.50	Fine blond sand
		4	200	4.93	4.05	88.54	3.71	3.70	Mostly fine sand with some medium to coarse
		5	223	2.84	1.34	96.09	1.29	1.28	Medium with some coarse brown sand
		6	240	1.78	0.11	98.86	0.52	0.51	Medium brown sand
28+00	6/29/84	1	30	15.25	2.46	94.31	1.62	1.61	Fine sand, blond
		2	90	10.94	8.32	86.69	2.50	2.49	Fine sand, blond
		3	140	7.72	4.83	91.14	2.02	2.01	Fine to medium, blond
		4	180	5.52	5.34	88.07	3.30	3.29	Fine sand
		5	200	2.97	1.61	94.53	2.67	1.20	Medium sand, blond
		6	215	1.26	3.60	94.83	0.79	0.79	Fine to medium, some coarse tan sand

+ Distances are from centerline of roadway.
*MLW datum

TABLE 9. (cont.)

TABLE 9. HART-MILLER ISLANDS BEACH STUDY SEDIMENT SAMPLES COLLECTED ON PROFILE LINES

Profile Number	Date Collected	Sample Number	Dist.+ (ft)	Elev.* (ft)	Percent Gravel	S	Si	Cl	Sand Description
40+00	6/29/84	1	53	14.66	2.04	93.84	2.47	1.75	Blond fine sand
		2	150	8.50	1.43	86.71	7.40	4.46	Medium to fine blond sand
		3	200	4.10	12.45	83.34	2.86	1.36	Fine to medium sand, light tan
		4	230	2.95	0	100.00	0		Fine sand , blond
		5	245	1.05	49.00	49.18	1.50	0.31	Gravelly medium to coarse sand
44+00	7/5/84	1	50	14.19	1.53	95.71	2.17	0.59	Fine sand, blond, some gravel
		2	101	11.26	0.75	92.94	5.28	1.04	Fine sand, blond
		3	147	8.56	2.19	90.93	5.32	1.56	Medium to fine sand,blond
		4	188	4.92	0.28	95.93	3.26	0.55	Fine sand
		5	200	3.39	0.67	92.66	5.43	1.23	Medium to fine blond sand
		6	210	1.92	0.04	99.62	0.17	0.17	Blond fine sand
48+00	7/5/84	1	63	14.73	1.92	95.59	1.75	0.75	Medium sand
		2	109	10.00	0.69	97.09	1.41	0.81	Fine sand
		3	153	7.26	0	97.27	1.37	1.36	Medium to fine sand, blond
		4	164	3.02	0	99.21	0.40	0.39	Fine sand
		5	173	2.14	0.21	99.52	0.14	0.13	Medium sand
49+31	7/5/84	1	51	15.16	8.89	85.64	3.66	1.81	Some gravel, medium-fine orange sand
		2	101	12.33	8.32	80.49	8.26	2.93	Medium to coarse sand, tan to brown
		3	175	6.89	39.67	51.91	5.65	2.77	Gravelly silty fine to medium orange sand
		4	185	4.09	1.23	95.45	2.62	0.71	Fine sand, orange-tan
		5	200	2.33	0.36	99.37	0.14	0.14	Medium sand

+ Distances are from centerline of roadway

* MLW datum

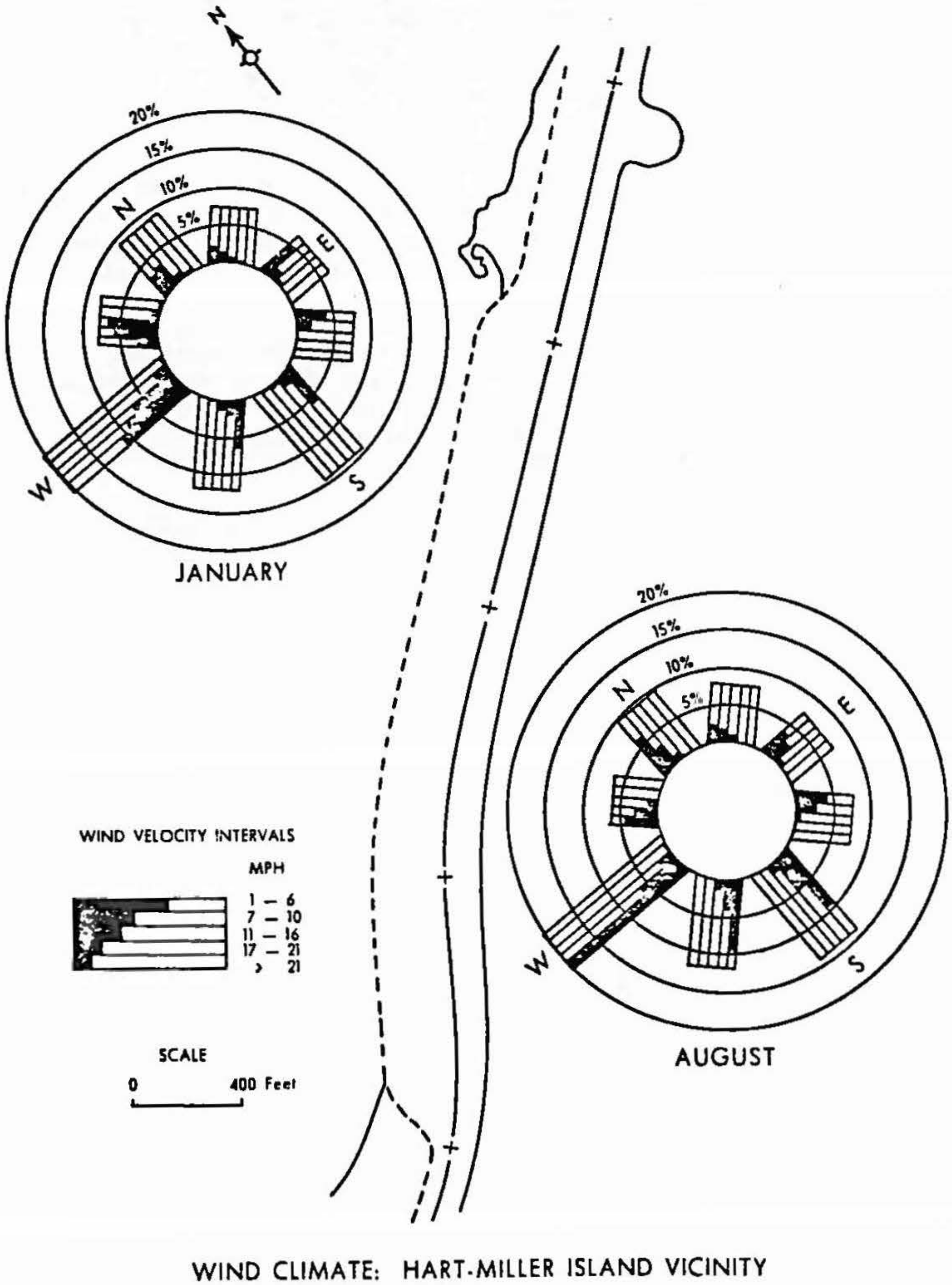


Figure 16. Wind rose diagrams for the Hart and Miller Island region (Mann, 1975).

CONCLUSIONS AND RECOMMENDATIONS

Sedimentary Environment

Information from the third year monitoring has indicated no gross changes in the physical or textural characteristics of the sediments around Hart and Miller Island disposal dike. The blanket of fluid mud deposited as a result of dike construction is still detected in areas south and east of the dike structure. Enrichment factor values for Zn associated with these fluid muds still remain lower than "normal" for sediments typical of this area.

Radiographs of the sediments at stations near the Hart and Miller Islands area (Stations BC-1 and BC-3) continues to show the distorted bedding and coloration patterns indicative of an anthropogenic impact. The only major change is that the thickness of the original fluid mud blanket has decreased at both sites. Explanations for these observations are fairly straightforward. The channel dredging activities accessing the unloading basin area are near Station BC-1. Such operations are likely to have caused a substantial amount of resuspension of bottom sediments. The difference in thickness of the light color fluid mud blanket at Station BC-3between the two years is probably due to the acceptable sampling error ofthe Loran C navigational system.

It is recommended that further monitoring of the sedimentary environment be continued. Also further emphasis should be placed on trace metal studies in the sediment, particularly in the areas adjacent to the unloading basin and access channels south of the dike as well as the sluice gate area.

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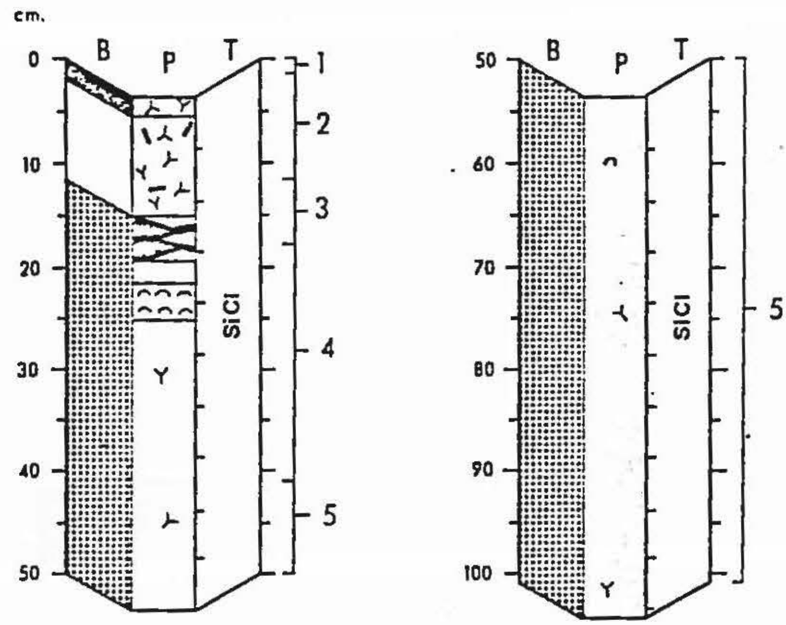
APPENDIX A

Figures A-1 through A-7 :
Geophysical representations of gravity cores collected June 1984.

Plates I through VII :
X-radiographs of gravity cores collected June, 1984.

STATION BC-1

(June, 1984: Gravity Core)

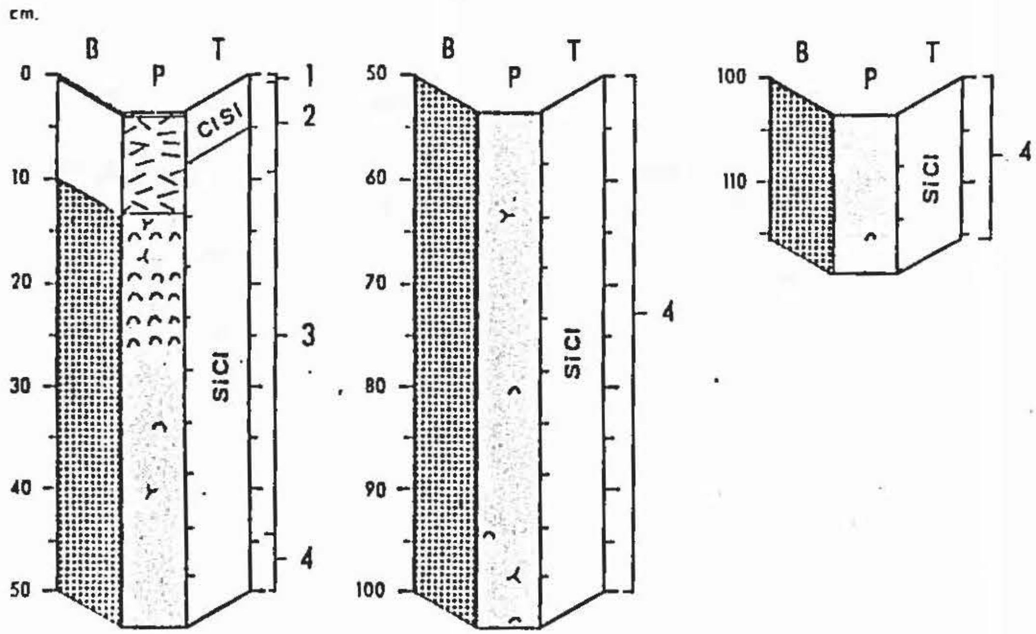


1. Light brown, fluid oxidized zone.
2. Very light brown, fluid smooth zone.
3. Fluid, smooth zone with brown and grey banding.
4. Dark brown, semi-cohesive zone.
5. Light to medium greenish-grey, cohesive zone.

Figure A-1

STATION BC-3

(June, 1984: Gravity Core)

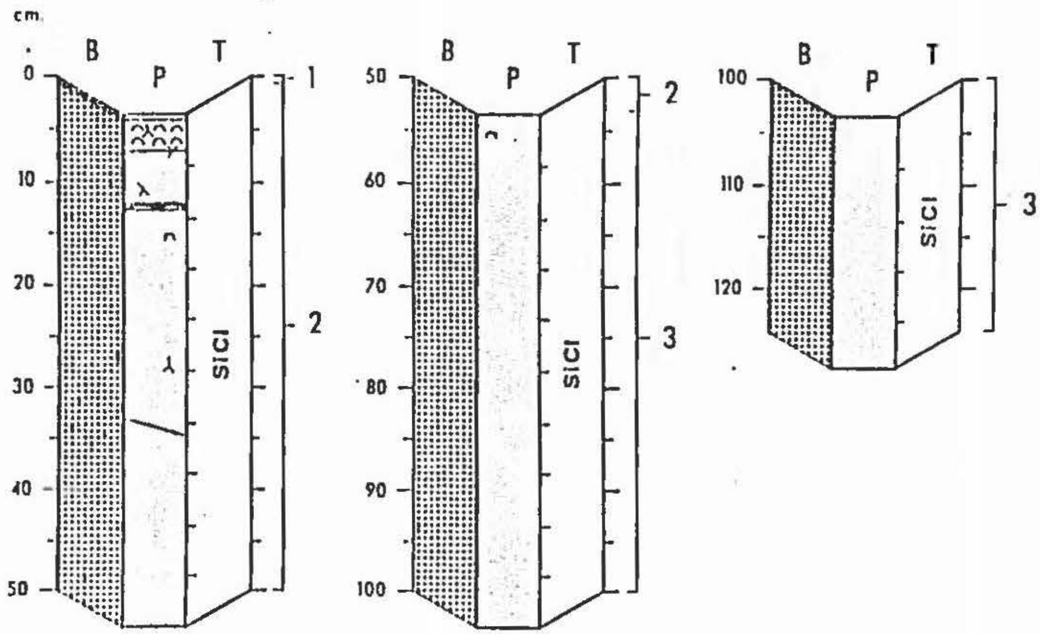


1. Light brown, fluid, oxidized zone.
2. Fluid and smooth layer with alternating orange, beige, brown and grey laminations.
3. Medium to dark grey, semi-cohesive zone.
4. Medium greenish-grey cohesive zone.

Figure A-3

STATION BC-5

(June, 1984: Gravity Core)

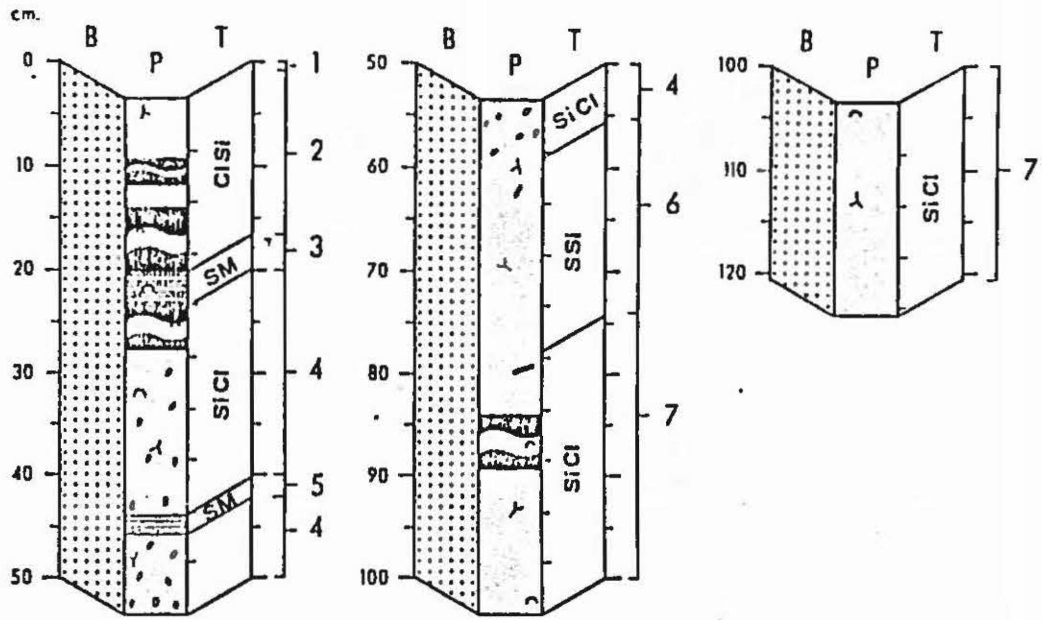


1. Light brown, fluid oxidized zone.
2. Medium grey-brown, semi-cohesive zone.
3. Medium grey, cohesive zone.

Figure A-5

STATION BC-7

(June, 1984: Gravity Core)

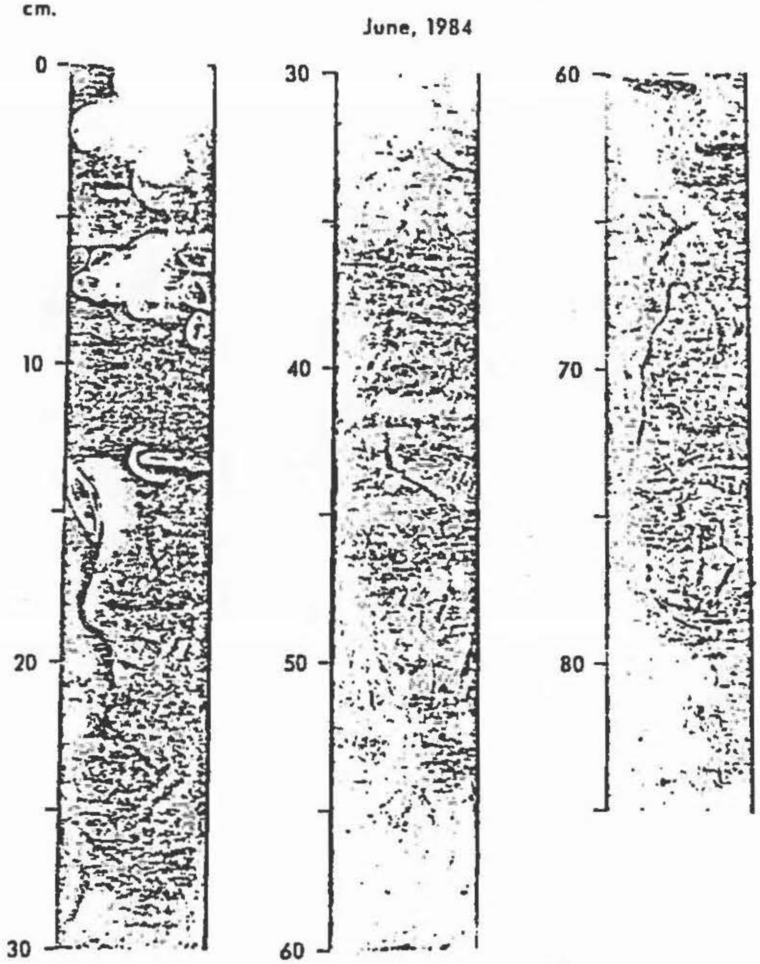


1. Light brown, fluid oxidized mud.
2. Black, fluid mud zone.
3. Medium grey, lightly gritty, fluid zone.
4. Brown-grey, mottled semi-cohesive zone.
5. Medium grey, lightly gritty, semi-cohesive zone.
6. Grey-green, highly gritty, cohesive zone.
7. Steel grey, cohesive zone.

Figure A-7

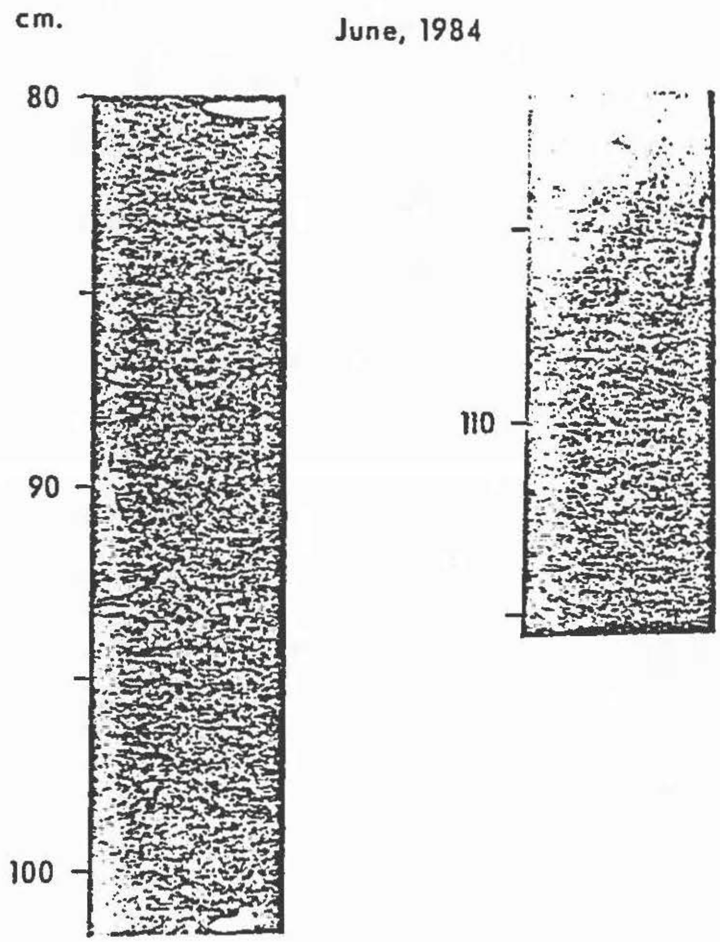
STATION BC—2

June, 1984



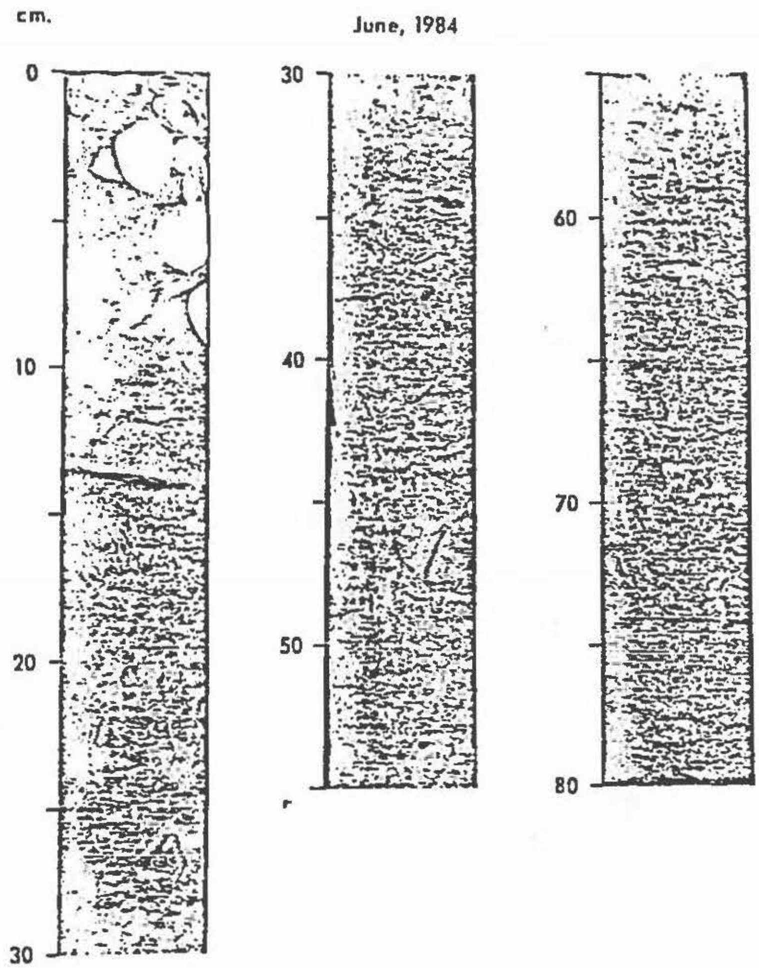
STATION BC—3

June, 1984



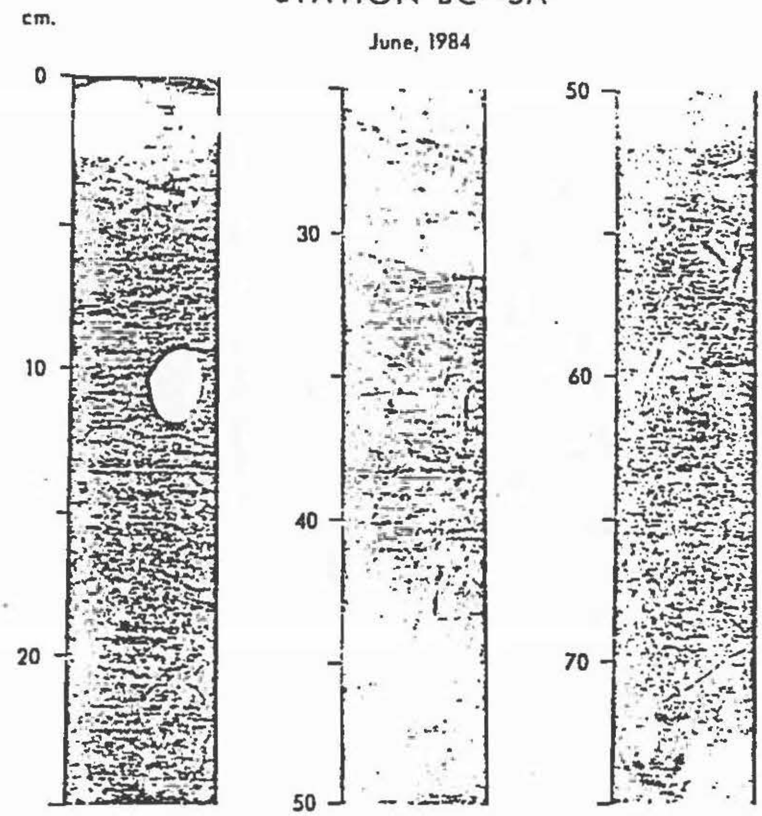
STATION BC—4

June, 1984



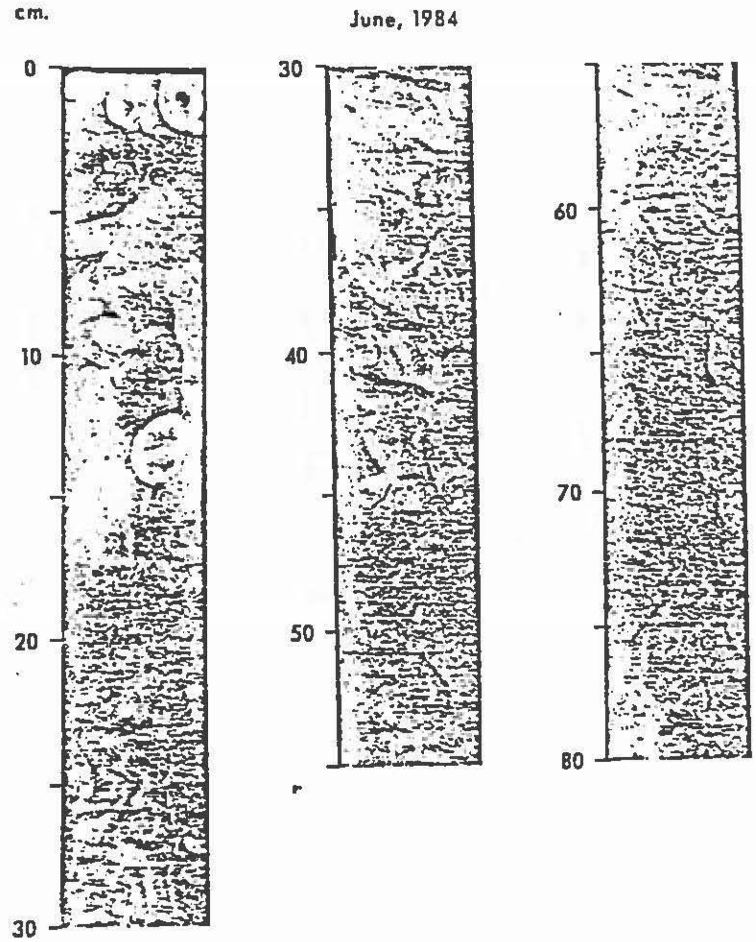
STATION BC—5A

June, 1984

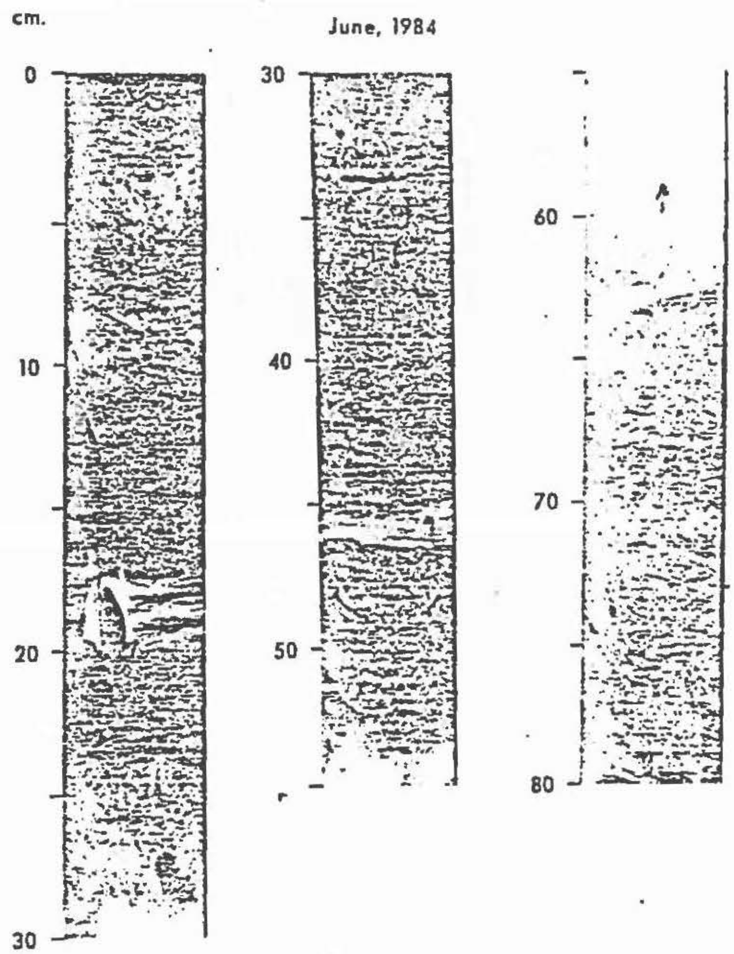


STATION BC—6

June, 1984



STATION BC—7



APPENDIX B

Table B-1 :
Distance and elevation data for Hart-Miller recreational beach profiles shown in Figures B-1 through B-14.

Figures B-1 through B-14 :
Graphs of beach profiles.

TABLE B-1 (cont.)

TABLE B-1. DISTANCE AND ELEVATION DATA FOR THE HART-MILLER RECREATIONAL BEACH PROFILES SHOWN IN FIGURES B-1 THROUGH B-14.

Station	First Survey Elev. (ft)	First Survey Dist. from CL (ft)	Second Survey Elev. (ft)	Second Survey Dist. from CL (ft)	Third Survey Elev. (ft)	Third Survey Dist. from CL (ft)
24+40	17.97	-				
	14.29	50				
	11.34	100				
	8.91	150				
	4.23	219				
	1.77	247				
28+00			17.81	-	17.77	-
			15.25	30	13.30	53
			10.94	90	10.01	108
			7.72	140	6.52	170
			5.52	180	4.37	200
			2.97	200	2.52	200
			1.26	215	2.07	220
			-0.15	227	0.57	220
					-0.48	240
28+40	17.94	-				
	14.10	50				
	10.98	100				
	7.85	150				
	4.95	188				
	1.74	212				

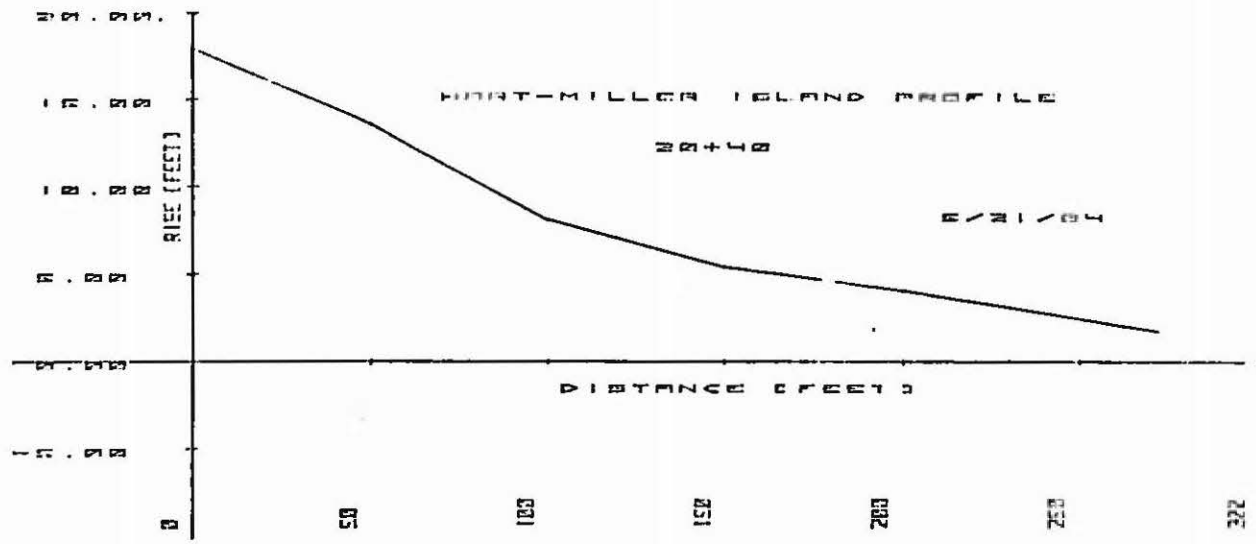
BM at Station 30+00 elevation 14.57' mlw
BM 22' from CL of dike roadway at station 30+00
All other stations are at CL of dike roadway

TABLE B-1 (cont.)

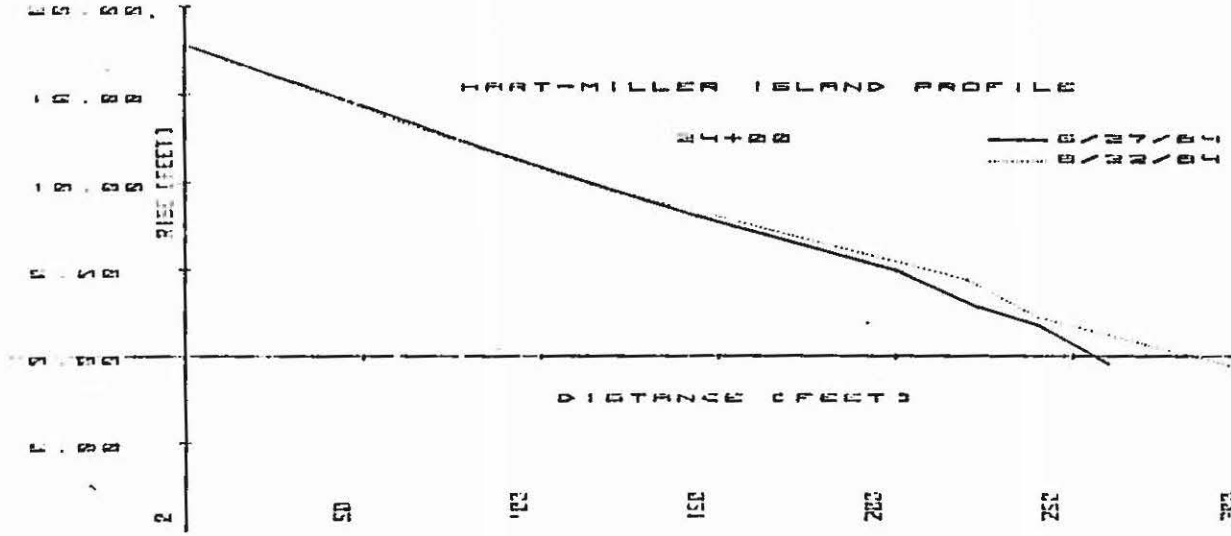
TABLE B-1. DISTANCE AND ELEVATION DATA FOR THE HART-MILLER RECREATIONAL BEACH PROFILES SHOWN IN FIGURES B-1 THROUGH B-14.

Station	First Survey Elev. (ft)	First Survey Dist. from ℄ (ft)	Second Survey Elev. (ft)	Second Survey Dist. from ℄ (ft)	Third Survey Elev. (ft)	Third Survey Dist. from ℄ (ft)
40+00	17.50	-	17.52	-	17.46	-
	14.80	48	14.66	53	13.92	66
	11.82	100	8.50	150	9.56	140
	8.13	164	4.10	200	4.69	200
	3.72	207	2.95	230	2.88	220
	0.30	247	1.05	245	2.71	224
			-0.35	275	1.84	233
					-0.06	257
					-0.34	285
44+00	17.83	-	17.92	-	17.81	-
	14.08	62	14.19	50	13.70	64
	10.80	111	11.26	101	9.66	132
	5.08	202	8.56	147	7.52	171
	0.28	226	4.92	188	3.47	200
			3.39	200	2.57	201
			1.92	210	0.27	220
			0.45	220	-0.55	258
48+00	18.06	-	17.94	-	18.01	-
	16.22	48	14.73	63	14.51	58
	11.61	107	10.00	109	12.25	104
	7.75	161	7.26	153	8.71	147
	0	205	3.02	164	7.24	164
			2.14	173	4.28	167
			0.52	182	3.06	180
					2.76	180
					0.51	200
					-0.44	240

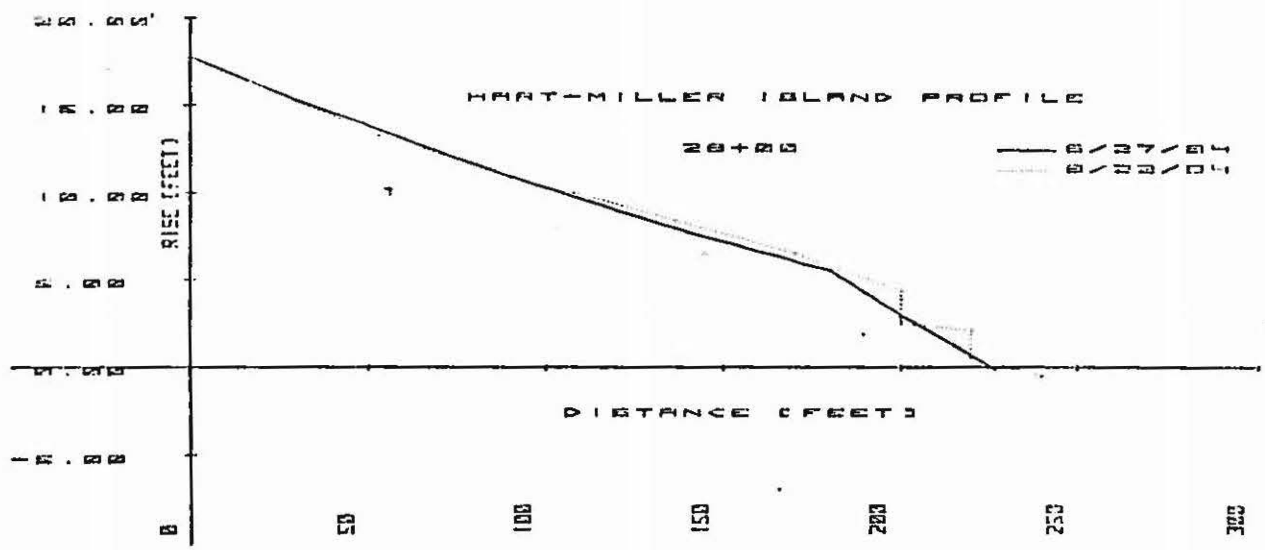
BM at Station 30+00 elevation 14.57' mlw
BM 22' from ℄ of dike roadway at station 30+00
All other stations are at ℄ of dike roadway


HART-MILLER ISLAND PROFILE
20+40
6/21/84
RISE (FEET)
20.00
15.00
10.00
5.00
0.00
-5.00
DISTANCE (FEET)
0
50
100
150
200
250
322

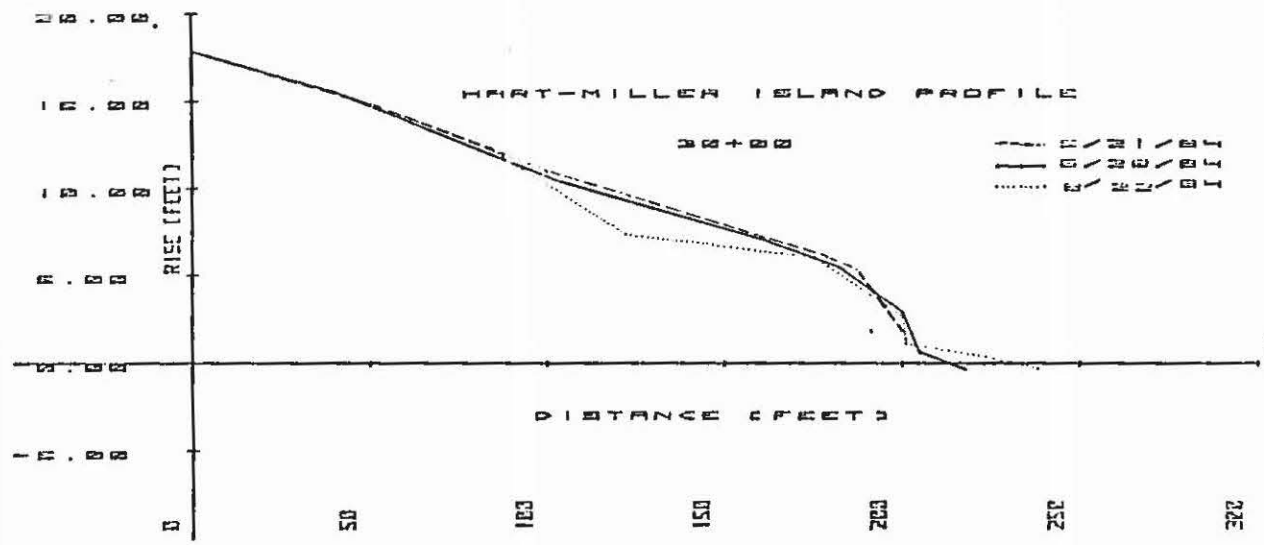
Graph A-1


HART-MILLER ISLAND PROFILE
RISE (FEET)
DISTANCE (FEET)
50
150
200
250
300

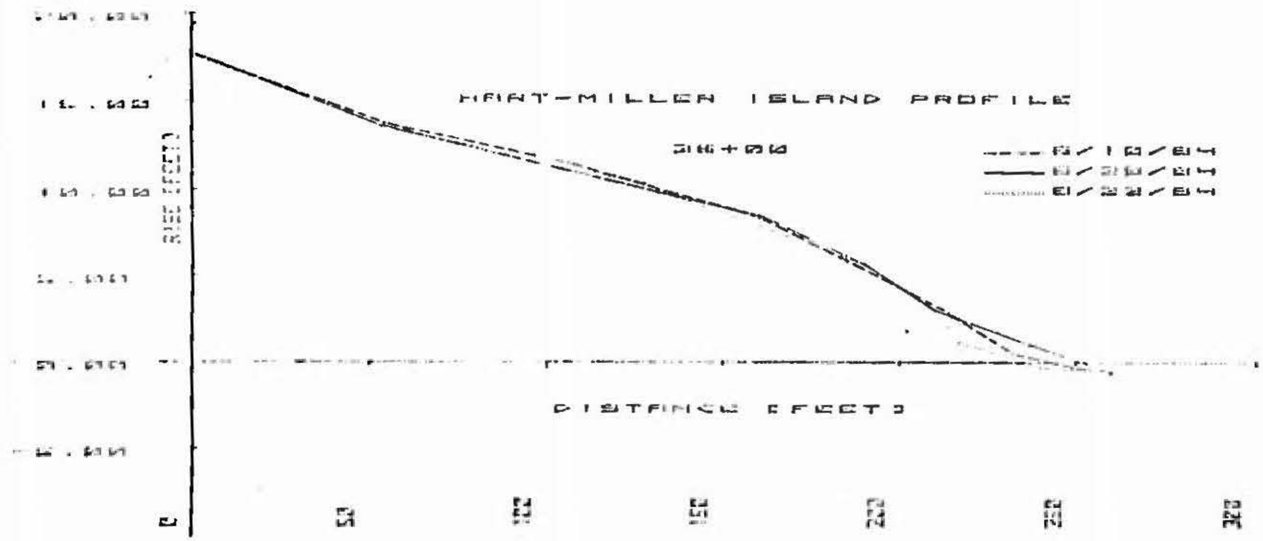
Graph B-3


HART-MILLER ISLAND PROFILE
28+00
6/27/84
8/23/84
RISE (FEET)
20.00
15.00
10.00
5.00
0.00
-5.00
DISTANCE (FEET)
0
50
100
150
200
250
300

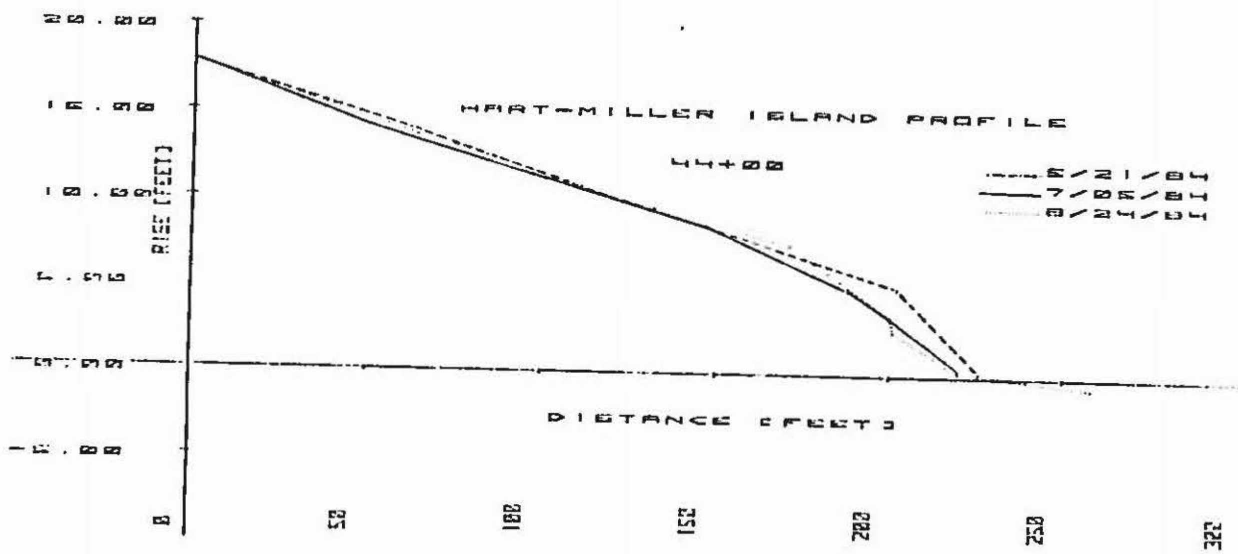
Graph B-5


HART-MILLER ISLAND PROFILE
RISE (FEET)
DISTANCE (FEET)
20.00
15.00
10.00
5.00
0.00
-5.00
0
50
100
150
200
250
300

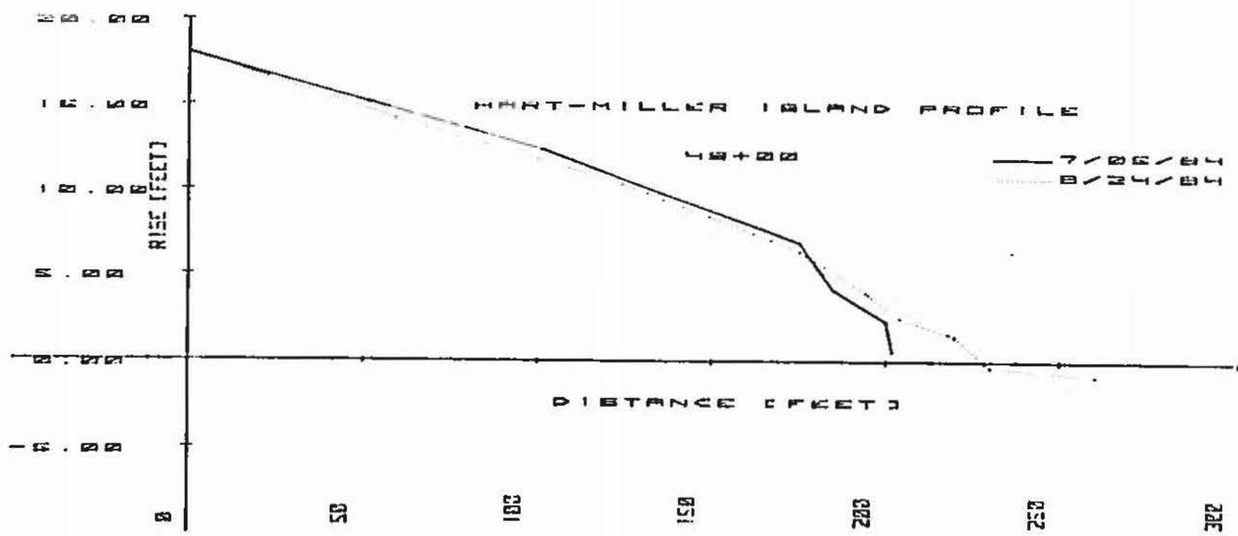
Graph B-7



Graph B-9


HART-MILLER ISLAND PROFILE
44+00
5/21/84
7/05/84
8/24/84
RISE (FEET)
DISTANCE (FEET)
20.00
15.00
10.00
5.00
0.00
-5.00
0
50
100
150
200
250
322

Graph B-11



HART-MILLER ISLAND PROFILE
48+00
7/06/84
8/24/84
RISE [FEET]
20.00
15.00
10.00
5.00
0.00
-5.00
DISTANCE [FEET]
0
50
100
150
200
250
300

Graph B-13

APPENDIX C

BATHYMETRIC CHANGES AROUND HART AND MILLER ISLANDS

Supplemental Report
to
ASSESSMENT OF THE ENVIRONMENTAL IMPACTS OF
CONSTRUCTION AND OPERATION OF THE
HART AND MILLER ISLANDS CONTAINMENT FACILITY

Third Interpretive Report
August 1983 - August 1984

Submitted to
Maryland Water Resources Administration

Prepared by
Maryland Geological Survey

BATHYMETRIC CHANGES AROUND HART AND MILLER ISLANDS

INTRODUCTION

The physical presence of the Hart and Miller Islands dike structure may cause certain changes in the bathymetry in the vicinity around the islands. These changes may be accretionary or erosional depending on the alteration of the wave patterns by the emplacement of the dike wall, the slope of the dike face, and the availability of sediments during and after dike construction. Other factors which could effect change in the bathymetry are activities associated with the construction and the operation of the dike facility. Examples of such activities are dredging of channels outside the dike structure and scouring caused by the propellers of tugs and dredges in shallow areas around the facility.

In order to document these changes, if any, the bathymetry in the Hart and Miller Islands vicinity would have to be measured before and after the construction of the dike facility and following severe storm events during the life of the structure. In July, 1981, the pre-construction bathymetry in the vicinity of the islands was surveyed, the results of which have been reported by Zoltan and Kerhin (1981). A second bathymetric survey was conducted in the winter of 1983 immediately following the completion of the diked disposal facility. The track lines, navigational and survey equipment and analytical methodology were consistent with the first bathymetric survey. Presented in this report are the results of the second survey and a discussion of the changes in the bathymetry which have occurred in the time between the first and second surveys.

PROCEDURES

The bathymetry surrounding the Hart and Miller Islands was surveyed in the summer of 1981 and again in December of 1983. The survey area was bordered to the west (island side) by the dike wall and/or the 6 foot (1.8m) contour and ran a distance of 2km offshore to the east. Latitude 39°16'06" bounded the area to the north and latitude 39°12'24" to the south. In all, an area of approximately 21 km^2 eventually was surveyed (Figure 1).

The sounding data were gathered using a Raytheon DE-719 recording fathometer coupled to a high-resolution 200 kHz transducer. Continous chart recordings were taken with all measurements read in meters and tenths.

Navigation was supplied by a Loran-C navigational system supplemented by a Teledyne-Hastings system. The Raydist system was linked to the DE-719 and referenced to the bathymetric chart recording by the way of an inter-connected auto-firing relay. This auto-relay system was set to record one minute fix marks during all survey work.

Bathymetric Grid

The sampling grid was composed of 34 transects aligned in a NE-SW direction. Approximately half of the study area was covered with a grid interval of 100 meters; the remainder was spaced at 200 meters. Four transverse runs were made intersecting all the NE-SW sampling transects.

The boat was navigated along Loran-C coordinates with speed held to 4 to 5 knots. The Loran-C navigator provided boat speed and course information which enabled prompt adjustments to be made to correct for wind and tide effects.

Data Reduction

In the laboratory, the bathymetry was digitized at every time fixed, marked and plotted on a base map. These data represent uncorrected depths relative to a mean low water datum. To correct the data to a mean low water datum, tidal heights with respect to time had to be determined. Therefore, estimation of tidal heights had to be interpolated from three known tidal stations in the Upper Bay region. Estimated time of tide arrival at the Hart and Miller Island area was based on rate compiled through comparison plots of the change in the Matapeake to Baltimore tidal velocity. Adjustments were made at 10 cm increments within each stage of the tide cycle. These tidal adjustments were applied to each measured depth sounding to correct to a mean low water datum. The uncorrected and corrected data were digitally stored.

The corrected data were replotted on a six-second Mercator grid system, the same grid used in the first bathymetric survey. Within a six-second Mercator cell, all data were averaged and a final depth per cell was calculated. The corrected data from both bathymetric surveys were overlaid and the differences plotted. The differences between the two surveys are interpreted as depositional or erosional changes. If the differences between the two surveys are within $\pm$ 0.30 meters, these areas are interpreted as no change. Changes within these bounds are less than the resolution of the system and, therefore, cannot be designated as depositional or erosional.

RESULTS

Plate 1 is a map of the recently collected bathymetry around the diked facility. The bathymetric contours generelly follow the outline of the diked facility except in two areas, the north end and the southern end. The contours in the north end depict a steeper gradient and the water depths are generally greater than the rest of the study area.

The comparison of the most recent bathymetry (1983) with the 1981 bathymetry reveals several interesting features (Plate 2). Most of the area exhibits very low erosion or no change. The erosional changes range from -0.30 to -0.50 meters, particularly in the central portion of the study area. This is the area of the handling facility and docking areas. The area of low deposition is along the base of the dike structure in this general area. The areas of low erosion are associated with the areas of no change. Although the

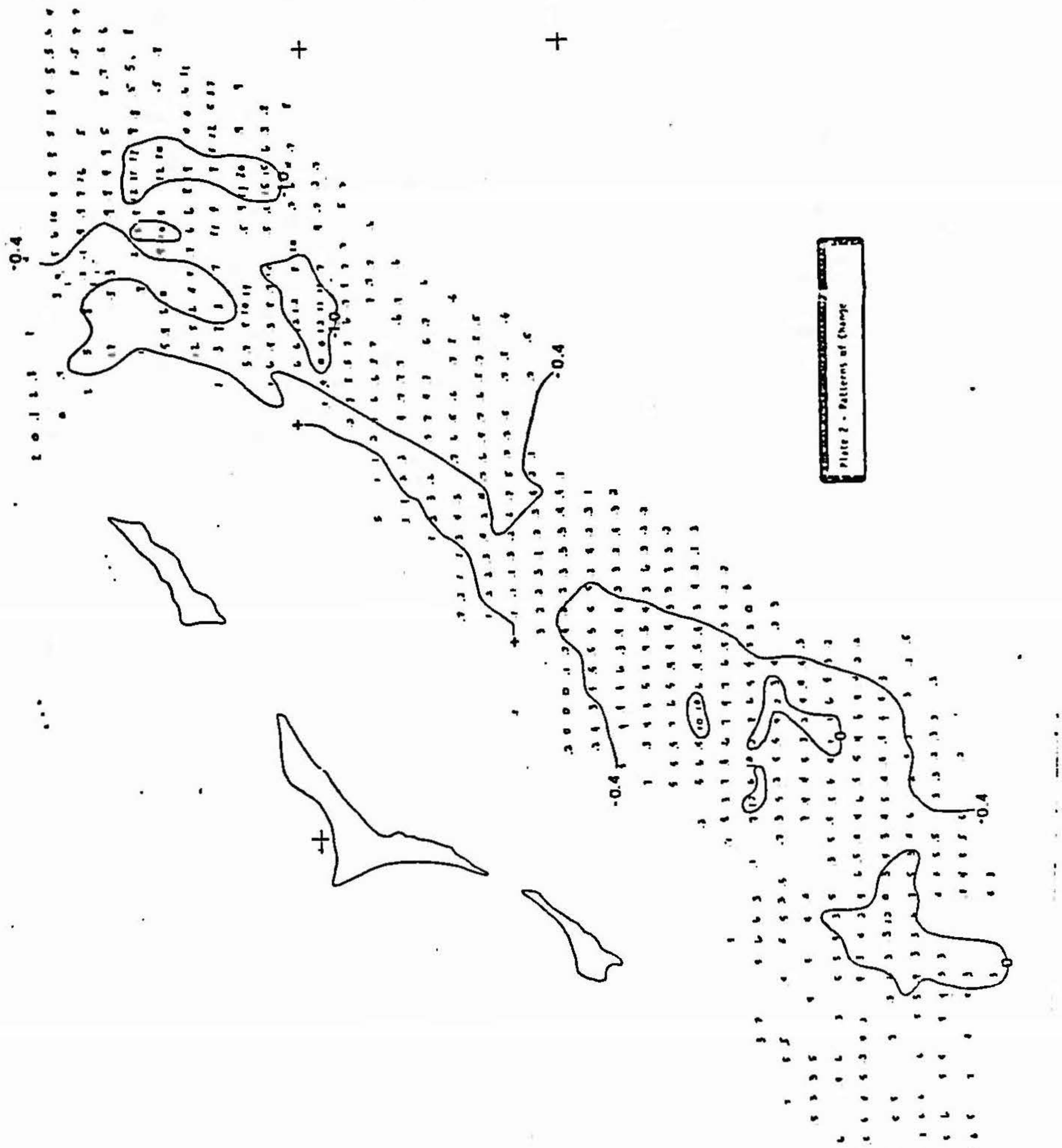


Plate 2 - Patterns of Change

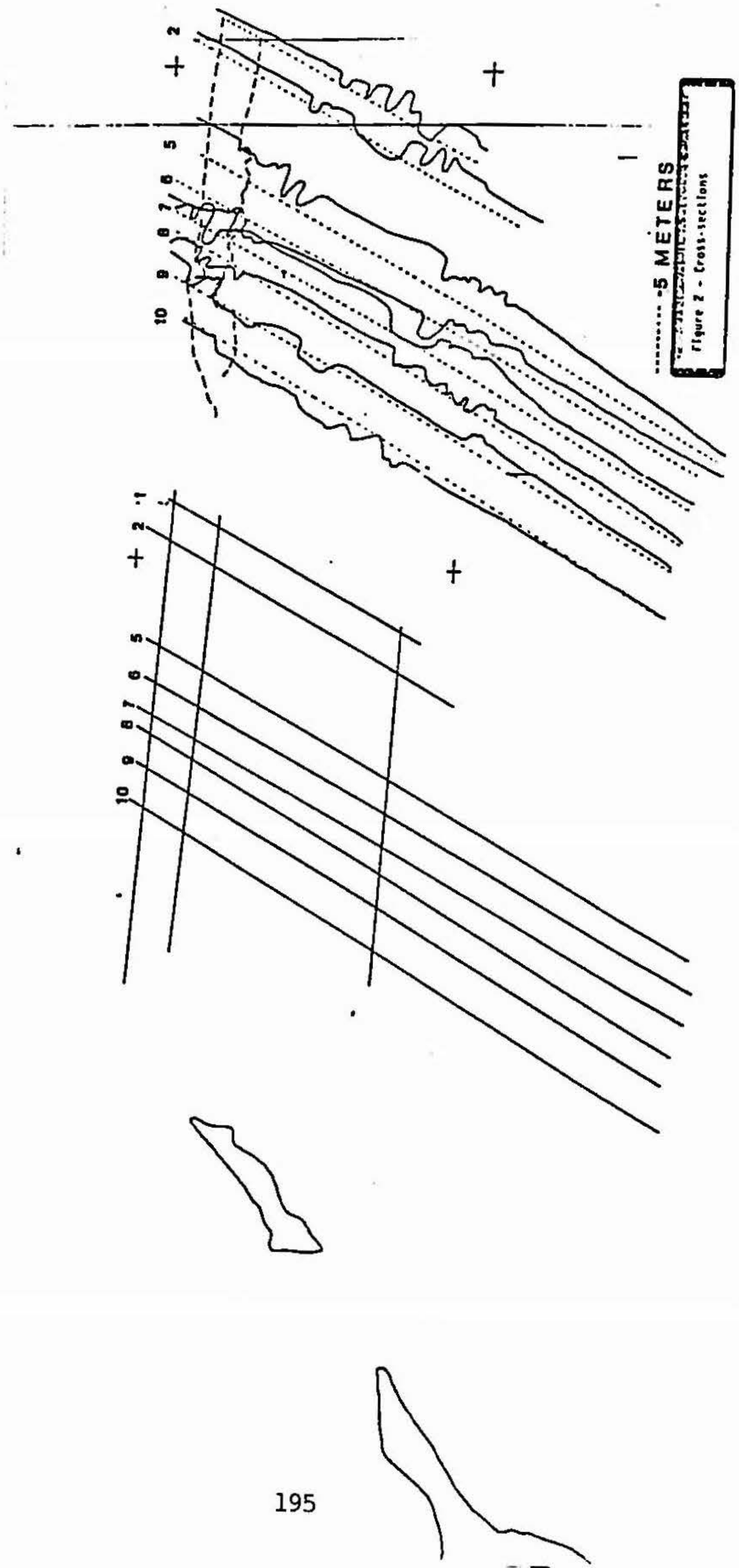


Figure 2 - Cross-sections

UNCORRECTED BATHYMETRIC DATA

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#1	93.28	702.99	39°14'12"	76°21'0"	115517	-5.17	
11/18/83	92.96	706.42	39°14'08"	76°21'03"	115559	-5.22	
	92.15	717.60	39°13'54"	76°21'15"	115759	-5.22	
	92.02	720.44	39°13'50"	76°21'18"	115829	-5.20	
	91.85	723.26	39°13'46"	76°21'21"	115859	-5.22	
	91.82	726.03	39°13'43"	76°21'24"	115929	-5.20	
	91.87	728.85	39°13'39"	76°21'26"	115959	-5.09	
	91.95	731.65	39°13'35"	76°21'28"	120029	-5.09	
	92.14	734.41	39°13'31"	76°21'30"	120059	-5.04	
	92.31	737.21	39°13'27"	76°21'33"	120129	-5.07	
	92.43	739.94	39°13'23"	76°21'35"	120159	-5.17	
	92.53	742.73	39°13'19"	76°21'37"	120229	-5.32	
	92.45	745.55	39°13'16"	76°21'40"	120259	-5.32	
	92.44	748.31	39°13'12"	76°21'43"	120329	-5.37	
	92.39	751.07	39°13'08"	76°21'46"	120359	-5.37	
	92.25	753.93	39°13'05"	76°21'49"	120429	-5.30	
	92.07	756.65	39°13'01"	76°21'52"	120459	-5.37	
	91.84	759.43	39°12'58"	76°21'55"	120529	-5.42	
	91.73	762.24	39°12'54"	76°21'58"	120559	-5.45	
	91.53	764.96	39°12'51"	76°22'02"	120629	-5.42	
	91.18	767.67	39°12'48"	76°22'05"	120659	-5.40	
	91.19	770.46	39°12'44"	76°22'08"	120729	-5.37	
	91.38	773.26	39°12'40"	76°22'11"	120759	-5.14	
	91.65	776.09	39°12'37"	76°22'13"	120829	-5.32	
	91.89	778.85	39°12'33"	76°22'15"	120859	-5.30	
	92.01	781.56	39°12'29"	76°22'18"	120929	-5.27	
	92.23	784.39	39°12'25"	76°22'21"	120959	-5.27	
	92.47	787.20	39°12'22"	76°22'23"	121029	-5.20	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#3	88.25	705.48	39°14'15"	76°21'15"	122820	-5.14	
11/18/83	88.26	706.33	39°14'14"	76°21'15"	122830	-5.14	
	88.44	708.99	39°14'10"	76°21'17"	122900	-5.14	
	88.29	711.75	39°14'06"	76°21'20"	122930	-5.17	
	88.12	714.49	39°14'03"	76°21'23"	123000	-5.17	
	87.87	717.20	39°13'59"	76°21'25"	123030	-5.14	
	87.55	719.93	39°13'56"	76°21'29"	123100	-5.14	
	87.33	722.72	39°13'52"	76°21'32"	123130	-5.14	
	87.19	725.45	39°13'48"	76°21'34"	123200	-5.14	
	87.03	728.19	39°13'45"	76°21'37"	123230	-5.17	
	86.94	730.98	39°13'41"	76°21'40"	123300	-5.20	
	86.76	733.71	39°13'38"	76°21'43"	123330	-5.20	
	86.63	736.47	39°13'34"	76°21'45"	123400	-5.25	
	86.53	739.21	39°13'30"	76°21'48"	123430	-5.30	
	86.45	741.96	39°13'27"	76°21'51"	123500	-5.42	
	86.44	744.68	39°13'23"	76°21'53"	123530	-4.84	
	86.55	747.41	39°13'19"	76°21'56"	123600	-5.42	
	86.60	750.14	39°13'16"	76°21'58"	123630	-5.12	
	86.52	752.85	39°13'12"	76°22'01"	123700	-5.42	
	86.31	755.60	39°13'09"	76°22'04"	123730	-5.37	
	86.08	758.29	39°13'05"	76°22'07"	123800	-5.42	
	85.77	761.05	39°13'02"	76°22'11"	123830	-5.40	
	85.39	763.75	39°12'59"	76°22'14"	123900	-5.42	
	85.17	766.46	39°12'55"	76°22'17"	123930	-5.45	
	85.01	769.22	39°12'52"	76°22'20"	124000	-5.40	
	85.01	771.93	39°12'48"	76°22'23"	124030	-5.40	
	84.98	774.67	39°12'45"	76°22'26"	124100	-5.37	
	85.12	777.47	39°12'41"	76°22'29"	124130	-5.35	
	85.18	780.19	39°12'37"	76°22'31"	124200	-5.32	
	85.16	782.94	39°12'34"	76°22'34"	124230	-5.25	
	85.16	785.70	39°12'30"	76°22'37"	124300	-5.30	
	85.49	788.37	39°12'27"	76°22'39"	124330	-5.22	
	85.52	788.58	39°12'26"	76°22'40"	124332	-5.22	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#5	82.65	709.31	39°14'16"	76°21'32"	130130	-4.96	
11/18/83	82.29	711.92	39°14'13"	76°21'35"	130200	-4.91	
	82.08	714.60	39°14'09"	76°21'38"	130230	-4.88	
	81.83	717.33	39°14'06"	76°21'41"	130300	-4.91	
	81.66	720.00	39°14'02"	76°21'43"	130330	-5.01	
	81.53	722.65	39°13'59"	76°21'46"	130400	-5.06	
	81.44	725.35	39°13'55"	76°21'48"	130430	-5.09	
	81.30	728.02	39°13'51"	76°21'51"	130500	-5.03	
	81.02	730.62	39°13'48"	76°21'54"	130530	-5.09	
	80.89	733.31	39°13'45"	76°21'57"	130600	-5.14	
	80.85	736.02	39°13'41"	76°21'59"	130630	-5.19	
	80.70	738.73	39°13'37"	76°22'02"	130700	-5.19	
	80.51	741.37	39°13'34"	76°22'05"	130730	-5.24	
	80.35	744.10	39°13'30"	76°22'07"	130800	-5.37	
	80.28	746.78	39°13'27"	76°22'10"	130830	-5.37	
	80.17	749.44	39°13'23"	76°22'13"	130900	-5.47	
	79.94	752.14	39°13'20"	76°22'16"	130930	-5.65	
	79.86	754.88	39°13'16"	76°22'18"	131000	-5.70	
	79.80	757.59	39°13'13"	76°22'21"	131030	-5.98	
	79.77	760.28	39°13'09"	76°22'24"	131100	-5.85	
	79.82	763.02	39°13'05"	76°22'26"	131130	-5.52	
	79.63	765.73	39°13'02"	76°22'29"	131200	-5.01	
	79.61	768.40	39°12'58"	76°22'32"	131230	-5.55	
	79.60	771.10	39°12'55"	76°22'34"	131300	-5.39	
	79.60	773.84	39°12'51"	76°22'37"	131330	-5.39	
	79.61	776.53	39°12'48"	76°22'40"	131400	-5.37	
	79.64	779.22	39°12'44"	76°22'42"	131430	-5.37	
	79.67	781.95	39°12'40"	76°22'45"	131500	-5.34	
	79.71	784.67	39°12'37"	76°22'48"	131530	-5.34	
	79.76	787.40	39°12'36"	76°22'57"	131600	-5.34	
	79.77	790.07	39°12'30"	76°22'53"	131630	-5.29	
	79.79	792.09	39°12'27"	76°22'56"	131651	-5.29	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
78.60	729.01	39°13'53"	76°21'59"	133030	-5.20	
78.83	726.17	39°13'57"	76°21'56"	133100	-5.12	
79.04	723.37	39°14'01"	76°21'53"	133130	-5.04	
79.29	720.52	39°14'04"	76°21'50"	133200	-4.89	
79.51	717.69	39°14'08"	76°21'47"	133230	-4.76	
79.76	714.88	39°14'12"	76°21'44"	133300	-4.63	
79.95	712.07	39°14'15"	76°21'41"	133330	-4.63	
80.23	709.17	39°14'19"	76°21'38"	133400	-4.68	
80.37	706.34	39°14'23"	76°21'36"	133430	-4.63	
80.57	703.50	39°14'27"	76°21'33"	133500	-4.53	
80.77	700.65	39°14'31"	76°21'30"	133530	-4.48	
80.98	697.78	39°14'35"	76°21'28"	133600	-4.45	
81.29	694.95	39°14'38"	76°21'25"	133630	-4.33	
81.53	692.23	39 14'42"	76 21'22"	133658	-4.04	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
73.84	752.84	39°13'25"	76°22'31"	134930	-5.54	
73.85	755.45	39°13'22"	76°22'33"	135000	-5.59	
73.81	758.06	39°13'18"	76°22'35"	135030	-5.69	
73.71	760.75	39°13'15"	76°22'38"	135100	-5.64	
73.58	763.42	39°13'11"	76°22'41"	135130	-5.59	
73.51	766.06	39°13'08"	76°22'43"	135200	-5.51	
73.47	768.72	39°13'04"	76°22'46"	135230	-5.48	
73.45	771.42	39°13'00"	76°22'49"	135300	-5.13	
73.32	774.04	39°12'57"	76°22'51"	135330	-5.48	
73.17	776.64	39°12'54"	76°22'54"	135400	-5.41	
73.13	779.32	39°12'50"	76°22'57"	135430	-5.36	
73.14	781.99	39°12'47"	76°23'00"	135500	-5.31	
73.07	784.66	39°12'43"	76°23'02"	135530	-5.28	
73.19	787.26	39°12'40"	76°23'05"	135600	-5.23	
73.26	789.93	39°12'36"	76°23'07"	135630	-5.20	
73.31	792.63	39°12'32"	76°23'10"	135700	-5.18	
73.34	795.29	39°12'29"	76°23'13"	135730	-5.18	
73.37	795.78	39°12'28"	76°23'13"	135735		

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
72.72	744.07	39°13'39"	76°22'26"	140930	-5.64	
72.83	741.27	39°13'43"	76°22'23"	141000	-5.38	
72.90	738.42	39°13'46"	76°22'21"	141030	-5.31	
72.92	735.56	39°13'50"	76°22'18"	141100	-5.20	
73.00	732.66	39°13'54"	76°22'16"	141130	-5.10	
73.14	729.85	39°13'58"	76°22'13"	141200	-5.05	
73.29	727.00	39°14'02"	76°22'10"	141230	-4.97	
73.48	724.13	39°14'06"	76°22'08"	141300	-4.74	
73.65	721.28	39°14'10"	76°22'05"	141330	-4.62	
73.99	718.47	39°14'14"	76°22'02"	141400	-4.57	
74.35	715.63	39°14'17"	76°21'59"	141430	-4.49	
74.61	712.70	39°14'21"	76°21'56"	141500	-4.52	
74.86	709.91	39°14'25"	76°21'53"	141529	-4.57	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#10	65.07	800.05	39°12'31"	76°23'36"	143453	-5.01	
11/18/83	64.81	799.62	39°12'31"	76°23'36"	143500	-4.98	
	64.77	796.84	39°12'35"	76°23'33"	143530	-4.98	
	64.79	794.04	39°12'39"	76°23'30"	143600	-4.98	
	64.54	791.22	39°12'43"	76°23'28"	143630	-4.98	
	64.46	788.36	39°12'47"	76°23'25"	143700	-4.98	
	64.59	785.52	39°12'50"	76°23'22"	143730	-4.98	
	64.73	782.70	39°12'54"	76°23'19"	143800	-5.01	
	64.77	779.82	39°12'58"	76°23'16"	143830	-5.06	
	64.92	776.93	39°13'02"	76°23'13"	143900	-5.06	
	65.11	774.11	39°13'05"	76°23'10"	143930	-5.08	
	65.26	771.26	39°13'09"	76°23'07"	144000	-5.11	
	65.32	768.43	39°13'13"	76°23'05"	144030	-5.19	
	65.30	765.52	39°13'17"	76°23'02"	144100	-5.34	
	65.30	762.64	39°13'21"	76°23'00"	144130	-5.44	
	65.32	759.79	39°13'25"	76°22'57"	144200	-4.45	
	65.32	756.95	39°13'29"	76°22'55"	144230	-4.12	
	65.48	754.05	39°13'33"	76°22'52"	144300	-4.30	
	65.63	751.14	39°13'37"	76°22'49"	144330	-4.98	
	65.88	748.24	39°13'41"	76°22'46"	144400	-4.86	
	66.14	745.32	39°13'44"	76°22'43"	144430	-5.16	
	66.36	742.41	39°13'48"	76°22'40"	144500	-5.31	
	66.65	739.48	39°13'52"	76°22'37"	144530	-5.21	
	66.89	736.55	39°13'56"	76°22'35"	144600	-4.91	
	67.15	733.65	39°14'00"	76°22'32"	144630	-4.78	
	67.37	730.78	39°14'04"	76°22'29"	144700	-4.63	
	67.79	727.91	39°14'07"	76°22'26"	144730	-4.55	
	68.36	725.08	39°14'11"	76°22'22"	144800	-4.55	
	68.53	722.94	39°14'14"	76°22'20"	144823	-4.50	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Corredtion
	110.68	644.62	39°15'12"	76°19'26"	102600	6.71	
	110.96	647.42	39°09'24"	76°26'27"	102630	6.20	
	110.93	650.29	39°15'04"	76°19'30"	102700	6.13	
	110.93	653.17	39°15'00"	76°19'32"	102730	5.64	
	110.85	656.07	39°14'56"	76°19'35"	102800	5.75	
	110.55	658.94	39°14'53"	76°19'38"	102830	5.67	
	110.48	661.59	39°14'49"	76°19'40"	102857	5.72	
#3	107.74	669.31	39°14'42"	76°19'54"	103054	6.13	
11/21	107.55	669.03	39°14'42"	76°19'54"	103100	6.11	
	107.62	666.50	39°14'46"	76°19'52"	103130	6.16	
	107.75	663.84	39°14'49"	76°19'49"	103200	6.13	
	107.43	661.28	39°14'53"	76°19'48"	103230	6.21	
	107.51	658.69	39°14'57"	76°19'46"	103300	6.31	
	107.72	656.09	39°15'00"	76°19'43"	103330	6.29	
	107.55	653.55	39°15'04"	76°19'41"	103400	6.52	
	107.67	650.95	39°15'07"	76°19'39"	103430	6.49	
	107.93	648.34	39°15'11"	76°19'36"	103500	6.31	
	108.16	645.68	39°15'14"	76°19'33"	103530	4.83	
	108.33	643.07	39°15'18"	76°19'31"	103600	4.70	
	108.57	640.43	39°15'21"	76°19'28"	103630	5.88	
	108.72	637.82	39°15'24"	76°19'25"	103700	5.49	
	108.81	635.25	39°15'28"	76°19'23"	103730	4.24	
	108.71	632.69	39°15'32"	76°19'21"	103800	6.26	
	108.81	630.07	39°15'35"	76°19'19"	103830	6.26	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
105.17	660.98	39°14'57"	76°19'54"	105100	6.86	
104.75	663.88	39°14'53"	76°19'57"	105130	6.71	
104.45	666.83	39°14'49"	76°20'01"	105200	6.58	
104.27	669.74	39°14'45"	76°20'04"	105230	6.51	
104.30	672.64	39°14'41"	76°20'06"	105300	6.38	
104.47	675.58	39°14'37"	76°20'08"	105330	6.28	
104.85	678.44	39°14'33"	76°20'09"	105400	6.10	
105.04	681.34	39°14'29"	76°20'11"	105430	6.02	
104.91	684.33	39°14'25"	76°20'14"	105500	5.92	
104.54	687.28	39°14'21"	76°20'18"	105530	5.87	
104.21	690.19	39°14'17"	76°20'21"	105600	5.84	
103.91	693.12	39°14'14"	76°20'25"	105630	5.66	
103.71	696.07	39°14'10"	76°20'28"	105700	5.64	
103.69	699.02	39°14'06"	76°20'30"	105730	5.36	
103.65	701.97	39°14'02"	76°20'33"	105800	5.48	
103.51	704.92	39°13'58"	76°20'36"	105830	5.54	
103.57	707.85	39°13'54"	76°20'39"	105900	5.48	
103.69	710.79	39°13'50"	76°20'41"	105930	5.46	
103.48	713.71	39°13'46"	76°20'44"	110000	5.46	
103.14	716.62	39°13'43"	76°20'48"	110030	5.46	
103.27	718.54	39°13'40"	76°20'49"	110050	5.43	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
6	102.81	620.47	39°15'57"	76°19'28"	113417	5.23	
1/21	102.32	621.32	39°15'56"	76°19'31"	113430	5.38	
	102.01	624.26	39°15'53"	76°19'34"	113500	5.69	
	101.83	627.23	39°15'49"	76°19'36"	113530	6.86	
	101.64	630.27	39°15'44"	76°19'39"	113600	5.28	
	101.42	633.28	39°15'40"	76°19'42"	113630	5.51	
	101.24	636.27	39°15'36"	76°19'45"	113700	5.66	
	101.08	639.30	39°15'32"	76°19'48"	113730	5.74	
	100.97	642.33	39°15'28"	76°19'50"	113800	5.77	
	100.79	645.39	39°15'24"	76°19'53"	113830	5.82	
	100.66	648.47	39°15'20"	76°19'56"	113900	5.92	
	100.50	651.54	39°15'16"	76°19'59"	113930	6.07	
	100.23	654.62	39°15'12"	76°20'02"	114000	4.26	
	99.96	657.73	39°15'08"	76°20'05"	114030	5.99	
	99.77	660.85	39°15'03"	76°20'08"	114100	6.43	
	99.63	663.93	39°14'59"	76°20'11"	114130	6.40	
	99.30	667.02	39°14'55"	76°20'14"	114200	6.53	
	99.05	670.14	39°14'51"	76°20'18"	114230	6.12	
	98.92	673.25	39°14'47"	76°20'20"	114300	6.05	
	98.87	676.34	39°14'43"	76°20'23"	114330	5.97	
	98.98	679.45	39°14'38"	76°20'25"	114400	5.89	
	99.06	682.53	39°14'34"	76°20'28"	114430	5.82	
	99.18	685.61	39°14'30"	76°20'30"	114500	5.79	
	99.06	688.73	39°14'25"	76°20'33"	114530	5.77	
	98.90	691.86	39°14'21"	76°20'36"	114600	5.74	
	98.86	695.01	39°14'17"	76°20'39"	114630	5.77	
	98.81	698.11	39°14'13"	76°20'42"	114700	5.69	
	98.79	699.14	39°14'11"	76°20'43"	114709	5.66	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	TIdal Correction
#8	98.83	623.17	39°15'59"	76°19'42"	120510	4.82	
11/21	98.94	624.96	39°15'56"	76°19'43"	120530	5.71	
	99.25	627.77	39°15'51"	76°19'44"	120600	5.15	
	99.35	630.69	39°15'47"	76°19'46"	120630	5.79	
	99.28	633.69	39°15'43"	76°19'48"	120700	5.92	
	99.08	636.72	39°15'39"	76°19'51"	120730	6.12	
	98.80	639.75	39°15'35"	76°19'54"	120800	6.15	
	98.58	642.76	39°15'31"	76°19'57"	120830	6.07	
	98.39	645.75	39°15'27"	76°20'00"	120900	6.20	
	98.11	648.77	39°15'23"	76°20'03"	120930	6.12	
	97.88	651.81	39°15'19"	76°20'06"	121000	6.48	
	97.60	654.86	39°15'15"	76°20'09"	121030	5.41	
	97.16	657.85	39°15'11"	76°20'13"	121100	6.45	
	96.62	660.88	39°15'07"	76°20'17"	121130	6.30	
	95.90	663.82	39°15'04"	76°20'21"	121200	6.10	
	95.29	666.86	39°15'01"	76°20'25"	121230	6.28	
	95.07	669.90	39°14'57"	76°20'28"	121300	5.89	
	94.88	672.96	39°14'53"	76°20'31"	121330	5.87	
	94.69	676.03	39°14'48"	76°20'34"	121400	5.89	
	94.68	679.05	39°14'44"	76°20'36"	121430	5.87	
	94.63	682.08	39°14'40"	76°20'39"	121500	5.82	
	94.76	685.07	39°14'36"	76°20'41"	121530	5.79	
	94.87	688.08	39°14'31"	76°20'43"	121600	5.74	
	94.45	691.14	39°14'28"	76°20'47"	121630	5.71	
	93.89	694.14	39°14'24"	76°20'51"	121700	5.64	
	93.48	697.21	39°14'20"	76°20'54"	121730	5.56	
	93.04	700.25	39°14'17"	76°20'58"	121800	5.48	
	92.72	702.57	39°14'14"	76°21'01"	181822	5.56	

	Red	Green	Latitude	Longitude	TIme	Uncorrected Depth	Tidal Correction
#10	94.21	627.02	39°15'59"	76°19'58"	123551	5.29	
11/21	93.79	627.21	39°16'00"	76°20'00"	123600	5.29	
	93.47	629.86	39°15'56"	76°20'02"	123630	5.37	
	93.45	632.73	39°15'52"	76°20'05"	123700	4.73	
	93.22	635.60	39°15'48"	76°20'07"	123730	4.52	
	92.90	638.50	39°15'45"	76°20'10"	123800	4.63	
	92.47	641.42	39°15'41"	76°20'1[illegible]"	123830	4.73	
	92.22	644.27	39°15'37"	76°20'16"	123900	4.40	
	91.80	647.14	39°15'34"	76°20'20"	123930	4.09	
	91.41	650.06	39°15'30"	76°20'23"	124000	4.70	
	91.02	652.98	39°15'26"	76°20'26"	124030	4.50	
	90.64	655.87	39°15'22"	76°20'29"	124100	5.06	
	90.35	658.79	39°15'19"	76°20'32"	124130	3.99	
	90.05	661.71	39°15'15"	76°20'35"	124200	4.88	
	89.72	664.71	39°15'11"	76°20'39"	124230	4.73	
	89.58	667.64	39°15'07"	76°20'41"	124300	4.65	
	89.43	670.60	39°15'03"	76°20'44"	124330	4.73	
	89.29	673.46	39°14'59"	76°20'46"	124400	4.78	
	88.94	676.36	39°14'55"	76°20'50"	124430	4.86	
	88.68	679.31	39°14'51"	76°20'53"	124500	5.06	
	88.12	682.17	39°14'48"	76°20'56"	124530	5.14	
	87.73	685.10	39°14'44"	76°21'00"	124600	5.14	
	87.54	688.05	39°14'40"	76°21'02"	124630	5.14	
	87.28	691.02	39°14'36"	76°21'05"	124700	5.14	
	87.21	693.98	39°14'32"	76°21'08"	124730	5.11	
	87.02	696.94	39°14'28"	76°21'11"	124800	5.14	
	86.95	699.90	39°14'24"	76°21'13"	124830	5.14	
	86.98	702.84	39°14'20"	76°21'16"	124900	5.21	
	86.87	705.84	39°14'16"	76°21'18"	124930	5.21	
	86.81	706.64	39°14'15"	76°21'19"	124938	5.21	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#12	83.63	688.16	39°14'45"	76°21'13"	125906	4.19	
	83.40	690.25	39°14'42"	76°21'15"	125930	4.26	
	83.31	693.10	39°14'38"	76°21'18"	130000	4.62	
	83.17	696.00	39°14'34"	76°21'20"	130030	4.85	
	82.86	698.88	39°14'31"	76°21'23"	130100	4.75	
	82.47	701.80	39°14'27"	76°21'27"	130130	4.75	
	82.07	704.69	39°14'23"	76°21'30"	130200	4.75	
	81.67	707.60	39°14'20"	76°21'33"	130230	4.82	
	81.35	710.49	39°14'16"	76°21'36"	130300	4.80	
	81.30	710.91	39°14'15"	76°21'37"	130304	4.80	
#14	75.69	708.17	39°14'26"	76°21'50"	131015	4.52	
11/21	75.60	708.73	39°14'26"	76°21'50"	131030	4.44	
	75.10	711.43	39°14'22"	76°21'54"	131100	4.41	
	74.44	714.07	39°14'19"	76°21'57"	131130	4.41	
	73.81	716.74	39°14'16"	76°22'01"	131200	4.41	
	73.51	719.49	39°14'13"	76°22'04"	131230	4.44	
	73.46	722.17	39°14'09"	76°22'06"	131300	4.49	
	73.40	724.89	39°14'05"	76°22'09"	131330	4.69	
	73.21	727.57	39°14'01"	76°22'11"	131400	4.90	
	72.84	730.32	39°13'58"	76°22'14"	131430	5.00	
	72.52	733.04	39°13'55"	76°22'17"	131500	5.05	
	72.09	735.76	39°13'51"	76°22'21"	131530	5.15	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
69.93	798.01	39°12'29"	76°23'23"	133124	5.14	
69.81	797.85	39°12'29"	76°23'23"	133130	5.04	
69.90	796.17	39°12'31"	76°23'21"	133200	5.04	
69.82	793.54	39°12'35"	76°23'19"	133230	5.02	
69.65	790.91	39°12'38"	76°23'16"	133300	5.14	
69.50	788.26	39°12'42"	76°23'14"	133330	5.09	
69.48	785.64	39°12'45"	76°23'11"	133400	5.22	
69.48	782.99	39°12'49"	76°23'09"	133430	5.22	
69.42	780.35	39°12'52"	76°23'06"	133500	5.22	
69.36	777.70	39°12'56"	76°23'04"	133530	5.27	
69.27	775.06	39°13'00"	76°23'02"	133600	5.35	
69.25	772.42	39°13'03"	76°22'59"	133630	5.25	
69.29	769.75	39°13'07"	76°22'57"	133700	5.37	
69.38	767.07	39°13'11"	76°22'54"	133730	5.48	
69.43	764.40	39°13'14"	76°22'51"	133800	5.68	
69.54	761.75	39°13'18"	76°22'49"	133830	5.63	
69.84	759.08	39°13'21"	76°22'46"	133900	4.81	
70.13	756.35	39°13'25"	76°22'43"	133930	5.32	
70.33	753.67	39°13'28"	76°22'40"	134000	5.35	
70.50	750.94	39°13'32"	76°22'37"	134030	4.99	
70.55	748.23	39°13'35"	76°22'35"	134100	5.42	
70.58	745.58	39°13'39"	76°22'32"	134130	5.09	
70.68	742.87	39°13'43"	76°22'30"	134200	5.25	
70.74	740.16	39°13'46"	76°22'28"	134230	5.09	
70.90	737.44	39°13'50"	76°22'25"	134300	5.04	
71.27	734.73	39°13'54"	76°22'22"	134330	4.99	
71.58	732.04	39°13'57"	76°22'19"	134400	4.89	
71.89	729.30	39°14'01"	76°22'16"	134430	4.66	
72.23	726.58	39°14'04"	76°22'13"	134500	4.51	
72.39	723.85	39°14'08"	76°22'10"	134530	4.43	
72.66	721.12	39°14'11"	76°22'08"	134600	4.38	
72.99	718.41	39°14'15"	76°22'05"	134630	4.33	
73.31	715.69	39°14'18"	76°22'02"	134700	4.30	
73.35	713.71	39°14'21"	76°22'00"	134722		

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#3	56.86	768.34	39°13'22"	76°23'25"	141545	4.35	
	56.66	769.59	39°13'21"	76°23'27"	141600	4.43	
	56.10	772.19	39°13'18"	76°23'30"	141630	4.48	
	55.45	774.78	39°13'15"	76°23'34"	141700	4.51	
	55.12	777.43	39°13'11"	76°23'37"	141730	4.51	
	54.93	780.07	39°13'08"	76°23'40"	141800	4.51	
	54.99	782.74	39°13'04"	76°23'42"	141830	4.58	
	55.10	785.40	39°13'00"	76°23'44"	141900	4.63	
	55.19	783.06	39°12'56"	76°23'46"	141930	4.63	
	55.22	790.75	39°12'53"	76°23'48"	142000	4.66	
	55.27	793.44	39°12'49"	76°23'51"	142030	4.71	
	54.83	796.10	39°12'46"	76°23'54"	142100	4.68	
	54.29	798.78	39°12'43"	76°23'58"	142130	4.68	
	54.06	801.43	39°12'39"	76°24'01"	142200	4.74	
	54.16	804.10	39°12'36"	76°24'03"	142230	4.74	
	54.61	806.77	39°12'32"	76°24'05"	142300	4.79	
	54.69	807.37	39°12'31"	76°24'06"	142307		

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
#4	40.33	815.36	39°12'34"	76°24'45"	141105	5.14	
	41.20	814.91	39°12'33"	76°24'42"	141130	5.11	
	41.26	812.13	39°12'37"	76°24'40"	141200	5.09	
	41.46	809.28	39°12'41"	76°24'37"	141230	5.06	
	41.84	806.42	39°12'45"	76°24'33"	141300	4.98	
	42.28	803.56	39°12'48"	76°24'30"	141330	4.98	
	42.76	800.68	39°12'52"	76°24'26"	141400	4.96	
	42.98	797.82	39°12'55"	76°24'23"	141430	4.91	
	43.35	794.89	39°12'59"	76°24'20"	141500	4.91	
	43.67	791.98	39°13'03"	76°24'17"	141530	4.88	
	43.90	789.11	39°13'07"	76°24'14"	141600	4.83	
	44.03	786.27	39°13'11"	76°24'11"	141630	4.86	
	44.25	783.39	39°13'15"	76°24'08"	141700	4.78	
	44.49	780.55	39°13'19"	76°24'06"	141730	4.68	
	44.17	779.34	39°13'21"	76°24'06"	141745	4.57	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
S1	93.67	764.98	39°12'49"	76°21'57"	145448	5.91	
XV4	93.56	765.81	39°12'48"	76°21'58"	145500	5.91	
11/29	91.66	765.57	39°12'50"	76°22'02"	145530	5.96	
	89.64	765.96	39°12'52"	76°22'07"	145600	6.04	
	87.65	766.56	39°12'53"	76°22'12"	145630	5.98	
	85.75	767.57	39°12'53"	76°22'17"	145700	5.96	
	83.95	768.83	39°12'53"	76°22'22"	145730	5.91	
	82.30	770.49	39°12'53"	76°22'28"	145800	6.04	
	80.53	771.84	39°12'53"	76°22'33"	145830	5.96	
	78.65	772.90	39°12'53"	76°22'38"	145900	5.88	
	76.80	774.05	39°12'54"	76°22'44"	145930	5.96	
	75.01	775.40	39°12'54"	76°22'49"	150000	5.88	
	73.14	776.50	39°12'54"	76°22'54"	150030	5.78	
	71.24	777.50	39°12'54"	76°22'59"	150100	5.73	
	69.60	779.16	39°12'54"	76°23'05"	150130	5.70	
	67.92	780.71	39°12'53"	76°23'10"	150200	5.63	
	66.16	782.10	39°12'53"	76°23'15"	150230	5.50	
	64.27	783.16	39°12'54"	76°23'21"	150300	5.35	
	62.35	784.14	39°12'54"	76°23'26"	150330	5.25	
	60.56	785.55	39°12'54"	76°23'31"	150400	5.12	
	58.76	786.84	39°12'54"	76°23'37"	150430	5.09	
	56.82	787.71	39°12'55"	76°23'42"	150500	5.07	
	54.82	788.42	39°12'56"	76°23'47"	150530	5.02	
	53.01	789.64	39°12'56"	76°23'52"	150600	5.02	
	51.40	791.39	39°12'56"	76°23'58"	150630	4.97	
	49.64	792.90	39°12'55"	76°24'03"	150700	4.97	
	47.73	793.96	39°12'56"	76°24'09"	150730	4.94	
	45.77	794.73	39°12'57"	76°24'14"	150800	4.97	
	43.83	795.63	39°12'58"	76°24'19"	150830	4.99	
	42.07	797.12	39°12'57"	76°24'25"	150900	4.97	
	40.41	798.80	39°12'57"	76°24'30"	150930	4.99	
	38.59	800.03	39°12'57"	76°24'36"	151000	4.97	
	37.65	800.65	39°12'57"	76°24'38"	151015	4.84	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
76.22	735.60	39°13'47"	76°22'10"	104200	-4.85	
76.41	733.05	39°13'50"	76°22'07"	104230	-4.74	
76.59	730.43	39°13'53"	76°22'05"	104300	-4.69	
76.67	727.81	39°13'57"	76°22'02"	104330	-4.57	
76.68	725.15	39°14'01"	76°22'00"	104400	-4.64	
77.17	722.50	39°14'04"	76°21'57"	104430	-4.46	
77.27	719.91	39°14'08"	76°21'55"	104500	-4.44	
77.35	717.30	39°14'11"	76°21'52"	104530	-4.34	
77.58	714.53	39°14'15"	76°21'50"	104600	-4.18	
77.87	712.03	39°14'18"	76°21'47"	104630	-4.23	
78.14	709.35	39°14'22"	76°21'44"	104700	-4.11	
78.46	706.73	39°14'25"	76°21'41"	104730	-4.08	
78.46	706.23	39°14'26"	76°21'41"	104736	-4.06	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
83.69	698.79	39°14'30"	76°21'21"	112200	-4.44	
84.15	696.12	39°14'33"	76°21'18"	112230	-4.44	
84.48	693.39	39°14'37"	76°21'15"	112300	-4.41	
84.52	690.75	39°14'40"	76°21'13"	112330	-4.34	
84.62	688.04	39°14'44"	76°21'10"	112400	-4.16	
84.91	685.33	39°14'47"	76°21'07"	112430	-3.93	
84.97	684.82	39°14'48"	76°21'07"	112435	-3.93	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
84.00	741.86	39°13'29"	76°21'57"	114300	-5.14	
83.96	744.73	39°13'26"	76°21'59"	114330	-5.21	
83.90	747.54	39°13'22"	76°22'02"	114400	-5.21	
83.76	750.40	39°13'18"	76°22'05"	114430	-5.21	
83.43	753.20	39°13'15"	76°22'08"	114500	-5.24	
83.17	756.04	39°13'11"	76°22'12"	114530	-5.19	
83.12	758.86	39°13'07"	76°22'14"	114600	-5.19	
83.23	761.67	39°13'04"	76°22'17"	114630	-5.16	
83.68	764.45	39°12'59"	76°22'19"	114700	-5.21	
83.88	767.28	39°12'56"	76°22'21"	114730	-5.16	
83.92	770.14	39°12'52"	76°22'24"	114800	-5.16	
83.92	770.90	39°12'51"	76°22'25"	114808	-5.16	

Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
92.26	693.40	39°14'27"	76°20'54"	152100	-5.26	
92.00	696.05	39°14'24"	76°20'57"	152130	-5.19	
91.73	698.70	39°14'20"	76°21'00"	152200	-5.19	
91.46	701.35	39°14'17"	76°21'03"	152230	-5.19	
91.15	704.02	39°14'14"	76°21'06"	152300	-5.16	
90.96	706.68	39°14'10"	76°21'09"	152330	-5.14	
90.84	709.35	39°14'06"	76°21'11"	152400	-5.11	
90.72	711.98	39°14'03"	76°21'14"	152430	-5.11	
90.57	714.66	39°13'59"	76°21'17"	152500	-5.14	
90.32	717.31	39°13'56"	76°21'19"	152530	-5.14	
90.15	719.99	39°13'53"	76°21'22"	152600	-5.14	
89.99	722.65	39°13'49"	76°21'25"	152630	-5.19	
89.82	725.33	39°13'46"	76°21'28"	152700	-5.14	
89.66	728.03	39°13'42"	76°21'31"	152730	-5.14	
89.60	730.69	39°13'39"	76°21'33"	152800	-5.16	
89.60	733.37	39°13'35"	76°21'36"	152830	-5.14	
89.56	734.06	39°13'34"	76°21'36"	152837		

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
XVI 12/1/83	116.72	611.24	39°15'51"	76°18'42"	145029	-4.63	
	115.28	611.83	39°15'52"	76°18'47"	145100	-4.73	
	114.03	613.77	39°15'51"	76°18'52"	145130	-4.83	
	112.47	615.11	39°15'51"	76°18'57"	145200	-4.88	
	110.97	616.63	39°15'51"	76°19'02"	145230	-4.96	
	109.32	617.26	39°15'53"	76°19'08"	145300	-5.03	
	107.83	618.78	39°15'52"	76°19'13"	145330	-5.03	
	106.32	620.27	39°15'52"	76°19'18"	145400	-5.01	
	104.73	621.47	39°15'53"	76°19'24"	145430	-5.08	
	103.14	622.63	39°15'53"	76°19'29"	145500	-5.19	
	101.57	623.89	39°15'54"	76°19'35"	145530	-5.36	
	99.98	625.02	39°15'54"	76°19'40"	145600	-4.53	
	98.38	626.25	39°15'55"	76°19'46"	145630	-5.31	
	96.80	627.39	39°15'55"	76°19'51"	145700	-5.72	
	95.29	628.78	39°15'55"	76°19'56"	145730	-5.39	
	93.80	630.26	39°15'55"	76°20'02"	145800	-5.11	
	92.29	631.56	39°15'56"	76°20'07"	145830	-5.03	
	90.75	632.58	39°15'56"	76°20'12"	145900	-4.27	
	89.17	633.12	39°15'58"	76°20'17"	145930	-3.61	
	87.68	634.17	39°15'58"	76°20'23"	150000	-3.31	
	86.46	636.15	39°15'57"	76°20'28"	150030	-3.13	
	85.18	637.87	39°15'57"	76°20'33"	150100	-3.03	
	83.70	638.75	39°15'57"	76°20'38"	150130	-2.87	
	82.22	639.57	39°15'58"	76°20'43"	150200	-2.90	
	80.79	640.82	39°15'59"	76°20'48"	150230	-3.02	
	79.53	642.53	39°15'58"	76°20'53"	150300	-2.69	
	78.19	643.39	39°15'59"	76°20'57"	150330	-2.49	
	77.82	643.65	39°15'59"	76°20'59"	150337	-2.82	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
CH2 12/16/83	69.36	643.90	39°16'12"	76°21'26"	130905	-3.67	
	68.18	645.25	39°16'12"	76°21'30"	130930	-3.67	
	66.89	647.54	39°16'10"	76°21'36"	131000	-3.65	
	65.75	649.96	39°16'08"	76°21'41"	131030	-3.57	
	64.77	652.53	39°16'06"	76°21'46"	131100	-3.50	
	63.96	655.15	39°16'03"	76°21'50"	131130	-3.60	
	63.25	657.73	39°16'00"	76°21'54"	131200	-3.57	
	62.49	660.38	39°15'57"	76°21'58"	131230	-3.57	
	61.69	662.97	39°15'54"	76°22'02"	131300	-3.57	
	60.92	665.52	39°15'52"	76°22'06"	131330	-3.55	
	60.03	668.07	39°15'49"	76°22'10"	131400	-3.49	
	59.21	670.64	39°15'46"	76°22'14"	131430	-3.44	
	58.56	673.31	39°15'43"	76°22'18"	131500	-3.37	
	57.91	675.99	39°15'40"	76°22'21"	131530	-3.27	
	57.25	678.59	39°15'37"	76°22'25"	131600	-3.29	
	56.58	681.19	39°15'34"	76°22'28"	131630	-3.24	
	55.83	683.77	39°15'31"	76°22'32"	131700	-3.21	
	54.96	686.24	39°15'28"	76°22'37"	131730	-3.19	
	54.15	688.76	39°15'26"	76°22'41"	131800	-3.16	
	53.32	691.22	39°15'23"	76°22'45"	131830	-2.98	
	52.52	693.59	39°15'21"	76°22'48"	131900	-2.63	
	51.60	695.87	39°15'18"	76°22'53"	131930	-2.96	
	50.54	698.18	39°15'17"	76°22'57"	132000	-3.04	
	49.57	700.53	39°15'14"	76°23'02"	132030	-3.01	
	48.68	703.01	39°15'12"	76°23'06"	132100	-3.01	
	47.90	705.49	39°15'09"	76°23'10"	132130	-2.96	
	47.22	707.92	39°15'06"	76°23'13"	132200	-2.70	
	46.95	708.89	39°15'05"	76°23'15"	132230	-2.12	
	46.80	708.13	39°15'07"	76°23'15"	132300	-2.91	
	45.77	707.35	39°15'10"	76°23'18"	132330	-3.21	
	44.54	708.76	39°15'09"	76°23'23"	132400	-3.32	
	43.65	710.90	39°15'07"	76°23'27"	132430	-2.88	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
7 Foot	137.46	922.87	39°09'19"	76°24'28"	94701	-3.51	
Craighill	87.71	841.32	39°11'20"	76°23'41"	95539	-5.12	
Sniffin'	73.77	647.90	39°15'59"	76°21'14"	103504	-2.42	
	74.84	646.70	39°15'59"	76°21'10"	103607	-2.24	
	75.89	644.55	39°16'00"	76°21'05"	103700	-2.22	
	77.03	642.10	39°16'02"	76°21'00"	103800	-2.52	
	78.73	641.09	39°16'01"	76°20'54"	103900	-2.52	
	80.45	640.80	39°15'59"	76°20'49"	104000	-2.62	
	82.16	641.13	39°15'56"	76°20'44"	104100	-2.60	
	83.89	641.43	39°15'53"	76°20'39"	104200	-2.57	
	85.58	641.74	39°15'50"	76°20'34"	104300	-2.93	
	86.94	643.30	39°15'46"	76°20'31"	104400	-3.74	
	88.12	645.34	39°15'41"	76°20'29"	104500	-4.10	
	88.81	648.01	39°15'36"	76°20'29"	104600	-4.20	
	88.95	651.08	39°15'32"	76°20'31"	104700	-4.23	
	88.98	654.13	39°15'27"	76°20'33"	104800	-4.15	
	88.84	657.18	39°15'23"	76°20'35"	104900	-3.60	
	89.03	660.14	39°15'18"	76°20'37"	105000	-4.01	
	90.08	661.60	39°15'15"	76°20'35"	105054	-4.69	
	90.06	661.80	39°15'15"	76°20'35"	105100	-4.67	
	88.91	662.33	39°15'15"	76°20'39"	105147	-3.88	
	88.74	662.81	39°15'15"	76°20'40"	105200	-3.78	
	88.43	665.74	39°15'11"	76°20'43"	105300	-3.62	
	88.12	668.79	39°15'07"	76°20'46"	105400	-3.75	
	87.97	671.91	39°15'03"	76°20'49"	105500	-4.11	
	87.86	674.97	39°14'59"	76°20'51"	105600	-4.44	
	87.30	677.93	39°14'55"	76°20'55"	105700	-4.44	
	86.51	680.69	39°14'52"	76°21'00"	105751	-4.31	
	86.40	681.08	39°14'52"	76°21'00"	105800	-4.29	
	85.53	684.00	39°14'49"	76°21'05"	105900	-4.26	
	84.24	686.63	39°14'46"	76°21'10"	110000	-4.16	
	82.89	689.14	39°14'45"	76°21'16"	110100	-4.01	
	81.76	691.96	39°14'42"	76°21'21"	110200	-4.06	
	80.55	694.60	39°14'40"	76°21'26"	110300	-4.18	
	79.51	697.47	39°14'37"	76°21'31"	110400	-4.16	
	78.38	700.27	39°14'34"	76°21'36"	110500	-4.08	

	Red	Green	Latitude	Longitude	Time	Uncorrected Depth	Tidal Correction
XV2	115.19	644.95	39°15'06"	76°19'14"	122743	-5.92	
12/16/83	114.67	644.06	39°15'08"	76°19'15"	122800	-6.13	
	113.23	645.59	39°15'08"	76°19'20"	122830	-5.90	
	111.90	647.49	39°15'07"	76°19'25"	122900	-5.87	
	110.29	648.72	39°15'07"	76°19'30"	122930	-5.95	
	108.58	649.71	39°15'08"	76°19'36"	123000	-6.25	
	106.90	650.82	39°15'09"	76°19'41"	123030	-6.36	
	105.19	651.65	39°15'10"	76°19'46"	123100	-6.46	
	103.48	652.25	39°15'11"	76°19'51"	123130	-6.36	
	101.81	653.14	39°15'12"	76°19'56"	123200	-5.52	
	100.23	654.50	39°15'12"	76°20'02"	123230	-4.32	
	98.66	655.84	39°15'12"	76°20'07"	123300	-4.73	
	97.26	657.71	39°15'11"	76°20'12"	123330	-5.75	
	95.75	659.23	39°15'11"	76°20'18"	123400	-4.88	
	94.11	660.37	39°15'11"	76°20'23"	123430	-4.98	
	92.52	661.70	39°15'12"	76°20'29"	123500	-5.11	
	90.98	663.07	39°15'12"	76°20'34"	123530	-5.01	
	89.44	664.49	39°15'12"	76°20'39"	123600	-4.04	
	88.06	665.92	39°15'11"	76°20'44"	123629	-3.92	