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***A Preliminary Assessment of Effects to
Fish Habitat Associated With the Placement
of Dredged Materials at the Alcatraz Disposal Site
San Francisco Bay, California***

Submitted to:

U.S. Army Corps of Engineers
San Francisco District
211 Main Street
San Francisco, California, 94105

Prepared for:

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Prepared by:

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50 Beale Street
San Francisco, California, 94105

Bechtel Project Number 21845-004

August 1994

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August 24, 1994

U.S. Army Engineer District,
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Corps of Engineers
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San Francisco, California 94105-1905

Attention: Dr. Barney Opton; Project Management Branch

Re: Submittal of Task 6: Final Report, *A Preliminary Assessment of Effects To Fish Habitat Associated with the Placement of Dredged Materials at the Alcatraz Disposal Site, San Francisco Bay, California*, (Alcatraz Marine Habitat Report); Contract No. DACW07-92-D-0007, Delivery Order No. 0016.

Dear Barney:

Attached for your use, in accordance with the Scope of Services for the subject delivery order, dated September 29, 1993, are twenty one (21) copies of our final report submittal (twenty bound and one unbound).

We are pleased to be of continued service to the Corps under this contract. If there are any questions, please contact me at (415) 883-7683.

Sincerely,

GAHAGAN & BRYANT ASSOCIATES, Inc.



Rick Olejniczak, P.E.
Deputy Project Manager

Attachments

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1.0 INTRODUCTION AND OBJECTIVES

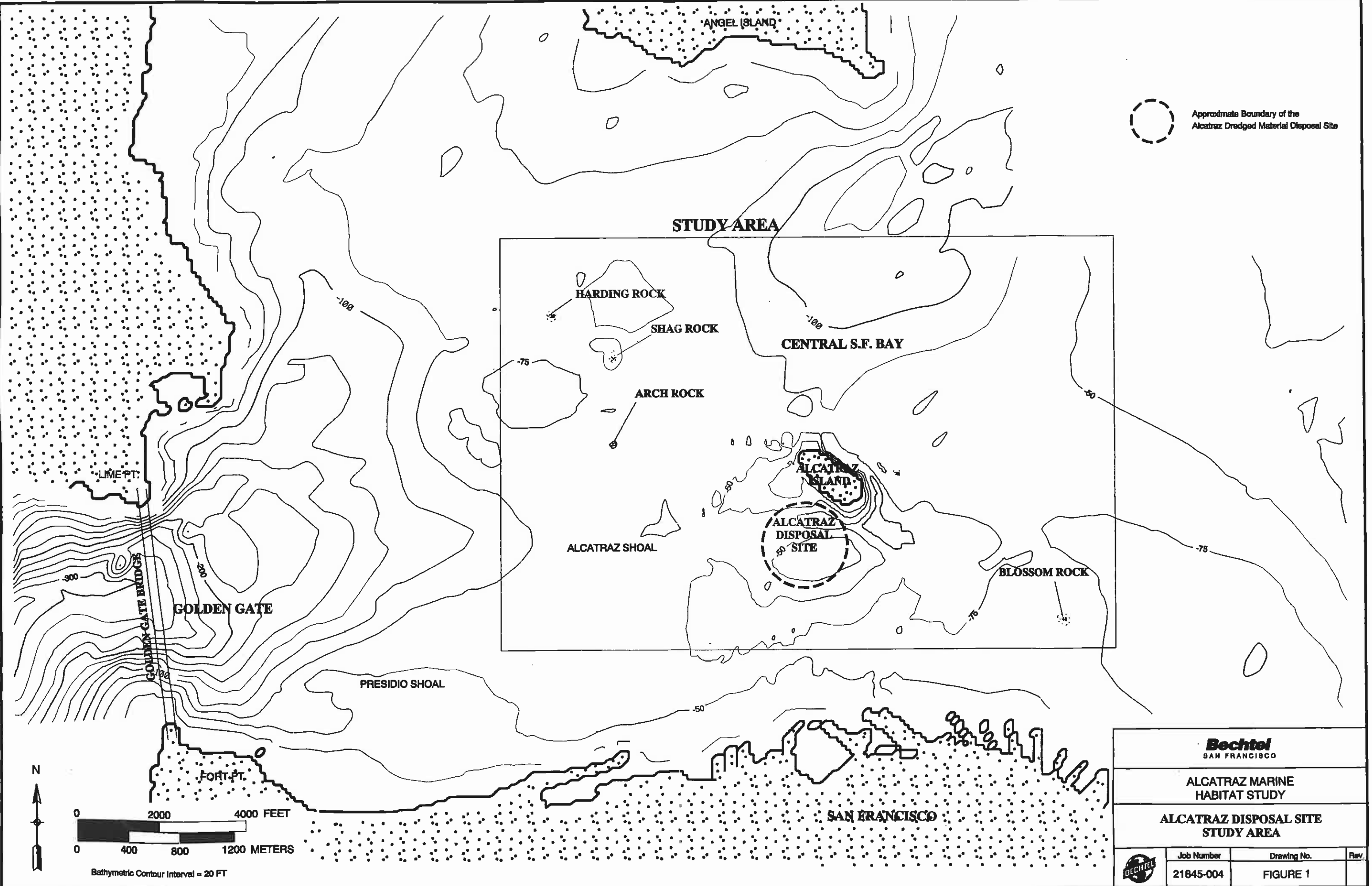
1.1 Background

Dredged material disposal in the San Francisco Bay Area is the subject of intensive study by the U. S. Army Corps of Engineers/San Francisco District (USACOE), the U.S. Environmental Protection Agency, Region IX (EPA), the San Francisco Regional Water Quality Control Board (RWQCB), and the San Francisco Bay Conservation and Development Commission (BCDC) under the Long-Term Management Strategy (LTMS). This study has been conducted for the LTMS In-Bay Work Group.

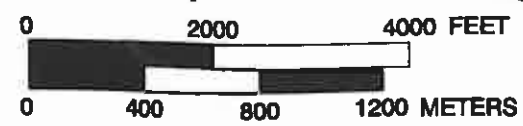
The Alcatraz Dredge Material Disposal Site is situated within the San Francisco Bay between the Hyde Street Pier and Alcatraz Island (Figure 1). The site is designated as a 2000 foot diameter circle with its geographic center at latitude 37° 49' 17" North, longitude 122° 25' 23" West.

The site has been used as a dredged material disposal site since its designation in 1894. The area between Alcatraz Island and the Hyde Street Pier was originally selected because of its depth (formally approximately -165 feet Mean Lower Low Water) and the presence of high current velocities. It was assumed at that time that the high current would carry and disperse the sediments out to sea on the ebb tide, and into other deep regions of the Bay on flood tides. Currents have proved to be insufficient to transport the volume of material that has been placed at the site, and a mound of sediment has accumulated to the extent that it could present a hazard to navigation, a situation currently being addressed by the Corps. There has also been concern that the materials dispersed from the Alcatraz site may be affecting adversely the habitat for commercial and recreational fish species in the Bay. In particular, some local party-boat operators have stated that sediments migrating from the Alcatraz site have degraded prime fishing sites in the Central Bay

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 Approximate Boundary of the Alcatraz Dredged Material Disposal Site



Bathymetric Contour Interval = 20 FT

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ALCATRAZ MARINE HABITAT STUDY			
ALCATRAZ DISPOSAL SITE STUDY AREA			
	Job Number	Drawing No.	Rev.
	21845-004	FIGURE 1	

including Harding Rock, Shag Rock, Arch Rock, Alcatraz Shoal, and Blossom Rock (R. Tasto, pers. comm., 1993). These operators suspect that fines from sediment disposal may be smothering these rocky habitats and sandy shoals, reducing the available habitat for fishes sought, and subsequently reducing the catch.

Additionally, the National Parks Service on Alcatraz Island suspects that tidepool habitats facing the disposal site (on the south shore of the island) may be silting in because of disposal at the Alcatraz site (Tasto, pers. comm., 1993).

Unfortunately, there are presently no available data to confirm nor refute these statements. The principal objective of this study is to investigate qualitatively the extent to which dredged materials discharged at the Alcatraz Disposal Site has been transported from the site sufficiently to cause degradation of benthic habitat. This objective was approached by a combination of interviews and reviews of scientific literature, review of reports and data pertaining to fish habitat in the Central San Francisco Bay, and reconnaissance field studies. One of the primary goals of the literature search was to determine sediment conditions in the Central Bay existing prior to disposal at Alcatraz so that in combination with a reconnaissance survey, the nature and extent of benthic habitat modification associated with disposal at Alcatraz could be assessed qualitatively.

A secondary objective of this project was to design a quantitative study to delineate in the future, and if desired, more precisely the aerial extent to which material discharged at Alcatraz has migrated beyond the boundaries of the disposal site, and to determine to what extent modification of fish habitat in the Central Bay has affected commercial and recreational fishing in the Central Bay.

Sediment samples were collected and analyzed to estimate the presence and distribution of fine-grained dredged materials within the Central Bay that could be covering fish habitat, and to examine the presence of benthic invertebrate infauna as an additional indicator of modified benthic habitat conditions. This information,

together with reviews of surveys conducted in previous years and with visual observations using an ROV, were used to obtain a general understanding of conditions existing at sandy and rocky habitat in Central San Francisco Bay, as well as the extent of sediment modifications associated with disposal at Alcatraz.

This report summarizes past studies, discusses results of field studies conducted to assess habitat modifications related to disposal activities at Alcatraz, and recommends future work to examine conditions of fish habitat in central San Francisco Bay.

Study Area

The literature search reviewed previous studies pertaining to Central San Francisco Bay. Field reconnaissance focused on the area surrounding the Alcatraz Disposal site, extending from Alcatraz Shoal to the west, to Blossom Rock to the east, north to Alcatraz Island, extending slightly beyond the island to the northeast, and south of the disposal site as depicted in Figure 3. Single samples were also collected near Harding Rock, Shag Rock and Arch Rock.

2.0 REVIEW OF PROPOSED TASKS

There were five tasks in this study of the effects of Alcatraz disposal activities ¹.

The purpose of Task 1 is first to identify and review previous studies in the Bay pertinent to the evaluation of effects of Alcatraz disposal to Central Bay fisheries habitat. Materials of interest included historic records of sediment composition in the Bay prior to disposal at Alcatraz, locations of sediments or rocky outcrops typically identified as fish habitat, and historic collections and surveys focused on fish populations. Second was to prepare a preliminary map locating areas of sensitive fish habitat in the Central Bay. This preliminary map was based on existing literature and discussions and was used to locate all reconnaissance stations reported here. This task also included discussion of methods employed to identify fish habitat.

The first purpose of Task 2 is to use the hydrographic survey results developed by Gahagan & Bryant (G&B) under Delivery Order 0015 to prepare a contour map to overlay the preliminary habitat map developed in Task 1. The G&B hydrographic survey was not intended to cover the entire area of interest in this habitat study. Thus, we obtained from the National Oceanic and Atmospheric Administration additional hydrographic survey data and subsequently were able to prepare a detailed baseline contour map of the Central San Francisco Bay, as well as for terrain surrounding the Bay.

Contour lines within San Francisco Bay below mean lower low tide (MLLT) and outside the G&B surveys were obtained from R. Chang of the USGS, Menlo Park, California, who is using these in unpublished, ongoing modeling studies in the Bay.

¹ The first two tasks were completed and the results submitted in an earlier report, Task 1 and 2, Literature Review and Reconnaissance Field Study Design, to the U.S. Army Corps of Engineers, San Francisco (Corps) in November, 1993. This document reviews the highlights of the Tasks 1 and 2 report, as well as results of Tasks 3, 4, and 5.

Points are derived from NOAA Presidio Tide Station #4290. Elevational data for points above MLLT were obtained from the USGS Digital Elevation Model (DEM), 1984 survey, which are derived from the 7.5 minute USGS quadrangle sheets. Together, these surveys helped delineate the distribution of Alcatraz disposal materials including the extent of the apron of deposited material marking the extremes of deposition, and also clearly link the Bay to land contours above water level.

The second purpose of Task 2 is to design a field reconnaissance study to determine the extent and nature of the movement of discharged material away from the Alcatraz disposal site. During this reconnaissance study, sediments from a wide area of the Central Bay were sampled to assess the areal extent of the Alcatraz sediments.

Task 3 includes two principal purposes. First, is to carry out field studies to delineate the apron of the Alcatraz mound; and second, to assess the potential degradation of Central Bay fisheries habitat.

The principal purpose of Task 4 is to design a quantitative field study to determine the effects of the Alcatraz disposal activities and sediment transfer on sediment characteristics around the margins of the mound including the impact to Central Bay fish habitat.

The purpose of Task 5 is to prepare a report summarizing the results of work on this project. Information included in the earlier Tasks 1 and 2 report submitted to the Corps and which is important to an overall understanding of the work on this project is repeated herein.

3.0 LITERATURE REVIEW

3.1 Background to the Alcatraz Disposal Site and Environment

When the Army Corps of Engineers designated in-Bay disposal sites in the early 1970s, it selected sites from which disposed material would disperse. Some considered that the capacity of the Alcatraz Island site to disperse material was unlimited, and for many years dredged material was disposed in the deep water next to Alcatraz Island. However, in 1982, it was discovered that this site had accumulated enough material to pose a hazard to navigation. The mounding problem at Alcatraz stimulated widespread discussion among scientists, dredgers, and regulators regarding the fate of materials deposited there.

The fate of disposed material that reaches the bottom is determined largely by the direction and strength of the bottom currents (ABAG, 1992). Because the lower portion of the water column in much of San Francisco Bay has a net transport landward, much of the disposed material is carried in that direction, rather than toward the ocean. This landward transport of currents was demonstrated by seabed drifter studies conducted in the late 1960s (Conomos et al., 1970). Studies argue strongly for the net landward transport of currents, especially in Central Bay. Thus, material disposed at the Alcatraz site most likely is dispersed within the estuary, rather than carried westward to the Pacific Ocean. Studies also suggest that some of the material disposed into Central Bay is transported to the estuary's northern reach (Conomos and Peterson, 1977).

Several studies have been completed to optimize current transport of material from the mound and to try to mitigate accumulation of dredged materials (Tetra Tech, 1984; Winzler and Kelly, 1985; Trawle and Johnson, 1986; Trawle, 1986; SAIC, 1986, 1987a, b; Teeter, 1987; Pankow, 1988; and Hauck et al., 1990). However, limited attention has been given to the ultimate depositional area of the current

redistributed dredged materials including the possible adverse effects to biologic habitat resulting from the redistribution of fine clay and silt dredged materials by currents or slide transport. In a report on suspended sediment movement within the Bay (Hauck et al., 1990), it was recommended that detailed mapping of surface sediments be conducted to determine sediment grain size and distribution over an annual cycle. These studies have not yet been conducted.

A brief historical account of research in the San Francisco Bay and a study of human activities effecting general and sedimentological conditions in the Bay is found in Hedgpeth, 1979. In his paper, Hedgpeth makes reference to the study by Gilbert (1917) as "the nearest thing we have to a baseline analysis of the physical characteristic of the San Francisco Bay". Gilbert's report on the hydraulic-mining debris in the Sierra Nevada Mountains also included a study of currents and debris transport into and out of the Bay. In Gilbert's report the general area of the Alcatraz Dredge Disposal Site is shown with a water depth of greater than 20 fathom (approximately -120 feet MLLW). Reference is also made to the volume of material being delivered to the Bay system at that time.

3.2 Sediments Within The Central Bay

San Francisco Bay sediments between the Golden Gate and the area around Alcatraz Island are comprised of primarily coarse to fine sand with minor amounts of silt and clay. East of Alcatraz, sediment particle size generally becomes finer towards the interior of the Bay. Goldman (1967; 1969) provides generalized geologic maps of the San Francisco Bay area which indicate sandy bottom conditions with relatively shallow to exposed bedrock surfaces in some locations.

Sand waves were identified throughout most of the Central Bay area during a hydrographic survey using echo-sounding equipment (Gibson, 1951). A detailed

bathymetric map was contoured for the Alcatraz Shoal area and showed sand waves as high as six feet.

The Wave Research Laboratory of the University of California at Berkeley conducted a core penetration study of sediments in San Francisco Bay in 1953 (Trask, et al., 1953; Trask, 1954²). The study indicated that in the area of strong tidal action between Angel Island, Treasure Island and the Golden Gate, core penetration generally ranged from two to four feet. Cores were collected using a piston core (Kullenberger) sampler. Sediment from nine cores (Sample numbers 139 - 141 and 146 - 151) recovered in the area between Alcatraz Island and the San Francisco shoreline contained primarily fine to medium sands with some shell material. One core (151) on the Alcatraz Shoal contained gravel.

Johnson (1971) conducted some grain size analyses from several cores collected from the 1953 survey. His analyses indicated that sand between Alcatraz Island and the San Francisco Bar is fine to coarse grained (125-1000 microns). A later study by Thompson (1981), using a coring transect from the offshore area through the Golden Gate to the Central Bay, indicated a similar trend with coarse sands in the Golden Gate region fining inward towards the east. Sediment grain size distribution around the Central Bay from available sources are shown in Figure 2.

A detailed study of bedforms within the Central Bay was conducted using side-scanning sonar (Rubin & McCulloch, 1979). Their report shows three types of bedform topography around the disposal site area: 1) a flat bed topography with bedrock and boulders located just south and southwest of Alcatraz Island, 2) a bottom topography with 1 - 3 meter sandwaves located southwest of Alcatraz Island, primarily along the Alcatraz Shoal, and, 3) a bottom topography with sandwaves

² The California state plane coordinates translated from latitude and longitude values presented in Table C-1 of Trask, 1954 unfortunately do not correspond with locations shown on Figure 3 of Trask, et al., 1953. Sample locations from Figure 3 of Trask, et al., 1953 were visually transferred to show the data on the base map of this report.

less than 1 meter located south of Alcatraz Island and east of the Alcatraz Shoal. The junction point of the three bedforms area is in the vicinity of the Alcatraz Dredge Disposal Site.

A general study of dredged materials and natural sediment characteristics within the Alcatraz Dredge Disposal Site area was performed by Farmer (1985). His report included an appendix by Subsurface Consultants which contained boring logs from six holes that were drilled by rotary methods in and around the Alcatraz disposal mound. Some of the significant findings of Farmer's report include:

- The former depth of the dredge disposal site area was approximately -165 feet (MLLW).
- Recent dredged materials are composed of a mixture of ~75% highly plastic clays and ~25% clayey sands. Older dredged materials are predominantly highly plastic clays.
- Recent shoal deposits are comprised of relatively clean dense fine-sands. In some places the shoal deposits have covered the older dredged materials.
- Natural pre-dump site deposits were encountered in one borehole at a 85 feet sub-bottom depth (SBD). Approximately four feet of dense clayey sands were found to overlie a graywacke sandstone bedrock at 89 feet SBD (-129 MLLW).

The results of Farmer's investigation with respect to natural deposits around the site are generally consistent with other reports which indicate sandy-bottom conditions around the area and on the Alcatraz Shoal (Trask, 1954; Goldman, 1969; Johnson, 1971; and Thompson, 1981). The thin sediment cover overlying bedrock also corresponds well with shallow bedrock depths (-100 to -200 feet MLLW) indicated in top of bedrock contours (Goldman, 1967; Carlson and McCulloch, 1970).

An additional study of bedforms and bottom characteristics around the Alcatraz Disposal Site was conducted using side-scanning sonar, piston coring, and bathymetric profiling (SAIC, 1987). Their report shows five types of bedform around the disposal site: 1) long wave length (10 meter) sand waves, south and west of the disposal site; 2) short wave length (1-2 meter) sand waves, south of the disposal site; 3) fine grain deposits characterized by smooth topography (indicated by relatively low reflectance) around the margins of the disposal mound; 4) coarse grained deposits, gravels and clumps of sediments (characterized by relatively high reflectance) around the base of the disposal mound and to the southeast of the disposal site; and 5) extremely coarse dredge deposits characterized by large variations in topography resulting from shadowing effects, located on the disposal mound.

The SAIC also compared the differing methods for material disposal and dispersal along with the effects of the materials in a limited area around the disposal site. This study concluded that it was best to dispose of the material in a fluid matter to achieve the best dispersal and to limit accumulation within the site. They further found that after initial disposal, the more fluid material was eroded by current transport within several months. However, once the material was deposited, the more consolidated material would remain at the site without significant loss of material. The study did not address the ultimate depositional site of the dispersed material, or the effects of the material over a wider area of the Bay.

Bioassay testing and chemical analysis of sediments from cores collected within the disposal site were conducted by EVS Consultants (1988). The EVS report identified locations of contaminated sediment within the pile and included data from biological and chemical testing. Physical descriptions of dredge materials are similar to those reported by Farmer (1985).

The Corps designated in 1987 eight sampling stations (Alcatraz Environs Stations) around the Alcatraz Disposal Site as a reference for determining suitability for dredged materials disposal. These stations have provided a significant volume of data on the area surrounding the disposal site. Grain size data are available for the sites (Corps, 1993); however the sediments have been composited and data for specific sites is not available. Analyses of the sediments indicate 81-98% sand with up to 17% gravel and 0-6% silt and clay. Figures 3 and 4 shows the locations of these sampling stations.

3.3 Distribution of Fishes and Habitat Use Near the Alcatraz Disposal Site

The Bay provides habitat for both marine, estuarine, and anadromous species, each with varying dependencies on substrate conditions. The pelagic anadromous species, such as salmonids and American shad, that move through the Central Bay, either to upstream spawning grounds or as outmigrating juveniles, do not spend a great deal of time near the bottom. In contrast, flatfishes such as halibut, English sole, and starry flounder are demersal species that are in constant contact with the bottom and thus dependent on the benthic resources for food items and cover. The focus of this study is on the demersal species most likely to be directly affected by changes in substrate composition associated with dredged materials placement at the Alcatraz Site.

Other studies have evaluated the effects of substrate quality on fish use. Pearcy (1978) and Pearcy and Hancock (1978) studied the relationship of sediment size and fish species distribution, abundance, and feeding habits of various flatfishes off the coast of Oregon. Deeper mud substrates were dominated by slender sole and shallow sandy bottoms were dominated by Pacific sanddab. Amongst the sanddabs, the small sanddabs predominated at silt-sand stations, whereas the larger sanddabs appeared to prefer sandy sediments (Pearcy, 1978).

EXPLANATION

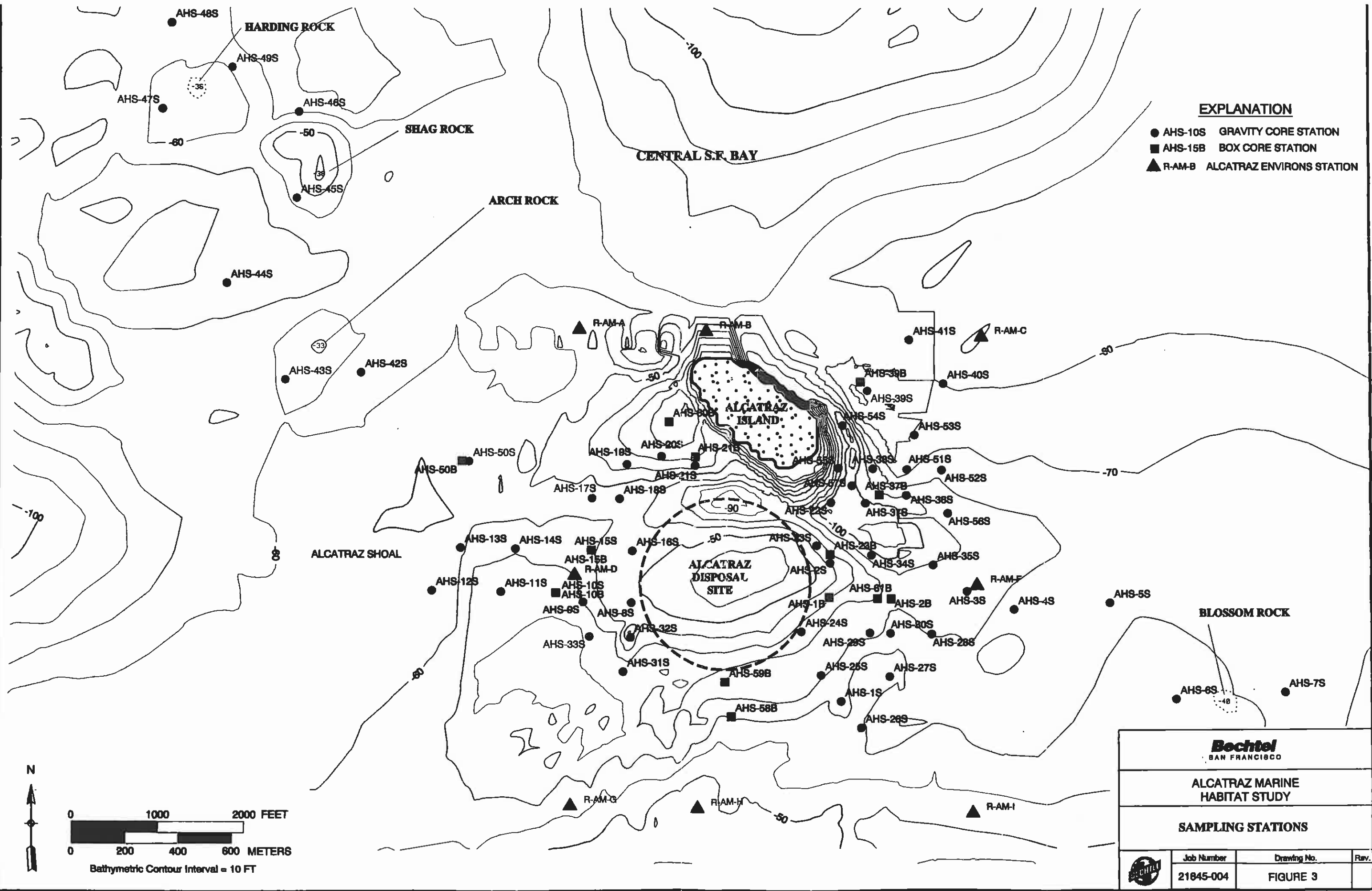
- AHS-10S GRAVITY CORE STATION
- AHS-15B BOX CORE STATION
- ▲ R-AM-B ALCATRAZ ENVIRONS STATION

ALCATRAZ MARINE HABITAT STUDY

SAMPLING STATIONS

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Drawing No.: FIGURE 3

● AHS-10S GRAVITY CORE STATION
 ■ AHS-15B BOX CORE STATION
 ▲ R-AM-B ALCATRAZ ENVIRONS STATION

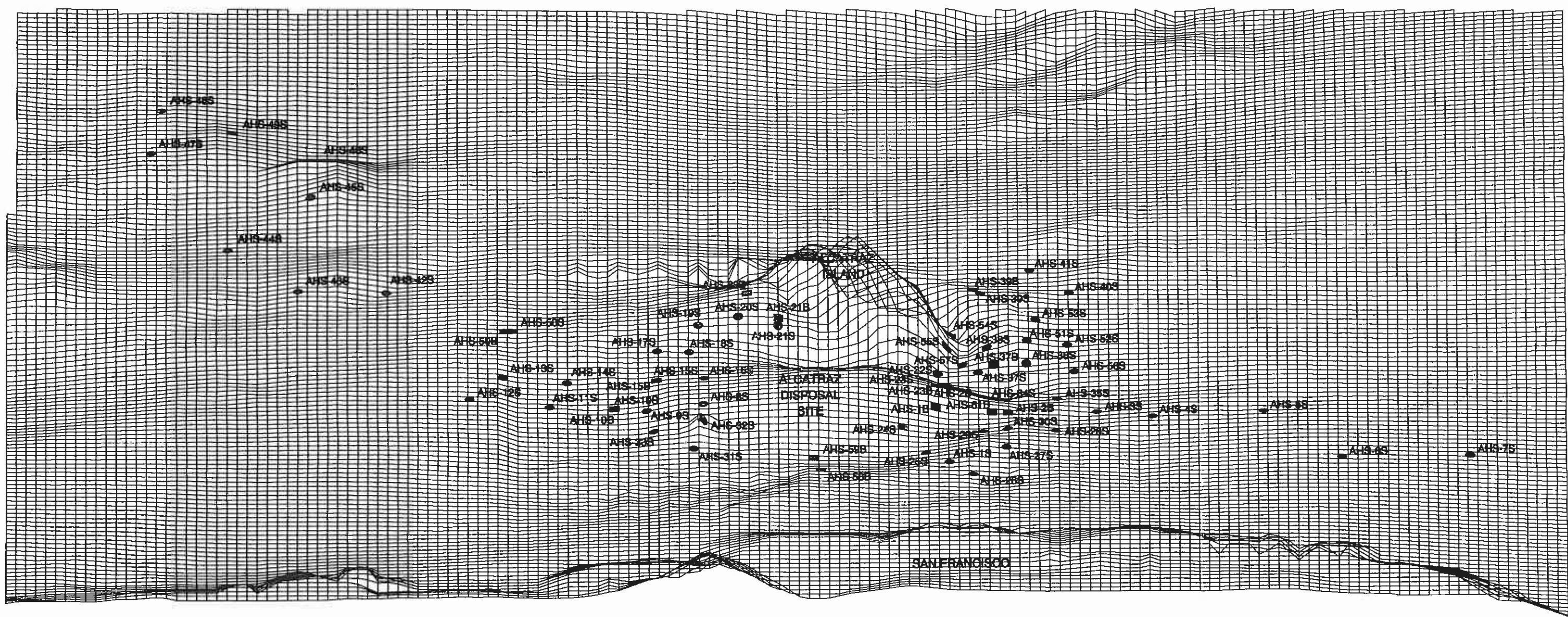


SAMPLING STATIONS

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- AHS-10S GRAVITY CORE STATION
- AHS-15S BOX CORE STATION



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ALCATRAZ MARINE
HABITAT STUDY

OBLIQUE VIEW OF ALCATRAZ HABITAT
STUDY AREA AND SAMPLING STATIONS

	Job Number 21845-004	Drawing No. FIGURE 4	Rev.
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In the second 1978 study, Percy and Hancock found slender sole and Pacific sanddab in the same feeding group, which fed primarily on pelagic crustaceans. The other group, comprised of dover sole and rex sole, fed mainly on polychaetes and amphipods. They determined that feeding preferences were associated with mouth and digestive morphology and concluded their study with a quote from Petersen (1918): "It is clear then that the character of the bottom is of fundamental importance for the presence or absence of epifauna. Nevertheless, the succession of the various types of epifauna and of the communities belonging to the level bottom cannot be explained by the character of the bottom alone."

Skinner (1962) described the Alcatraz area as historically supporting a commercial fishery for bottomfish, such as sablefish (*Anoplopoma fimbria*), lingcod (*Ophiodon elongatus*), hake (*Merluccius productus*), and rockfish (*Sebastes* spp.). Later accounts by Aplin (1967) describe the west edge of Treasure Island, which is east of the Alcatraz Disposal Site, as mostly homogeneous sand and mud. Some of the more common fishes noted in the Aplin studies included: Pacific herring (*Clupea harengus harengus*), northern anchovy (*Engraulis mordax*), jacksmelt (*Atherinopsis californiensis*), English sole (*Parophrys vetulus*), tomcod (*Microgadus proximus*), speckled sanddab (*Citharichtys stigmaeus*), shiner perch (*Cymatogaster aggregata*), white croaker (*Genyonemus lineatus*), starry flounder (*Platichthys stellatus*), northern midshipman (*Porichthys notatus*), pile perch (*Rhacochilus [Damalichthys] vacca*), Pacific staghorn sculpin (*Leptocottus armatus*), and tonguefish (*Symphurus atricauda*).

Compendia of fisheries and aquatic resources of San Francisco Bay by Herbold et al. (1992), Monroe et al. (1992), Booth et al. (1989), and WESCO (1988), as well as discussions of turbidity effects to the biota (O'Connor, 1991), provide more current comprehensive descriptions of presence, distribution, and possible causes of population fluctuations of significant fisheries in the Bay. The U.S. Army Corps of Engineers Waterways Experiment Station (WES) also compiled a literature review

of documents providing information on the potential impacts of dredged material disposal on fisheries and contaminant bioavailability in the Central Bay (WES, 1992). However, there is little information cited focusing directly on fish habitat identification or habitat modification as related to changes in Bay substrate. Much of the work that has been reported relates to declines in fish populations and catches, and is directed at water column effects such as changes in flows from rivers entering the Bay and impacts to anadromous fishes caused by alterations of freshwater habitats, turbidity, and levels of pollutants.

The CDFG Bay-Delta Monitoring Program is the only on-going biological monitoring program that has been conducted in the Central Bay (it also includes other stations within the Bay). CDFG has been sampling selected sites since 1980. Otter trawls have been used at stations near the Alcatraz site, although no trawls have been taken at the mound itself. The fish catch data generated by this program are acknowledged to be biased by gear type. Otter trawls tend to capture the slower moving bottom fishes and can be deployed most successfully on even, softer bottoms. Areas of exposed rocks are not satisfactorily sampled by this method, nor by many others for that matter. An examination of the CDFG data suggests that the fishes near the Alcatraz area tend to be more marine than estuarine due to the effects of the sea water entering the Golden Gate. Some of the more common fish encountered include northern anchovy, Pacific herring, longfin smelt (*Spirinchthys thaleichthys*), white croaker, English sole, and marine surfperches.

Between 1984 and 1986, the Corps commissioned a number of biological studies by Kinnetic Laboratories, Inc., to evaluate other potential in-Bay aquatic disposal sites that could provide capacity additional to the Alcatraz site. These sites were located at the South Tower of the Golden Gate Bridge and Bonita Cove (KLI, 1985) and South Tower and "Alcatraz Annex" located east of the present Alcatraz site (WES, 1986). As part of these studies, some data on aquatic resources near the Alcatraz site were collected. In the first study (KLI, 1985) fisheries data were collected from mid-

water and from otter trawl surveys conducted during two seasons. Mid-water catches were mostly comprised of northern anchovy and longfin smelt. The trawl data from the Alcatraz Annex site showed lower fish abundance and number of species (4 species in October; 8 species in February) compared to the South Tower (16 species in October; 11 species in February) and Bonita Cove (23 species in October; 17 species in February). The fishes collected at the Alcatraz Annex site by otter trawl included: shiner perch, plainfin (northern) midshipman, brown rockfish (*Sebastes auriculatus*), longfin smelt, Pacific herring, northern anchovy, white croaker, Pacific staghorn sculpin, English sole, and big skate (*Raja binoculata*).

The Kinnetic Laboratories survey also collected benthic invertebrate data over the same period and in approximately the same locations as the fish sampling. The data showed that variability was very high within the sites as it was between the sites, which would require the collection of far more samples to detect any statistically significant differences in abundance and number of species. The surveys showed seasonal shifts in the composition of dominant taxa, finding for instance that the amphipod *Ampelisca abdita* was numerically dominant at the Alcatraz Annex site during October, but the bivalve *Tellina nukuloides* ranked highest in February.

The second study, conducted by the Waterways Experiment Station (WES, 1986), was performed as part of the decision-making process in the selection of an interim in-Bay disposal site ("Annex Site") immediately east of the main Alcatraz Disposal Site. WES developed the Benthic Resources Assessment Technique (BRAT) for this study to estimate the benthic habitat quality through the collection and analysis of benthic organisms from the sediment and the prey exploitation pattern of demersal fishes collected within the same area. Due to technical difficulties in the field, benthic samples were not collected. The sampler was not adequately equipped to penetrate and retain samples from the sandy/debris (shell fragments) sediments, and the effectiveness of the BRAT procedure was not fully tested.

The study team was able to collect qualitative food habit data for the five species collected at the Annex Site: California halibut, Pacific staghorn sculpin, white croaker, speckled sanddab, and English sole. The report concluded that no unusual feeding patterns for the dominant fish species were observed, but without box-core samples evaluations of the trophic importance of the site for bottom feeders such as white croaker, speckled sanddab, and English sole could not be made. Their data indicated that the species other than these demersal species did not appear to be directly dependent on infaunal organisms for food. From the limited data collected, it appeared that anchovy and pandalid shrimp were important to many of the fish of Central Bay (halibut, sculpin, croaker, rockfish, perch, and sole); however, polychaetes and bivalves could become important on a seasonal basis.

One of the few studies of fishes conducted in the Bay focusing directly on active sediment disposal was a hydroacoustic survey conducted in 1991 at the Alcatraz site immediately before, during, and after a disposal event (MEC, 1991; Bio Sonics, 1991). Survey transects were located around the site and tracked both fish movement and plume dynamics during a flood tide. Fishes were tracked in the water column, and mid-depth trawls deployed to collect fishes and confirm identification of species. The study determined that the plume was dense and sank slowly. Fish in the water column and near the site (herring, Pacific butterfish (*Peprilus simillimus*), and anchovies) left the area during the event. The schools returned two to three hours later. Monitoring of additional disposal events would have been necessary to provide better definition in the tracking system. However, this survey was not repeated. Demersal fishes were not studied in this program.

Anecdotal information also exists that is helpful in determining habitat conditions in the vicinity of Alcatraz. As noted above, it is the suspicion of some local party-boat operators that habitat degradation resulting from sediments migrating from the Alcatraz disposal site has diminished the quality of fishing at sites in the Central Bay. The San Francisco Bay Harbor Pilots Association raised concerns regarding

what they perceived to be recent or increased shoaling of northeast of Alcatraz Island. They attributed this shoaling to off-site migration of dredged material from the disposal site. Some of the operators suspect that fine materials drifting from the Alcatraz disposal site have smothered these rocky habitats, and perhaps sandy shoals, reducing the available habitat preferred by their recreational fisheries, and subsequently reducing their catch. Although the Corps report (USACOE, 1988) concluded that little correlation was evident between sportfishing catch reports and turbidity levels, substrate effects were not evaluated.

Representatives of the National Park Service have also voiced concern related to sediment disposal at the Alcatraz site (Horner, 1994). She believes that disposal activities affect many of the aquatic resources of the Bay, and that wildlife such as sea birds and marine mammals are disturbed and leave the area during disposal events at the Alcatraz site.

Tidepools on Alcatraz have been monitored seasonally as part of a program to assess changes of these habitats, especially as the effects may relate to sediment disposal (Horner, 1994; Hatch, 1994). Much of the data collected are anecdotal, but Park Service biologists have noted die-offs of the intertidal algae *Endocladia* in tidepools facing the Alcatraz Disposal Site. However, no quantitative measurements have been made, nor have attempts been made to link sediments in tide pools with disposal activities at Alcatraz. Although there is insufficient information to substantiate a cause and effect relationship, a COE consultation with UCLA research scientist, Richard Zimmerman, indicates that gross burial by dredged material would likely cause a mass die-off of *Endocladia*, not the patchy one observed. In the latter part of 1993, a natural resource management specialist with the Park Service commented that the *Endocladia* at the tidepools had begun to recover and that die-offs and regeneration of this algae are common at Alcatraz. *Endocladia* is an annual species, and no attempt has yet been made to separate suspected effects of sedimentation and natural seasonal death of this plant.

Exposed subtidal rock surfaces in clean waters of northern California are usually covered with marine organisms (Rickettes, E. F., and J. Calvin, 1968; Johnson, M. E., and H. J. Snook, 1955).

Marine algae communities can be dense in the shallower waters, and hundreds of species of invertebrate animals have been identified from rocks at all depths along the coast. Most of these plants and animals are relatively small, and require rocky substrate relatively clear of muds and sands. Thus, if rock surfaces naturally free of sediments become covered with a layer of sand or mud, the resident organisms die.

The attached plants and animals in clean waters attract feeding fishes and their predators. Rocky surfaces also can provide crevices and caves for refuge and for lurking.

Unfortunately, the subtidal rocky habitat within San Francisco Bay has received little attention (but see Rickettes and Calvin for a general review). Nevertheless, it can be reasonably assumed that clean rocky surfaces, particularly close to the clean marine waters flowing in the Golden Gate, will support a community of surface plants and animals and an associated population of fish predators and grazers. For these reasons, attempts were made in this study to see if evidence of habitat burying was evident. The only technique available within the boundaries of this reconnaissance study to examine deeper waters in the vicinity of the Alcatraz Disposal Site was brief deployment of an ROV.

Rocky outcrops occur around the entire perimeter of Alcatraz Island, and elsewhere in the study area at Arch, Harding, Shag, and Blossom Rocks.

3.4 Demersal Fishes, Dungeness Crab (*Cancer magister*) and Crangon Shrimp (*Crangon* spp) in Central San Francisco Bay

The natural history of demersal fishes of commercial and recreational importance, and of Dungeness crab and Crangon shrimp, that may be commonly found near the Alcatraz disposal site are basically as follows.

California halibut (*Paralichthys californicus*) The California halibut supports an important commercial fishery offshore the Central California coast. This species is primarily marine and spawns pelagic eggs offshore. The eggs and pelagic larvae remain in shallow water in near-shore coastal waters. Young halibut are then transported into the Bay by tidal currents and small juveniles can be found in bays and estuaries and outside the surf zone. Once in the bays and estuaries, juveniles remain in these waters about two to three years and eventually migrate out to shallow open coastal waters.

The juveniles and adults apparently prefer sandy bottoms but may also appear near rocks, sand dollar beds, and channels that enter coastal embayments (Emmett et al., 1991). California halibut are active predators and feed primarily on fish, but when young feed on small invertebrates such as mysids, gammarid amphipods, and harpacticoid copepods. Arrow gobies (*Clevelandia ios*) may also serve as food for juvenile halibut in bays and estuaries. The commercial landings of halibut have declined over time, which has been attributed to overfishing, changes in the marine habitat, changes in estuarine habitat, populations shifts, and pollution (Emmett et al., 1991).

English sole (*Parophrys vetulus*). English sole is another commercially caught flatfish, although it is not a particularly important recreational species. English sole spawn offshore. Eggs and larvae are pelagic, but as the larvae grow, they descend through the water column and are transported into the Bay in the spring and

summer (Herbold et al., 1992). Most of the English sole that appear in the CDFG data are young-of-the-year (YOY) that most likely move out in the fall and winter to deeper water. The Bay appears to be a nursery ground for the coastal population (Herbold et al., 1992).

The juveniles and adults prefer fine sand and soft mud bottoms (Emmett et al., 1991), with males showing a preference for finer sediments (Becker, 1988). It is conjectured that the sexes may ingest different prey items so that there is less competition between males and females, but this has yet to be demonstrated conclusively. Juveniles feed on harpacticoid copepods, gammarid amphipods, cumaceans, mysids, polychaetes, small bivalves, other benthic invertebrates, and the extended siphons of clams. Larger juveniles shift to polychaetes, and adult diets may include crustaceans, mollusks, and ophiuroids (Emmett et al., 1991).

Starry flounder (*Platichthys stellatus*). Starry flounder populations apparently are declining in the Bay and Delta (Herbold et al., 1992). This species is more dependent on the estuary for spawning and nursery habitat than the previous two species. Starry flounder penetrates further into the estuary and may actually be represented by two populations - one that remains permanently further up in the North Bay and one that is primarily offshore, but whose young move inland. The North Bay catches have declined more in San Pablo than Suisun Bay with an increase in the presence of English sole. Herbold et al., (1992) suggest that there is an "extrinsic" factor, possibly organic contaminants, that may be affecting adult starry flounder, but not young starry flounder or English sole in the Central Bay. Decreased inflows of fresh water from rivers may also be a factor.

Juveniles prefer bottom types such as mud, sand, and gravel, but not rocks. Larval forms feed on phytoplankton and zooplankton, whereas juveniles and adults are benthic carnivores, preferring copepods, crustaceans, polychaetes, bivalves, echinoderms, and fish (Emmett et al., 1991). Since juveniles are almost exclusively

estuarine, species populations would reflect decreases in the extent of estuarine habitat.

White croaker (*Genyonemus lineatus*). White croaker is very common in the Central Bay. This species is not generally considered to be a prime recreational fish. However, there is an increased popularity among some recent immigrant populations. It is one of the most common native piscivores in the Bay (Herbold et al., 1992) and is commonly caught from piers and nearshore shallow waters. Due to its high fat content, the tissues of this species has a propensity to bioaccumulate contaminants such as PCBs and DDTs and thus has been the subject of number of contaminant studies to assess potential health threats to humans through the ingestion of its flesh. It is also a target species of the National Status and Trends Program (Emmett et al., 1991).

This species spawns in the lower reaches of the estuary or in offshore waters. The pelagic eggs and larvae are released over sand and gravel bottoms (Wang, 1986). They are carried into the upstream portions of the Bay by tidal currents. As larvae and juveniles mature, they tend to descend to the bottom and move towards the Central Bay. At the same time juveniles from the previous year begin to enter the Bay and reside in deeper waters in the South Bay (Herbold et al., 1992). As adults, white croaker may remain in the Bay, but many migrate out. All of these lifestages may be found over mostly sandy bottoms, but may sometimes be found in kelp beds (Emmett et al., 1991). All forms are omnivorous and diets may include mollusks, polychaetes, copepods, crab, shrimp, amphipods, fish, and detritus (Emmett et al., 1991; Wang, 1986).

Shiner perch (*Cymatogaster jaggregata*). Shiner perch is one of the most common of the marine surfperches to be found in the Bay. It does not support a commercial fishery although it is caught recreationally and is used for bait (Emmett et al., 1991; Wang, 1986). The shiner perch apparently uses the estuary for a nursery ground

more than any of the other marine surfperches. This species moves to inshore waters and the Bay in the spring to spawn. It is a live bearer, giving birth to fully-formed young that begin feeding in the same manner as the adults (Herbold et al., 1992). The young and juveniles remain in the Bay for up to two years (Wang, 1986), when they move to deeper waters offshore.

All forms of this species can be found over sandy beaches, rocky areas, piers, and pilings, but the preferred substrate is sandy and muddy bottoms (Emmett et al., 1991). Juveniles and adults are omnivorous and may include in their diets algae, copepods, isopods, amphipods, bivalves and bivalve siphons, mollusks, polychaetes, and detritus (Emmett et al., 1991; Wang, 1986).

Brown rockfish (*Sebastes auriculatus*). Brown rockfish is apparently the most common rockfish to be found in San Francisco Bay, but is not found in the less saline waters (Wang, 1986). It is primarily a marine species with adult forms found generally near rocks, ledges, piers, and other hard substrates. Juvenile and larval rockfish have been found in the Central and San Pablo Bays (Booth et al., 1989). Very little is known about the habitat requirements and behavior of the larval and early juvenile forms of this species. Juveniles can be found near the bottom and their diet may consist of small crustaceans and small fish (Wang, 1986).

Dungeness crab (*Cancer magister*). Dungeness crab historically supported a commercial fishery within San Francisco Bay, but since 1900 commercial landings have all been outside the Golden Gate. This is one of the few benthic organisms of the Bay that has been the subject of research studies (Herbold et al., 1992). The juvenile life stage is the form most commonly found in the Central Bay. Spawning takes place offshore, the juveniles move into the Bay, and return to the ocean after approximately a year. Juveniles found intertidally prefer soft substrate with eelgrass and bivalve shells. Dungeness crab are more common from Richardson Bay to Suisun Bay. Their numbers and distribution appear to be influenced by ocean

changes caused by El Niño events and outflow from the Bay, i.e., fewer juveniles in the Bay during higher outflows (Herbold et al., 1992). Both incoming and outgoing year classes of Dungeness crab use Central San Francisco Bay as a migratory corridor. Juveniles feed on fish, mollusks, and crustaceans and are cannibalistic on smaller Dungeness crabs.

Crangon shrimp. Shrimp are fished commercially in San Francisco Bay by 18 or so boats. Together with the Pacific herring fleet, these constitute the last remaining commercial fisheries operations in the Bay (R. Tasto, pers. comm.). The fishery is dominated by three species: *Crangon nigricauda*, *C. nigromaculata*, and *C. franciscorum* (Smith and Carlton, 1975). A fourth species (*C. alaskensis elongata*) has been reported from the Bay (R. Tasto, pers. comm.), but is readily confused with the larger *C. nigricauda* (Smith and Carlton, 1975). These organisms are found throughout the Central Bay, on mud and sandy bottoms where they feed and seek refuge (Smith and Carlton, 1975). Presumably, conditions that alter the character of the benthic habitat preferred by these species can have effects on one or more of these shrimps, although the extent of these effects in San Francisco Bay has not been studied.

4.0 RECONNAISSANCE FIELD STUDIES:

4.1 Background and Rationale

Based on the literature review and an assessment of Central Bay conditions, the reconnaissance field study was designed and implemented to collect sediment samples from identified fish habitat areas, and to observe, as possible, habitat conditions using a remotely operated vehicle (ROV). The sandy shoals and rocky outcrops that are near the Alcatraz Disposal Site, and that may be subject to deposition of fine particles transported from the disposal site were the focus of these activities. At the level of this reconnaissance study, only the presence of benthic habitat was to be qualitatively evaluated during the single sampling event. For this study, substrate composition and grain size were to be considered to be primary descriptors of "fisheries habitat". This is a fairly restrictive definition of the term in that fish habitat also depends on adequate water quality, water flows, and habitat that provide essential feeding, spawning, and nursery grounds. Also, habitat requirements vary by species and life stage. Details of these habitat requirements are beyond the intended scope of this study, in nature and will have to be addressed in future programs. Specific information sought as evidence for habitat alteration in this study included the following:

- Discontinuities in sediment characteristic within a core sample, especially when evidence exists of freshly deposited materials overlaying historic (previous recorded natural) deposits.
- Evidence of benthic organisms characteristic of disturbed sediments, or present in different quantities than is characteristic of undisturbed sediments in the Bay; variation in species composition among sediment types.

- Surface sediments different from historic descriptions for a locale, i.e. mud where sands were reported, or fine sands where coarse sands or gravels were reported.
- Visual evidence from the ROV study.

4.2 Sampling Methods

The reconnaissance field study was carried out aboard the San Francisco State University Research Vessel "Questuary" from 19 through 21 January, 1994. The vessel was equipped with a 3,000-ton A-frame hoist which was adapted for gravity coring and grab sampling. Sample station positioning was accomplished by means of a dual global positioning system.

A series of general north to south sampling stations was located along the east and west margins of the disposal site (Figures 3 and 4). An east-to-west series of stations was also positioned on both sides of the dredge disposal area as was proposed in the reconnaissance field study design. Additional points were also picked between sediment changes identified during the field study and at selected points around Harding Rock, Shag Rock, Arch Rock, Blossom Rock, and along the Alcatraz Shoal.

The two methods of sediment recovery for this investigation were a gravity core and a box core sampler. A Van Veen core was tested at one station, but it was not so successful for sediment collection as the box corer, and was not used afterwards.

Gravity Corer

The gravity corer designed for collection of sediment samples was fitted with a 4-inch diameter, two-foot or three-foot long core barrel. Approximately 300 lbs of lead weights was used for driving the corer. Before sampling, a plastic liner was inserted

into the corer barrel to retain the sediment sample. A core-catcher device was installed in the cutter nose, which was then threaded onto the corer barrel. The gravity corer was launched by suspending the device from the A-frame on a drop-line and letting out the desired amount of cable from the winch. The drop line was then released at the selected sampling location and the corer was allowed to free-fall to the bottom. The corer was recovered by the winch.

After the coring device was recovered, the core liner was pulled from the corer barrel to expose the bottom of the liner. The liner bottom was then covered with a rubber cap and sealed with duct tape. The liner was then removed from the barrel, labeled with station number and orientation, cut to the length of the sediment retained, and the other end capped and sealed with duct tape. Core samples containing only a minor amount of sediment were transferred to one-gallon size plastic bags, labeled and sealed for later description. All cores and bag samples were transported at the end of the day to a designated storage location for opening and sediment description later.

Box Corer

An approximately two-foot square box corer was used for recovering biological samples. Approximately 400 lbs of lead was bolted to the corer for driving the sampler. The coring device was launched in the same manner as the gravity corer.

A sub-sample of the recovered sediment was retained for geologic logging, determination of particle-size-distribution, and total-organic-carbon analysis. The remaining sediment sample was then passed through a 1 mm sieve and the retained organisms preserved in 10% buffered formalin for identification and enumeration. Organisms were later identified to species when possible.

Upon collection of sediment at each station, the station number, location, water depth, length of recovered volume and initial sediment observations were recorded. Sample location coordinates and water depth data were recorded at the time the coring device reached the sediment surface, as noted by observations of the drop line. Some differences occurred between the desired coordinates and coordinates actually sampled, because of the drift of the ship during the time the sampling device took to free-fall to the bottom. Station locations were recorded for sites actually sampled.

A total of 70 sampling drops were made at 61 collection stations (Table 1). Of these, 57 gravity core stations were attempted for sediment distribution analyzes and 13 box core stations were attempted for biologic analyzes. Nine of the 13 box core stations were attempted as dual stations for sediment and biologic analyzes.

Of the 57 gravity core stations for sediment analyzes, sediment cores with a maximum length of 2.9 feet were recovered from 18 stations, sediment bag samples were recovered from 26 stations, and no sediment samples were recovered at 13 stations whose sediments were either too coarse for retention in the sampler, or where the substrate appeared to be exposed rock. Sediment samples for biological analysis were collected from 12 of the 13 boxes core stations; the thirteenth station, AHS-02B, yielded only a limited amount of sediment and a sample for biological analysis was not collected.

4.3 Sample Analyses

4.3.1 Sediments

Cores were cut longitudinally with a power saw, split with a wire and cleaned of cuttings. Sediments were visually described as to sediment type, color, grain size, particle sorting, firmness, lithology, and other miscellaneous characteristics. Grain

Table 1

Table 1

Table1

size characteristics were determined using information presented on Table 2. Geologic logs were prepared for all core samples showing the vertical distribution of different sediment layers. Geologic logs were also prepared for bagged samples. Geologic logs are presented in Appendix A.

Dredged material were visually discernable from natural deposits (sediment type, color, grain size and sorting). Grain-size analyses were performed on the sub-samples from the box core samples and four of the bagged samples. Sediments were not analyzed for physical parameters such as moisture content, density, and plasticity index, because of the limited nature of the vertical recovery, and because of past studies of cores (Farmer, 1984) which indicated only gradual changes in physical characteristic over an extended length of the sediment column.

4.3.2 Infauna

The biological sampling program carried out in this program was not intended to provide sufficient data to permit a detailed and quantitative evaluation of populations of benthic invertebrates (or fishes) in the Central San Francisco Bay: only 12 stations were sampled for benthic invertebrates in the entire Central Bay. Rather, the purpose was to seek biological evidence that Alcatraz disposal activities are associated with benthic habitat degradation or habitat modification. The relative abundances and the species present can be a good indicator of differences between sediments. Although this evidence in itself does not necessarily reveal the suitability of the sediments as benthic fish habitat, variations in numbers and species present can reflect physical or chemical dissimilarities, or both, among locations sampled. Benthic invertebrates are an important part of the diet of a number of fishes, directly or indirectly in the food web. Thus in this study, degradation and modification of the benthic community would be seen as evidence that demersal fish habitat, and thus the presence of these fishes, was being affected as well.

Replicate k Dominance Curve

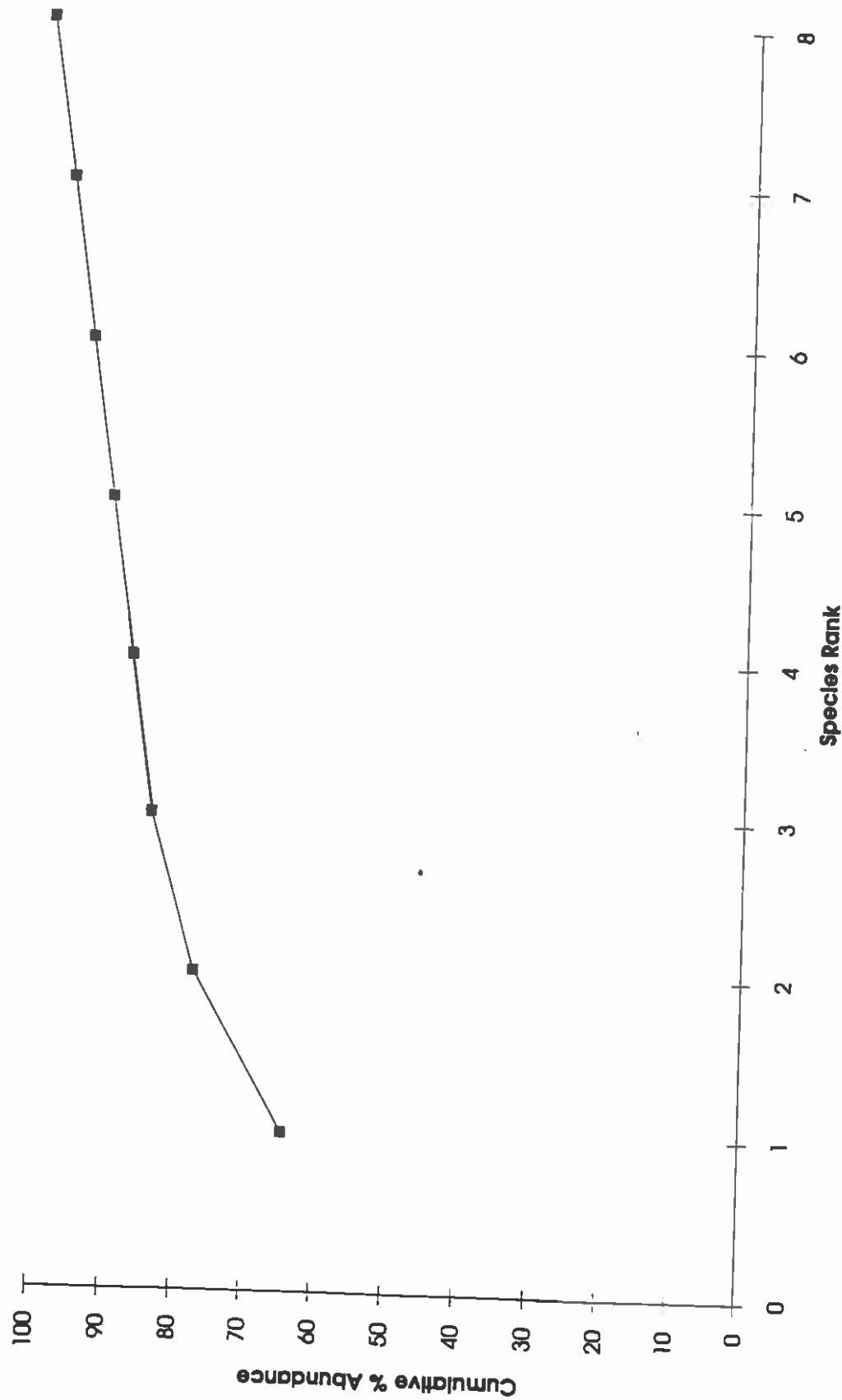


Figure 5. Species Abundance Curve Demonstrating Low Species Number And Relatively Uneven Distribution

Replicate k Dominance Curves

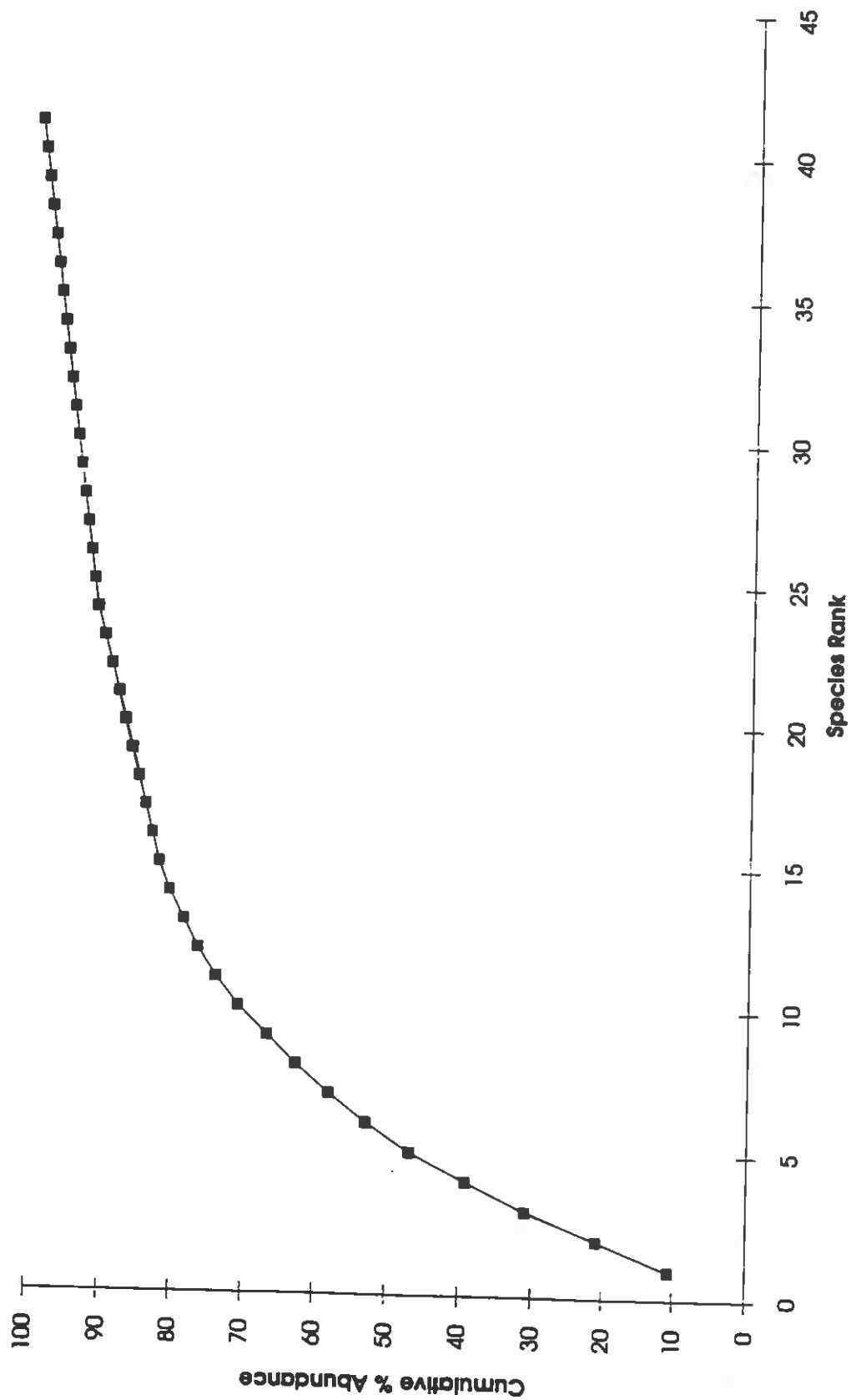


Figure 6. Species Abundance Curve Deviation Demonstration High Species Number And Relatively Even Distribution

The ROV was operated from an 85' vessel. The vehicle was represented to operate well in currents less than 1.5 to 2 knots.

Some good images of the Bay benthos were obtained. Whenever a clear image appeared on the monitor, the time was recorded from the screen and appropriate field notes for the observation were written in data logs by one or two observers. On the whole, however, the ROV used was not particularly effective for a benthic survey in the Bay. The greatest problem related to current speeds. Although the vehicle was purported to be capable of moving at 2.5 knots, an experienced operator was unable to control the vehicle adequately in currents greater than about .5 knots. On the positive side, suspended sediments were not usually a problem when the camera was able to view a lighted spot on the bottom through 10 or 15 centimeters of water. Oblique or forward viewing was possible only in the clearest water.

5.0 RESULTS

5.1 Description of Sediments

Sediments recovered during the investigation can be divided into three basic types: Type 1 sediments (Recent Sands and Gravels), Type 2 Sediments (Muds and Sand Deposits), and Type 3 sediments (Fine Sands with Minor Deposits). These sediments were visually discernable from each other. The most distinctive physical characteristics used to separate these three sediment types were color, grain size, and to a lesser extent, sorting. These characteristics are discussed below.

5.1.1 *Type 1 Sediments (Recent Sands and Gravels)*

Type 1 sediments (sand and gravel deposits) are varying shades of browns with some grayish red to pink. These deposits are primarily poorly to moderately sorted, medium- to very-coarse-grained sands with some pebbles and shell fragments up to several inches in diameter. Some fine-grained sand is present; however, this size fraction forms a minor part of the sediment. The sediments are relatively clean of clay and silt-sized sediment, generally less than 5%.

These sediments are found in areas away from the Alcatraz Disposal Site (Alcatraz Shoal, Arch Rock, and Shag Rock). They are consistent with previously described sediment deposits in the Central Bay (Trask et al., 1953; Trask, 1954, Johnson, 1975, Thompson, 1981).

Some sediments are primarily composed of whole and broken shell fragments. Man-made debris, not directly associated with dredge material disposal, were recovered from several stations around the disposal site where dredge materials were not encountered.

5.1.2 Type 2 Sediments (Muds and Sand Deposits)

The majority of Type 2 sediments are mud with some interlayered fine-grained sand layers which were segregated during disposal. These sediments are primarily black to dark gray or dark greenish gray; some of the black sediments change to a light olive gray color after exposure to air. The mud is soft with varying amounts of shell fragments, wood debris, and organic material.

These sediments are found primarily adjacent to and around the Alcatraz Disposal Site and are interpreted as dredged material from direct deposits. These sediments are similar to those described from several borings made in the pile at the Alcatraz Disposal Site (Farmer, 1985).

5.1.3 Type 3 Sediments (Fine Sands and Minor Mud Deposits)

Type 3 sediments are primarily fine sands with minor mud deposits. The sands are generally well-sorted, fine-grained, and dark gray to dark greenish gray. Grain size ranges from very fine to medium with few to no coarse grains and generally minor amounts of mud. Varying amounts of shell fragments are present. Some of the sands are mixed with the Type 1 sediments. These sediments are generally olive brown to grayish brown and grain size ranges from very fine to coarse.

These sediments are basically similar to the fine sands described as Type 2 sediments which are interlayered within the disposal site muds. These sands are different in color, grain size, and sorting from the previously reported natural sediments in the Central Bay and the natural deposits observed by this investigation.

These sediments are found in and to a wider extent around the Alcatraz Disposal Site and are interpreted as sediments redistributed by currents. Their presence at a

distance from the disposal site is attributed to current redistribution rather than direct deposit outside the boundaries of the Alcatraz Disposal Site.

5.2 Distribution of Sediment Types

Distribution of the three basic sediment types identified in this reconnaissance study are shown in Figure 7 and 8. The figure represents the areal distribution of the sediment type as identified from our coring recovery. Vertical distribution and thickness of these layers could not be assessed because of the shallow penetration of the gravity corer. (A color version Figure 7 is in Appendix F).

5.2.1 Type 1 Sediments (*Recent Sands and Gravels*)

Type 1 sediments assumed not affected by dredge materials were encountered within the northwest Central Bay near Arch, Shag and Harding Rocks (AHS-42S through AHS-49S); along the Alcatraz Shoal (AHS-13S, AHS-50S and AHS-50B); and along the northern side of the shoal to the east of Alcatraz Island (AHS-41S).

Type 1 sediments which show very limited effect by Type 3 sediments were encountered to the south-southeast (AHS-58B, AHS-01S, AHS-26S) and east-southeast (AHS-26S, AHS-27S and AHS-30S) of the disposal site.

On the west side of the Alcatraz Disposal Site (AHS-15S), these coarse sediments are moving to cover dredged materials, and appear to be armoring them from further erosion. This could contribute to erosion rates lower than anticipated.

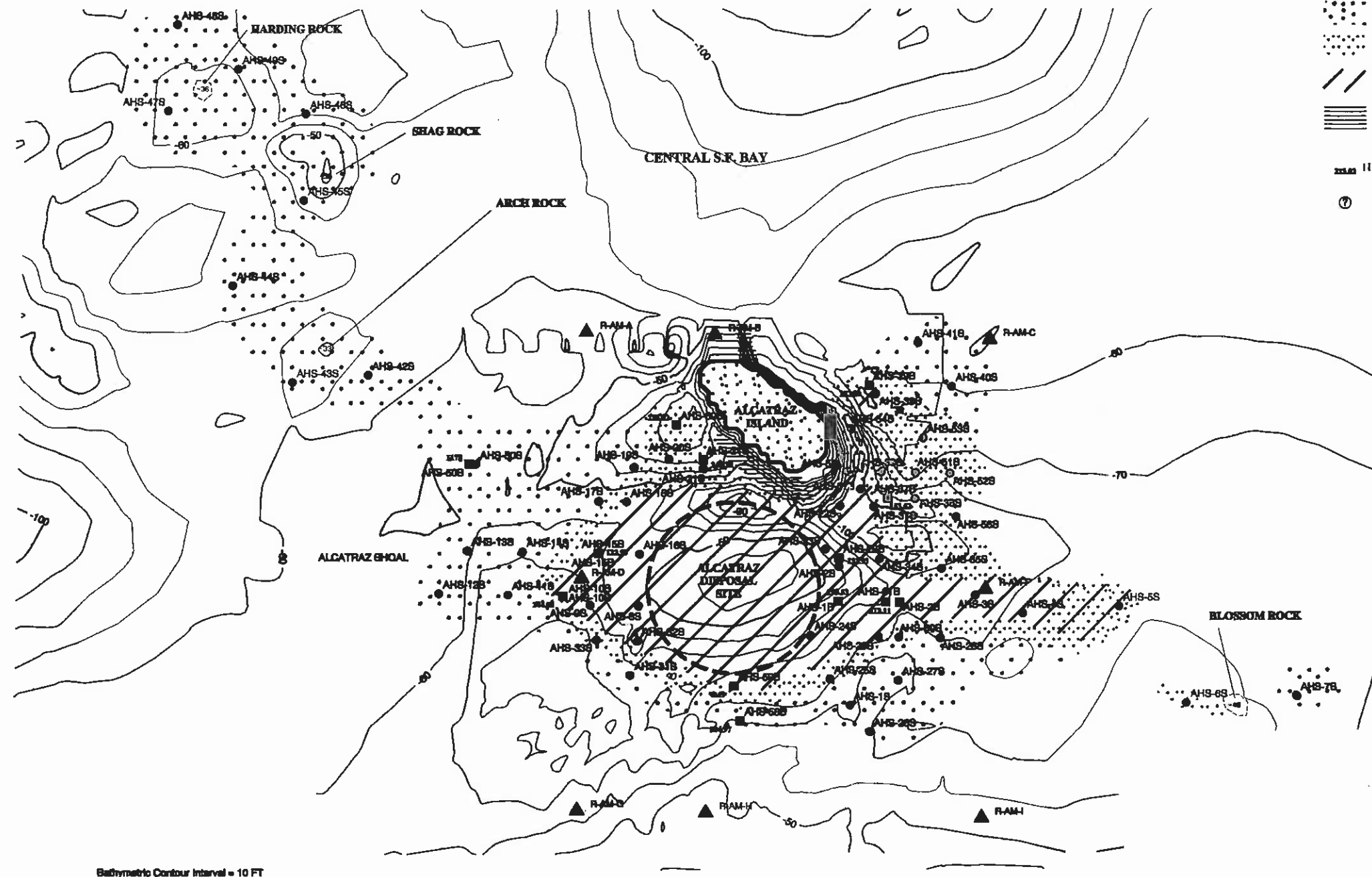
5.2.2 Type 2 Sediments (*Muds and Sand Deposits*)

Type 2 sediments were found in and around the margin of the disposal site. Muds were found to a limited extent around the margins however some muds were

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EXPLANATION

- AHS-108 GRAVITY CORE STATION
- AHS-158 BOX CORE STATION
- ▲ R-AM-A ALCATRAZ ENVIRONS STATION
- RECENT SANDS AND GRAVEL
- DREDGED MATERIALS (PRIMARILY FINE SANDS) REDISTRIBUTED BY CURRENTS
- /// DREDGED MATERIALS (PRIMARILY MUD)
- ==== COBBLES (ROV OBSERVATION)
- ||||| MEDIAN GRAIN SIZE
- ⑦ UNKNOWN OR UNCERTAIN SEDIMENT DISTRIBUTION DUE TO LACK OF SAMPLING POINTS



Bathymetric Contour Interval = 10 FT

Bechtel
SAN FRANCISCO

ALCATRAZ MARINE
HABITAT STUDY

BOTTOM SEDIMENT DISTRIBUTION
FROM RECONNAISSANCE STUDY

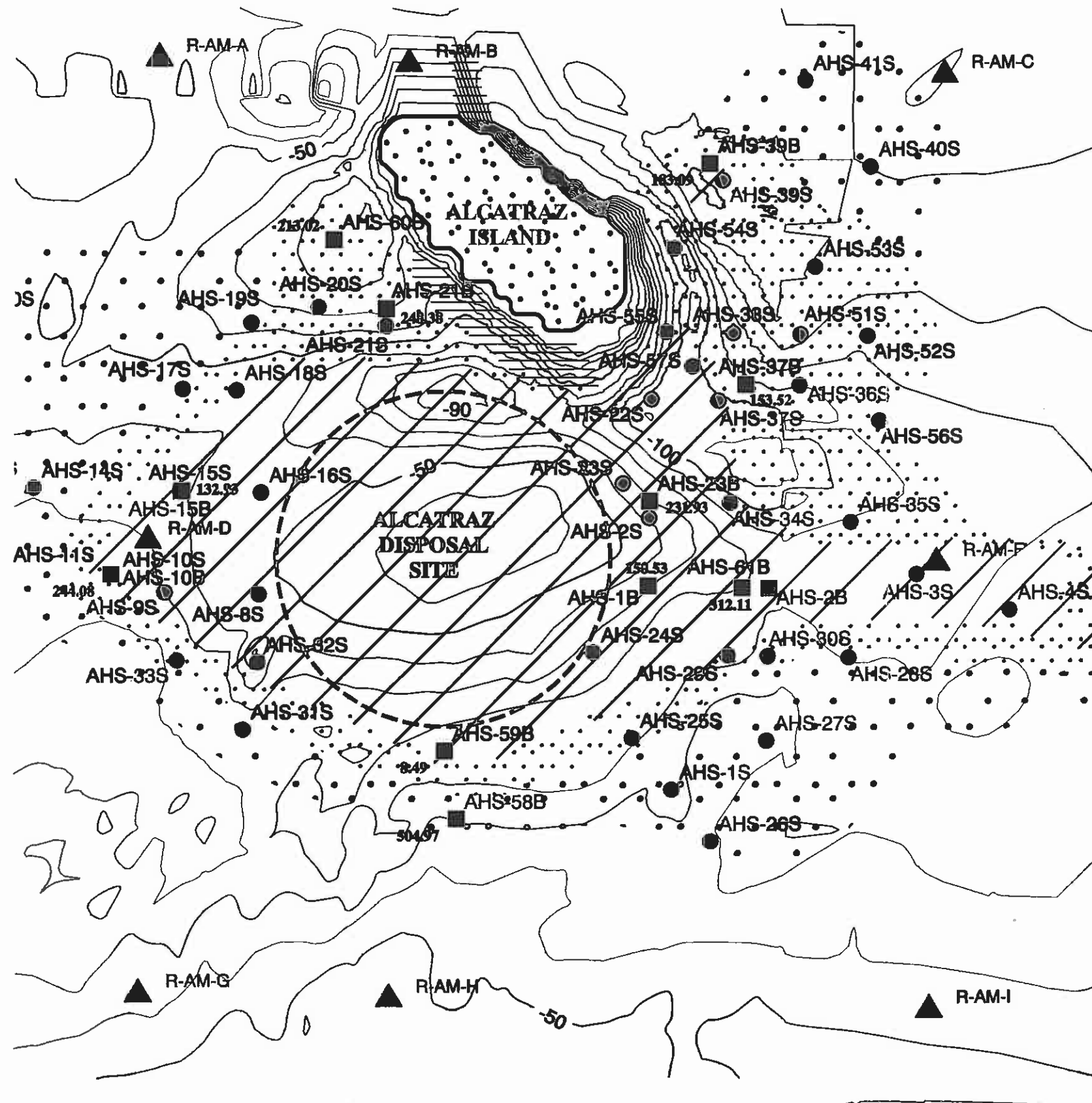


Job Number
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FIGURE 7

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recovered to the east (AHS-02B, AHS-03S and AHS-04S) and northeast (AHS-37S, AHS-57S and AHS-39S) of the disposal site. Some fine sand layers were identified interlayered with the mud layers.

5.2.3 Type 3 Sediments (Fine Sands and Minor Mud Deposits)

Type 3 sediments were found around the margins of the disposal site, primarily to the north of the disposal site and on the south slope of Alcatraz Island (AHS-20S, AHS-21S&B, and AHS-60B); to the northeast of the disposal site - east of Alcatraz Island (AHS-38S, AHS-39S, AHS-51S, and AHS-52S); and to the east of the disposal site (AHS-35S and AHS-05S).

5.3 Benthic Invertebrates

Figure 2 depicts the locations of the 12 benthic sampling stations. A summary of the species collected at the stations is presented on Table 3. Lists and enumeration of species identified for each station are attached in Appendix B.

Species Diversity and Abundance

The most species rich-stations were 61B (52 taxa/41 distinct species identified), 37B (43/37), 1B (34 /30), and 23B (23/20). Stations 61B and 1B are dark, muddy sand (Type 3) identified as derived from dredged materials transported by water movement to their present locations. Stations 23B and 37B appear to be natural sands (Type 1) typical of broad areas of the central San Francisco Bay. Four stations were intermediate in species abundance: 60B (10/10), 59B (10/9), 39B (8/6), and 15B (7/7). All four stations are derived from dredged materials (Type 3). Stations with the lowest numbers of benthic infauna collected are 10B (5/5), 58B (5/5), 50B (4/3), and 21B (2/2). Station 10B is Type 3 sediments, but the others are natural Bay sands

Table 3
SPECIES ABUNDANCE IN BENTHIC SAMPLES

Phylum	Annelida Species/No. of Organisms ¹	Crustacea Species/No. of Organisms ¹	Echinodermata Species/No. of Organisms ¹	Mollusca Species/No. of Organisms ¹	Other Taxa/ No. of Organisms ²	Station Total Taxa/No. of Organisms ³
Station						
1B	<i>Armandia brevis</i> -15	<i>Melita dentata</i> -21	<i>Amphiodia urtica</i> -1	<i>Gemma gemma</i> -20		
	<i>Glycinde picta</i> -8	<i>Pinnixa franciscana</i> -20	<i>Ophiuroidea</i> sp.-4	<i>Macoma</i> sp.-8		
	<i>Sigambra tentaculata</i> -10 17 other species-40	<i>Scleroplax granulata</i> -9 7 other species-11		<i>Protothaca staminea</i> -12 3 other species-6		
	Totals: Species-20 Organisms-65	Totals: Species-10 Organisms-62	Totals: Species-2 Organisms-5	Totals: Species-6 Organisms-46	Totals: Taxa-4+ Organisms-86	Totals: Taxa-40 Organisms-264
10B	<i>Magelona piteikai</i> -3	<i>Photis californica</i> -1				
	<i>Hemipodus borealis</i> -1					
	<i>Mediomastus</i> sp.-1					
	Totals: Species-3 Organisms-5	Totals: Species-1 Organisms-1	Totals: 0	Totals: 0	Totals: Taxa-1 Organisms-1	Totals: Taxa-5 Organisms-7
15B	<i>Spiophanes missionensis</i> -1	<i>Foxiphalus obtusidens</i> -1	<i>Amphiodia</i> sp.-1	<i>Amygdalum pallidulum</i> -1		
				<i>Mya arenaria</i> -1		
	Totals: Species-1 Organisms-1	Totals: Species-1 Organisms-1	Totals: Species-1 Organisms-1	Totals: Species-2 Organisms-2	Totals: Taxa-2 Organisms-2	Totals: Taxa-7 Organisms-7
21B	<i>Mediomastus</i> sp.-1			<i>Odostomia</i> sp.-1		
	Totals: Species-1 Organisms-1	Totals: 0	Totals: 0	Totals: Species-1 Organisms-1	Totals: 0	Totals: Taxa-2 Organisms-2

Phylum	Annelida Species /No. of Organisms	Crustacea Species/No. of Organisms	Echinodermata Species/No. of Organisms	Mollusca Species/ No. of Organisms	Other Taxa/ No. of Organisms	Station Total Taxa/No. of Organisms
Station						
23B	<i>Armandia brevis</i> -18 <i>Mediomastus spp</i> -6 9 other species-12 Totals: Species-11+ Organisms-36	<i>Melita dentata</i> -6 <i>Cancer anthonyi</i> -2 2 other species-2 Totals: Species-4 Organisms-10	<i>Amphiodia</i> sp-2 Totals: Species-1 Organisms-2	<i>Acanthodoris</i> sp-1 <i>Cephalaspidea</i> -1 <i>Macoma</i> sp-1 Totals: Species-3 Organisms-3	Totals: Taxa-4+ Organisms-8	Totals: Taxa-23 Organisms-59
37B	<i>Armandia brevis</i> -31 <i>Mediomastus spp.</i> -79 <i>Spiophanes missionensis</i> - 207 Tubificidae-17 17 other species-29 Totals: Species-21+ Organisms-363	<i>Cancer</i> spp.-2 Totals: Species-5 Organisms-6	<i>Amphiodia digitata</i> -3 Totals: Species-1 Organisms-3	<i>Tellina modesta</i> -4 <i>Transenella tantilla</i> -7800 Totals: Species-7 Organisms-7810	Totals: Taxa-9+ Organisms-105	Totals: Taxa-43 Organisms-8287
39B	<i>Spiophanes missionensis</i> -20 Tubificidae-4 2 other species-2 Totals: Species-4 Organisms-26	Totals: 0	Totals: 0	Total: 0	Totals: Taxa-4+ Organisms-5	Totals: Taxa-8 Organisms-31
50B	<i>Saccocirrus</i> spp.-11 <i>Hemipodius borealis</i> -5 2+ other species-12 Totals: Species-4+ Organisms-23	Totals: 0	Totals: 0	Totals: 0	Totals: Taxa-4+ Organisms-23	Totals: Taxa-4+ Organisms-23

Phylum	Annelida Species /No. of Organisms	Crustacea Species/No. of Organisms	Echinodermata Species/No. of Organisms	Mollusca Species/ No. of Organisms	Other Taxa No. of Organisms	Station Total Taxa/No. of Organisms
Station						
58B	<i>Acmira catherinae</i> -1 Goniadidae-1 <i>Hemipodus borealis</i> -1 <i>Myriochele</i> sp.-1 Totals: Species-4 Organisms-4					Totals: Taxa-5 Organisms-5
	<i>Holothuroidea</i> -1					
59B	<i>Glycera americana</i> -3 4 other species-4 Totals: Species-5 Organisms-7					Totals: Taxa-10+ Organisms-20
	<i>Corophium</i> spp.-16 <i>Melita dentata</i> -3 2 other species-2 Totals: Species-4+ Organisms-21					
60B	<i>Hesionura coineau</i> <i>difficilis</i> -1 <i>Steptosyllis</i> sp.-1 Tubificidae-1 Totals: Species-3 Organisms-3					Totals: Taxa-4 Organisms-4
	<i>Rhepoxynius stenodes</i> -1 <i>Alvania compacta</i> -1 <i>Gemma gemma</i> -1 Totals: Species-2 Organisms-2					
61B	<i>Armandia brevis</i> -171 <i>Eusyllis</i> spp.-7 19 other species-27 Totals: Species-21+ Organisms-205					Totals: Taxa-52+ Organisms-471
	<i>Melita dentata</i> -6 <i>Photis brevipes</i> -21 8 other species-18 Totals: Species-10 Organisms-45					
	<i>Amphiodia urtica</i> -3 <i>Amphiodia</i> sp.-1 <i>Ophiuroidea</i> -7 Totals: Species-3 Organisms-11					
	<i>Gemma gemma</i> -12 <i>Alia carinata</i> -6 Mytilidae-7 6+ other species-15 Totals: Species-9+ Organisms-40					
	<i>Totals:</i> Species-21+ Organisms-205					

Note:

- 1 Only predominant species in the indicated phyla that were present in each sample are identified by name in this table. Other species present (within the indicated phylum) are included in Other Species within that column. Appendix B lists all the species that were collected at the sampling stations.
- 2 "Other Taxa " column refers to organisms collected from the samples that are included in phyla other than annelida, crustacean, ekinodermata, and molluska. In most instances the organisms have been taxonomically identified to family or species and in a few instances, to phyla only. Therefore, these organisms are grouped and numerically counted according to taxa rather than species. The taxa names are listed in Appendix B.
3. "Total Taxa" is the sum of the species identified in the annelida, crustacean, ekinodermata, and molluska columns and the taxa identified in the "Other Taxa " column. Therefore, total species count at these stations is a conservative estimate.

(Type 1). The cumulative abundance curves (Appendix C) corroborate the species counts of the biological collection stations.

High Species Abundance Stations. The species abundance data thus indicate the general pattern of approximately equally high abundance among the four stations east of the Alcatraz disposal site (1B, 23B, 37B, and 61B). Two of the stations are derived from Type 1 native sands (23B, 37B), the other two from Type 3 redistributed dredge sands (1B, 61B). Annelid species predominated in samples from these four locations. The annelid *Armandia brevis* was the only species that was present in samples from all four stations, ranging from 15 animals at Station 1B to 171 animals at Station 61B. *Mediomastus* spp. was present in samples from two of the four stations (23B, 37B) and *Spiophanes missionensis* was present at three of the stations (1B, 23B, 37B). Various species of the echinoderm *Amphiodia* were found in samples from all four stations. Ophiuroidea sp. was present at two of the stations (1B, 61B). The crustacean *Melita dentata* was found at Stations 1B, 23B, and 61B. The mollusk *Gemma gemma* was present at Stations 1B, 37B, and 61B. *Macoma* spp. was present in samples from three stations, 1B, 23B, and 37B.

The species found in greatest abundance was the mollusk *Transenella tantilla*, with a count of 7800 in the one sample from Station 37B (Type 1 sediment). This mollusk was not found in any of the other samples.

Intermediate Species Abundance Station. Intermediate species abundance was found at the four dredged materials stations, (all are Type 3 sediments), three stations on the periphery of the disposal area to the south (59B), west (15B), and north (60B) of the disposal site, and the single site to the northeast of Alcatraz Island (39B). Annelid species predominated at Station 39B with greater representation from other phyla evident at the other three stations. The species found in the highest abundance from these four stations was *Spiophanes missionensis*, with a count of 20 animals from the Station 39 B. None of the species present in the

samples were found at all four stations. Species present in samples from intermediate abundance stations that were also found in samples from the high abundance stations include *Spiophanes missionensis* (Stations 15B and 39B), *Melita dentata* (Station 39B) and *Amphiodia* sp. (Station 15B).

Low Species Abundance Stations. Low species abundances occurred at one Type 1 station about one kilometer west of the disposal area on Alcatraz shoal (50B), one Type 1 station south of the disposal area (58B), and another Type 1 station several hundred meters north of the disposal site (21B). Sediments at all these stations are consistent with descriptions of "natural sands" in Central San Francisco Bay. Station 10B, presumably derived from dredged materials and several hundred meters west of the disposal site also had a low number of species. Most of the animals collected from these above stations were annelids. The annelid *Mediomastus* sp. was present in very low numbers in two of the four samples (Stations 10B and 21B). This species was also found at some of the intermediate and high abundance stations in far greater numbers, as high as 79 animals at Station 37B. The annelid *Hemipodus borealis* was found at Stations 10B and 50B (one at each station). This annelid was not present in any samples from the other 10 stations. One echinoderm (*Holothuroidea*) was present in the sample from Station 58B and one mollusk (*Osdostomia* sp.) was present in the sample from Station 21B. No crustaceans nor other phylas were represented in these four samples.

A preliminary examination of the organic carbon data (presented in Appendix D) reveals no strong correlation of numbers of species at a station and the levels of organic carbon present in the sediments. For instance, Station 59B, with the highest portion of organic carbon at 1.347%, had 10 taxa (8 species identified) present. Station 60B, with the lowest portion of organic carbon at .024%, also had 10 taxa (8 species identified) present. There appears to be only a slight correlation between the amount of organic carbon and decreasing grain size.

5.4 ROV Survey

On January 6, 1994, an in-situ reconnaissance survey of the Alcatraz environs was completed by means of an ROV. The ROV was deployed at six locations in central San Francisco Bay: four around the periphery of Alcatraz Island, one along the western shore of Angel Island, and one at Arch Rock. Throughout the survey, visibility was limited due to high levels of suspended material that scattered and diffused the light. Maximum visibility near Alcatraz and Arch Rock was approximately 1 foot; visibility offshore of Angel Island increased to as much as several feet. In addition, the sub-surface currents, which were sometimes greater than 2 knots, exceeded the optimum operating limits of the ROV and made it difficult to remain on station.

ROV observation Stations 1 through 13 were located along a linear transect trending north to south from the mid-point of the southern side of Alcatraz Island towards the Alcatraz Disposal Site. When the ROV was in contact with the bottom, which was between 40 and 59 feet on this transect, the substrate was seen to consist of large boulders, rock rubble, and cobble embedded in a dark sediment. Pieces of algae were seen floating through the water column, and coverage of organisms on hard surfaces was sparse.

When the ROV was positioned next to the southern wall of Alcatraz Island, an orange starfish (*Patiria miniata*) and a crab (*Cancer* sp.) were observed. What appeared to be either red or orange bryozoans or sponges were common on rocks. This position was held only briefly because ebb currents were rising and the boat could not be kept on station for prolonged periods. The decision was made to relocate to a calmer portion of the central Bay until tidal currents decreased.

Observations at Station 14, a cove on the west-southwest shore of Angel Island revealed rocks, boulders, and outcrops in the deeper substrate (17 feet and above)

and what appeared to be muddy sand in the shallower areas. Visibility was approximately 2 feet. *Patiria miniata* were common, as were red and orange incrusting organisms. Red (possibly *Halosaccion* and others), brown, and green (possibly *Ulva*) algae were also present. A fish, probably a sculpin, and a yellow nudibranch with brown spots was observed.

The substrate and organisms appeared to be covered with a very fine flocculent easily resuspended. From approximately 40 feet up to 1 foot depth, sea pens (*Pennatulacea*) were visible. These are anthozoans that in the Bay are characteristic of areas of low current velocities and deep sediments. Sea pens were observed at any of the other study locations.

Several *Patiria miniata*, purple sea stars (*Pisaster ochraceus*), and bryozoans or sponges were seen between 30 and 60 feet at Arch Rock. Nothing was visible in the water column while the ROV was operated between locations on the bottom.

On the northwest side of Alcatraz, incrusting red bryozoans or sponges were observed. One *Patiria miniata* and an unidentified pink sea anemone (Anthozoa) were also seen.

At the southern point of Alcatraz Island currents were high (approximately 4 knots) and consequently the ROV was operated as the vessel drifted with the current. The survey revealed the presence of *Patiria miniata* and the ubiquitous red or orange incrusting organisms.

The next cluster of observations were performed along approximately the same transect as Stations 1 through 13. Clean rocks were observed at 30 feet. No significant biological material other than small incrusting organisms was observed. This area has the appearance more of a river bottom than of a marine habitat, and few sediments were seen among the cobbles and boulders. This could be a result of

the high currents passing through the depression between the disposal mound and Alcatraz Island. To the east of the previous transect at Stations 21, 21' and 22, an increase in the red and orange incrusting material was noted. A crab (*Cancer* sp.) was seen.

Blossom Rock, to the southeast of Alcatraz Island, was to be the last station surveyed. Surveys could not be conducted at Blossom Rock as the currents exceeded the ability to safely operate the ROV.

Although qualitative, the ROV observations reveal that none of the areas examined around Alcatraz Island were blanketed in sediments, dredged or otherwise. On the contrary, rock surfaces near Alcatraz were relatively clear of sands and mud, probably the result of the high current velocities through the area.

6.0 CONCLUSIONS

6.1 Sediment Characteristics

Natural deposits were visually discernable from dredged materials. The characteristics of the sediments recovered in cores from this investigations are as follows:

- Observed native sands (Type 1 materials) which appear unaffected by dredge materials (Type 2 materials) are generally:
 - 1) shades of brown with some red and pink;
 - 2) between a grain size of upper-medium sand ($>350\text{ }\mu\text{m}$) and very-coarse sand ($<2000\text{ }\mu\text{m}$) with some gravel;
 - 3) moderately sorted; and
 - 4) with less than 5% clay and silt content.
- Dredge materials (Type 2 materials) recovered around the Alcatraz disposal mound are primarily:
 - 1) black to grayish black;
 - 2) muds with some interlayered black to dark gray fine sands.
 - 3) comprised primarily of clay and silt with minor amounts of fine sand.

7.2 Background

7.2.1 *Habitat Utilization*

Habitat utilization can be based on a frequency analysis of habitat characteristics at specific locations within the study area, in this case, the Alcatraz Disposal Site. Data are collected to evaluate habitat utilization, which is represented by the presence of one or more individuals of target species at a fixed location, which can be defined as a focal point or as a part of the species home range. Because data are only collected where target species or organisms are found, these data represent the probability of occurrence of a particular environment given the presence of a species. It also represents, in part, the habitat characteristics available to the species at the time of sampling.

Habitat preference is related to the habitat utilization concept. A species found in a high proportion in a particular environment, compared to the availability of those conditions, has actively selected that set of conditions. If the species' frequency distribution is identical to the distribution of environmental conditions, then it is randomly distributed; all measured conditions are equally suitable for the species (Bovee, 1986). More simply stated, a particular species may be frequently observed associated with a specific habitat type because that habitat is more readily available or accessible to the target organisms than their preferred habitat. However, this does not imply that the target prefers the particular habitat type on which it is found. It is utilizing what is available. In contrast, if suitable or preferred habitat is readily available in a number of different locations within the species or organisms home range, then the one habitat occurrence where the organism is most commonly found is the one that has been actively sought out and is preferred.

7.2.2 Methods for Collection of Fish

The dynamics of the Bay system prevent the use of the more unobtrusive methods of collecting fish habitat use data, such as through direct observation or the use of gill or fyke nets. The use of direct observation is limited due to visibility in the area being confined to within a few inches or feet due to high levels of suspended materials. The Bay environment near Alcatraz would make difficult the use of nets due to the high current velocities, and endangerment to non-target organisms by entanglement in the equipment. Other methods of collecting fish use data, such as electrofishing and biotelemetry, are not logistically feasible, again due to the in-Bay environment.

Hydroacoustic surveys have been used successfully to monitor the distribution of fish in the vicinity of Alcatraz (Bio Sonics, Inc., 1991). When combined with trawling, good data can be collected on the presence of various species. These techniques are best for identification of fishes in mid-water, and not particularly effective for demersal species. For this reason, hydroacoustic techniques are not recommended in studies to determine the presence of fishes associated with specific sediments and other benthic habitat.

Among the few choices available for scientists to collect this type of data is the careful use of trawls. Otter trawls are effective in catching fish; however they have limitations which must be considered: 1) they are species and size selection; 2) they are not particularly useful around cover substrates, such as boulders and rock outcroppings, because the nets may snag on these objects and become a safety hazard during sampling; 3) the deployment of the nets is highly disruptive and the more highly mobile fish are able to avoid capture; and 4) the actual trawling distance may inadvertently cover more than one substrate type. However, because some of these limitations can be remedied to an extent, trawls are the preferred choice for collection of fish for this study.

7.3.1 Sampling Methods

The effect of natural variability, both temporal and spacial is an important consideration for all habitat analyses. Although time is not a material part of the habitat it does relate to the daily and seasonal habitat changes. The distribution and amount of the physio-chemical components vary in both time and space, and in turn influence the distribution and abundance of the biotic components. The amount of information that can be generated on seasonal or daily patterns of distribution in a community is limited by the number of sampling occurrences and the timing of each sampling event. The biological field study will be carried out over a sufficient period of time to allow for incorporation of temporal variation in sampling occurrences. Although field sampling during different portions of the day can provide important information on fish and invertebrates that are diurnal, nocturnal, and crepuscular (daytime, nighttime, and dawn and/or dusk, respectively), such a program would involve an extensive sampling effort; thus this study will be limited to an evaluation of seasonal patterns. Recorded spacial information should include specific locality, topography, and physical conditions. A description of the physical factors affecting the site such as substrate, currents, and turbidity, will be recorded. This is further discussed in the following sections.

Core samples will be collected using a vibra-core device or drilling equipment capable of approximately 10 to 20 feet of sub-bottom penetration, depending on sediment type. These deeper core samples (as compared to those collected in the reconnaissance study) will enable greater penetration of the dredge materials to establish the thickness of the redistributed sediment. Gravity coring and box-core sampling may also be used in selected location for further surface habitat studies. Samples from the core barrel will be recovered within an acrylic liner or another suitable liner material. Limited recovery or grab samples will be transferred to 1-gallon plastic bags or containers as appropriate. After sediments are collected, the station number, location, water depth, and length of recovered volume will be

recorded. Shipboard logs will be maintained and any geologic and biologic notes made on board will be recorded. The core liners and bag samples will be sealed after initial observations are made and the samples will be transported to the laboratory for further study and analyses. The core samples will be sectioned in the laboratory after shipboard procedures are completed and detailed sediment logs will be generated. The number of samples for sediment-size and biologic testing will be determined at that time.

Biological samples will be collected by surface grab at some of the sediment stations. Sediments will be passed through a 1 mm sieve and retained organisms preserved in 10% buffered formalin and identified to genus, and to species when possible. A sub-sample will be retained for particle-size-distribution and total-organic-carbon analysis.

Trawls will be used for collection of demersal fish as the net drags across the substrate along the transect. Based on the results of the sediment surveys, a minimum of five trawling stations will be established. Each station, with two additional replicate stations per grain size category, will be in an area previously sampled for substrate analysis and represented by different grain sizes (categories). For example, one station will be in mud, perhaps at the edge of the active disposal pile; one station in the mud/sand interface, possibly between Stations 58 and 59 south of the disposal site; one in fine "muddy sands", as typified by Stations 37 or 61; one in fine "clean sands", such as Station 44S; and one station in clean coarse sands such as those observed on the Alcatraz Shoal or near Arch and Harding Rocks. The total number of trawling stations will be 15, 3 in each of the grain size categories.

To account for the seasonal use of the study area, trawls will be conducted once a month. Each trawling survey will consist of one ten-minute trawl performed at each station. Date, station coordinates, weather, distance traveled by the trawl, water quality (temperature, pH, dissolved oxygen, conductivity/salinity), depth, and

current speed will be recorded for each trawl. The four latter parameters and grain size will be used to generally define habitat type within the sampling stations. The fish captured from each trawl will be identified to genus and species, and length and weight determined, any gross anomalies (e.g., tumors, fin necrosis) noted, and released. If more than twenty individuals of one species are captured, only twenty fish will be measured and weighed. Any incidental catches of macroinvertebrates will be recorded and identification will be to genus and species if possible.

7.3.2 *Sample Analyses*

Sediment will be analyzed for physical and chemical characterization. Physical parameters will include grain-size, color, density, consolidation, and sorting. Chemical analyses of selected samples will include total organic carbon, heavy metals and polynuclear aromatic hydrocarbons (PAHs). The sediments will be analyzed using the appropriate EPA procedures, and appropriate QA/QC (quality assurance and quality control).

Biological samples will be evaluated qualitatively and a description of the benthic invertebrate assemblage described. Difference in physical, chemical, and biological characteristics will be considered. Directional trends and changes will be discussed and compared in an attempt to correlate benthic community structure with changes associated with transport of sediments from the Alcatraz site.

Potential habitat degradation or habitat modification that may be associated with Alcatraz disposal activities will be considered during this study. As discussed in the reconnaissance study, degradation and modification of the benthic community would be seen as evidence that demersal fish habitat, and thus the presence of these fishes would be affected. Biological evidence of habitat degradation may include the following:

- ❑ Reduced numbers of species when compared to local undisturbed reference communities: Certain species are more tolerant of degraded conditions and can tend to dominate the community (Kennish, 1991; Clark, 1986; Widdows, 1985).
- ❑ The presence of species commonly associated with severely polluted habitats: Some species appear to be universally favored by degraded conditions. For instance, the polychaete worm *Capitella capitata* is commonly with sediments with very high levels of organic material (Kennish, 1991; Gray, 1981).
- ❑ Presence of a different assemblage of species ("community") than is typical of an undisturbed local reference community natural sediments in the area: Conditions favoring one assemblage of species over another include a large suite of physical and chemical environmental factors, including organic content of the sediments, pH, grain size and distribution, temperature, levels of suspended materials, depth, and patterns of water flow, to name a few (Kennish, 1991; Cobb, 1993; Eckman, 1983).
- ❑ The dominance of the community by one or a few species, evidence of recent changes in sediment particle size distribution, organic content, or chemistry: These differences can occur even as a result of the deposition of non-polluted sediments, or from current changes associated with deposition of and accumulation new materials (Gray, 1981).

7.3.3 Data Analysis

For each of the target species, trawl data will be compiled by month, size class, and grain size category. The mean and 95 percent confidence intervals for the number of

fish captured within the stations will be calculated and graphed. It is possible that the trawls may actually cover more than one grain size category and the catch may reflect fish presence over more than one substrate, therefore caution must be taken in formulating firm conclusions on this dataset. Any general trends of occurrence over particular substrates that are observed will be assessed.

7.4 Reporting and Conclusions

All observations made and data generated during this study will be combined in a final report. The data will be compared to existing studies and will be used to generate recommendations for future management of the disposal site.

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Appendix A: Geologic Logs



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-01B

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,013 E 6,006,894

ELEVATION (below MLLW)

-76

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
BX	2.0'	-1.0'	-76.0				Box core sample: Muddy SAND over MUD, Dark gray to Black, sand is fine grained, some shell fragments.	Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from surface sub-sample: 10% gravel (shells) 2% coarse-vc sand 12% medium sand 37% fine sand 4% very-fine sand 20% silt 15% clay Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).
			-76.3	0.5				
			-77.0	1.0				

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-01B





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-02B

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,998 E 6,007,616

ELEVATION (below MLLW)

-81

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

-81.0

Depth In Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-0.1'

-81.1

Box core sample: Coarse Sand, Gravel, and Shell fragments.

Box core dropped from
water surface and
allowed to free-fall to
bottom.Little recovery, sample
washed with box core
retrieval.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-02B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-02S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,125,796 E 6,007,029

ELEVATION (below MLLW)

-70

SAMPLE LENGTH

2.9

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	3.0'	2.9'	-70.0					(Template: SEA)
			-70.2				0.0 - 0.2 ft: Muddy SAND, Black, fine grained, moderately sorted, common white shell fragments, gradational contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
				0.5			0.2 - 1.2 ft: Sandy MUD, Black to Greenish gray, moderately soft, sand is fine grained, sharp contact.	Torvane reading at 0.3' = 0.9 tons/sq.ft.
			-71.2	1.0				Torvane reading at 1.0' = 0.5 tons/sq.ft.
				1.5			1.2 - 2.9 ft: MUD, Grayish black to Black, mottled in areas with Dark greenish gray, changing to Light olive gray with exposure to air; moderately firm, minor shell fragments.	
				2.0				Torvane reading at 2.0' = 1.5 tons/sq.ft.
				2.5				
			-72.0					Description and classification by visual examination of sample.
								Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-02S





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-04S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,868 E 6,009,058

ELEVATION (below MLLW)

-77

SAMPLE LENGTH

1.1

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

1.1'

-77.5

-77.6

0.5

1.0

-78.1

0.0 - 1.1 ft: MUD, Grayish black mottled with Greenish gray changing to Grayish green at 0.5', soft to moderately soft, sandy layer between 0.5 - 0.6', abundant shell fragments between 0.9 - 1.1'.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Torvane reading at 0.4' = 0.5 tons/sq.ft.

Torvane reading at 0.9' = 0.5 tons/sq.ft.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-04S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-05S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,946 E 6,010,183

ELEVATION (below MLLW)

-87

SAMPLE LENGTH

0.3

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	3.0'	bag sample	-87.0				Bag sample: Muddy SAND, Olive black, fine grained, ~15% silt and clay, with shell fragments up to 0.5".	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop yielded ~0.3' of sample which was bagged.
			-87.3					Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-05S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-06S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Blossom Rock area, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,125,817 E 6,010,962

ELEVATION (below MLLW)

-100

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

-200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag
sample

-100.1

●

Bag sample: Gravel, Olive gray, with sand, minor mud content, gravel is primarily medium-grained sandstone, some shell fragments up to 0.6".

Gravity core dropped from water surface and allowed to free-fall to bottom.

First core drop had no recovery, second core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Blossom Rock area San Francisco Bay

HOLE NO.

AHS-06S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-07S

SAMPLER

MEC, Inc.

SITE and LOCATION

Blossom Rock area, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,125,892 E 6,012,248

ELEVATION (below MLLW)

-80

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

-80.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Two core drops
attempted - no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Blossom Rock area San Francisco Bay

HOLE NO.

AHS-07S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-08S

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,960 E 6,004,565

ELEVATION (below MLLW)

-47

SAMPLE LENGTH

1.3

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

1.3'

-47.0

-47.2

-47.5

-47.6

-47.8

-48.0

-48.3

0.5

1.0

0.0 - 0.2 ft: SAND, Olive black, fine to medium grained, moderately sorted, minor mud, 2" rounded pebble with encrusted barnacles.

0.2 - 0.8 ft: MUD, Greenish gray to Grayish black, mottled, soft; sandy layer with shell fragments between 0.5 - 0.6'.

0.8 - 1.0 ft: SAND, Olive black, fine to medium grained, moderately sorted, shell fragments up to 0.5", 3.0 x 1.5 x 1.5" black piece of wood.

1.0 - 1.3 ft: MUD, Greenish gray to Grayish black, mottled, soft.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Torvane reading at 0.3' = 0.7 tons/sq.ft.

Torvane reading at 1.2' = 0.7 tons/sq.ft.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-08S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-09S

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,972 E 6,004,004

ELEVATION (below MLLW)

-67

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

-67.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag sample

-67.1

Bag sample: Sandy MUD, Olive black, changing to Grayish brown with exposure to air. soft. sand is very fine to fine grained.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-09S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-10B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,079 E 6,003,685

ELEVATION (below MLLW)

-74

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

-400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
BX	2.0'	-1.0'	-74.0	0.5			Box core sample: SAND, Olive gray, fine to medium grained, well sorted, minor fines.	(Template: SEA) Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from surface sub-sample: 0% gravel <1% coarse-vc sand 47% medium sand 46% fine sand 2% very-fine sand 3% silt 2% clay
			-75.0	1.0				Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-10B





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-11S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,093 E 6,003,043

ELEVATION (below MLLW)

-74

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

-200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

-74.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Two core drops
attempted - no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-11S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-12S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,109 E 6,002,241

ELEVATION (below MLLW)

-67

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

-67.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Two core drops
attempted - no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-12S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-13S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,608 E 6,002,573

ELEVATION (below MLLW)

-60

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

-200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag
sample

-60.1

...

Bag sample: SAND, Moderate brown, medium grained, some pebbles
up to 0.25".Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.
Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-13S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-14S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,595 E 6,003,214

ELEVATION (below MLLW)

-72

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

-72.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop had no
recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-14S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-15B

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,577 E 6,004,097

ELEVATION (below MLLW)

-58

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-1.0'

-58.1

0.5

-59.0

1.0

Box core sample: SAND, Grayish brown, fine to medium grained; over MUD, Black, soft.

Box core dropped from water surface and allowed to free-fall to bottom.

Grain-size analysis performed from sub-sample (mixed):

5% gravel and shells
2% coarse-vc sand
28% medium sand
15% fine sand
2% very-fine sand
21% silt
27% clay

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-15B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-15S

SAMPLER

MEC, Inc.

SITE and LOCATION

West of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,577 E 6,004,097

ELEVATION (below MLLW)

-72

SAMPLE LENGTH

1.6

SAMPLER WEIGHT

~200 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

3-24-94									
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks	
GC	3.0'	1.8'	-72.0					(Template: SEA)	
									Remarks
			-72.4	0.5			0.0 - 0.4 ft: SAND, Moderate olive brown, fine to coarse grained, moderately well sorted, abundant shell fragments, sharp contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.	
				1.0			0.4 - 1.3 ft: MUD, Grayish black mottled with Dark greenish gray, soft, sharp contact.	Torvane reading at 0.7' = 0.7 tons/sq.ft.	
			-73.3				1.3 - 1.5 ft: SAND, Greenish gray, fine grained, well sorted, sharp contact.		
			-73.5	1.5			1.5 - 1.6 ft: MUD, similar to 0.4 - 1.3'.	Torvane reading at 1.5' = 0.7 tons/sq.ft.	
			-73.6						
GC = GRAVITY CORE; BX = BOX CORE.									
SITE and LOCATION							HOLE NO.		
West of Disposal Site San Francisco Bay							AHS-15S		

 GEOLOGIC LOG		PROJECT and JOB NUMBER <i>Alcatraz Habitat Study</i> 21845-004		HOLE NO. AHS-16S				
SAMPLER MEC, Inc.		SITE and LOCATION West of Disposal Site, San Francisco Bay		SHEET NO. 1 OF 1				
VESSEL R.V. Questuary		COORDINATES N 2,127,567 E 6,004,578		SAMPLE DATE 1-19-94				
SAMPLER WEIGHT ~200 lbs		BARREL SIZE 4"		ELEVATION (below MLLW) -56				
LOGGED BY Stephen Knuttel		UPDATE 3-24-94						
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	3.0'	1.9'	-56.0				0.0 - 0.3 ft: Muddy SAND, Greenish gray, fine grained, moderately sorted, 2" white shell fragment, gradational contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-56.3				0.3 - 0.7 ft: MUD, Grayish black, soft, minor fine sand, common shell fragments, sharp contact.	
			-56.7				0.7 - 1.0 ft: SAND, Olive brown to Grayish green, fine to medium grained, well sorted, abundant white shell fragments up to 0.25", sharp contact.	
			-57.0				1.0 - 1.9 ft: MUD, Grayish black mottled with Greenish gray, soft; -0.25" layer of sandy mud between 1.8 - 1.9'.	
			-57.9					
GC = GRAVITY CORE; BX = BOX CORE.						SITE and LOCATION West of Disposal Site San Francisco Bay		HOLE NO. AHS-16S

Description and classification by visual examination of sample.
Colors from "Rock-Color Chart" (GSA, 1948).



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-17S

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,183 E 6,004,109

ELEVATION (below MLLW)

-60

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-60.0

-60.1

...

Bag sample: Shelly SAND, Moderate brown to Moderate yellowish brown, fine to coarse grained, with shell fragments up to 0.6".

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Grain-size analysis performed from bagged sample:

20% gravel and shells
15% coarse-vc sand
44% medium sand
15% fine sand
<1% very-fine sand
2% silt
4% clay

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-17S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-18S

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,177 E 6,004,430

ELEVATION (below MLLW)

-62

SAMPLE LENGTH

0.9

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	2.0'	0.9'	-62.0				0.0 - 0.3 ft: MUD, Grayish black, soft, sharp contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-62.3	0.5			0.3 - 0.9 ft: SAND, Dark greenish gray, fine to medium grained, moderately sorted, abundant shell fragments up to 0.75".	
			-62.9					
GC = GRAVITY CORE; BX = BOX CORE.							Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).	
SITE and LOCATION							HOLE NO.	
NW of Disposal Site San Francisco Bay							AHS-18S	



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-19S

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,580 E 6,004,519

ELEVATION (below MLLW)

-42

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-42.1

...

Bag sample: Sandy SHELL HASH, Very pale orange, shell fragments up to 1.5"; sand is Moderate brown, fine to coarse grained, with some pebbles up to 0.25".

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Grain-size analysis performed from bagged sample:

41% gravel and shells
15% coarse-vc sand
31% medium sand
8% fine sand
1% very-fine sand
2% silt
2% clay

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-19S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-20S

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,672 E 6,004,922

ELEVATION (below MLLW)

-40

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-40.1

Bag sample: SAND, Olive gray, fine to medium grained, with shell
fragments up to 0.25".Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-20S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-21B

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,664 E 6,005,323

ELEVATION (below MLLW)

-38

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-1.0'	-38.0	0.5			Box core sample: SAND, Grayish brown, fine to medium grained, well sorted, little fines.	Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from sub-sample: <1% gravel and shells 1% coarse-vc sand 48% medium sand 44% fine sand 1% very-fine sand 1% silt 5% clay
			-39.0	1.0				Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-21B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-21S

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,563 E 6,005,321

ELEVATION (below MLLW)

-45

SAMPLE LENGTH

0.9

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

0.9'

-45.0

0.5

-45.9

0.0 - 0.9 ft: SAND, Olive gray, fine to medium grained, moderately well sorted, some shell fragments up to 0.5"; 2" clast of black mud between 0.7 - 0.9'.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-21S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-22S

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,126 E 6,006,917

ELEVATION (below MLLW)

-114

SAMPLE LENGTH

1.7

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

1.7'

-114.0

0.5

1.0

1.5

-115.7

0.0 - 1.7 ft: MUD, Grayish black slightly mottled with Greenish gray, soft, some white shell fragments, minor sand content between 0.0 - 0.2'.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BK = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-22S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-23B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,519 E 6,006,904

ELEVATION (below MLLW)

-64

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-1.0'	-64.0				Box core sample: Muddy SAND over MUD, Dark gray to Black, some gravel and shell fragments.	(Template: SEA)
			-64.3	0.5				Box core dropped from water surface and allowed to free-fall to bottom.
			-65.0	1.0				Grain-size analysis performed from sub-sample: 18% gravel and shells 10% coarse-vc sand 19% medium sand 28% fine sand 3% very-fine sand 9% silt 13% clay
								Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-23B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-23S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,623 E 6,006,746

ELEVATION (below MLLW)

-77

SAMPLE LENGTH

1.4

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

1.4'

-77.0

0.5

-77.7

-77.8

-77.9

1.0

-78.4

0.0 - 0.9 ft: MUD, Greenish black to Black, very soft, minor sand; layer of sandy mud with shell fragments between 0.7 - 0.8'; gradational contact.

0.9 - 1.4 ft: MUD, Black changing to Greenish black at 1.0', soft, -0.2' very light gray shell fragments between 1.1 - 1.3'.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-23S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-24S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,615 E 6,006,565

ELEVATION (below MLLW)

-94

SAMPLE LENGTH

1.6

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	1.8'	-95.6	0.0 0.5 1.0 1.5			0.0 - 1.6 ft: MUD, Black slightly mottled with Greenish gray, soft, 2" x 3" metamorphic rock fragment between 0.3 - 0.6'; sandy between 0.0 - 0.3'.	Gravity core dropped from water surface and allowed to free-fall to bottom. Torvane reading at 0.8' = <0.5 tons/sq.ft. Torvane reading at 1.4' = <0.5 tons/sq.ft. Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-24S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-25S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,105 E 6,006,795

ELEVATION (below MLLW)

-80

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

-300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	bag sample	-80.1				Bag sample: SAND, Olive gray to Moderate brown, fine medium to grained, with shell fragments up to 0.5", minor mud content.	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop yielded -0.1' of sample which was bagged.
								Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

SE of Disposal Site San Francisco Bay

HOLE NO.

AHS-25S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-26S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,125,488 E 6,007,264

ELEVATION (below MLLW)

-72

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-72.1

...

Bag sample: SAND, Moderate brown to Grayish brown, medium
grained with some coarse grains, with shell fragments up to 1.0".Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

SE of Disposal Site San Francisco Bay

HOLE NO.

AHS-26S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-27S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,088 E 6,007,597

ELEVATION (below MLLW)

-70

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

0.0'

-70.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop attempted -
no recovery; core cutter
dented.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

SE of Disposal Site San Francisco Bay

HOLE NO.

AHS-27S





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-42S

SAMPLER

MEC, Inc.

SITE and LOCATION

Arch Rock area, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,655 E 6,001,411

ELEVATION (below MLLW)

-74

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag sample

-74.1

•••

Bag sample: SAND, Moderate brown to Grayish red, medium to very coarse grained.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Arch Rock area San Francisco Bay

HOLE NO.

AHS-42S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-28S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,584 E 6,008,089

ELEVATION (below MLLW)

-72

SAMPLE LENGTH

0.4

SAMPLER WEIGHT

-300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	bag sample	-72.0 -72.4				Bag sample: SAND, Olive gray to Moderate brown, fine to very coarse grained, with pebbles up to 1.2", abundant shell fragments up to 1.0"; -1/16" thick piece of green plastic on top of core barrel sample.	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop yielded -0.4' of sample which was bagged. Grain-size analysis performed from bagged sample: 29% gravel and shells 22% coarse-vc sand 41% medium sand 6% fine sand <1% very-fine sand <1% silt 1% clay Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-28S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-29S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,599 E 6,007,367

ELEVATION (below MLLW)

-80

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Stephen H. Hunter								3-14-94
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth In Feet	Lithology	Sample	Lithologic Description	(Template: SEA) Remarks
GC	2.0'	1.0'	-80.0					
			-80.2				0.0 - 0.2 ft: Sandy MUD, Greenish gray, soft, sand is fine to medium grained, abundant shells fragments, gradational contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-80.4				0.2 - 0.4 ft: MUD, Black, moderately stiff, sharp contact.	
			-80.7				0.4 - 0.7 ft: Muddy SAND, Black, fine to medium grained, moderately well sorted, sharp irregular contact.	
			-81.0				0.7 - 1.0 ft: MUD, Black, moderately stiff.	
GC = GRAVITY CORE; BX = BOX CORE.								
SITE and LOCATION						East of Disposal Site San Francisco Bay		NOLE NO. AHS-29S

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-29S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-30S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,594 E 6,007,608

ELEVATION (below MLLW)

-77

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-77.1

...

Bag sample: Sandy SHELL HASH, Moderate brown to Very pale orange, some sandstone gravel, gravel and shell fragments up to 1.0"; sand is fine to very-coarse grained.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-30S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-31S

SAMPLER

MEC, Inc.

SITE and LOCATION

SW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,153 E 6,004,469

ELEVATION (below MLLW)

-84

SAMPLE LENGTH

0.6

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	bag sample	-84.0	0.5			Bag sample: SAND, Moderate brown to Grayish brown, fine to medium grained with some coarse grains, abundant shell fragments up to 0.25".	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop yielded -0.6' of sample which was bagged. Grain-size analysis performed from bagged sample: 20% gravel and shells 12% coarse-vc sand 45% medium sand 19% fine sand <1% very-fine sand 2% silt 2% clay
								Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

SW of Disposal Site San Francisco Bay

HOLE NO.

AHS-31S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-32S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

SW of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,555 E 6,004,557

ELEVATION (below MLLW)

-75

SAMPLE LENGTH

1.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

							Lithologic Description	(Template: SEA)
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample		Remarks
GC	2.0'	1.1'	-75.0					Gravity core dropped from water surface and allowed to free-fall to bottom.
			-75.4					
			-75.5	0.6		0.4 - 0.5 ft: MUD, Grayish black, soft; minor fine sand content, sharp contact.		
			-75.6			0.5 - 0.6 ft: SAND, Olive brown, fine grained, some shell fragments up to 0.5", sharp contact.		
						0.6 - 1.0 ft: MUD, Greenish gray to Grayish black, mottled, soft.		
			-76.0	1.0				
			-76.1			1.0 - 1.1 ft (Core Catcher): Sandy MUD, Olive black changing to Light olive gray with exposure to air, soft, sand is fine grained.		
								Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).
GC = GRAVITY CORE; BX = BOX CORE.						SITE and LOCATION SW of Disposal Site San Francisco Bay		HOLE NO. AHS-32S

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

SW of Disposal Site San Francisco Bay

HOLE NO.

AHS-32S





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-34S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,509 E 6,007,386

ELEVATION (below MLLW)

-94

SAMPLE LENGTH

1.3

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	1.3'	-94.0				0.0 - 1.0 ft: Muddy SAND, Black, fine grained, moderately well sorted, common black shell fragments, gradational contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
				0.5				Torvane reading at 0.3' = 0.5 tons/sq.ft.
			-95.0	1.0			1.0 - 1.3 ft: Sandy MUD, Black, soft, sand is fine grained.	
			-95.3					Torvane reading at 1.2' = 0.7 tons/sq.ft.
								Description and classification by visual examination of sample.
								Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-34S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-35S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,393 E 6,008,105

ELEVATION (below MLLW)

-90

SAMPLE LENGTH

0.2

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-90.0

-90.2



Bag sample: Muddy SAND, Olive gray to Moderate brown, fine to coarse grained, with shell fragments up to 1.5".

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.2' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-35S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-36S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,209 E 6,007,801

ELEVATION (below MLLW)

-94

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

0.0'

-94.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop attempted -
no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-36S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-43S

SAMPLER

MEC, Inc.

SITE and LOCATION

Arch Rock area, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,573 E 6,000,527

ELEVATION (below MLLW)

-80

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-80.1

...

Bag sample: SAND, Moderate brown to Grayish red, medium to vary
coarse grained.Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Arch Rock area San Francisco Bay

HOLE NO.

AHS-43S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-45S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Shag Rock area, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,131,694 E 6,000,651

ELEVATION (below MLLW)

-77

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

0.0'

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop attempted -
no recovery; core cutter
dented.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Shag Rock area San Francisco Bay

HOLE NO.

AHS-45S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-48S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Harding Rock area, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,133,749 E 5,999,169

ELEVATION (below MLLW)

-73

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag sample

-73.1

...

Bag sample: SAND, Moderate brown to Grayish red, fine to coarse grained.

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Harding Rock area San Francisco Bay

HOLE NO.

AHS-48S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-49S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Harding Rock area, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,133,228 E 5,999,881

ELEVATION (below MLLW)

-50

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

-300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	2.0'	0.0'	-50.0				no sample recovery.	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop attempted - no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Harding Rock area San Francisco Bay

HOLE NO.

AHS-49S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-50B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Alcatraz Shoal, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,619 E 6,002,593

ELEVATION (below MLLW)

-57

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-1.0'	-57.0	0.5			Box core sample: SAND, Moderate brown, coarse to very coarse grained, with pebbles up to 1.0", with abundant shell fragments (hash), little fines (clean).	Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from sub-sample: 30% gravel and shells 57% coarse-vc sand 11% medium sand 1% fine sand <1% very-fine sand <1% silt 1% clay Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).
			-58.0	1.0				

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Alcatraz Shoal San Francisco Bay

HOLE NO.

AHS-50B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-50S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Alcatraz Shoal, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,618 E 6,002,674

ELEVATION (below MLLW)

-60

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag
sample

-60.1

...

Bag sample: SAND, Moderate brown to Grayish red, coarse to very coarse grained, with some fine to medium grains, some pebbles up to 0.5".

Gravity core dropped from water surface and allowed to free-fall to bottom.

Core drop yielded -0.1' of sample which was bagged.

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

Alcatraz Shoal San Francisco Bay

HOLE NO.

AHS-50S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-51S

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,512 E 6,007,807

ELEVATION (below MLLW)

-60

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

-60.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag
sample

-60.1

Bag sample: SAND, Olive black, fine grained, abundant mica flakes,
minor mud content.Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-51S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-52S

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,504 E 6,008,208

ELEVATION (below MLLW)

-64

SAMPLE LENGTH

1.5

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

1.5'

-64.0

0.5

1.0

-65.3

-65.5

1.5

0.0 - 1.3 ft: SAND, Greenish black, fine grained, well sorted, ~10% mud content, gradational contact.

1.3 - 1.5 ft: Muddy Sand, Grayish black, fine grained, 0.5 x 3" x 1/8" thick black wood fragment.

Gravity core dropped from water surface and allowed to free-fall to bottom.
Torvane reading at 0.1' = <0.5 tons/sq.ft.

Torvane reading at 0.5' = <0.5 tons/sq.ft.

Torvane reading at 1.4' = 1.0 tons/sq.ft.

Description and classification by visual examination of sample.
Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-52S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-53S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,915 E 6,007,896

ELEVATION (below MLLW)

-54

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

-300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

-54.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop attempted -
no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Alcatraz Island San Francisco Bay

HOLE NO.

AHS-53S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-54S

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,034 E 6,007,016

ELEVATION (below MLLW)

-114

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

0.0'

-114.0

no sample recovery.

Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop attempted -
no recovery; core cutter
dented.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Alcatraz Island San Francisco Bay

HOLE NO.

AHS-54S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-55S

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,528 E 6,007,005

ELEVATION (below MLLW)

-104

SAMPLE LENGTH

0.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

3.0'

bag
sample

-104.1

●

Bag sample: Gravel, mixed colors, brown to gray; with fine sand,
Olive gray, and some shell fragments up to 0.5".Gravity core dropped
from water surface and
allowed to free-fall to
bottom.Core drop yielded -0.1'
of sample which was
bagged.Description and
classification by visual
examination of sample.Colors from "Rock-Color
Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-55S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-56S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,996 E 6,008,278

ELEVATION (below MLLW)

-82

SAMPLE LENGTH

0.0

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks (Template: SEA)
GC	3.0'	0.0'	-82.0				no sample recovery.	Gravity core dropped from water surface and allowed to free-fall to bottom. Core drop attempted - no recovery.

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-56S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-57S

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,323 E 6,007,162

ELEVATION (below MLLW)

-100

SAMPLE LENGTH

2.1

SAMPLER WEIGHT

~300 lbs

BARREL SIZE

4"

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
GC	3.0'	2.1'	-100.0	0.0			0.0 - 1.4 ft: Muddy SAND, Dark greenish gray, fine grained, well sorted, mud content ~20-25%.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-101.4	0.5			1.4 - 2.1 ft: MUD, Grayish black to Black, soft, abundant shell fragments between 1.4 - 1.7', minor fine sand between 1.4 - 1.8'.	
			-102.1	1.0				
				1.5				
				2.0				

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NE of Disposal Site San Francisco Bay

HOLE NO.

AHS-57S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-58B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

South of Disposal Site, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,125,621 E 6,005,742

ELEVATION (below MLLW)

-65

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

-400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-1.0'	-65.0	0.5 1.0			Box core sample: SAND, Moderate brown, medium to coarse grained, little fines (clean), with gravel and shell fragments.	Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from sub-sample: 4% gravel and shells 47% coarse-vc sand 45% medium sand 2% fine sand <1% very-fine sand 1% silt 1% clay Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

South of Disposal Site San Francisco Bay

HOLE NO.

AHS-58B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-59B

SAMPLER

MEC, Inc.

SITE and LOCATION

South of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,126,027 E 6,005,670

ELEVATION (below MLLW)

-89

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-1.0'	-89.0	0.5			Box core sample: Sandy MUD, Black, soft, sand is very fine to very coarse grained, some shell fragments and gravel.	Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from sub-sample: 9% gravel and shells 6% coarse-vc sand 5% medium sand 5% fine sand 3% very-fine sand 24% silt 48% clay
			-90.0	1.0				Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

South of Disposal Site San Francisco Bay

HOLE NO.

AHS-59B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-60B

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,075 E 6,005,010

ELEVATION (below MLLW)

-18

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

-400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler Length

Recovery (ft)

Elevation below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-1.0'

-18.0

1.0

0.5

-19.0

Box core sample: SAND, Olive gray, fine to medium grained, well sorted, minor fines.

Box core dropped from water surface and allowed to free-fall to bottom.

Grain-size analysis performed from sub-sample:

<1% gravel and shells
1% coarse-vc sand
30% medium sand
59% fine sand
3% very-fine sand
3% silt
4% clay

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

NW of Disposal Site San Francisco Bay

HOLE NO.

AHS-60B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-61B

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,127,002 E 6,007,455

ELEVATION (below MLLW)

-84

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

Sampler Type

Sampler
Length

Recovery (ft)

Elevation
below MLLW

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-1.0'

-84.0

0.5

-85.0

1.0

Box core sample: Gravelly SAND, Olive gray, fine to medium grained, mud -10%, gravel and shell fragments up to 1.5".

Box core dropped from water surface and allowed to free-fall to bottom.

Grain-size analysis performed from sub-sample:

33% gravel and shells
7% coarse-vc sand
21% medium sand
28% fine sand
2% very-fine sand
4% silt
5% clay

Description and classification by visual examination of sample.

Colors from "Rock-Color Chart" (GSA, 1948).

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

East of Disposal Site San Francisco Bay

HOLE NO.

AHS-61B

Appendix B: Species Collected At Biological Sampling Stations

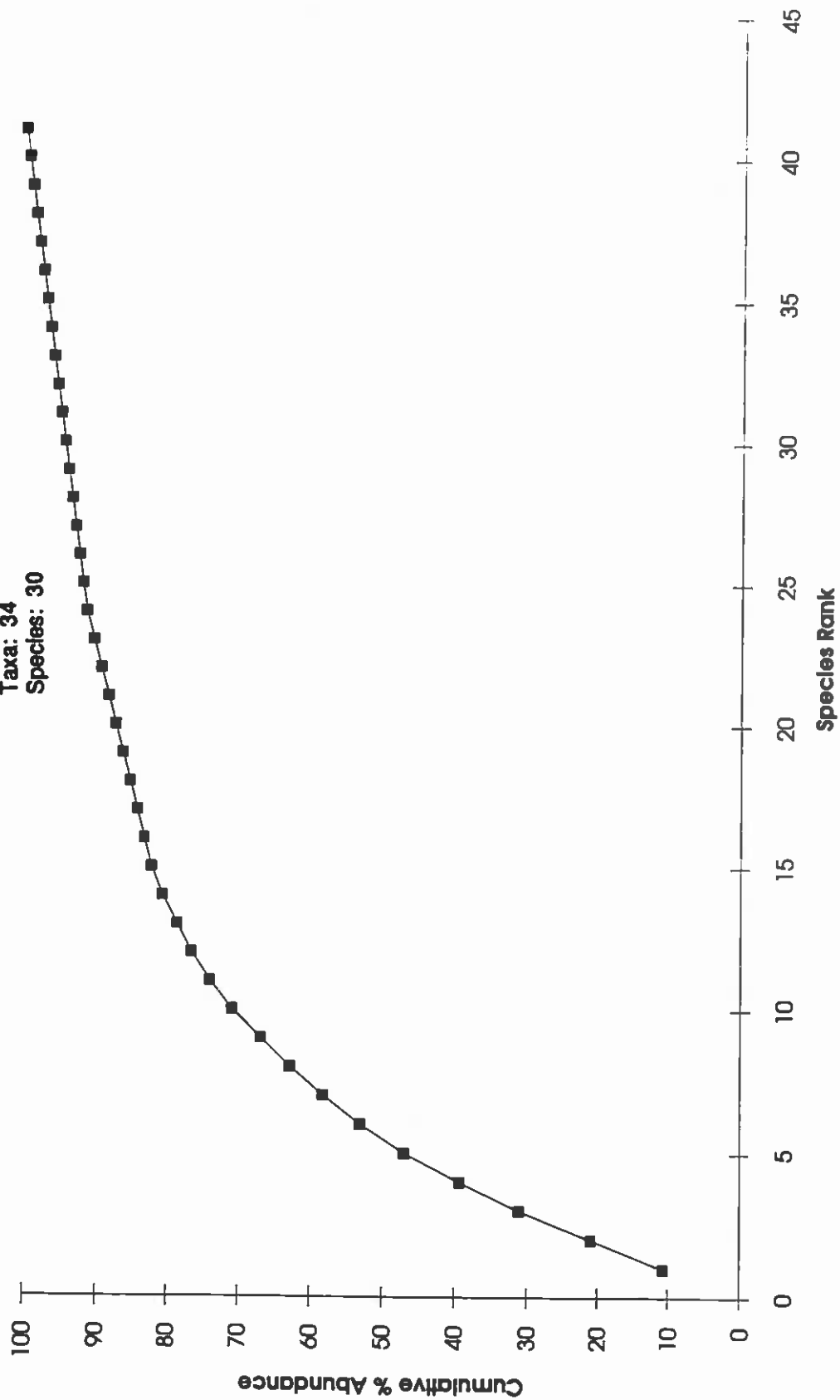
Appendix C: Cumulative Abundance Curve

Replicate k Dominance Curves: Station 1B

Dredged Material

Taxa: 34

Species: 30

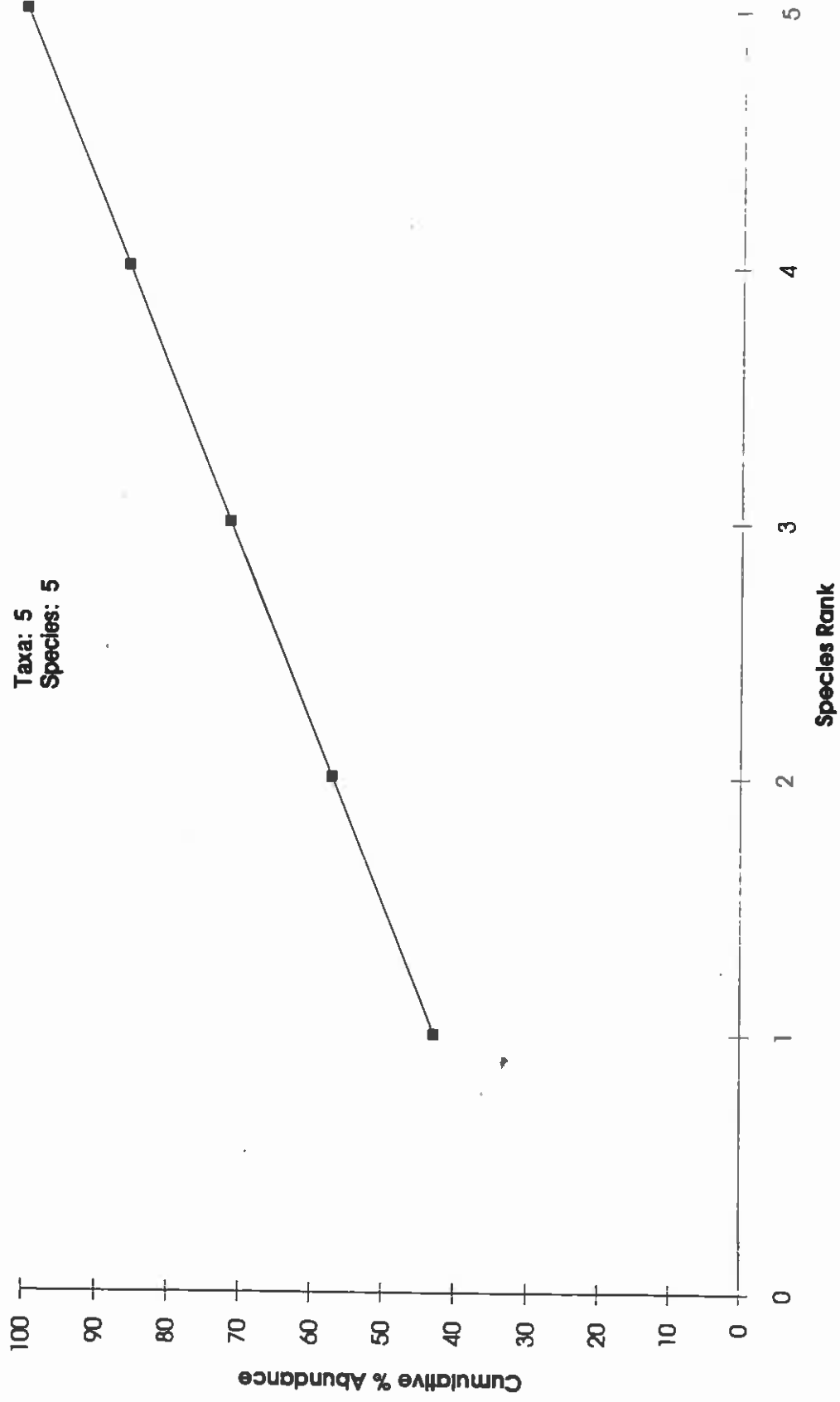


Replicate k Dominance Curve: Station 10B

Dredged Material

Taxa: 5

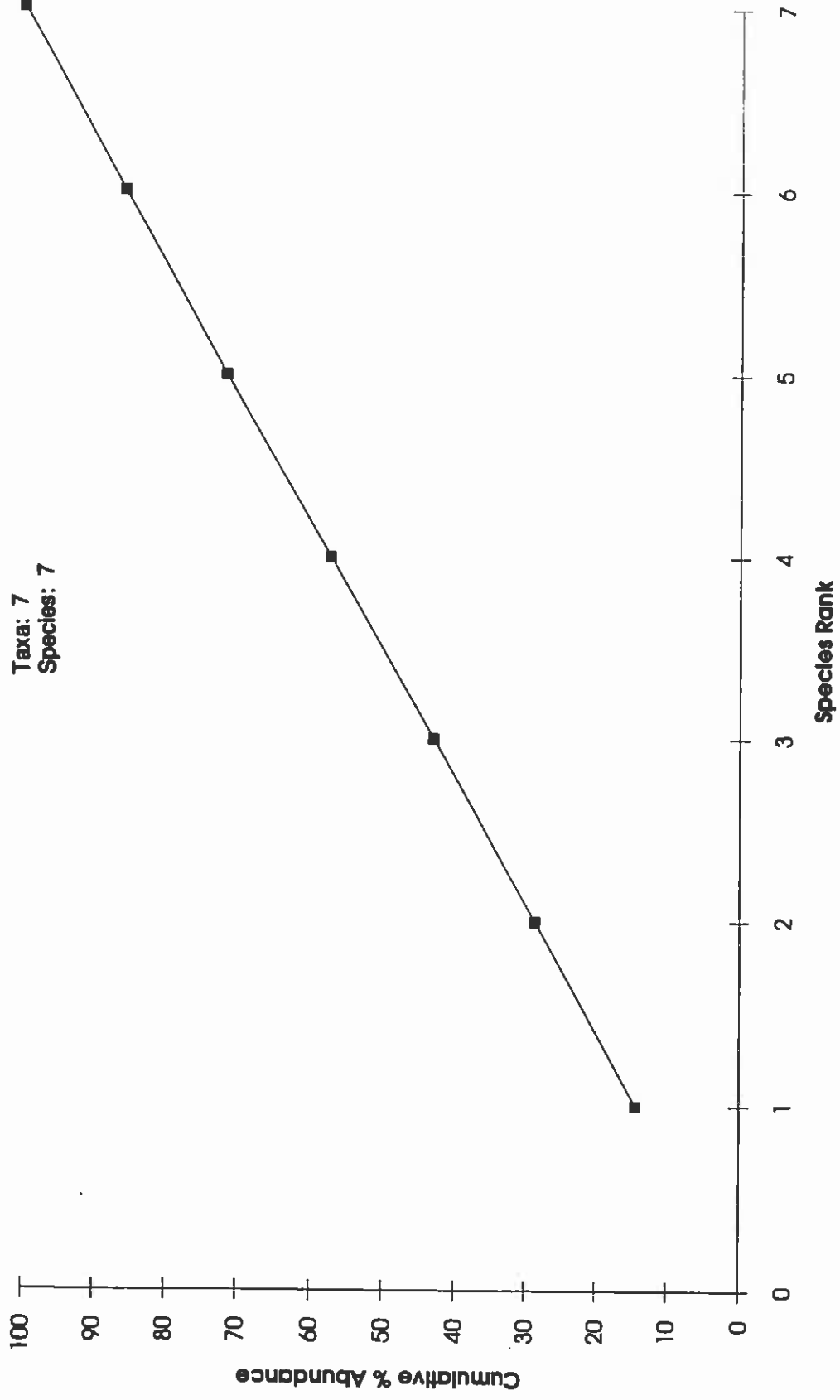
Species: 5



Replicate k Dominance Curve: Station 15B

Dredged Material

Taxa: 7
Species: 7

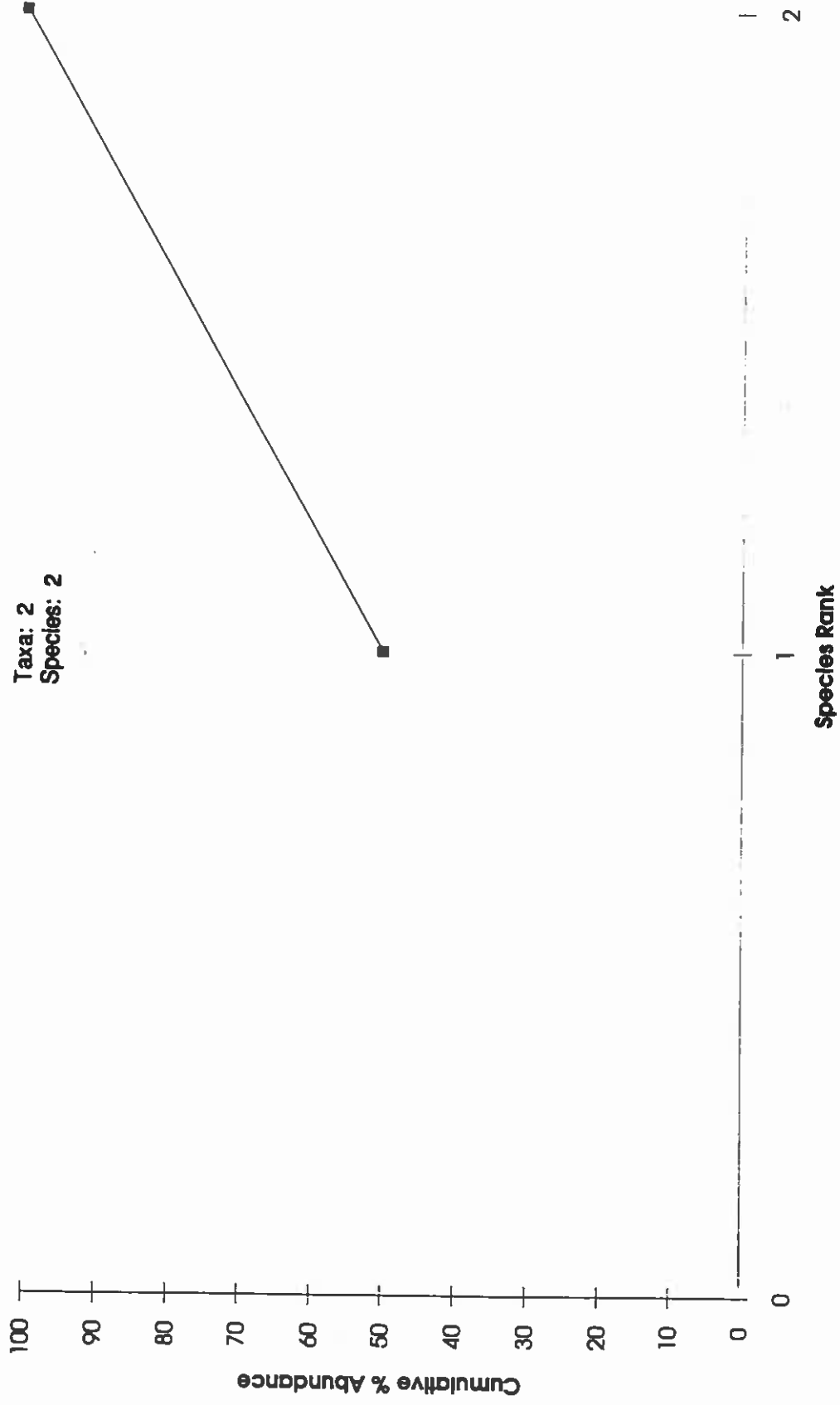


Replicate k Dominance Curve: Station 21B

Native Sands

Taxa: 2

Species: 2

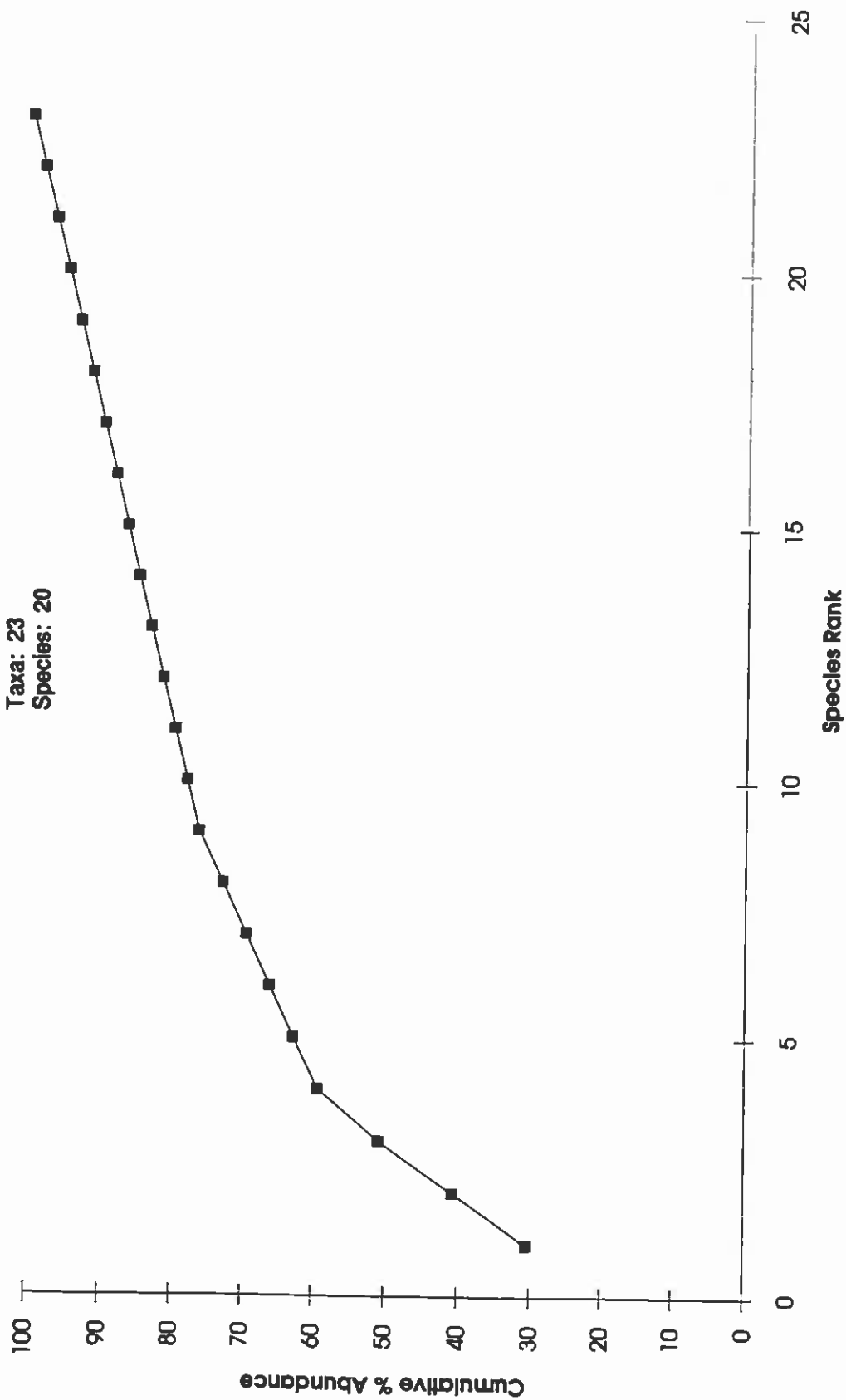


Replicate k Dominance Curve: Station 23B

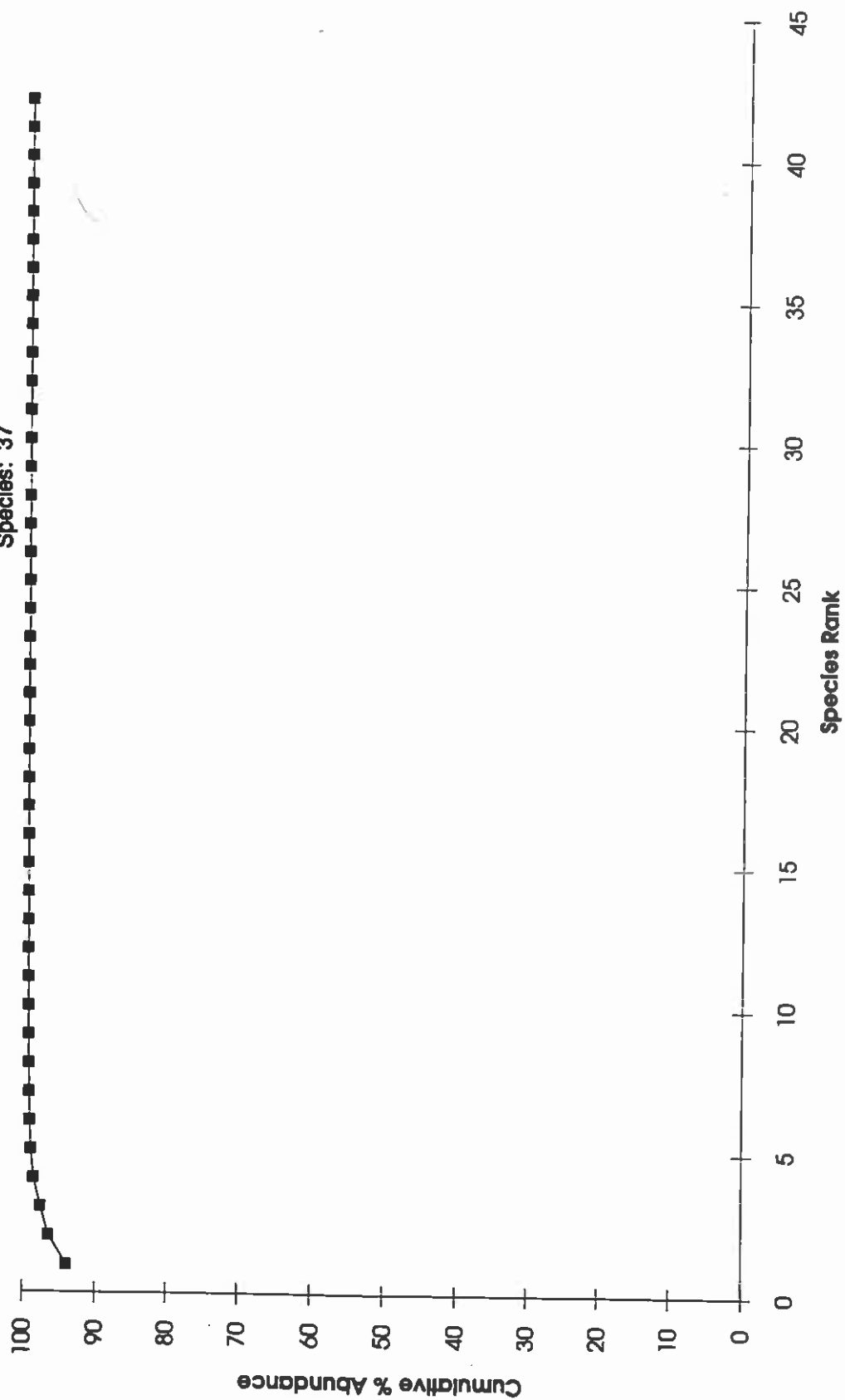
Native Sands

Taxa: 23

Species: 20

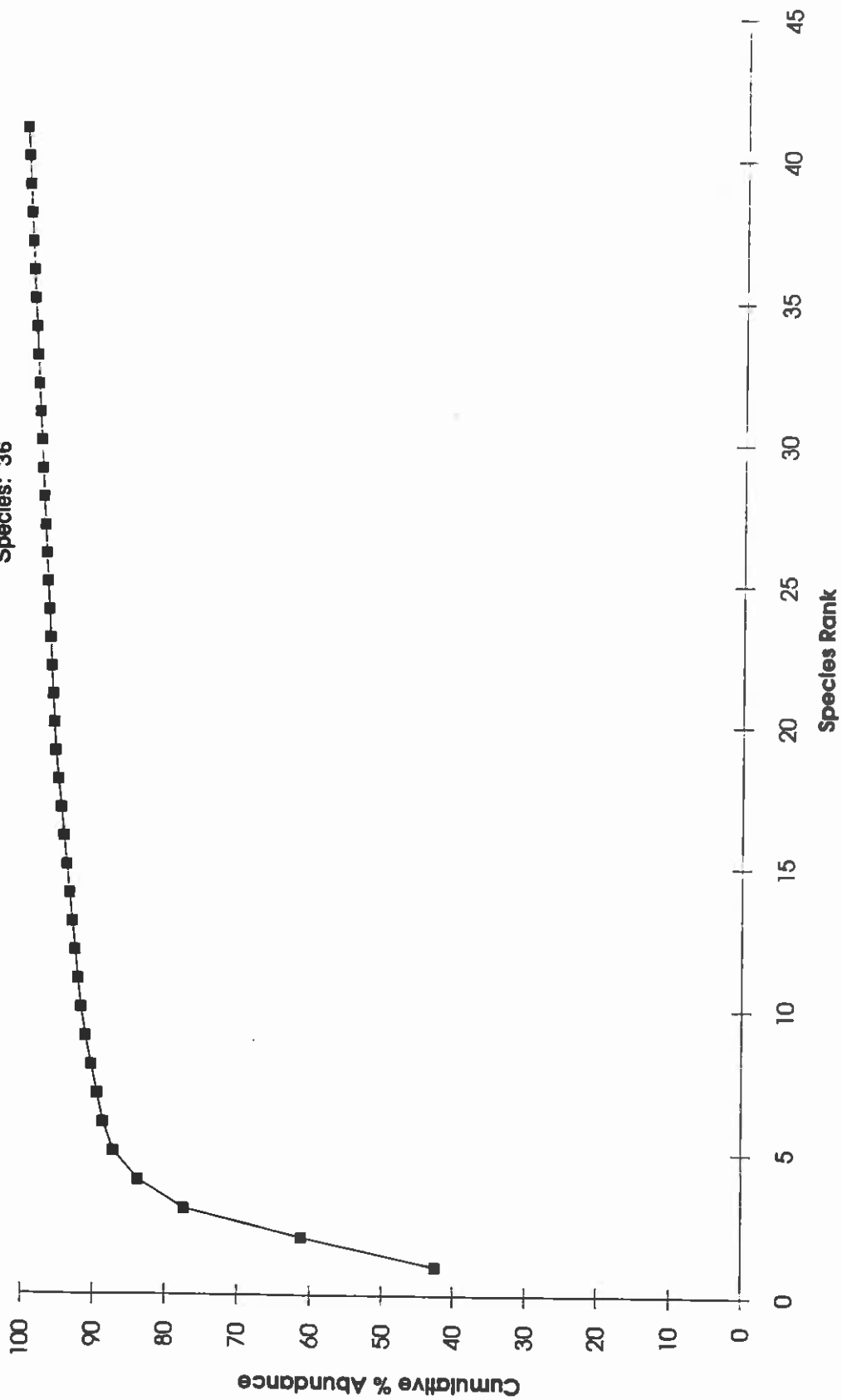


Replicate k Dominance Curve: Station 37B
Native Sands Taxa: 43
Species: 37



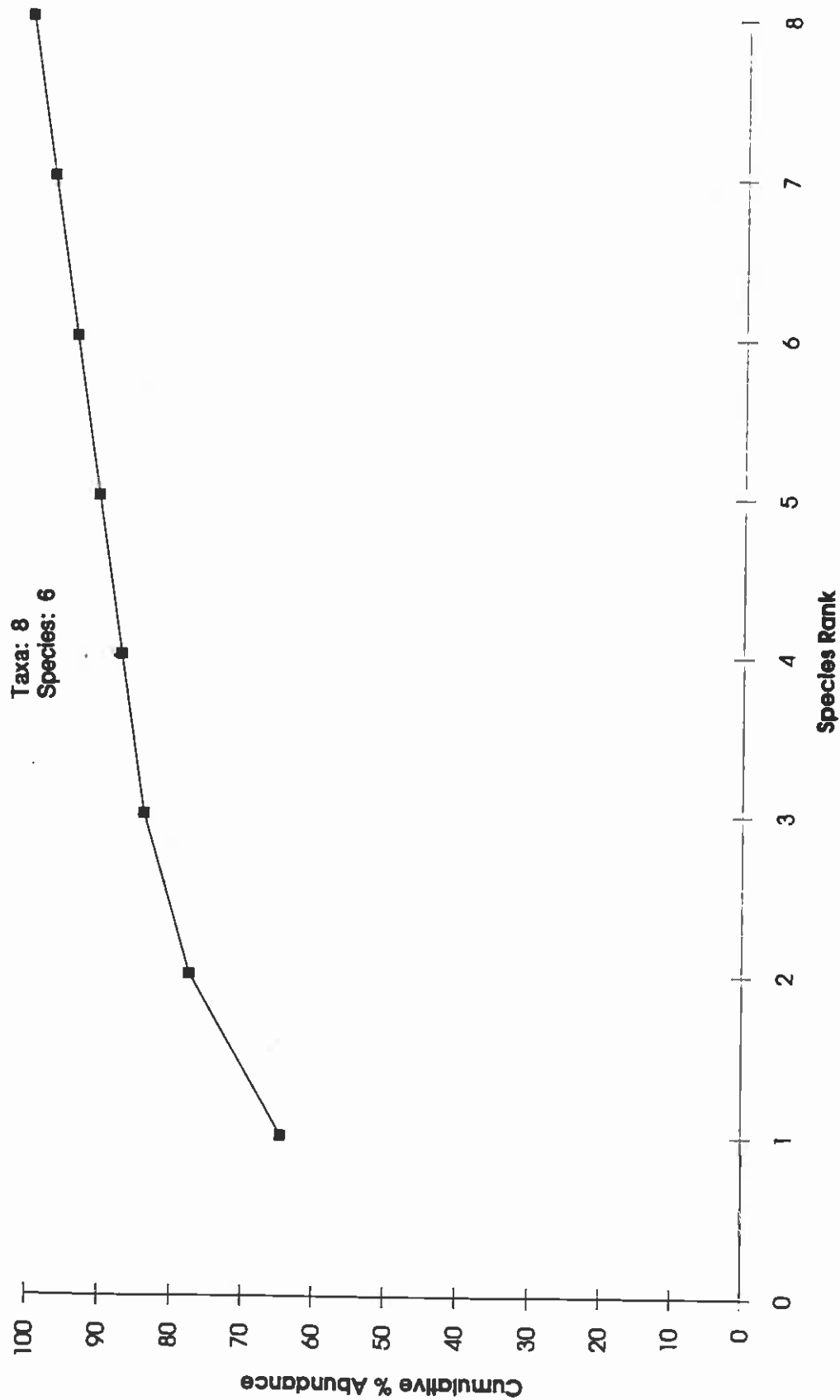
Replicate k Dominance Curve: Station 37B (Alt)

Native Sand
Taxa: 42
Species: 36



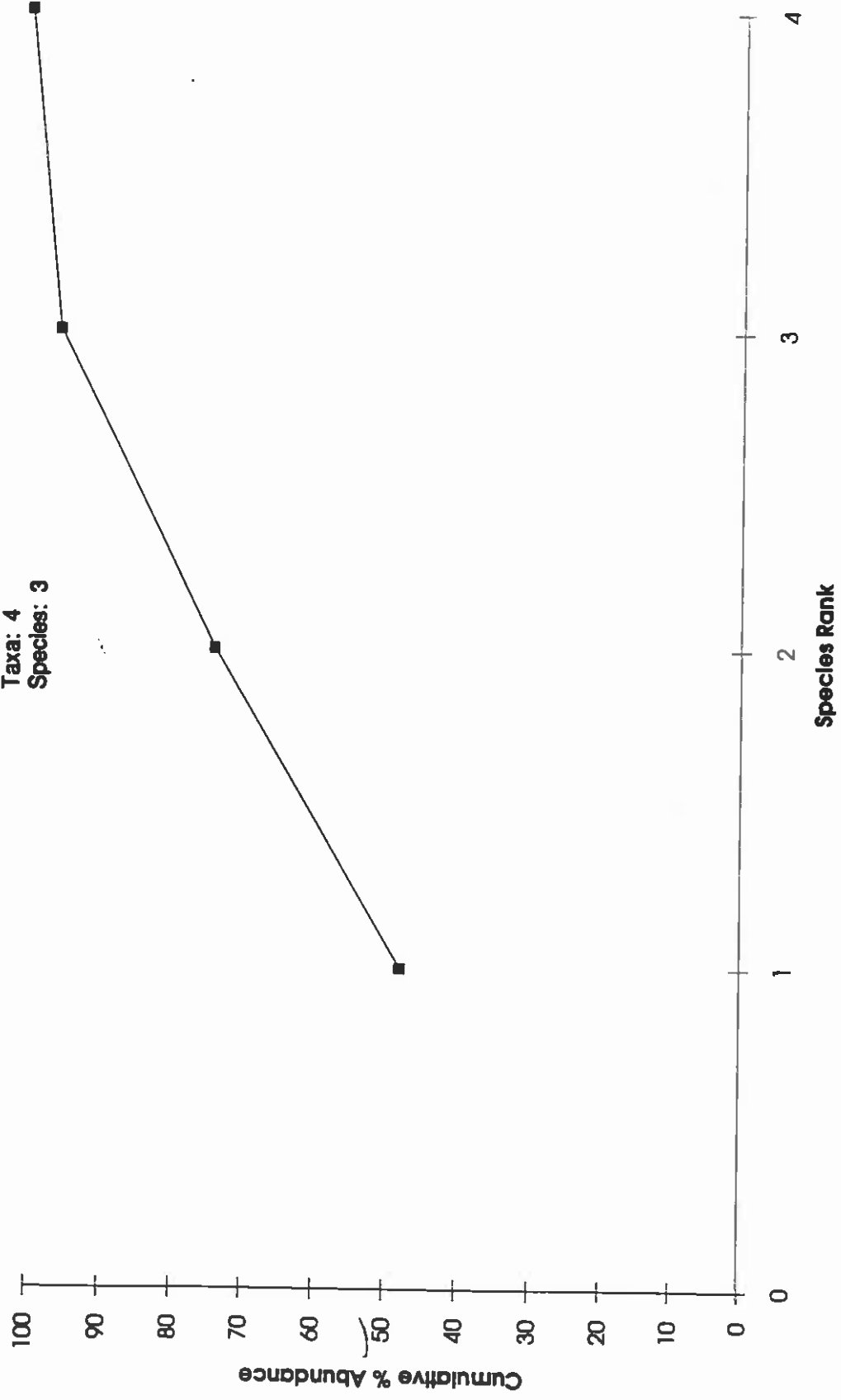
Replicate k Dominance Curve: Station 39B
Dredged Material

Taxa: 8
Species: 6



Replicate k Dominance Curve: Station 50B
Native Sands

Taxa: 4
Species: 3

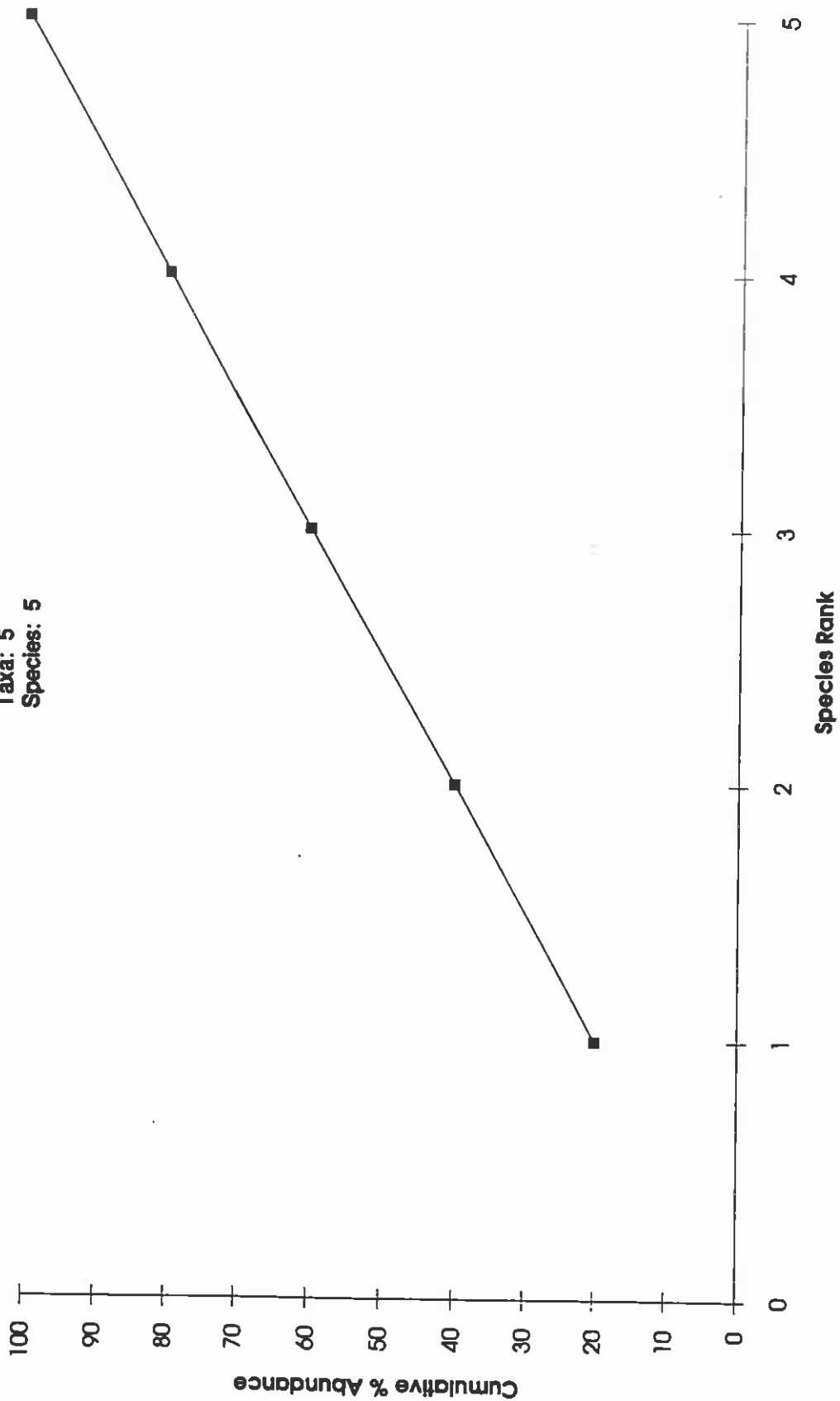


Replicate k Dominance Curve: Station 58B

Native Sands

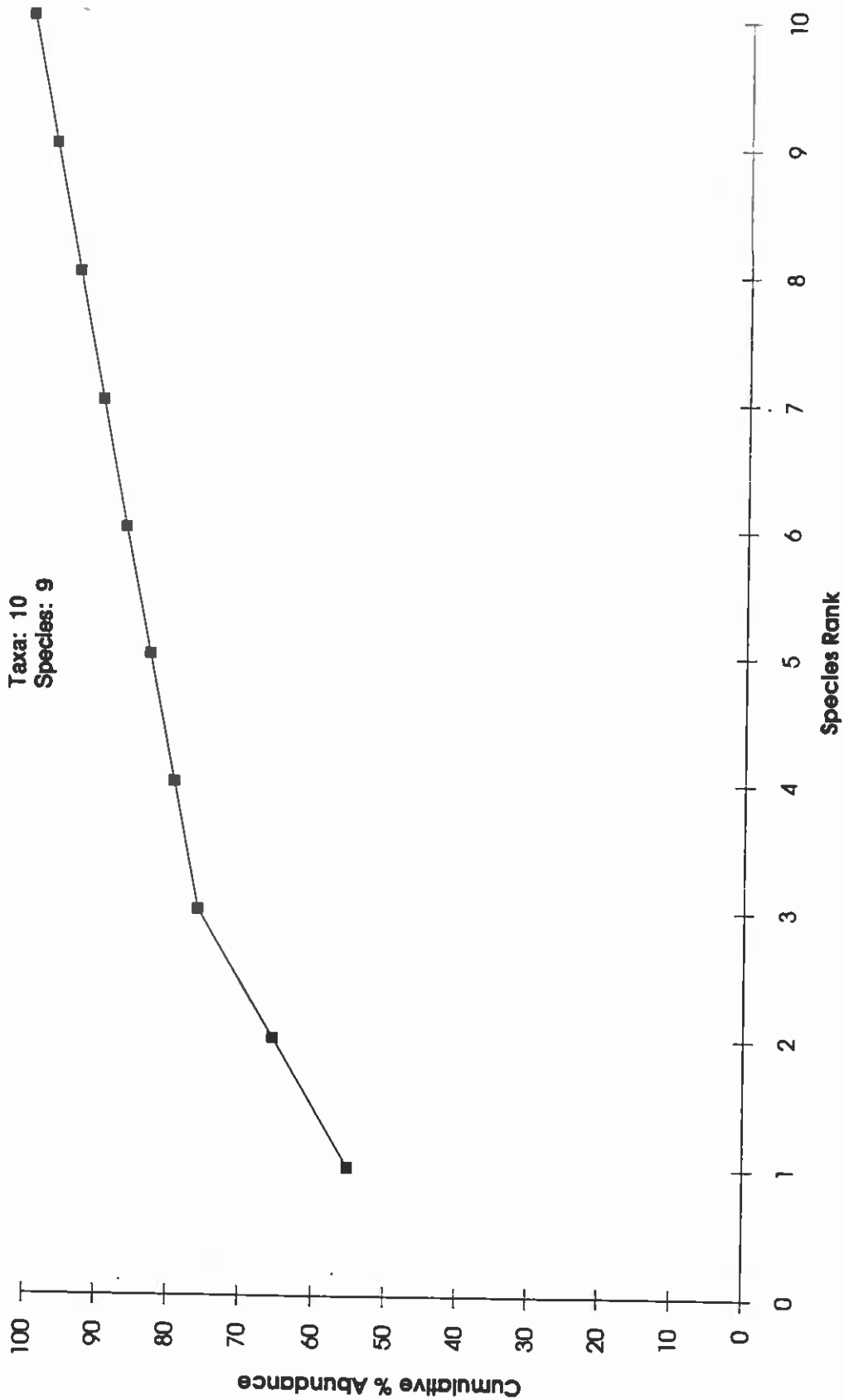
Taxa: 5

Species: 5



Replicate k Dominance Curve: Station 59B
Dredged Material

Taxa: 10
Species: 9

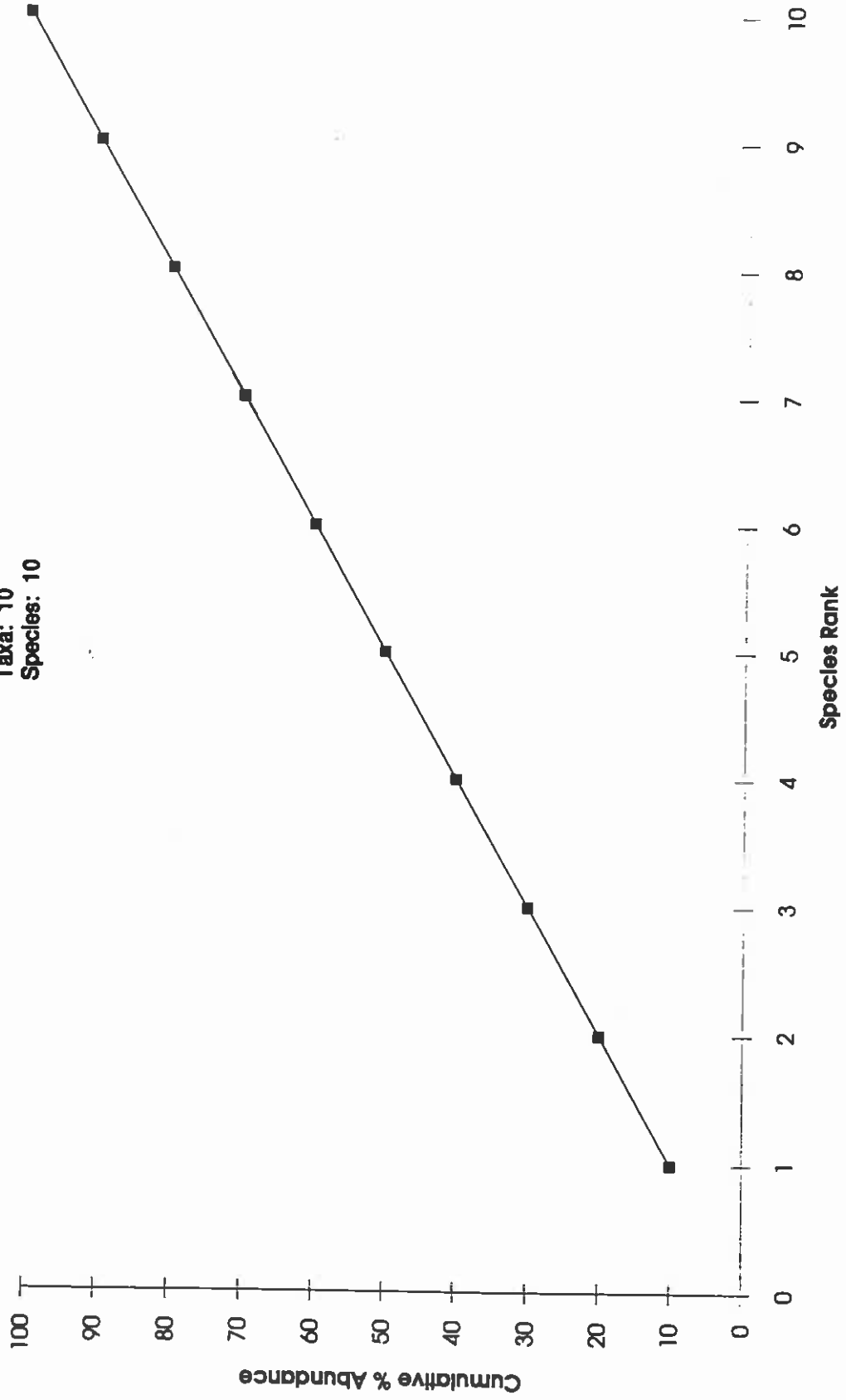


Replicate k Dominance Curve: Station 60B

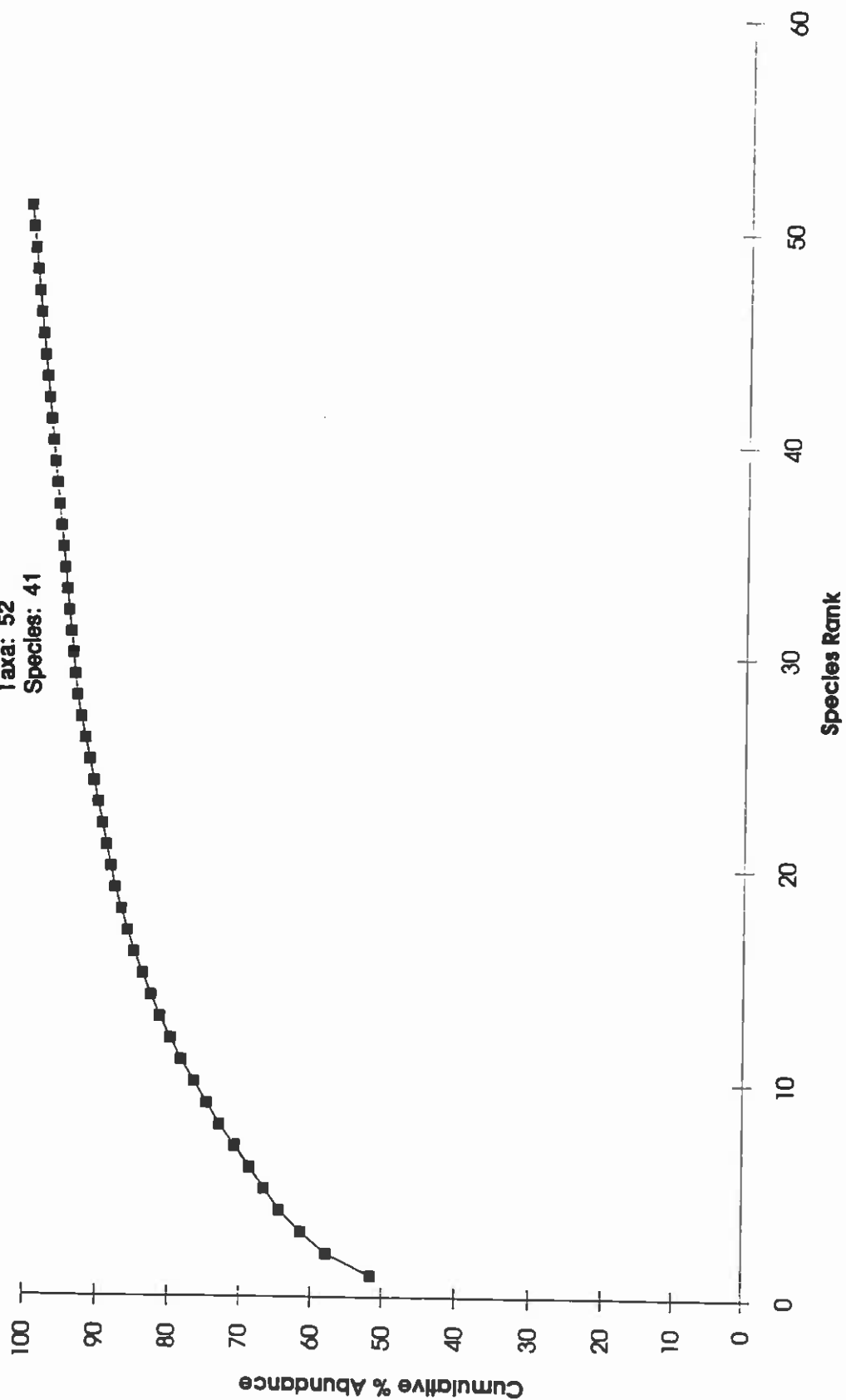
Native Sands

Taxa: 10

Species: 10



Replicate k Dominance: Station 61B
Dredged Material
Taxa: 52
Species: 41



Appendix D: Organic Carbon Analysis

ORGANIC CARBON ANALYSIS

Contract: ALCATRAZ
Contact person: Dr. William Muellenhof
Date of analysis: 9Mar94
Date of report: 10Mar94
Analysis method: Persulfate wet oxidation (Menzel and Vaccaro, 1964)

----- Carbon Values -----

Sample ID	% Carbon
10B	0.038
15B	0.556
1B	0.354
21B	0.036
23B	0.430
37B	0.377
39B	0.072
50B	0.060
58B	0.028
59B	1.347
60B	0.024
61B	0.275

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ORGANIC CARBON ANALYSIS

----- Sample Calibration -----				
Sample number	Weight (gm)	ugC	%Carbon	Sample ID
44	0.01880	66.569	0.354	1B
45	0.01825	6.982	0.038	10B
46	0.01856	106.414	0.573	15B
47	0.01825	98.266	0.538	15B
48	0.02023	7.310	0.036	21B
49	0.01831	78.740	0.430	23B
50	0.01891	71.206	0.377	37B
51	0.01809	13.097	0.072	39B
52	0.01973	11.744	0.060	50B
53	0.01857	5.189	0.028	58B
54	0.01604	216.138	1.347	59B
55	0.01843	4.354	0.024	60B
56	0.01823	50.178	0.275	61B

A
B

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ORGANIC CARBON ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhof
 Date of analysis: 9Mar94
 Date of report: 10Mar94
 Analysis method: Persulfate wet oxidation (Menzel and Vaccaro, 1964)

----- Standard Curve Fit -----

Standard X	Standard Y	Predicted Y
4463.00	0.00	1.3503
2399.00	0.00	-2.5220
2643.00	0.00	-2.0787
9438.00	9.90	11.8925
10704.00	9.90	14.8663
14304.00	24.90	24.0158
14313.00	24.90	24.0400
23796.00	49.90	53.5565
23461.00	49.90	52.3693
28415.00	74.90	71.0948
28551.00	74.90	71.6451
34811.00	99.90	99.2025
34331.00	99.90	96.9307
44911.00	149.90	153.6088
43970.00	149.90	147.9841
52783.00	199.90	205.4848
50189.00	199.90	187.4151
66323.00	299.80	316.6714
65375.00	299.80	307.9144
79892.00	499.80	459.5484
85036.00	499.80	522.8100

Product moment correlation=0.9969751

Coefficient of determination (R square)=0.9939594

Polynomial curve fit: $y = a + b \cdot x + c \cdot x^2 + d \cdot x^3$

a=-6.68137

b=0.0016603

c=2.99669e-08

d=2.79086e-13

----- Blank Calibration -----

Blank X(1)= 7811	Blank Y(1)= 8.2486
Blank X(2)= 5437	Blank Y(2)= 3.2764
Blank X(3)= 7011	Blank Y(3)= 6.5282
Blank X(4)= 6593	Blank Y(4)= 5.6476
Blank X(5)= 4580	Blank Y(5)= 1.5782

Mean Blank = 5.0558

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Appendix E: Grain Size Analysis

GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 1B
 Total sample weight: 26.726 grams

Size	Phi	Weight	Percent	Cumulative
Microns		grams		Percent
2000.000	-1.0	2.650	9.916	9.916
1414.214	-0.5	0.230	0.861	10.776
1000.000	0.0	0.104	0.389	11.165
707.107	0.5	0.158	0.591	11.756
500.000	1.0	0.130	0.486	12.243
353.553	1.5	1.083	4.052	16.295
250.000	2.0	2.100	7.858	24.153
176.777	2.5	5.566	20.826	44.979
125.000	3.0	4.269	15.973	60.953
88.388	3.5	0.723	2.705	63.658
62.500	4.0	0.254	0.950	64.608
31.250	5.0	1.501	5.617	70.225
15.625	6.0	1.704	6.376	76.600
7.812	7.0	1.055	3.947	80.547
3.906	8.0	1.014	3.795	84.342
1.953	9.0	0.568	2.125	86.468
< 1.953	> 9.0	3.617	13.532	100.000

% < 4 phi = 35.392
 % > 1 phi = 11.756
 % gravel = 9.916
 % sand = 54.693
 % silt = 19.734
 % clay = 15.658

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
2.657 158.53	4.687 38.83	3.223	0.630

5th percentile = .
 16th percentile = 1.464
 50th percentile = 2.657
 84th percentile = 7.910
 95th percentile = .
 *** 5th percentile not obtainable ***
 *** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 10B
 Total sample weight: 31.639 grams

----- Size -----		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.000	0.000	0.000
1414.214	-0.5	0.000	0.000	0.000
1000.000	0.0	0.005	0.016	0.016
707.107	0.5	0.035	0.111	0.126
500.000	1.0	0.119	0.376	0.503
353.553	1.5	1.858	5.872	6.375
250.000	2.0	13.107	41.427	47.802
176.777	2.5	10.054	31.777	79.579
125.000	3.0	4.334	13.698	93.277
88.388	3.5	0.398	1.258	94.535
62.500	4.0	0.141	0.446	94.980
31.250	5.0	0.365	1.154	96.135
15.625	6.0	0.203	0.641	96.776
7.812	7.0	0.041	0.128	96.904
3.906	8.0	0.243	0.769	97.673
1.953	9.0	0.203	0.641	98.314
< 1.953	> 9.0	0.533	1.686	100.000

% < 4 phi = 5.020
 % > 1 phi = 0.126
 % gravel = 0.000
 % sand = 94.980
 % silt = 2.693
 % clay = 2.327

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.035	244.08	2.139	227.07	0.523	0.199

5th percentile = 1.383
 16th percentile = 1.616
 50th percentile = 2.035
 84th percentile = 2.661
 95th percentile = 4.017

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 15B
 Total sample weight: 25.493 grams

Size	Weight		Cumulative
Microns	Phi	grams	Percent
2000.000	-1.0	1.308	5.131
1414.214	-0.5	0.152	0.596
1000.000	0.0	0.111	0.435
707.107	0.5	0.108	0.424
500.000	1.0	0.210	0.824
353.553	1.5	3.674	14.412
250.000	2.0	3.586	14.067
176.777	2.5	2.891	11.340
125.000	3.0	0.859	3.370
88.388	3.5	0.190	0.745
62.500	4.0	0.227	0.890
31.250	5.0	0.974	3.819
15.625	6.0	1.826	7.161
7.812	7.0	1.095	4.297
3.906	8.0	1.379	5.411
1.953	9.0	0.893	3.501
< 1.953	> 9.0	6.010	23.576
			100.000

% < 4 phi = 47.766
 % > 1 phi = 6.586
 % gravel = 5.131
 % sand = 47.103
 % silt = 20.688
 % clay = 27.077

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
2.911 132.93	6.022 15.39	4.724	0.659

5th percentile = .
 16th percentile = 1.298
 50th percentile = 2.911
 84th percentile = 10.746
 95th percentile = .
 *** 5th percentile not obtainable ***
 *** 84th percentile extrapolated ***
 *** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 15B QA
 Total sample weight: 26.176 grams

Size	Weight		Cumulative
Microns	Phi	grams	Percent
2000.000	-1.0	1.551	5.925
1414.214	-0.5	0.190	0.726
1000.000	0.0	0.128	0.489
707.107	0.5	0.087	0.332
500.000	1.0	0.221	0.844
353.553	1.5	1.423	5.436
250.000	2.0	5.797	22.146
176.777	2.5	2.638	10.078
125.000	3.0	1.033	3.946
88.388	3.5	0.169	0.646
62.500	4.0	0.235	0.898
31.250	5.0	1.623	6.199
15.625	6.0	1.907	7.284
7.812	7.0	1.663	6.354
3.906	8.0	1.014	3.875
1.953	9.0	1.014	3.875
< 1.953	> 9.0	5.483	20.946
			100.000

% < 4 phi = 48.534
 % > 1 phi = 7.472
 % gravel = 5.925
 % sand = 45.541
 % silt = 23.713
 % clay = 24.821

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
3.060 119.94	5.781 18.19	4.230	0.643

5th percentile =
 16th percentile = 1.551
 50th percentile = 3.060
 84th percentile = 10.011
 95th percentile =
 *** 5th percentile not obtainable ***
 *** 84th percentile extrapolated ***
 *** 95th percentile not reached ***

MEC Analytical Systems, Inc.
 2433 Impala Dr.
 Carlsbad, CA 92008

GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 21B
 Total sample weight: 33.201 grams

----- Size -----		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.020	0.060	0.060
1414.214	-0.5	0.018	0.054	0.114
1000.000	0.0	0.037	0.111	0.226
707.107	0.5	0.060	0.181	0.407
500.000	1.0	0.168	0.506	0.913
353.553	1.5	7.359	22.165	23.078
250.000	2.0	8.725	26.279	49.357
176.777	2.5	11.362	34.222	83.579
125.000	3.0	3.234	9.741	93.320
88.388	3.5	0.199	0.599	93.919
62.500	4.0	0.025	0.075	93.995
31.250	5.0	0.041	0.122	94.117
15.625	6.0	0.162	0.489	94.606
7.812	7.0	0.081	0.244	94.850
3.906	8.0	0.041	0.122	94.972
1.953	9.0	0.041	0.122	95.094
< 1.953	> 9.0	1.629	4.906	100.000

% < 4 phi = 6.005
 % > 1 phi = 0.407
 % gravel = 0.060
 % sand = 93.934
 % silt = 0.978
 % clay = 5.028

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.009	248.38	1.931	262.25	0.591	-0.133

5th percentile = 1.092
 16th percentile = 1.340
 50th percentile = 2.009
 84th percentile = 2.522
 95th percentile = 8.228

MEC Analytical Systems, Inc.
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 Carlsbad, CA 92008

GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 23B
 Total sample weight: 29.976 grams

Size	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	5.525	18.432	18.432
1414.214	-0.5	0.910	3.036	21.467
1000.000	0.0	0.727	2.425	23.893
707.107	0.5	0.446	1.488	25.380
500.000	1.0	0.594	1.982	27.362
353.553	1.5	1.566	5.224	32.586
250.000	2.0	4.226	14.098	46.684
176.777	2.5	4.592	15.319	62.003
125.000	3.0	3.761	12.547	74.550
88.388	3.5	0.610	2.035	76.585
62.500	4.0	0.400	1.334	77.919
31.250	5.0	0.974	3.248	81.168
15.625	6.0	0.730	2.436	83.604
7.812	7.0	0.365	1.218	84.822
3.906	8.0	0.527	1.759	86.581
1.953	9.0	0.730	2.436	89.018
< 1.953	> 9.0	3.292	10.982	100.000

% < 4 phi = 22.081
 % > 1 phi = 25.380
 % gravel = 18.432
 % sand = 59.488
 % silt = 8.662
 % clay = 13.419

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
2.108 231.93	2.462 181.45	3.863	0.092

5th percentile = .
 16th percentile = -1.400
 50th percentile = 2.108
 84th percentile = 6.325
 95th percentile = .
 *** 5th percentile not obtainable ***
 *** 16th percentile extrapolated ***
 *** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 37B
 Total sample weight: 28.807 grams

Size	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.145	0.503	0.503
1414.214	-0.5	0.074	0.257	0.760
1000.000	0.0	0.026	0.090	0.850
707.107	0.5	0.050	0.174	1.024
500.000	1.0	0.073	0.253	1.277
353.553	1.5	0.307	1.066	2.343
250.000	2.0	0.486	1.687	4.030
176.777	2.5	7.524	26.119	30.149
125.000	3.0	14.049	48.769	78.918
88.388	3.5	2.395	8.314	87.232
62.500	4.0	0.670	2.326	89.558
31.250	5.0	0.893	3.098	92.656
15.625	6.0	0.122	0.423	93.079
7.812	7.0	0.325	1.127	94.205
3.906	8.0	0.162	0.563	94.769
1.953	9.0	0.162	0.563	95.332
< 1.953	> 9.0	1.345	4.668	100.000

% < 4 phi = 10.442
 % > 1 phi = 1.024
 % gravel = 0.503
 % sand = 89.054
 % silt = 5.211
 % clay = 5.231

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
2.704 153.52	2.767 146.87	0.538	0.119

5th percentile = 2.019
 16th percentile = 2.229
 50th percentile = 2.704
 84th percentile = 3.306
 95th percentile = 8.411

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 39B
 Total sample weight: 32.252 grams

Size	Weight		Cumulative
Microns	Phi	grams	Percent
2000.000	-1.0	0.009	0.028
1414.214	-0.5	0.004	0.012
1000.000	0.0	0.004	0.012
707.107	0.5	0.011	0.034
500.000	1.0	0.042	0.130
353.553	1.5	0.782	2.425
250.000	2.0	2.415	7.488
176.777	2.5	14.308	44.363
125.000	3.0	11.604	35.979
88.388	3.5	1.061	3.290
62.500	4.0	0.140	0.434
31.250	5.0	0.081	0.252
15.625	6.0	0.162	0.503
7.812	7.0	0.041	0.126
3.906	8.0	0.203	0.629
1.953	9.0	0.041	0.126
< 1.953	> 9.0	1.345	4.169
			100.000

% < 4 phi = 5.805
 % > 1 phi = 0.087
 % gravel = 0.028
 % sand = 94.167
 % silt = 1.509
 % clay = 4.295

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
2.449 183.09	2.488 178.24	0.422	0.092

5th percentile = 1.657
 16th percentile = 2.066
 50th percentile = 2.449
 84th percentile = 2.910
 95th percentile = 6.397

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 50B
 Total sample weight: 34.779 grams

Size	Weight	Cumulative
Microns	grams	Percent
2000.000	10.379	29.842
1414.214	3.795	40.754
1000.000	6.084	58.247
707.107	5.023	72.690
500.000	4.900	86.779
353.553	2.812	94.864
250.000	0.992	97.716
176.777	0.187	98.254
125.000	0.061	98.429
88.388	0.010	98.458
62.500	0.003	98.467
31.250	0.041	98.583
15.625	0.041	98.700
7.812	0.041	98.817
3.906	0.041	98.933
1.953	0.041	99.050
< 1.953	0.330	100.000

% < 4 phi = 1.533
 % > 1 phi = 72.690
 % gravel = 29.842
 % sand = 68.624
 % silt = 0.467
 % clay = 1.067

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
0 1178	0 1289	1.268	-0.103

5th percentile = .
 16th percentile = -1.634
 50th percentile = -0.236
 84th percentile = 0.901
 95th percentile = 1.524
 *** 5th percentile not obtainable ***
 *** 16th percentile extrapolated ***

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 58B
 Total sample weight: 32.914 grams

Size	Weight	Cumulative
Microns	grams	Percent
2000.000	1.172	3.561
1414.214	0.521	5.144
1000.000	1.007	8.203
707.107	3.300	18.229
500.000	10.764	50.932
353.553	13.507	91.969
250.000	1.367	96.123
176.777	0.577	97.876
125.000	0.207	98.505
88.388	0.034	98.608
62.500	0.006	98.626
31.250	0.041	98.749
15.625	0.041	98.873
7.812	0.041	98.996
3.906	0.081	99.242
1.953	0.041	99.366
< 1.953	> 9.0	100.000

% < 4 phi = 1.374
 % > 1 phi = 18.229
 % gravel = 3.561
 % sand = 95.065
 % silt = 0.616
 % clay = 0.758

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
0.986 504.97	0.896 537.43	0.507	-0.177

5th percentile = -0.545
 16th percentile = 0.389
 50th percentile = 0.986
 84th percentile = 1.403
 95th percentile = 1.865

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 59B
 Total sample weight: 18.775 grams

Size	Phi	Weight grams	Percent	Cumulative Percent
Microns				
2000.000	-1.0	1.646	8.767	8.767
1414.214	-0.5	0.273	1.454	10.221
1000.000	0.0	0.308	1.640	11.861
707.107	0.5	0.252	1.342	13.204
500.000	1.0	0.304	1.619	14.823
353.553	1.5	0.352	1.875	16.697
250.000	2.0	0.614	3.270	19.968
176.777	2.5	0.543	2.892	22.860
125.000	3.0	0.463	2.466	25.326
88.388	3.5	0.251	1.337	26.663
62.500	4.0	0.213	1.134	27.797
31.250	5.0	0.811	4.322	32.119
15.625	6.0	0.893	4.754	36.873
7.812	7.0	2.799	14.910	51.782
3.906	8.0	0.041	0.216	51.998
1.953	9.0	8.073	43.000	94.999
< 1.953	> 9.0	0.939	5.001	100.000

% < 4 phi = 72.203
 % > 1 phi = 13.204
 % gravel = 8.767
 % sand = 19.030
 % silt = 24.201
 % clay = 48.002

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
6.880 8.49	5.029 30.63	3.715	-0.498

5th percentile = .
 16th percentile = 1.314
 50th percentile = 6.880
 84th percentile = 8.744
 95th percentile = .
 *** 5th percentile not obtainable ***
 *** 95th percentile not reached ***

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 60B
 Total sample weight: 30.049 grams

Size		Weight		Cumulative
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	0.029	0.097	0.097
1414.214	-0.5	0.021	0.070	0.166
1000.000	0.0	0.061	0.203	0.369
707.107	0.5	0.119	0.396	0.765
500.000	1.0	0.265	0.882	1.647
353.553	1.5	3.568	11.874	13.521
250.000	2.0	5.330	17.738	31.259
176.777	2.5	12.194	40.580	71.839
125.000	3.0	5.617	18.693	90.532
88.388	3.5	0.605	2.013	92.546
62.500	4.0	0.165	0.549	93.095
31.250	5.0	0.243	0.810	93.905
15.625	6.0	0.122	0.405	94.310
7.812	7.0	0.527	1.755	96.065
3.906	8.0	0.041	0.135	96.200
1.953	9.0	0.081	0.270	96.470
< 1.953	> 9.0	1.061	3.530	100.000

% < 4 phi = 6.905
 % > 1 phi = 0.765
 % gravel = 0.097
 % sand = 92.998
 % silt = 3.105
 % clay = 3.800

Sample Statistics

Median		Mean		Dispersion	Skewness
phi	microns	phi	microns		
2.231	213.02	2.198	218.00	0.628	-0.053

5th percentile = 1.141
 16th percentile = 1.570
 50th percentile = 2.231
 84th percentile = 2.825
 95th percentile = 6.393

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GRAIN SIZE ANALYSIS

Contract: ALCATRAZ
 Contact person: Dr. William Muellenhoff
 Date of analysis: 9Feb94
 Date of report: 15Feb94
 Analysis method: Sieve/pipette (Plumb, 1981)
 Sample Identification: Station 61B
 Total sample weight: 32.849 grams

Size		Weight	Cumulative	
Microns	Phi	grams	Percent	Percent
2000.000	-1.0	10.729	32.661	32.661
1414.214	-0.5	0.766	2.332	34.993
1000.000	0.0	0.549	1.671	36.665
707.107	0.5	0.346	1.053	37.718
500.000	1.0	0.523	1.592	39.310
353.553	1.5	1.592	4.846	44.156
250.000	2.0	5.336	16.244	60.400
176.777	2.5	5.427	16.521	76.921
125.000	3.0	3.903	11.882	88.803
88.388	3.5	0.472	1.437	90.240
62.500	4.0	0.198	0.603	90.843
31.250	5.0	0.162	0.494	91.337
15.625	6.0	0.609	1.853	93.189
7.812	7.0	0.284	0.865	94.054
3.906	8.0	0.122	0.371	94.424
1.953	9.0	0.365	1.112	95.536
< 1.953	> 9.0	1.466	4.464	100.000

% < 4 phi = 9.157
 % > 1 phi = 37.718
 % gravel = 32.661
 % sand = 58.181
 % silt = 3.582
 % clay = 5.576

Sample Statistics

Median	Mean	Dispersion	Skewness
phi microns	phi microns		
1.680 312.11	. *	.	.

5th percentile = .
 16th percentile = .
 50th percentile = 1.680
 84th percentile = 2.798
 95th percentile = 8.518

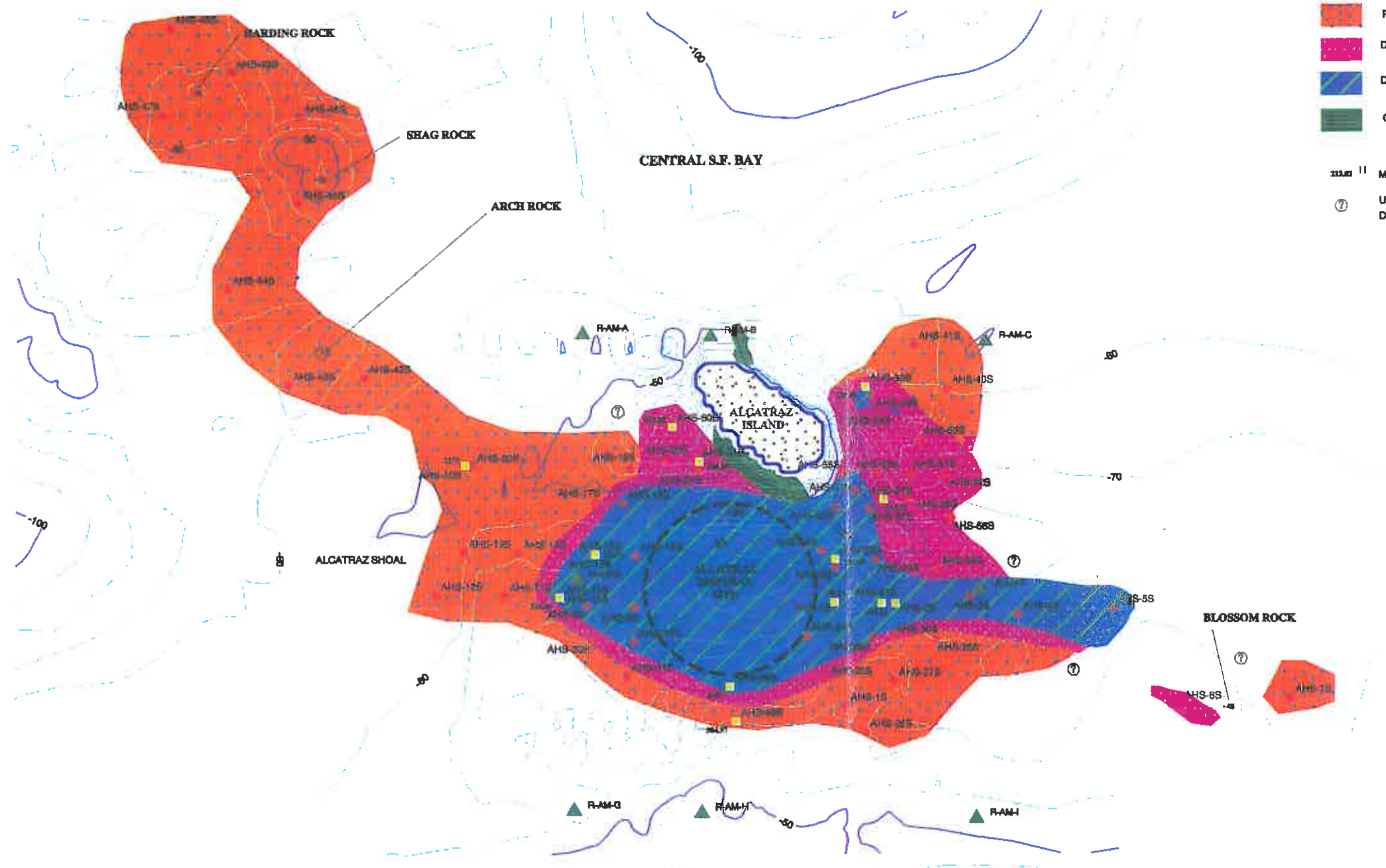
*** 5th percentile not obtainable ***
 *** 16th percentile not obtainable ***
 *** 16th percentile extrapolated ***

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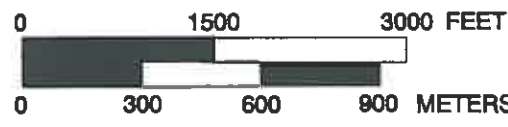
Appendix F: Colored copy of Figure 7 (Bottom Sediment Distribution)

EXPLANATION

- AHS-10S GRAVITY CORE STATION
- AHS-15S BOX CORE STATION
- R-AM-A ALCATRAZ ENVIRONS STATION
- RECENT SANDS AND GRAVEL
- DREDGED MATERIALS (PRIMARILY FINE SANDS) REDISTRIBUTED BY CURRENTS
- DREDGED MATERIALS (PRIMARILY MUD)
- COBBLES (ROV OBSERVATION)
- 11 MEDIAN GRAIN SIZE
- UNKNOWN OR UNCERTAIN SEDIMENT DISTRIBUTION DUE TO LACK OF SAMPLING POINTS



Bathymetric Contour Interval = 10 FT



Bechtel
SAN FRANCISCO

ALCATRAZ MARINE
HABITAT STUDY

**BOTTOM SEDIMENT DISTRIBUTION
FROM RECONNAISSANCE STUDY**



Job Number	Drawing No.	Rev.
21845-004	FIGURE 7	