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Alcatraz Marine Habitat Study:

*Task 3 and 4, Results of Reconnaissance Field Study and
Quantitative Field Study Design*

Submitted to:

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May 1994

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May 3, 1994

U.S. Army Engineer District,
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Attention: Mr. Tom Wakeman; Project Management Branch

Re: Submittal of Checkpoint 2, Task 5 Draft Report; Alcatraz Marine Habitat Evaluation;
Contract No. DACW07-92-D-0007, Delivery Order No. 0016.

Dear Tom:

Attached for your use, in accordance with the Scope of Services for the subject delivery order, dated September 29, 1993, are three (3) copies of our submittal (two bound and one unbound) for Checkpoint 2: Task 5 Draft Report.

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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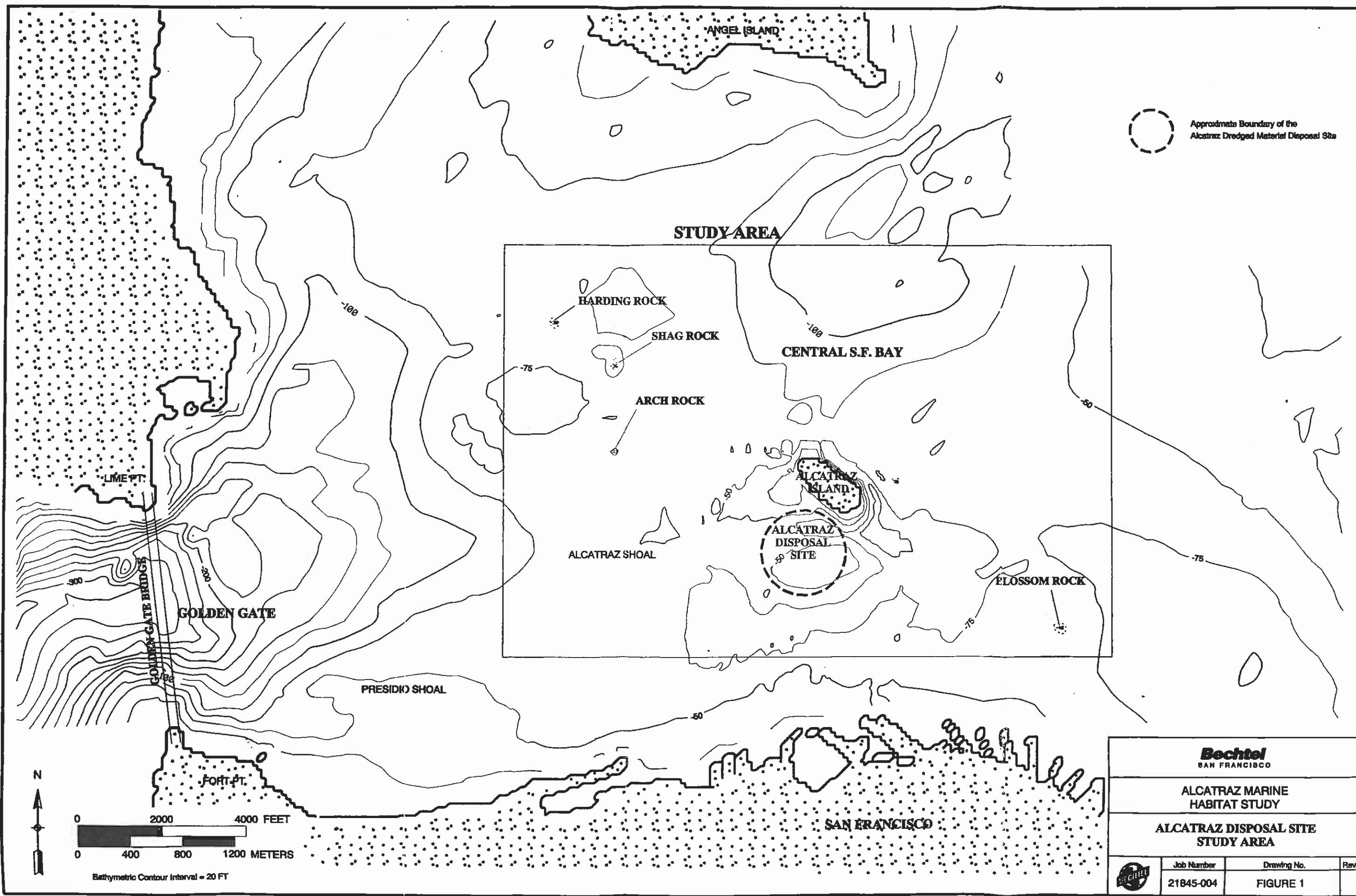
1.0 INTRODUCTION AND OBJECTIVES

1.1 Background

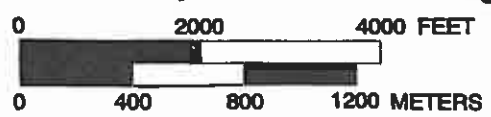
The Alcatraz Dredge Material Disposal Site is situated within the San Francisco Bay between the Hyde Street Pier and Alcatraz Island (Figure 1). The site is designated as a 2000 foot diameter circle with its geographic center at latitude 37° 49' 17" North, longitude 122° 25' 23" West.

The site has been used as a material disposal site since its designation in 1894. The area between Alcatraz Island and the Hyde Street Pier was originally designated because of its depth - formally approximately -165 feet Mean Lower Low Water (MLLW) - and the high current velocities. It was assumed at that time that the high current velocities would carry and disperse the sediments out to sea although 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 at the site to the extent that it could present a hazard to navigation. This situation is being dealt with by the Corps of Engineer, however, there has 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 the condition of prime fishing sites in the Central Bay including, Harding Rock, Shag Rocks, Arch Rock, Alcatraz Shoal, and Blossom Rock (R. Tasto, pers. comm., 1993). These operators feel that fines from sediment disposal may have begun to smother 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 believes that tidepool habitats facing the disposal site (on the south shore of the island) may be silting in because of disposal

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Approximate Boundary of the
Alcatraz Dredged Material Disposal Site



Bathymetric Contour Interval = 20 FT

at the Alcatraz site (Tasto, pers. comm., 1993). However, there are presently no available data to confirm nor refute these statements.

The principal objective of the Alcatraz Marine Habitat Evaluation was to determine if dredged materials discharged at the Alcatraz Disposal Site and transported from the site has caused degradation of fish habitat. This objective was achieved by a combination of interviews and reviews of scientific literature, reports and data pertaining to the existence of fish habitat in the Central San Francisco Bay, and reconnaissance field studies including a visual survey employing a remotely operated vehicle (ROV).

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

Sediment samples were collected and analyzed to assess the presence and distribution of fine-grained dredged materials material (within the proximity of the disposal site) 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 visual observations with the use of the ROV, was 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.

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This report reviews 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.

2.0 REVIEW OF PROPOSED TASKS

There were five tasks in this study of the effects of Alcatraz disposal activities. The first two tasks were been completed and the results submitted in an earlier report, Task 1 and 2, Literature Review and Reconnaissance Field Study Design, submitted to the U.S. Army Corps of Engineers, San Francisco (Corps) in November, 1993. Task 3, 4, and 5 are the subject of this document.

The purpose of Task 1 was, 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. This task also included discussion of methods employed to identify fish habitat.

The purpose of Task 2 was, first, 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. However, the G&H hydrographic survey was not designed to cover the entire area of interest to this habitat study. Thus we obtained from the National Oceanic and Atmospheric Administration additional hydrographic survey data and prepared a detailed baseline map of the Central San Francisco Bay. 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.

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Second, was 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 the reconnaissance study, sediments from a wide area of the central Bay were sampled to assess the areal extent of the Alcatraz sediments. The results of this survey are reported herein.

Third, was to evaluate the best procedures to quantify habitat alterations.

Task 3, as reported in this report, includes two principal purposes. First, is to gather field data to delineate the apron of the Alcatraz mound; and second, to assess the potential degradation of Central Bay fisheries habitat. In addition, the results of the reconnaissance study are discussed.

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. This study is included in this report as Appendix A.

The purpose of Task 5 is to prepare this report summarizing the results of work on this project. Any information included in the earlier document 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

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 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 base line 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.

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.

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 which shows sand waves up to six feet high.

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, 1954¹). 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.

¹ The California state plane coordinates translated from latitude and longitude values presented in Table C-1 of Trask, 1954 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.

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.

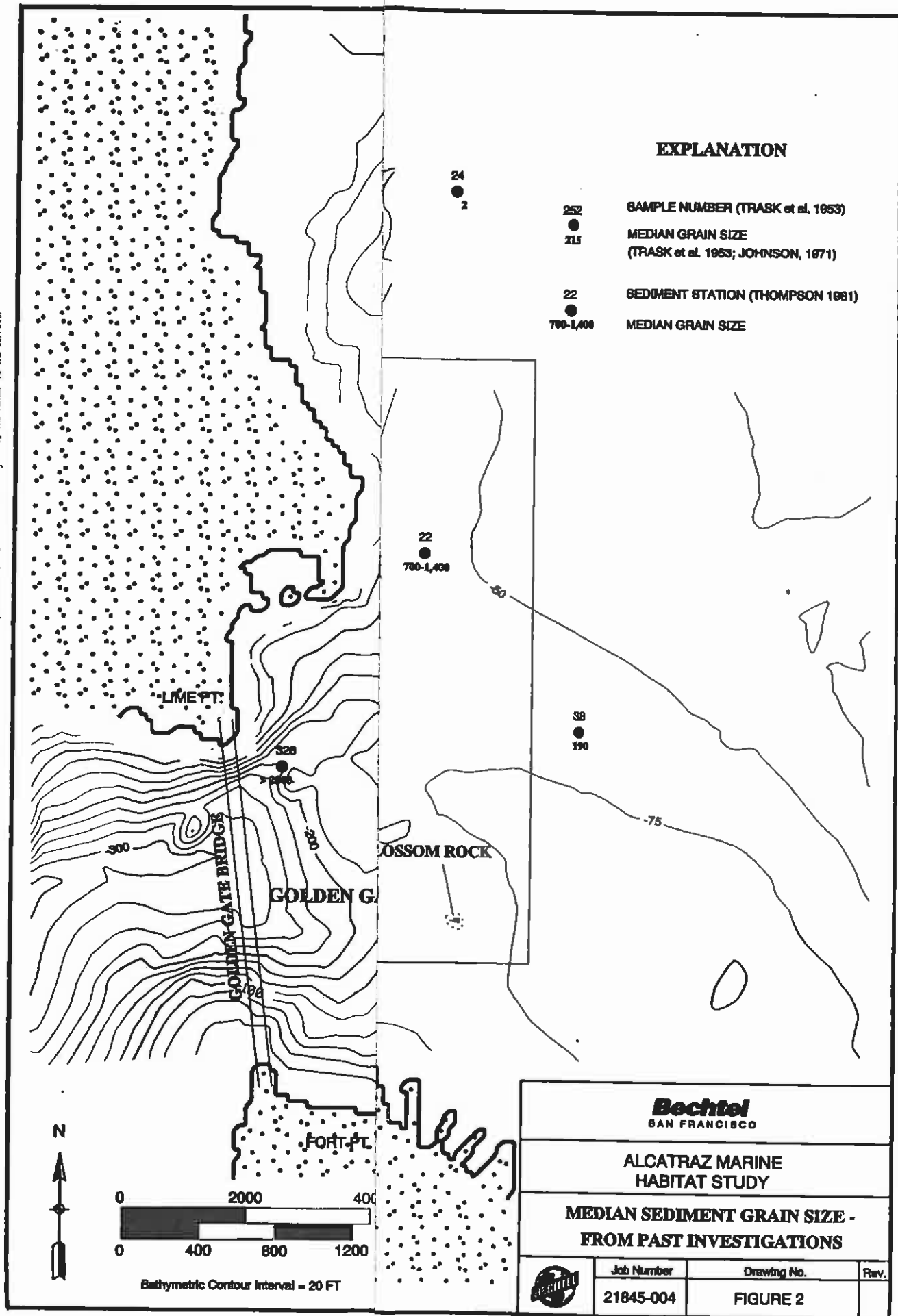
A detailed study of bedforms within the Central Bay was conducted using side-scanning sonar (Rubin & McCulloch, 1979). Their report shows three types of bedform topography around the disposal site area: 1) A flat bed topography with bedrock and boulders located just south and southwest of Alcatraz Island,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

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- 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 report 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 characteristic 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, low reflectance topography, around the margins of the disposal mound; 4) Coarse grained deposits, gravels and clumps of sediments characterized by high reflectance topography, 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.

SAIC conducted studies in 1987 to compare the differing methods for material disposal and dispersal along with the effects of the materials in a limited area around the disposal site. Their study concluded that it was best to dispose of the material in a fluid matter to achieve the best dispersal and limit accumulation on the pile. Further they found that after initial disposal, the more fluid material would be eroded by current transport within several months; however, once the material was deposited, the remaining 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 was 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.

Currently, the Corps has designated eight sampling stations (Alcatraz Environs Stations) around the Alcatraz Disposal Site as a reference for determining suitability for dredged materials disposal. Grain size data from the sites are available for the sites (Corps, 1993); however the sediments were composited. Analyses of the sediments indicate 81-98% sand with up to 17% gravel and 0-6% silt and clay.

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

The Bay provides habitat for both marine, estuarine, and anadromous species that exhibit varying dependencies on substrate. 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 evaluation concentrates on these demersal species most directly to be affected by changes in substrate composition that could be associated with dredged materials placement at the Alcatraz Site.

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 Alcatraz Island, as mostly homogeneous sand and mud. Some of the more common fishes present 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), 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 in-bay aquatic disposal sites at the (South Tower of the Golden Gate Bridge and Bonita Cove (KLI, 1985) and South Tower and "Alcatraz Annex" (WES, 1986), that could provide capacity additional to the Alcatraz site. 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 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 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 survey also collected benthic invertebrate data over the same period 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 species richness. The surveys showed seasonal shifts in the composition of dominant taxa and found that the amphipod, *Ampelisca abdita* was numerically dominant at the Alcatraz site during October, but the bivalve *Tellina nukuloides* ranked highest in February.

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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. This study attempted to estimate the benthic habitat quality of the "Annex Site" 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.

The study team was able to collect qualitative food habit data for the following 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-corer 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). Survey transects were located around the site and tracked both fish movement and plume dynamics during a flood tide. The study determined that the plume was dense and sank slowly. Fish in the water column and near the site (herring, butterfish, 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, nor were demersal fishes looked at during this study.

3.4 Demersal Fishes and Dungeness Crab in Central San Francisco Bay

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

California halibut. 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 first 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. 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, amphipods, mollusks, and ophiuroids (Emmett et al., 1991).

Starry flounder. 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 be actually 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 soft 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. 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 juvenile 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. 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. 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. Dungeness crab (*Cancer magister*) 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). Juveniles feed on fish, mollusks, and crustaceans and are cannibalistic on smaller crabs.

4.0 RECONNAISSANCE FIELD STUDIES:

4.1 Background and Rationale

After the literature review and an assessment of Central Bay conditions, a reconnaissance field study was designed and implemented to collect sediment samples from identified fish habitat areas, and to observe habitat conditions directly using a remotely operated vehicle (ROV). Specific items explored as evidence for habitat alteration included the following:

- Discontinuities in sediment characteristic within a core sample, especially when evidence exists of freshly deposited materials overlaying historic deposits.
- Evidence of benthic organisms characteristic of disturbed sediments, or present in different quantities than this characteristic of undisturbed sediments; 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.
- Levels of organic material greatly different from levels in undisturbed sediments, evidence of washing out of fine organic materials.
- Visual evidence from the ROV study.

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There is existing information helpful in determining habitat conditions in the vicinity of Alcatraz, although much is anecdotal. As noted above, it is the belief 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. Some 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 Corps report (USACOE, 1988) concluded that little correlation was evident between sportfishing catch reports and turbidity levels, substrate affects were not evaluated, and habitat modification may have occurred.

Representatives of the National Park Service have also voiced concern related to sediment disposal at the Alcatraz site (Horner, 1994). Horner 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 have been anecdotal, but Park Service biologists have noted die-offs of *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.

The sandy shoals and rocky outcrops that are near the Alcatraz Disposal Site, and that may be subject to deposition of finer particles transported from the disposal site,

were the focus of this study. Much of the shallow central Bay is dominated by mudflats and subtidal muds. Sands and rock are found in deeper parts of the Bay, primarily west and north of Alcatraz Island. Fine sands also occur east of Alcatraz Island. Recreational fish such as halibut, rockfish, striped bass, and lingcod have been caught near these types of substrates. It appears that at least the adult forms can be found near, and may be dependent upon these habitats; however, there is little site-specific information pertaining to the use by larval and juveniles of these substrates near the disposal site.

At the level of this reconnaissance study, only the presence of benthic habitat has been qualitatively evaluated during the one sampling event. For this study, substrate composition and grain size are considered to be primary descriptors of "fisheries habitat". This is a fairly restrictive definition of the term in that fish habitat also includes areas of adequate water quality, flows, and cover that provide essential feeding, spawning, and nursery grounds. Also, habitat requirements vary by species and life stage.

Others have attempted to evaluate substrate quality and 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. These studies found that species diversity was lowest at a shallow station containing 0.1% organic carbon. In one study deeper mud substrates were dominated by slender sole and shallow sandy bottoms were dominated by Pacific sanddab. Amongst the sanddabs, the small sanddabs predominated silt-sand stations whereas the larger sanddabs preferred sandy sediments (Pearcy, 1978).

In the second study (Pearcy and Hancock, 1978) slender sole and Pacific sanddab were found in the same feeding group, which fed primarily on pelagic crustaceans

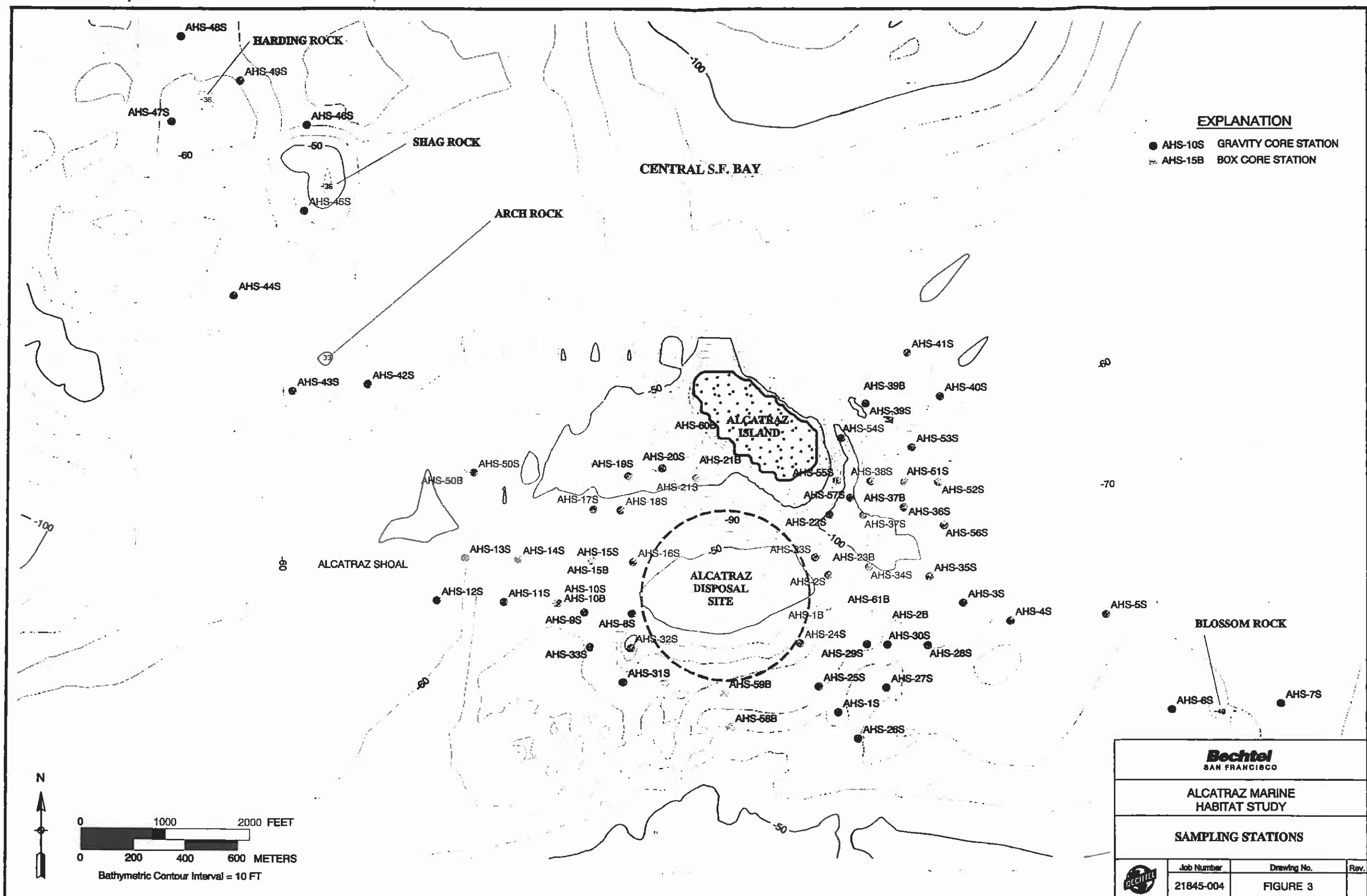
whereas the other group, comprised of dover sole and rex sole, fed mainly on polychaetes and amphipods. They determined that feeding preferences were associated with mouth and digestive morphology and concluded their study with a quote from Petersen (1918): "it is clear then that the character of the 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."

4.2 Sampling Methods

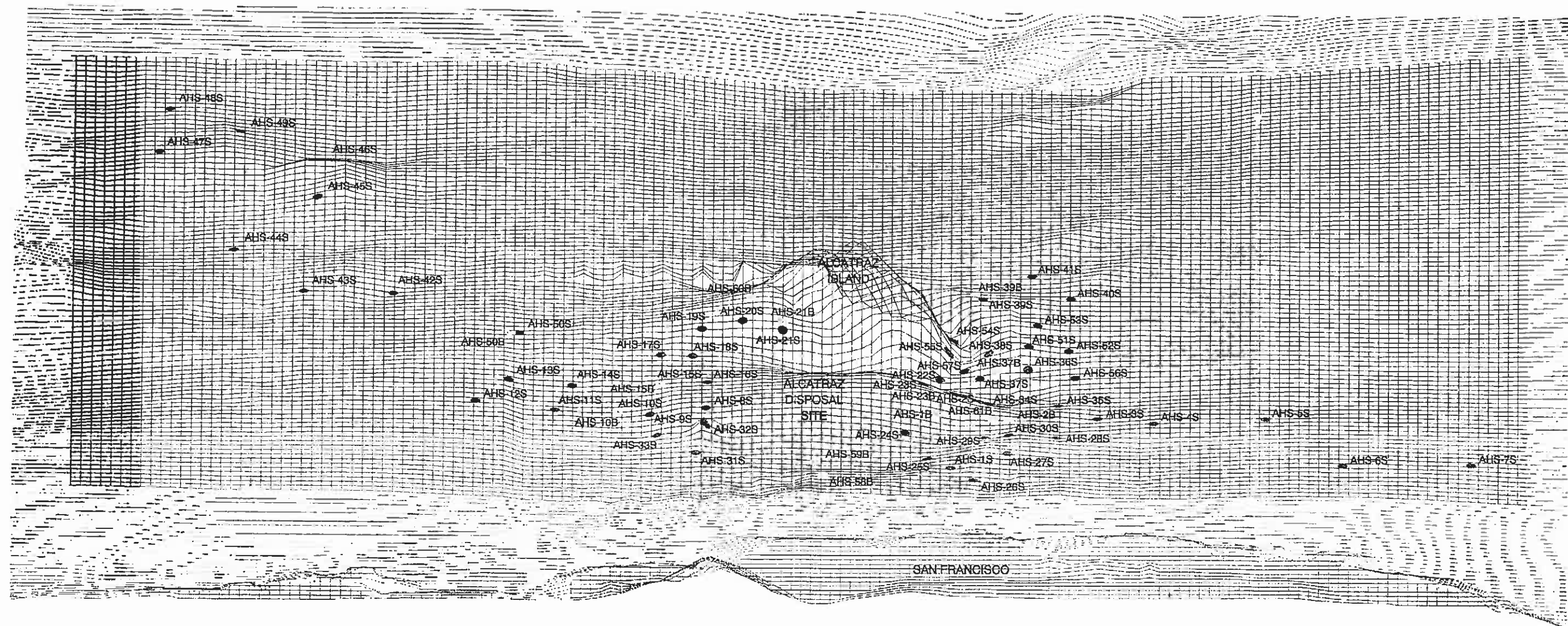
The reconnaissance field study of sediments and biologic characteristics around the Alcatraz Dredge Materials Disposal Site and in areas of the Central Bay was carried out aboard the San Francisco State University Research Vessel Questuary from 19 through 21 January, 1994. The vessel was equipped with 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 transects were made at stations along the east and west margins of the disposal site (Figures 3 and 3A). An east-to-west transect was also made on both sides of the dredge disposal area as was proposed in the proposed reconnaissance field study design. Additional points were also be picked between sediment changes identified during the field study and at selected points around Harding Rock, Shag Rocks, Arch Rock, Blossom Rock, and along the Alcatraz Shoal.

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ALCATRAZ MARINE
HABITAT STUDY

**OBLIQUE VIEW OF ALCATRAZ HABITAT
STUDY AREA AND SAMPLING STATIONS**

	Job Number	Drawing No.	Rev.
	21845-004	FIGURE 3A	

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

When sediments were recovered, 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 discrepancies 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.

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.

Coordinates for two of the stations, AHS-01S and AHS-02S, were entered incorrectly at the start of coring operations and therefore were not collected in the designed location, and do not correlate with the corresponding box-core station.

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. Sediment samples for biological analysis were collected from 12 of the 13 box core stations; the thirteenth station, AHS-02B, yielded only a limited amount of sediment and a sample for biological analysis was not collected.

Table 1: Summary of Sediment Sampling Stations
 Alcatraz Habitat Study, San Francisco Bay
 21845-004

STATION NUMBER	STATION LOCATION	NORTH (ft)	EAST (ft)	WATER DEPTH (MLLW)	SAMPLE RECOVERY (ft)	SEDIMENT TYPE
AHS-01B	East of Disposal Site	2127013	6006894	-76	-1.0'	Dredge materials
AHS-01S	SE of Disposal Site	2125796	6007029	-70	bag sample	Recent sand
AHS-02B	East of Disposal Site	2126998	6007616	-81	-1.0'	Redistributed sand
AHS-02S	East of Disposal Site	2125796	6007029	-70	2.9'	Dredge materials
AHS-03S	East of Disposal Site	2127081	6008500	-77	bag sample	Redistributed mud/dredge materials
AHS-04S	East of Disposal Site	2126868	6009058	-77	1.1'	Redistributed mud/dredge materials
AHS-05S	East of Disposal Site	2126946	6010183	-87	bag sample	Redistributed sand and mud
AHS-06S	Blossom Rock area	2125817	6010962	-100	bag sample	Gravel with redistributed mud
AHS-07S	Blossom Rock area	2125892	6012248	-80	none	No recovery
AHS-08S	West of Disposal Site	2126960	6004565	-47	1.3'	Dredge materials
AHS-09S	West of Disposal Site	2126972	6004004	-67	bag sample	Dredge materials
AHS-10B	West of Disposal Site	2127079	6003685	-74	-1.0'	Redistributed sand
AHS-10S	West of Disposal Site	2127079	6003685	-75	bag sample	Dredge materials
AHS-11S	West of Disposal Site	2127093	6003043	-74	none	No recovery
AHS-12S	West of Disposal Site	2127109	6002241	-67	none	No recovery
AHS-13S	West of Disposal Site	2127608	6002573	-60	bag sample	Recent sand
AHS-14S	West of Disposal Site	2127595	6003214	-72	none	No recovery
AHS-15B	West of Disposal Site	2127577	6004097	-58	-1.0'	Dredge materials
AHS-15S	West of Disposal Site	2127577	6004097	-72	1.6'	Recent sand over dredge materials
AHS-16S	West of Disposal Site	2127567	6004578	-56	1.9'	Dredge materials
AHS-17S	NW of Disposal Site	2128183	6004109	-60	bag sample	Recent sand
AHS-18S	NW of Disposal Site	2128177	6004430	-62	0.9'	Dredge materials
AHS-19S	NW of Disposal Site	2128580	6004519	-42	bag sample	Recent sand
AHS-20S	NW of Disposal Site	2128672	6004922	-40	bag sample	Redistributed sand
AHS-21B	NW of Disposal Site	2128664	6005323	-38	-1.0'	Redistributed sand
AHS-21S	NW of Disposal Site	2128563	6005321	-45	0.9'	Redistributed sand
AHS-22S	NE of Disposal Site	2128126	6006917	-114	1.7'	Dredge materials
AHS-23B	East of Disposal Site	2127519	6006904	-64	-1.0'	Dredge materials
AHS-23S	East of Disposal Site	2127623	6006746	-77	1.4'	Dredge materials
AHS-24S	East of Disposal Site	2126615	6006565	-94	1.6'	Dredge materials

Table 1: Summary of Sediment Sampling Stations
Alcatraz Habitat Study, San Francisco Bay
21845-004

STATION NUMBER	STATION LOCATION	NORTH (ft)	EAST (ft)	WATER DEPTH (MLLW)	SAMPLE RECOVERY (ft)	SEDIMENT TYPE
AHS-25S	SE of Disposal Site	2126105	6006795	-80	bag sample	Recent sand
AHS-26S	SE of Disposal Site	2125488	6007264	-72	bag sample	Recent sand
AHS-27S	SE of Disposal Site	2126088	6007597	-70	none	No recovery
AHS-28S	East of Disposal Site	2126584	6008089	-72	bag sample	Recent sand
AHS-29S	East of Disposal Site	2126599	6007367	-80	1.0'	Dredge materials
AHS-30S	East of Disposal Site	2126594	6007608	-77	bag sample	Recent sand and shells
AHS-31S	SW of Disposal Site	2126153	6004469	-84	bag sample	Recent sand
AHS-32S	SW of Disposal Site	2126555	6004557	-75	1.1'	Dredge materials
AHS-33S	SW of Disposal Site	2126565	6004076	-80	none	No recovery
AHS-34S	East of Disposal Site	2127509	6007386	-94	1.3'	Dredge materials
AHS-35S	East of Disposal Site	2127393	6008105	-90	bag sample	Redistributed sand
AHS-36S	NE of Disposal Site	2128209	6007801	-94	none	No recovery
AHS-37B	NE of Disposal Site	2128215	6007480	-100	~1.0'	Redistributed sand
AHS-37S	NE of Disposal Site	2128117	6007318	-105	2.4'	Dredge materials
AHS-38S	NE of Disposal Site	2128520	6007406	-82	1.2'	Redistributed sand
AHS-39B	East of Alcatraz Island	2129535	6007267	-53	-1.0'	Dredge materials
AHS-39S	East of Alcatraz Island	2129432	6007345	-50	0.6'	Redistributed sand
AHS-40S	East of Alcatraz Island	2129515	6008229	-47	none	No recovery
AHS-41S	East of Alcatraz Island	2130029	6007838	-52	bag sample	Recent sand
AHS-42S	Arch Rock area	2129655	6001411	-74	bag sample	Recent sand
AHS-43S	Arch Rock area	2129573	6000527	-80	bag sample	Recent sand
AHS-44S	Shag Rock area	2130700	5999828	-84	bag sample	Recent sand
AHS-45S	Shag Rock area	2131694	6000651	-77	bag sample	Recent sand
AHS-46S	Shag Rock area	2132706	6000672	-89	none	No recovery
AHS-47S	Harding Rock area	2132739	5999068	-89	bag sample	Recent sand
AHS-48S	Harding Rock area	2133749	5999169	-73	bag sample	Recent sand
AHS-49S	Harding Rock area	2133228	5999881	-50	none	No recovery
AHS-50B	Alcatraz Shoal	2128619	6002593	-57	~1.0'	Recent sand
AHS-50S	Alcatraz Shoal	2128618	6002674	-60	bag sample	Recent sand
AHS-51S	NE of Disposal Site	2128512	6007807	-60	bag sample	Redistributed sand

Table 1: Summary of Sediment Sampling Stations
Alcatraz Habitat Study, San Francisco Bay
21845-004

STATION NUMBER	STATION LOCATION	NORTH (ft)	EAST (ft)	WATER DEPTH (MLLW)	SAMPLE RECOVERY (ft)	SEDIMENT TYPE
AHS-52S	NE of Disposal Site	2128504	6008208	-64	1.5'	Redistributed sand
AHS-53S	East of Alcatraz Island	2128915	6007896	-54	none	No recovery
AHS-54S	East of Alcatraz Island	2129034	6007016	-114	none	No recovery
AHS-55S	NE of Disposal Site	2128528	6007005	-104	bag sample	Gravel with redistributed sand
AHS-56S	NE of Disposal Site	2127996	6008278	-82	none	No recovery
AHS-57S	NE of Disposal Site	2128323	6007162	-100	2.1'	Dredge materials
AHS-58B	South of Disposal Site	2125621	6005742	-65	-1.0'	Recent sand
AHS-59B	South of Disposal Site	2126027	6005670	-89	-1.0'	Dredge materials
AHS-60B	NW of Disposal Site	2129075	6005010	-18	-1.0'	Redistributed sand
AHS-61B	East of Disposal Site	2127002	6007455	-84	-1.0'	Redistributed sand

4.2.1 Gravity Corer

The gravity corer was fitted with a 4-inch diameter, two-foot or three-foot long core barrel. (Longer barrels were available but could not be used because of height limitations of the A-frame on the boat and the length of the configuration of the coring weights). Several reconfigurations of the weight assembly were made before the three-foot barrel corer could be used. 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. All cores were transported at the end of the day to a designated storage location for opening and sediment description later.

4.2.2 Box Corer

An approximately two-foot square box corer was used for recovering samples for biological sampling. 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 identified to species when possible.

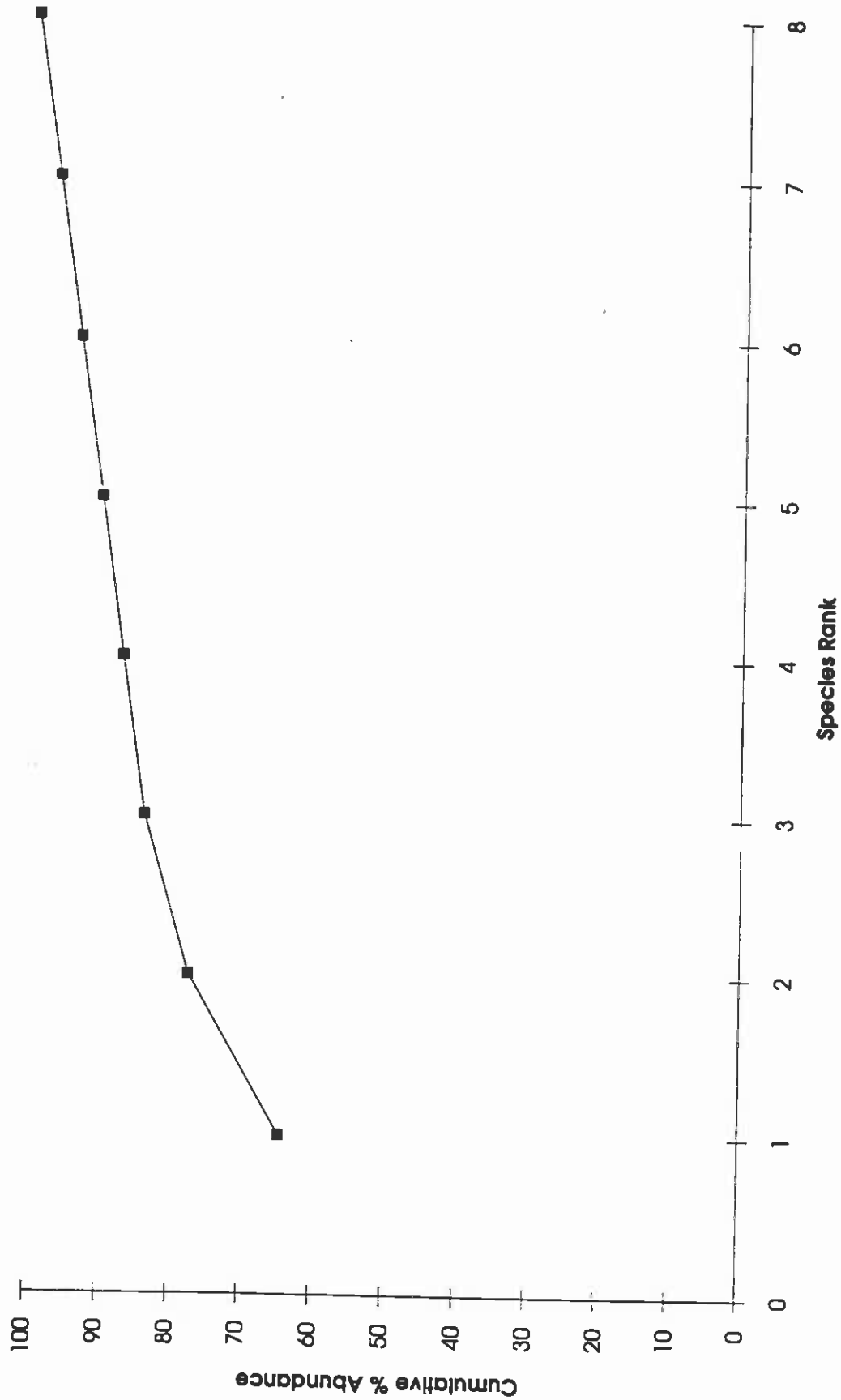
4.3 Sample Analyses

4.3.1 Sediments

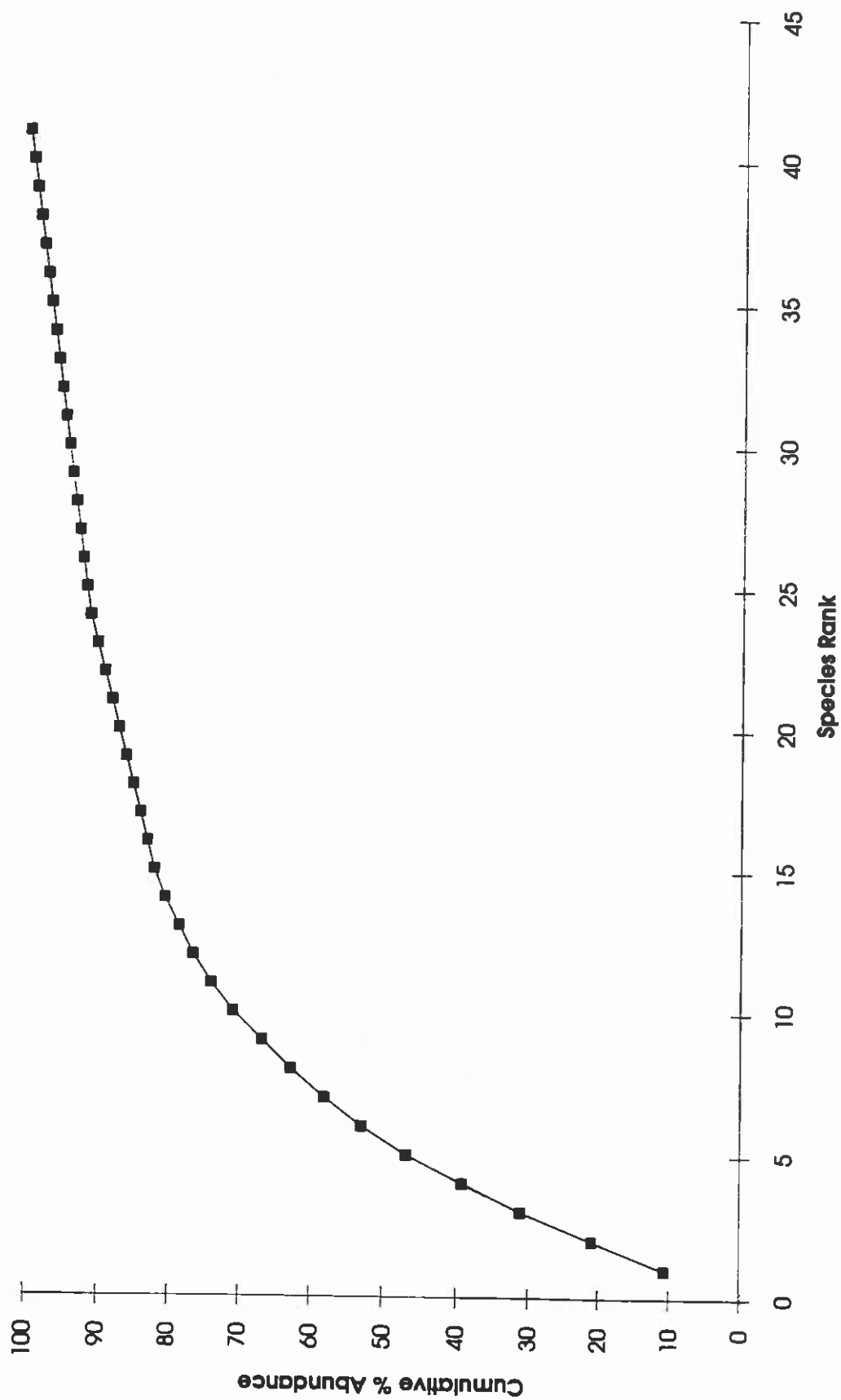
Cores were cut longitudinally by a power saw, split with a wire and cleaned of cuttings. Sediments were visually described as to sediment type, color, grain size, particle sorting, firmness, lithology, and miscellaneous characteristics. Geologic logs were prepared for all core samples showing the vertical 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 (sediments 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

Replicate k Dominance Curve



Replicate k Dominance Curves



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 generally changes in physical characteristic over an extended length of the sediment column.

4.3.2 Infauna

We had earlier identified natural sediments in the central Bay that are associated with "good fishing" as reported in the Preliminary Report. It was assumed, for this study, that changes to these sediments could alter their value as fish habitat.

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 fish habitat, variations in numbers and species present can reflect physical or chemical dissimilarities, or both, among locations sampled.

Several techniques were then used to compare infaunal communities at the 12 locations, including comparisons of species present and the "evenness" of their representation in the sample. A graphic technique useful to display both evenness and diversity of a community of organisms is to plot cumulative species (x axis) against percentage abundance (y axis). Data from a community strongly dominated by one or a few species will yield a low, flat slope (Figure 3B). Data from a diverse community will produce a strongly convex curve (Figure 3C). Although decidedly qualitative, this technique may provide helpful information on the relative environmental conditions at different locations. Its use is especially valid, and very much preferred, if few data exist at locations of interest.

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. Rather, the purpose was to seek biological evidence that Alcatraz disposal activities are associated with benthic habitat degradation or habitat modification. Biological evidence of habitat *degradation* can include the following:

- ☐ Reduced numbers of species when compared to local natural communities: Certain species are more tolerant of degraded conditions and can tend to dominate the community.
- ☐ 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.
- ☐ The dominance of the benthic population by one or a few species: This condition can indicate recent or chronic disturbance to natural communities. When a habitat recovers from degradation, the pattern of species recolonization can be dominated by species that are first able to tolerate decreasing levels of a pollutant in the environment, or whose manner of reproduction produces large numbers of offspring that can temporarily dominate the community.

Biological evidence of habitat *modification* may include:

- ☐ Presence of a different assemblage of species "community" than are typical 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.

- 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.

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.

4.4 Remote Operated Vehicle (ROV) Study

During the course of this study, the opportunity arose to use an ROV to videotape benthic habitat in the Bay. The use of an ROV had not been recommended earlier owing both to the high cost and uncertainties as to the ability of the vehicle to operate effectively under typical Bay conditions of high turbidity and current flow. However, early on in the project Deep Ocean Engineering, San Leandro, California, notified Bechtel through our subcontractor MEC Analytical Systems that they would make available an ROV for a demonstration, if the project could provide a vessel and provide compensation for the time of the two operating technicians. We were told that the vehicle was expected to operate well in currents less than 1.5 to 2 knots. On the recommendation of Bechtel, the Corps agreed to use of project funds for the

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ROV if the additional costs did not increase the estimated contract amount for work. The project was able to accommodate this requirement, and the ROV was deployed for the day on January 6, 1994.

The equipment used was a Phantom 500 ROV, equipped with a high-resolution color video camera with adjustable viewing angle and halogen lighting system. Two operators were provided by Deep Ocean Engineering. The ROV was operated from an 85' vessel equipped with an hydraulic crane, winches, positioning equipment, and power necessary to support ROV operations. Activities of the ROV were viewed from a pair of color television monitors on the vessel, one of which was used by the operator to maneuver the vehicle, the other to make field notes and to record the images on a VCR. Both monitors displayed the time on the screen to allow notes to be matched with the VCR images later.

The support vessel was maneuvered in to position at a pre-selected study site marked on a navigation chart. Generally, a bow anchor was then deployed to hold the vessel at that point. On several occasions, the vessel was allowed to drift with the current as the ROV operator attempted to operate the vehicle along the bottom in the direction of the drift. This practice was as a rule unsuccessful, and attempted only at several stations where currents were too high to permit operation of the ROV from an anchored vessel.

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.

Some good images of the Bay benthos were obtained. On the whole, however, the ROV provided was not particularly effective for a benthic survey in the Bay. The

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greatest problem related to current speeds. Although the vehicle was purported to be capable of moving at 2.5 knots, the 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 set to view a lighted spot on the bottom through 10 or 15 centimeters of water. Oblique or forward viewing was only possible in the clearest water, however.

5.0 RESULTS

5.1 Description of Sediments

Sediments recovered during the investigation can be divided into three basic types: 1) dredged material from direct disposal, primarily mud with some sands; 2) dredged material redistributed by currents, primarily fine sands; and 3) recent sands and gravels. The most distinctive physical characteristics used to separate these three sediment types were color, grain size and to a lesser extent sorting.

5.1.1 Dredged Materials From Direct Disposal

The majority of the dredged materials 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.

5.1.2 Dredged Material Redistributed by Currents

Current redistributed materials are primarily sands with some mud deposits. The sands are primarily 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 and silt. Varying amounts of shell fragments are present.

Some of the redistributed sands are mixed with the recent sand and gravels. These sediments are generally olive brown to grayish brown and grain size ranges from very fine to coarse.

5.1.3 Recent Sands and Gravels

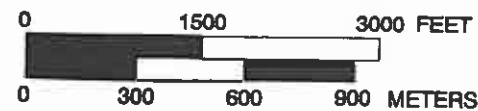
Recent sand and gravel deposits are varying shades of browns with some grayish red to pink. These deposits are primarily poorly to moderately sorted, medium- to very-coarse-grained sands with some pebbles and shell fragments up to several inches in diameter. Some fine-grained sand is present; however,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

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. In several locations, 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.

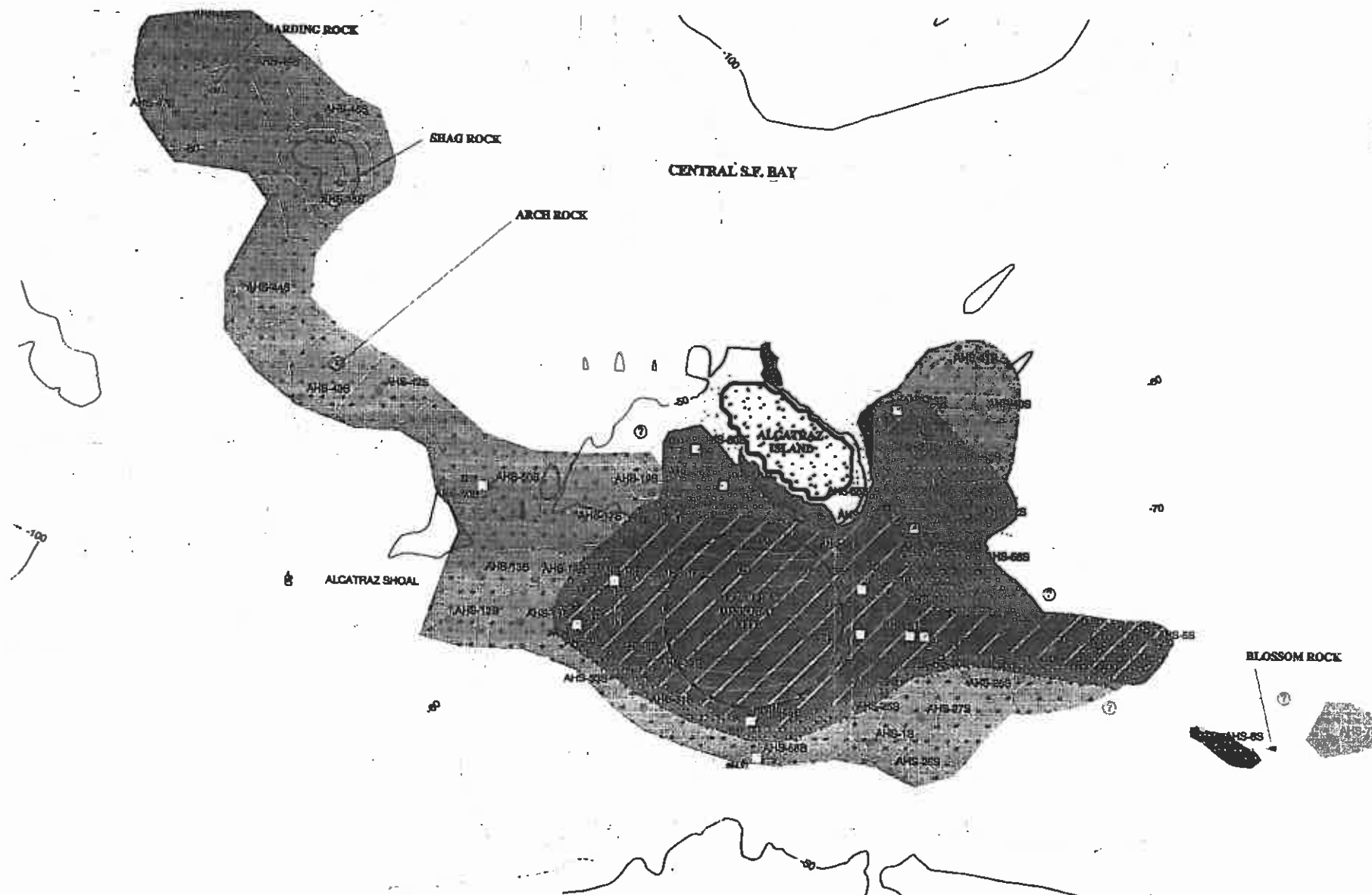
5.2 Distribution of Sediment

Distribution of the three basic sediment types identified in this reconnaissance study are shown in Figure 4.

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Bathymetric Contour Interval = 10 FT



EXPLANATION

- AHS-108 GRAVITY CORE STATION
- AHS-168 BOX CORE STATION

- RECENT SANDS AND GRAVEL
- DREDGED MATERIALS (PRIMARILY FINE SANDS) REDISTRIBUTED BY CURRENTS
- DREDGED MATERIALS (PRIMARILY MUD)
- COBBLES (ROV OBSERVATION)

- MEDIAN GRAIN SIZE
- UNKNOWN OR UNCERTAIN SEDIMENT DISTRIBUTION DUE TO LACK OF SAMPLING POINTS

Bechtel
SAN FRANCISCO

ALCATRAZ MARINE
HABITAT STUDY

BOTTOM SEDIMENT DISTRIBUTION
FROM RECONNAISSANCE STUDY



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21845-004

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FIGURE 4

Rev.

Direct deposited dredge materials were found around the margin of the disposal site. Muds were found to a limited extent around the margins however some muds were recovered to the east (AHS-02B, AHS-03S and AHS-04S) and northeast (AHS-37S, AHS-57S and AHS-39S) of the disposal site.

Current redistributed fine sands 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)

Sediments which shows very limited effect by redistributed dredge material sands 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.

Sediments not effected 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).

5.3 Benthic Invertebrates

Figure 2 depicts the locations of the 12 benthic sampling stations. Lists and enumeration of species identified for each station are attached in Appendix B.

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

identified as derived from dredged materials transported by water movement to their present locations. Stations 23B and 37B appear to be natural sands 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). Station 60B is native Bay sand, and the other three are derived from dredged materials. 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 derived from dredged materials; the others are natural Bay sands. The cumulative abundance curves (Appendix C) corroborate the species counts of the biological collection stations.

The species abundance data thus indicate the general pattern of approximately equally high abundance among the four stations to the east of the Alcatraz disposal site (1B, 61B, 23B, and 37B); intermediate abundance at the four dredged materials 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 (37B); and low abundances at one natural sand stations about one kilometer west of the disposal area on Alcatraz shoal (50B), one natural sand station south of the disposal area (58B), and another natural sand station several hundred meters north of the disposal site (21B). Station 10B, derived from dredged materials and several hundred meters west of the disposal site also had a low number of species.

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.

A general association of higher numbers of species with muddy sediments derived from dredged materials, and lower numbers in the coarser, natural sediments in the areas sampled was apparent (Appendix E). Within the muddy samples, numbers of species are independent of the fraction of fines. However, a detailed comparison of the full relationship of the few biological samples collected and the particle size distribution of the sediment samples has not been attempted at this time.

The spread of the clam *Potamocorbula amurensis* throughout much of the San Francisco Bay since first identified here in 1987 has been a process of interest and concern to many biologists. In several shallower benthic communities in the Bay it appears to have multiplied to the point that a monoculture of this species is present. There is also evidence that it may be filtering water to the extent that little planktonic material remains for other filter feeding species. No *P. amurensis* were identified from the 12 samples collected for this study, however. This was verified in discussions with the taxonomist responsible for the sorting and analysis who affirmed that he was very familiar with *P. amurensis* and that it was indeed absent from this collection.

5.4 ROV Survey

On January 6, 1994, an in-situ reconnaissance survey of the Alcatraz environs was completed by means of a remotely operated vehicle (ROV). The ROV was deployed at six clusters 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. The visibility was poor and the size of objects difficult to determine. 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, 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.

The next set of observations were taken at Station 14, a cove on the west-southwest shore of Angel Island. The water was calm and the currents less than one knot. The deeper substrate contained rocks, boulders, and outcrops, and in the shallower areas (17 feet and above) was primarily what appeared to be muddy sand. Visibility was approximately 2 feet. *Patiria miniata* were common, as were red and orange encrusting organisms. Red (possibly *Halosaccion* and others), brown, and green (possibly *Ulva*) algae were also present. A fish, probably a sculpin, was startled from a rock cluster. On another rock, a yellow nudibranch with brown spots was seen.

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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. Neither fish nor sea pens were observed at any of the other study locations.

The ROV was redeployed next in water between 30 and 60 feet at Arch Rock (Events 3 and 4), which is west of Alcatraz Island. Again, due to poor visibility, rocks and boulders were seen only when the ROV was in direct contact with the substrate, on which several *Patiria miniata*, purple sea stars (*Pisaster ochraceus*), and bryozoans or sponges were seen. Nothing was visible in the water column while the ROV was operated between locations on the bottom.

The ROV was next moved to the northwest side of Alcatraz during which time Events 7 through 13 were recorded. (No notes were recorded for events 5, 6, and 9.) These rocky surfaces were to be observed as a comparison for similar surfaces on the southern side of Alcatraz Island and closer to the disposal site. The water was again very turbid in the observation depths ranging from 35 to approximately 50 feet. When the ROV was in contact with the substrate, incrusting red bryozoans or sponges were observed. One *Patiria miniata* and an unidentified pink sea anemone (Anthozoa) were also seen.

Events 14 through 17 (in depths varying from approximately 30 and 60 feet) were off the southern point of Alcatraz Island to the east of the transect containing Stations 1 through 13. This cluster of observations was in an area where currents were high (approximately 4 knots) and it was difficult to remain on station and tow the ROV simultaneously. Nevertheless, the survey revealed the presence of *Patiria miniata* and the ubiquitous red or orange incrusting organisms.

The next cluster of observations (Events 18, 19, and 20) were performed along approximately the same transect as Stations 1 through 13. The water clarity was about the same. 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. The ROV was then moved slightly to the east of the previous transect in approximately 50 feet to 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 to be surveyed. After positioning on station, it was clear that the surveys would not be conducted as the currents exceeded the ability of the ROV to be operated without risking damage to the device. The ROV surveys were concluded at that time.

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, sites near Alcatraz were relatively clear of sands and mud, probably the result of the high current velocities through the area.

the remaining muds, reducing further erosion of the pile. These coarser lag deposit may correlate to the Type 4 deposits of SAIC (1987) around the base of the disposal mound. Natural coarser sands and shell fragments are also observed covering the muds in locations around the disposal pile.

- The primary observed areas of mud deposition are from the area south-east of Alcatraz Island extending east of Alcatraz Island within the deeper basin to the shoal east of the island; and, from the area east of the disposal site which may extend to and beyond the Blossom Rock area. Limited recovery of muddy gravel near Blossom Rock indicates muds may be blanketing the area.
- Fine to medium sands (125-350 μm) are being transported off the pile and are being deposited as follows: on the fringes of the Disposal Site; on the southwest slopes of Alcatraz Island; on the northeast side of the Disposal Site to around the southeast corner of Alcatraz Island; on the shoal east of Alcatraz Island; and east of the Disposal Site possibly as far as the Blossom Rock Area (Figure 4).
- The natural deposits in much of the areas around Alcatraz Island are primarily coarse to very coarse sands with gravelly slopes on the flanks of the island. These areas are being blanketed with finer sand deposits.

6.2 Biological Characteristics

- No evidence was found that dredged materials have been transported to Harding, Shag, Arch, and Blossom Park.

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- Sediments judged to originate from the Alcatraz Disposal Site appear to extend west to the eastern edge of Alcatraz Shoal, and east several thousand feet towards Arch Rock, and around to northeast of Alcatraz Island.
- Current velocities between the disposal site and Alcatraz Island appear to have removed all but larger rocks and cobbles.
- The effects of disposal at Alcatraz, as determined by the presence of transported fines and clays not common to the central Bay, but present at the Alcatraz site, have modified the characteristics of benthic sediments over an area approximately 3 times the area of the disposal site.
- No evidence was found to indicate that modified sediments are contaminated. In fact, benthic sediments outside the disposal area that receive transported dredged material appear for the most part to have more diverse infaunal populations than exist at Alcatraz Shore (although only one sample was collected on the shore for comparison).
- Modified sediments, however, may not be suitable habitat for commercial and recreational species.

7.0 RECOMMENDED QUANTITATIVE FIELD STUDY PROGRAM

7.1 Purpose

An assessment of habitat utilization by demersal fishes, such as English sole, starry flounder, shiner perch, and rockfish near the Alcatraz Disposal Site may be accomplished through the collection and analysis of data specifically for determining habitat characteristics for those species. Methods for evaluating fish habitat use and preference have been developed over the years for the Instream Flow Incremental Methodology, which is a habitat-based approach for evaluating environmental changes in streams and rivers (Bovee, 1986). The general approach to fish habitat use and preference as presented in this plan is based on these guidelines, as the overall concepts are applicable to other aquatics systems, such as the Bay, as well.

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 measured 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 organisms is most commonly found is the one that has been actively sought out and is preferred. For this study effort, data would be collected to evaluate the utilization of target demersal fishes in the vicinity of the Alcatraz Disposal Site including collection of fishes and of benthic sediment and biological samples.

Habitat availability is also important to establish because habitat availability determines preference. It is not within the scope of this plan, however, to assess the availability of all habitat types within the San Francisco Bay system and depending on the species, marine habitats as well.

7.2 Methods

The most accurate method of collecting unbiased measurements of habitat variables at specific fish locations would be through direct observation. This would allow data to be collected on the actual location of the target fishes with the minimum disturbance to the fish. Direct observation is generally less intrusive than sampling and can be highly efficient. However, near Alcatraz, levels of suspended matter (turbidity and total suspended solids) can be so high that visibility is limited to within a few inches or feet, as observed with the ROV survey. A second method

that could be employed would be the use of gill or fyke nets, deployed in the same locations that sediment samples are or were previously collected. However, the Bay environment near Alcatraz would make difficult the use of these 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 the Bay environment.

The dynamics of the Bay system prevent the use of the more unobtrusive methods of collecting fish habitat use data as described above. Among the few choices available for scientists to collect this type of data is the careful use of trawls. Otter trawls are often used for collecting demersal fish as the net drags across the substrate along pre-determined transects. Otter trawls are effective in catching fish; however they are known to be species and size selective. This can be remedied to some extent by using otter trawls of two different mesh sizes so that various sized fish can be caught. Trawling, however, is 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; they are most efficient in areas of even or smooth substrates. Trawling has further limitations in that deployment of the nets is highly disruptive, the more highly mobile fish are able to avoid capture, and the actual trawling distance may inadvertently cover more than one substrate type. But as mentioned previously, there are few data collection methods available in as highly dynamic and complex an environment as is observed at Alcatraz.

Sediment sampling will be conducted to assess and better define the horizontal and vertical distribution of fine-grained dredged materials material that are covering or changing fish habitat within the proximity of the disposal site and around Alcatraz Island. The boundaries of disposed sediments will be further evaluated and the

information will be used to develop more comprehensive recommendations to minimize habitat impacts in the area of the disposal site.

7.2.1 Sampling Coverage

A series of sampling points will be made along margins of the disposal site (as defined from the reconnaissance study) to evaluate the vertical extent of the mound around the margins and to study the effects of sediment armoring over time. A more detailed east-to-west transect will be made on the east side of the dredge disposal area to assess the impact between the disposal site and Blossom Rock and the area around Blossom Rock.

7.2.2 Sampling Ship

A vessel with the following characteristics: twin screws, large working area, differential GPS, recording bathometer, trawling gear, and appropriate hydraulics. The vessel should be equipped with an A-frame hoist which can be adapted for vibra-coring or use of drilling equipment.

7.2.3 Sampling Methods

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. Gravity coring and box-core sampling may also be used in selected location for further surface habitat studies.

Sample 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

plastic bags or containers as appropriate. After sediments are recovered, 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 opened (sectioned) in the lab 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 stations. Sediments will be passed through a 1 mm sieve and retained organisms preserved in 10% buffered formalin identified to genus, and to species when possible. A sub-sample will be retained for particle-size-distribution and total-organic-carbon analysis.

Habitat utilization will be determined by conducting a series of otter trawls along pre-determined transects that are in the same locations as the sediment collection. 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, current speed and direction, and approximations of Delta outflow 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 measured and identified to genus and species; any gross anomalies (e.g., tumors, fin necrosis) will also be noted. Any incidental catches of macroinvertebrates will be recorded and identification will be to genus and species if possible.

7.2.4 Sample Analyses

Sediments: Dredged materials material for the most part is discernable from natural deposits by visual identification (sediments type, color, grain size, and sorting). In samples where extensive mixing has occurred or where the change can not be easily discerned, sediment will be analyzed for physical parameters such as: grain-size, density, and consolidation.

Biological samples: 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.

7.2.5 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.

7.3 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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DRAFT

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Western Ecological Services Company, Inc., 1988. *Marine Resources Survey of Central San Francisco Bay*. Prepared for U.S. Army Corps of Eng. Contract No. DACW07-88-D-0007, Work Order No. 0001, ACE 8801-1, Draft, Nov. 22.

Winzler & Kelly Cons., 1985. *Oceanographic Investigation at the Alcatraz Disposal Site, San Francisco Bay, California*. for US Army Corps Eng.

OTHER REFERENCES REVIEWED

The following documents were briefly reviews during the course of this investigation. These documents were found to contain mostly general information or information that did not directly address the primary scope of this project. A general statement of the article content or lack of site specific information follows the reference in parentheses.

Brown, W.M., III and Jackson, L.E., Jr., 1973. *Erosional and Depositional Provinces and Sediment Transport in South and Central Part of San Francisco Bay*. (general bay area geologic information, mostly land based, little site specific geology).

CA Dept. Pubic Works, 1955. *Barriers in the San Francisco Bay System*. (general bay area geology, little site specific geology).

Krone, R.B., 1966. *Predicted Suspended Sediment Inflows to the San Francisco Bay System*, Univ. of CA, Davis, (General bay area conditions with projected sediment load information)

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DRAFT

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- Treasher, RC, 1963. *Geology of the Sediment Deposits in San Francisco Bay, CA*. CA Div. M&G SR-82. (contains general geologic information of the bay with bay mud formation contours in main regions of the bay).
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Appendix A: Geologic Logs



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-01B

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 2,127,013 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	(Template: SEA)
								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.	(Template: SEA)
			-76.3	0.5				Box core dropped from water surface and allowed to free-fall to bottom.
			-77.0	1.0				Grain-size analysis preformed from surface sub-sample: 10% gravel (shells) 2% coarse-vc sand 12% medium sand 37% fine sand 4% very-fine sand 30% silt 15% 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-01B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-01S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-19-94

VESSEL

R.V. Questuary

COORDINATES

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

ELEVATION (below MLLW)

-70

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

-70.1

...

Bag sample: Shelly SAND, Moderate brown to Moderate yellowish brown, medium to coarse grained, with shell fragments up to 0.5".

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

SE of Disposal Site San Francisco Bay

HOLE NO.

AHS-01S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-02B

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 2,126,998 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	Depth in Feet	Lithology	Sample	Lithologic Description	(Template: SEA)
								Remarks
BX	2.0'	-0.1'	-81.0					
			-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	(Template: SEA)
								Remarks
GC	3.0'	2.9'	-70.0				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.
			-70.2				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.
				0.5				
				1.0				
			-71.2				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.	Torvane reading at 1.0' = 0.5 tons/sq.ft.
				1.5				
				2.0				
				2.5				
			-72.9					
								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 <i>Alcatraz Habitat Study</i> 21845-004		HOLE NO. AHS-04S				
SAMPLER MEC, Inc.		SITE and LOCATION East of Disposal Site, San Francisco Bay		SHEET NO. 1 OF 1				
VESSEL R.V. Questuary		COORDINATES N 2,126,868 E 6,009,058		ELEVATION (below MLLW) -77				
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'	1.1'	-77.0					(Template: SEA)
			-77.5	0.5				
			-77.6					
				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-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

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 2,125,892 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	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	3.0'	0.0'	-80.0				no sample recovery.	(Template: SEA) 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

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 2,126,960 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	Remarks
GC	3.0'	1.3'	-47.0				0.0 - 0.2 ft: SAND, Olive black, fine to medium grained, moderately sorted, minor mud, 2" rounded pebble with encrusted barnacles.	Gravity core dropped from water surface and allowed to free-fall to bottom. Torvane reading at 0.3' = 0.7 tons/sq.ft.
			-47.2			0.2 - 0.8 ft: MUD, Greenish gray to Grayish black, mottled, soft; sandy layer with shell fragments between 0.5 - 0.6'.		
			-47.5	0.5				
			-47.6					
			-47.8					
			-48.0	1.0		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.		
			-48.3			1.0 - 1.3 ft: MUD, Greenish gray to Grayish black, mottled, soft.	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

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 2,126,972 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

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-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

-72.0

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.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

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 2,127,577 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	Remarks
BX	2.0'	~1.0'	-58.1	0.5			Box core sample: SAND, Grayish brown, fine to medium grained; over MUD, Black, soft.	(Template: SEA) Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis preformed 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
			-59.0	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-15B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-15S

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 2,127,577 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

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	3.0'	1.6'	-72.0				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. Torvane reading at 0.7' = 0.7 tons/sq.ft.
			-72.4	0.5			0.4 - 1.3 ft: MUD, Grayish black mottled with Dark greenish gray, soft, sharp contact.	
			-73.3	1.0				
			-73.5	1.5			1.3 - 1.5 ft: SAND, Greenish gray, fine grained, well sorted, sharp contact.	
			-73.6				1.5 - 1.6 ft: MUD, similar to 0.4 - 1.3'.	

GC = GRAVITY CORE; BX = BOX CORE.

SITE and LOCATION

West of Disposal Site San Francisco Bay

HOLE NO.

AHS-15S





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-17S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

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

-60.1

...

Bag sample: Shelly SAND, Moderate brown to Moderate yellowish brown, fine to coarse grained, with 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.

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-19S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

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

-42.0

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-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

S-24-94							
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	(Template: SEA)
Lithologic Description							Remarks
BX	2.0'	-1.0'	-38.0				
				0.5			
			-39.0	1.0			
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
							6% clay



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-21S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NW of Disposal Site, San Francisco Bay

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			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.
			-45.9					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-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'	1.6'	-94.0	0.5			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.
				1.0				Torvane reading at 0.8' = <0.5 tons/sq.ft.
				1.5				Torvane reading at 1.4' = <0.5 tons/sq.ft.
			-95.6					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

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

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

SAMPLER

MEC, Inc.

SITE and LOCATION

SE of Disposal Site, San Francisco Bay

SHEET NO. 1 OF 1

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

Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	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 danted.

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-41S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,130,029 E 6,007,838

ELEVATION (below MLLW)

-52

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

-52.1

...

Bag sample: SAND, Moderate brown, fine to coarse 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

East of Alcatraz Island San Francisco Bay

HOLE NO.

AHS-41S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-42S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Arch Rock area, San Francisco Bay

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

-74.0

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 <i>Alcatraz Habitat Study</i> 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		SAMPLE LENGTH 1.0	
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	
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Lithologic Description Remarks	
GC	2.0'	1.0'	-80.0			(Template: SEA) 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).	
			-80.2				
			-80.4				
			-80.7				
			-81.0				
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 <i>Alcatraz Habitat Study</i> 21845-004		HOLE NO. AHS-31S	
SAMPLER MEC, Inc.		SITE and LOCATION SW of Disposal Site, San Francisco Bay		SHEET NO. 1 OF 1	
VESSEL R.V. Questuary		COORDINATES N 2,126,153 E 6,004,469		ELEVATION (below MLLW) -84	
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
GC	2.0'	bag sample	-84.0	0.5	-84.6
Lithologic Description Bag sample: SAND, Moderate brown to Grayish brown, fine to medium grained with some coarse grains, abundant shell fragments up to 0.25". Remarks (Template: SEA) 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

							(Template: SEA)	
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
GC	2.0'	1.1'	-75.0					
			-75.4				0.0 - 0.4 ft: SAND, Olive brown, fine to coarse grained, moderately sorted, some gravel up to 0.5", abundant shell fragments up to 0.5", sharp contact.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-75.5	0.5		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.					
GC = GRAVITY CORE; BX = BOX CORE.							SITE and LOCATION	HOLE NO.
SW of Disposal Site San Francisco Bay							AHS-32S	



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-33S

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 2,126,565 E 6,004,076

ELEVATION (below MLLW)

-80

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'	-80.0				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

SW of Disposal Site San Francisco Bay

HOLE NO.

AHS-33S



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	0.5			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.
			-95.0	1.0			1.0 - 1.3 ft: Sandy MUD, Black, soft, sand is fine grained.	Torvane reading at 0.3' = 0.5 tons/sq.ft.
			-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	HOLE NO.
							East of Disposal Site San Francisco Bay	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

-90.2

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

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 2,128,209 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

-94.0

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.

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-37B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

NE of Disposal Site, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,128,215 E 6,007,480

ELEVATION (below MLLW)

-100

SAMPLE LENGTH

1.0

SAMPLER WEIGHT

~400 lbs

BARREL SIZE

24" sq.

LOGGED BY

Stephen Knuttel

UPDATE

3-24-94

3-24-74							(Template: SEA)	
Sampler Type	Sampler Length	Recovery (ft)	Elevation below MLLW	Depth in Feet	Lithology	Sample	Lithologic Description	Remarks
BX	2.0'	-1.0'	-100.0				Box core sample: SAND, Dark gray to Grayish brown, fine grained, well sorted, minor fines; some mud clast, Grayish black, with organic material and wood fragments.	Box core dropped from water surface and allowed to free-fall to bottom.
				0.5				Grain-size analysis preformed from sub-sample: <1% gravel and shells 1% coarse-vc sand 3% medium sand 75% fine sand 11% very-fine sand 5% silt 6% clay
			-101.0	1.0				
GC = GRAVITY CORE; BX = BOX CORE.							SITE and LOCATION	HOLE NO.
							NE of Disposal Site San Francisco Bay	AHS-37B
								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-37S

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 2,128,117 E 6,007,318

ELEVATION (below MLLW)

-105

SAMPLE LENGTH

2.4

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'	2.4'	-105.0	0.5 1.0 1.5 2.0			0.0 - 2.4 ft: MUD, Grayish black to Black, mottled in areas with Dark greenish gray, soft, minor shell fragments.	Gravity core dropped from water surface and allowed to free-fall to bottom. Torvane reading at 0.5' = <0.5 tons/sq.ft. Torvane reading at 1.4' = 0.7 tons/sq.ft. Torvane reading at 2.2' = 0.5 tons/sq.ft. Core weight assembly buried in mud, sediment recovered from weight assembly, and core catcher and cutter. 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-37S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-38S

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 2,128,520 E 6,007,406

ELEVATION (below MLLW)

-82

SAMPLE LENGTH

1.2

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'	1.2'	-82.0	0.5 1.0			0.0 - 1.2 ft: Muddy SAND, Grayish black, fine to medium grained, moderately well sorted, some black shell fragments, abundant organic material between 0.0 - 0.5' with sea grass on top of core.	Gravity core dropped from water surface and allowed to free-fall to bottom.
			-83.2					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-38S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-39B

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SAMPLE DATE

1-21-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,535 E 6,007,267

ELEVATION (below MLLW)

-53

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'	-53.0				Box core sample: SAND, Grayish brown, fine grained; over Sandy MUD, Grayish black, silty sand to sandy silt.	(Template: SEA) Box core dropped from water surface and allowed to free-fall to bottom. Grain-size analysis performed from surface sub-sample: <1% gravel and shells <1% coarse-vc sand 10% medium sand 80% fine sand 4% very-fine sand 2% silt 4% clay
			-53.5	0.5				
			-54.0	1.0				
GC = GRAVITY CORE; BX = BOX CORE.							Description and classification by visual examination of sample. Colors from "Rock-Color Chart" (GSA, 1948).	
SITE and LOCATION							East of Alcatraz Island San Francisco Bay	
HOLE NO.							AHS-39B	



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-39S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,432 E 6,007,345

ELEVATION (below MLLW)

-50

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

-50.0

Depth in Feet

0.5

-50.6

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

0.6'

0.0 - 0.6 ft: SAND, Olive gray, fine grained, well sorted, few shell fragments.

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 Alcatraz Island San Francisco Bay

HOLE NO.

AHS-39S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-40S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,129,515 E 6,008,229

ELEVATION (below MLLW)

-47

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'

-47.0

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-40S





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-42S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Arch Rock area, San Francisco Bay

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-43S

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

Arch Rock area, San Francisco Bay

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 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-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'	-77.0				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-46S

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 2,132,706 E 6,000,672

ELEVATION (below MLLW)

-89

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	-89.1				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

Shag Rock area San Francisco Bay

HOLE NO.

AHS-46S



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-47S

SAMPLER

MEC, Inc.

SITE and LOCATION

Harding Rock area, San Francisco Bay

SHEET NO. 1 OF 1

SAMPLE DATE

1-20-94

VESSEL

R.V. Questuary

COORDINATES

N 2,132,739 E 5,999,068

ELEVATION (below MLLW)

-89

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

-89.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

GC

2.0'

bag
sample

-89.1

...

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

Harding Rock area San Francisco Bay

HOLE NO.

AHS-47S



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

-73.0

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

-50.0

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.

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

SAMPLER

MEC, Inc.

SITE and LOCATION

Alcatraz Shoal, San Francisco Bay

SHEET NO. 1 OF 1

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	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).	(Template: SEA) 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
			-58.0	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

Alcatraz Shoal San Francisco Bay

HOLE NO.

AHS-50B





GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-51S

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 2,128,512 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	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

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 2,128,504 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				0.0 - 1.3 ft: SAND, Greenish black, fine grained, well sorted, ~10% mud content, gradational contact.	Gravity core dropped from water surface and allowed to free-fall to bottom. Torvane reading at 0.1' = <0.5 tons/sq.ft.
				0.5				Torvane reading at 0.5' = <0.5 tons/sq.ft.
				1.0				
			-65.3				1.3 - 1.5 ft: Muddy Sand, Grayish black, fine grained, 0.5 x 3" x 1/8" thick black wood fragment.	Torvane reading at 1.4' = 1.0 tons/sq.ft.
			-65.5	1.5				
								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

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

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

SHEET NO. 1 OF 1

SAMPLER

MEC, Inc.

SITE and LOCATION

East of Alcatraz Island, San Francisco Bay

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

-104.0

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

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 2,127,996 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

-82.0

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.

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

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 2,128,323 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	Remarks
GC	3.0'	2.1'	-100.0				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				
			-102.1	1.0				
				1.5			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'.	
				2.0				
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.	
NE of Disposal Site San Francisco Bay							AHS-57S	

 GEOLOGIC LOG		PROJECT and JOB NUMBER <i>Alcatraz Habitat Study</i> 21845-004		HOLE NO. AHS-58B				
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 2,125,621 E 6,005,742		ELEVATION (below MLLW) -65				
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'	-65.0	0.5			Box core sample: SAND, Moderate brown, medium to coarse grained, little fines (clean), with gravel and shell fragments.	(Template: SEA) 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
			-66.0	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-58B

 GEOLOGIC LOG		PROJECT and JOB NUMBER <i>Alcatraz Habitat Study</i> 21845-004		HOLE NO. AHS-59B 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 2,126,027 E 6,005,670		ELEVATION (below MLLW) -89	
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'	-89.0	0.5	Box core sample: Sandy MUD, Black, soft, sand is very fine to very coarse grained, some shell fragments and gravel.
			-90.0	1.0	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
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

-18.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-1.0'

-18.0

Depth in Feet

Lithology

Sample

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

-19.0

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-60B



GEOLOGIC LOG

PROJECT and JOB NUMBER

Alcatraz Habitat Study

21845-004

HOLE NO.

AHS-61B

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 2,127,002 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

-84.0

Depth in Feet

Lithology

Sample

Lithologic Description

(Template: SEA)

Remarks

BX

2.0'

-1.0'

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

STATION 1B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Ampharete labrops</i>	2
<i>Armandia brevis</i>	15
<i>Autolytus</i> sp.	1
<i>Capitella capitata</i>	6
<i>Caulleriella</i> nr. <i>hamata</i>	1
<i>Chone minuta</i>	2
<i>Cossura</i> sp.	1
<i>Eunoe</i> sp.	1
<i>Glycera americana</i>	3
<i>Glycera robusta</i>	1
<i>Glycinde picta</i>	8
<i>Heteromastus</i> sp.	1
<i>Lumbrineris inflata</i>	1
<i>Lumbrineris</i> sp.	1
<i>Mediomastus</i> spp.	5
<i>Sabaco elongata</i>	2
<i>Sigambra tentaculata</i>	10
<i>Sphaerosyllis californiensis</i>	1
<i>Spiophanes missionensis</i>	2
Tubificidae	1
CRUSTACEA	
<i>Balanus</i> spp.	2
<i>Callianassa (Neotrypaea)</i> sp.	1
<i>Corophium</i> sp.	1
<i>Foxiphalus obtusidens</i>	2
<i>Leptochelia</i> spp.	4
<i>Melita dentata</i>	21
<i>Pinnixa franciscana</i>	20
<i>Scleroplax granulata</i>	9
<i>Sphaeroma pentodon</i>	1
<i>Upogebia</i> sp.	1
ECHINODERMATA	
<i>Amphiodia urtica</i>	1
Ophiuroidea	4
MOLLUSCA	
<i>Cryptomya californica</i>	2
<i>Gemma gemma</i>	20

Planorbis abn-
 spec. 10-15
 for this reference

STATION 1B	
SPECIES	ABUNDANCE PER SAMPLE
MOLLUSCA	
<i>Macoma</i> spp.	8
Mytilidae	2
<i>Petricola</i> spp.	2
<i>Protothaca staminea</i>	12
OTHERS	
<i>Carinoma mutabilis</i>	1
Ctenostomata	1
Lineidae	16
Nematoda	68

STATION 10B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Hemipodus borealis</i>	1
<i>Magelona pitelkai</i>	3
<i>Mediomastus</i> sp.	1
CRUSTACEA	
<i>Photis californica</i>	1
OTHERS	
Lineidae	1

STATION 15B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Spiophanes missionensis</i>	1
CRUSTACEA	
<i>Foxiphalus obtusidens</i>	1
ECHINODERMATA	
<i>Amphiodia</i> sp.	1

STATION 15B	
SPECIES	ABUNDANCE PER SAMPLE
MOLLUSCA	
<i>Amygdalum pallidulum</i>	1
<i>Mya arenaria</i>	1
OTHERS	
Nemertea	1
<i>Scrupocellaria</i> sp.	1

STATION 21B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Mediomastus</i> sp.	1
MOLLUSCA	
<i>Odostomia</i> sp.	1

STATION 23B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Ampharete labrops</i>	1
<i>Armandia brevis</i>	18
<i>Eusyllis</i> spp.	1
<i>Glycinde picta</i>	2
<i>Lumbrineris</i> spp.	1
<i>Mediomastus</i> spp.	6
<i>Phyllodoce longipes</i>	2
<i>Sabellaria cementarium</i>	2
<i>Schistomeringos longicornis</i>	1
<i>Spiophanes missionensis</i>	1
<i>Streptosyllis</i> sp. B	1

STATION 23B	
SPECIES	ABUNDANCE PER SAMPLE
CRUSTACEA	
<i>Balanus</i> sp.	1
<i>Cancer anthonyi</i>	2
<i>Foxiphalus obtusidens</i>	1
<i>Melita dentata</i>	6
ECHINODERMATA	
<i>Amphiodia</i> spp.	2
MOLLUSCA	
<i>Acanthodoris</i> sp.	1
<i>Cephalaspidea</i>	1
<i>Macoma</i> sp.	1
OTHERS	
<i>Carinoma mutabilis</i>	1
<i>Epiactis prolifera</i>	1
Lineidae	5
<i>Tubulanus polymorphus</i>	1

STATION 37B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Amaeana occidentalis</i>	2
<i>Apoprionospio pygmaea</i>	2
<i>Armandia brevis</i>	31
<i>Cirriformia spirabranca</i>	1
<i>Eteone leptotes</i>	2
<i>Euchone limnicola</i>	2
<i>Glycinde picta</i>	4
<i>Leitoscoloplos pugettensis</i>	1
<i>Lumbrineris tetraura</i>	2
<i>Mediomastus</i> spp.	79
<i>Nephtys caecoides</i>	1
<i>Nephtys cornuta franciscana</i>	4
<i>Notomastus</i> sp.	1

STATION 37B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Onuphis</i> sp. A	1
<i>Pholoe minuta</i>	1
<i>Prionospio</i> sp. A	1
<i>Sigambra tentaculata</i>	1
<i>Spiophanes missionensis</i>	207
<i>Streptosyllis</i> sp. B	2
<i>Tharyx</i> sp.	1
Tubificidae	17
CRUSTACEA	
Calanoida	1
<i>Cancer gracilis</i>	1
<i>Cancer</i> spp.	2
<i>Foxiphalus obtusidens</i>	1
<i>Photis</i> sp.	1
ECHINODERMATA	
<i>Amphiodia digitata</i>	3
MOLLUSCA	
<i>Gemma gemma</i>	1
<i>Nassarius mendicus</i>	1
<i>Philine</i> spp.	2
<i>Protothaca staminea</i>	2
<i>Tellina modesta</i>	4
<i>Transennella tantilla</i>	7,800
OTHERS	
<i>Aglaophenia</i> sp.	1
<i>Anquinella palmata</i>	1
<i>Carinoma mutabilis</i>	1
Ctenostomata	1
<i>Glottidia albida</i>	1
Lineidae	7
Nemotoda	91
<i>Tubulanus polymorphus</i>	1
<i>Watersipora cucullata</i>	1

STATION 39B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Notomastus</i> sp.	1
<i>Sigambra tentaculata</i>	1
<i>Spiophanes missionensis</i>	20
Tubificidae	4
OTHERS	
Ctenostomata	1
Lineidae	1
Phoronida	2
<i>Watersipora cucullata</i>	1

STATION 50B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Hemipodus borealis</i>	5
<i>Pisione remota</i>	6
<i>Saccocirrus</i> spp.	11
<i>Spiophanes missionensis</i>	1

STATION 58B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Acmira catherinae</i>	1
Goniadidae	1
<i>Hemipodus borealis</i>	1
<i>Myriochele</i> sp. M	1
ECHINODERMATA	
Holothuroidea	1

STATION 59B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Glycera americana</i>	3
<i>Heteromastus</i> sp.	1
<i>Mediomastus</i> sp.	1
<i>Nereis latescens</i>	1
<i>Spiophanes missionensis</i>	1
CRUSTACEA	
<i>Cancer gracilis</i>	1
<i>Cancer</i> sp.	1
<i>Corophium</i> spp.	16
<i>Melita dentata</i>	3
OTHERS	
Lineidae	1

STATION 60B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Hesionura coineaui difficilis</i>	1
<i>Streptosyllis</i> sp. B	1
Tubificidae	1
CRUSTACEA	
<i>Rhepoxynius stenodes</i>	1
MOLLUSCA	
<i>Alvania compacta</i>	1
<i>Gemma gemma</i>	1
OTHERS	
<i>Aglaophenia</i> sp.	1
<i>Anquinella palmata</i>	1
Lineidae	1
<i>Watersipora cucullata</i>	1

STATION 61B	
SPECIES	ABUNDANCE PER SAMPLE
ANNELIDA	
<i>Ampharete labrops</i>	2
<i>Armandia brevis</i>	171
<i>Cauelleriella nr. hamata</i>	2
<i>Chone minuta</i>	2
Cirratulidae	1
<i>Diopatra ornata</i>	1
<i>Eusyllis</i> spp.	7
<i>Exogone lourei</i>	1
<i>Glycera americana</i>	2
<i>Harmothoe imbricata</i>	1
<i>Lumbrineris</i> spp.	2
<i>Lumbrineris tetraura</i>	1
Nereidae	1
<i>Nereis latescens</i>	1
<i>Notomastus</i> spp.	2
<i>Paleanotus bellis</i>	3
<i>Phyllodoce longipes</i>	1
<i>Polydora</i> sp.	1
<i>Sabellaria alcocki</i>	1
Sabellidae	1
<i>Streptosyllis</i> sp. B	1
CRUSTACEA	
<i>Caprella californica</i>	1
<i>Dulichia</i> sp.	1
<i>Erichthonius</i> sp.	1
<i>Gammaropsis thompsoni</i>	5
<i>Jaeropsis dubia</i>	1
<i>Leptochelia</i> spp.	4
<i>Melita dentata</i>	6
<i>Photis brevipes</i>	21
<i>Pinnixa franciscana</i>	1
<i>Pycnogonum rickettsi</i>	4
ECHINODERMATA	
<i>Amphiodia</i> sp.	1
<i>Amphiodia urtica</i>	3
Ophiuroidea	7

STATION 61B	
SPECIES	ABUNDANCE PER SAMPLE
MOLLUSCA	
<i>Acanthodoris</i> sp.	1
<i>Alia carinata</i>	6
<i>Gemma gemma</i>	12
<i>Macoma</i> spp.	4
<i>Mysella</i> sp. A	2
Mytilidae	7
<i>Nitidiscala</i> spp.	2
<i>Okenia plana</i>	2
<i>Protothaca staminea</i>	3
OTHERS	
<i>Anquinella palmata</i>	1
Ctenostomata	1
<i>Emplectonema gracile</i>	1
<i>Epiactis prolifera</i>	7
Lineidae	10
Nematoda	139
<i>Nephasoma</i> spp.	5
<i>Tubulanus polymorphus</i>	6
<i>Watersipora cucullata</i>	1

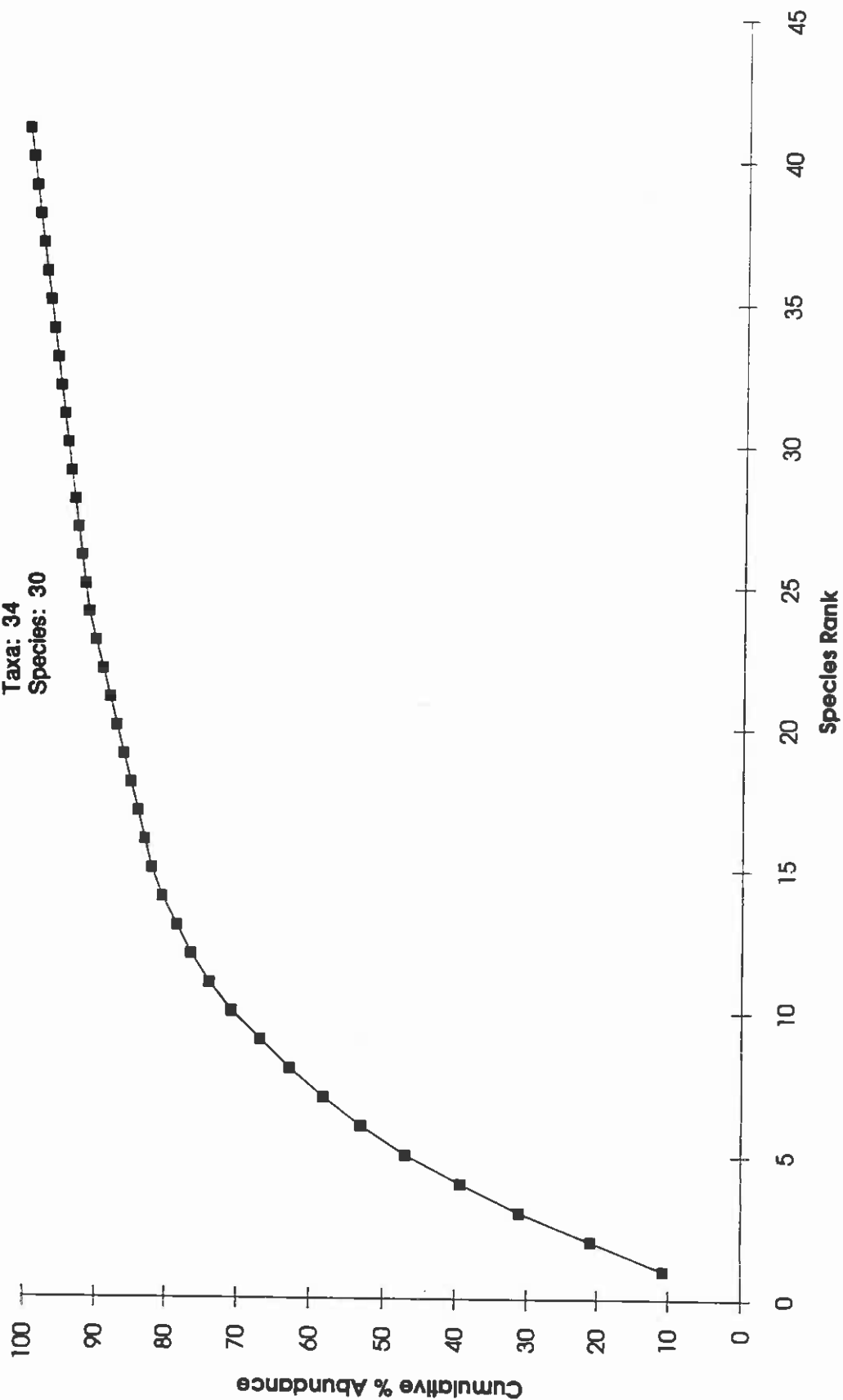
Appendix C: Cumulative Abundance Curves

Replicate k Dominance Curves: Station 1B

Dredged Material

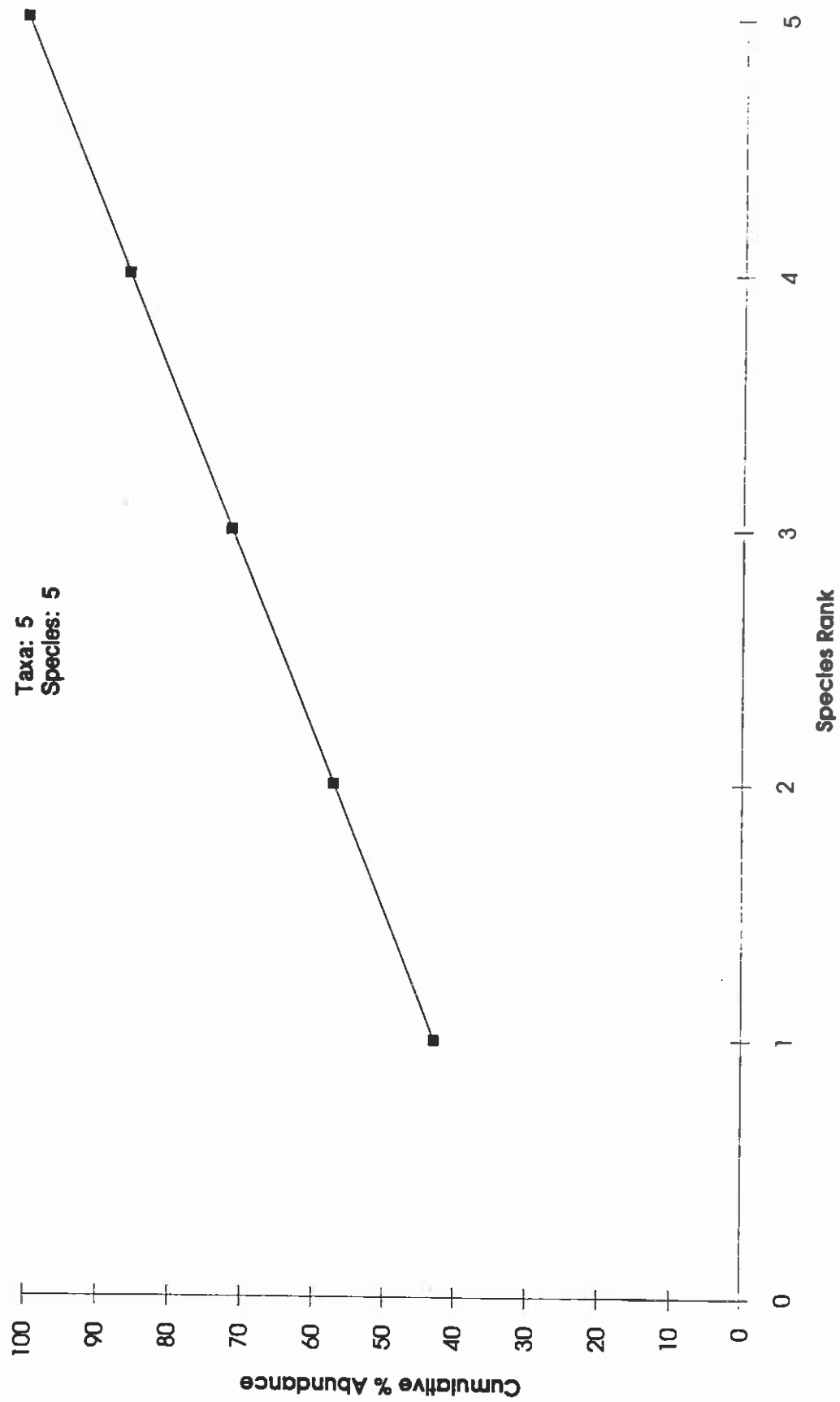
Taxa: 34

Species: 30



Replicate k Dominance Curve: Station 10B
Dredged Material

Taxa: 5
Species: 5

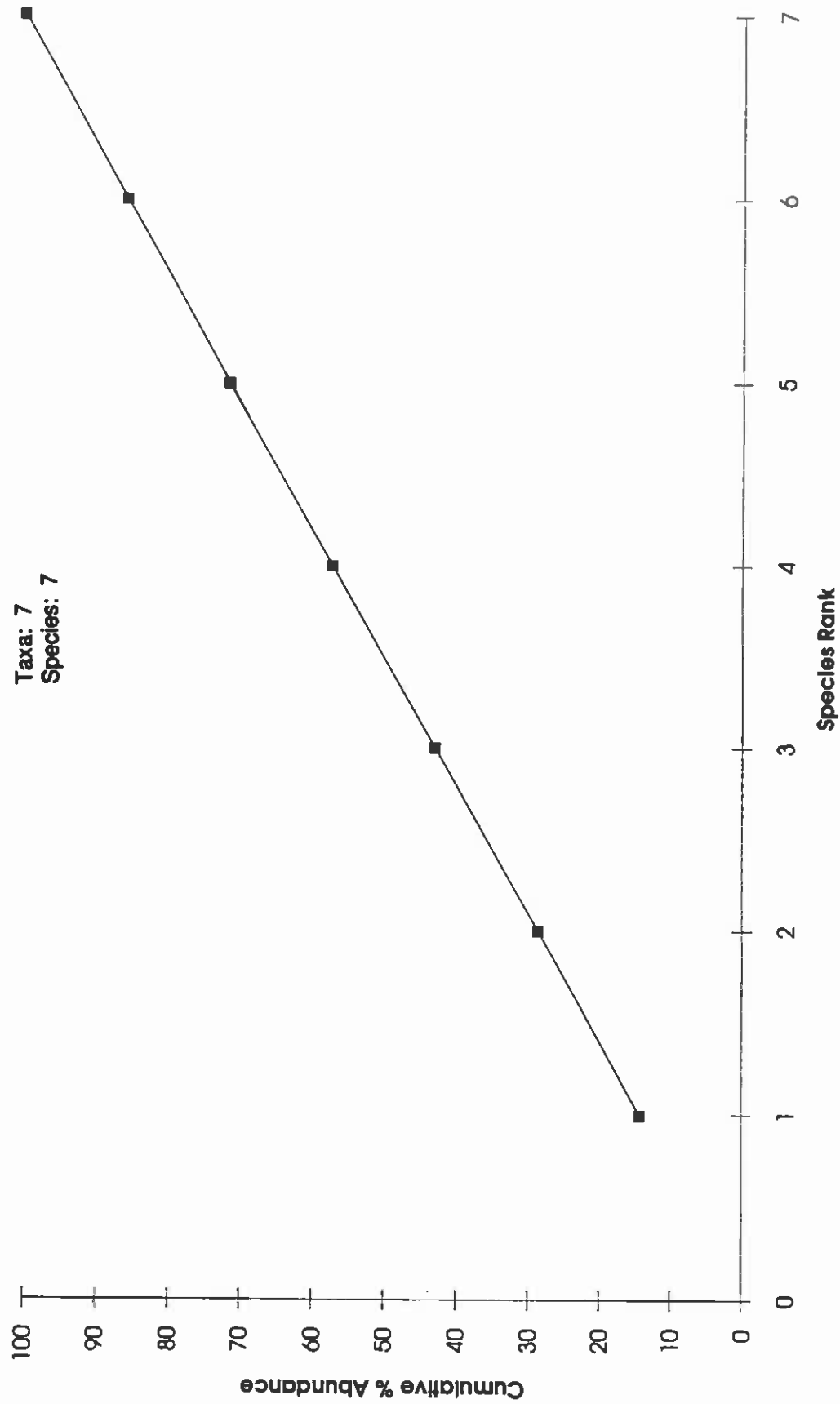


Replicate k Dominance Curve: Station 15B

Dredged Material

Taxa: 7

Species: 7

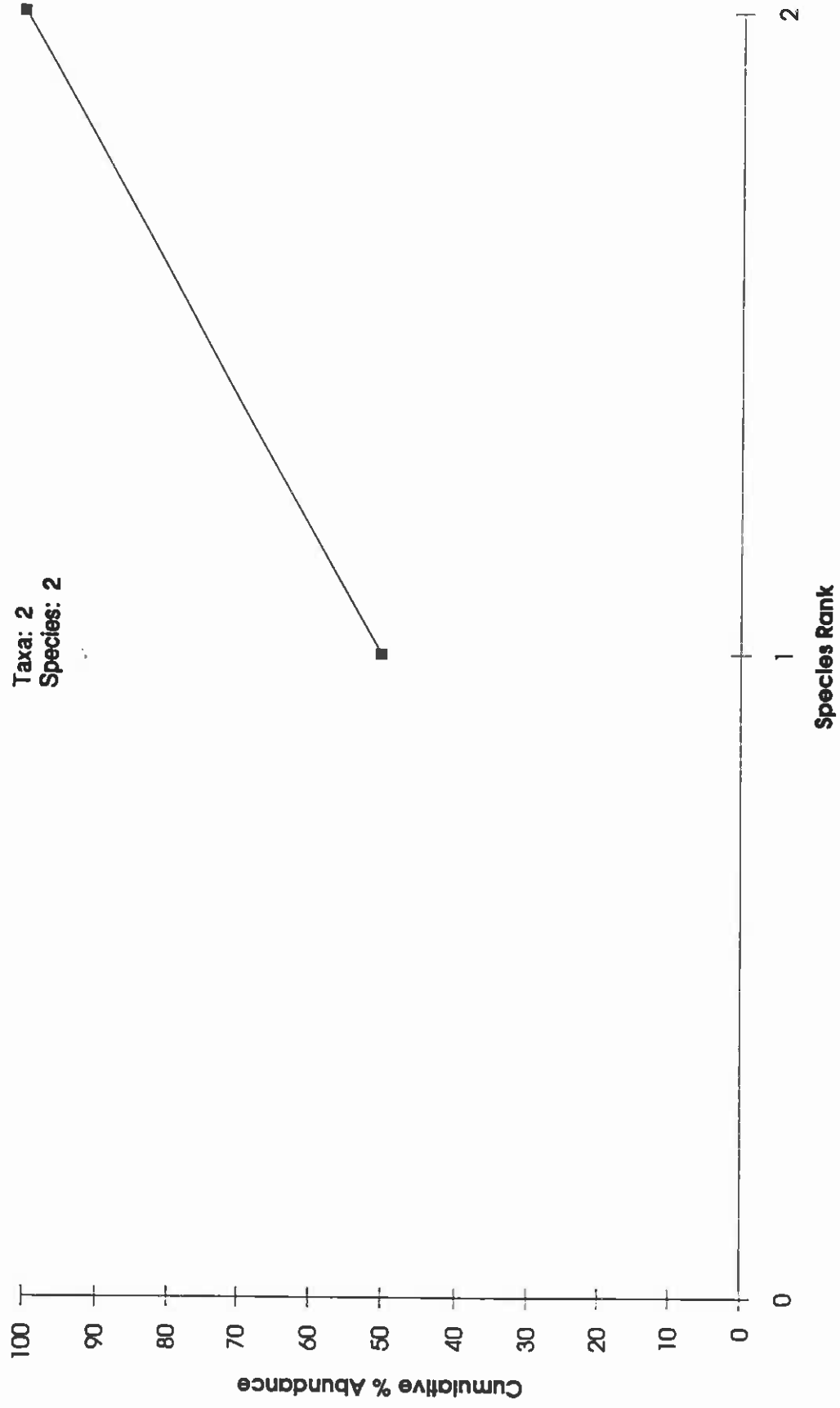


Replicate k Dominance Curve: Station 21B

Native Sands

Taxa: 2

Species: 2

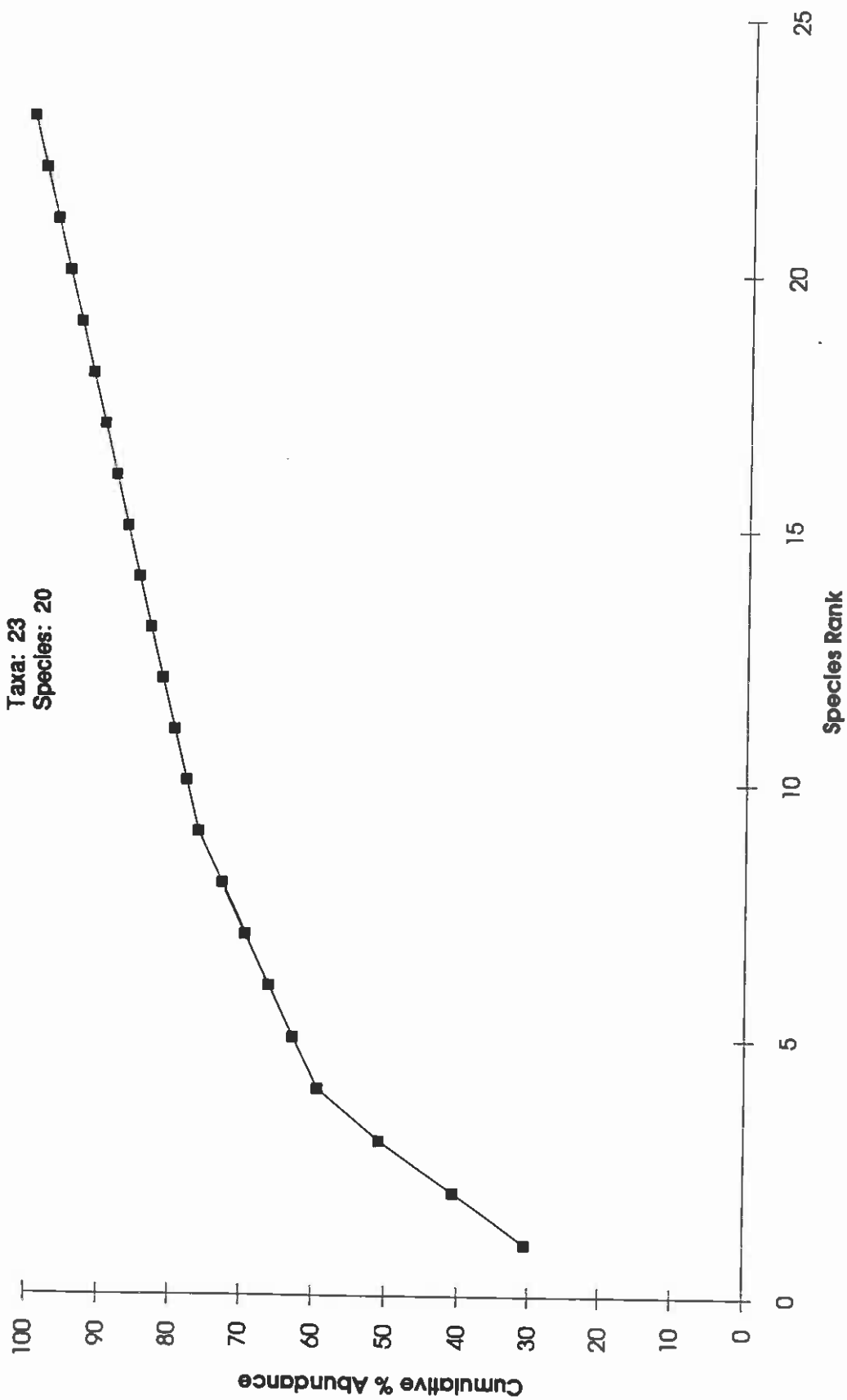


Replicate k Dominance Curve: Station 23B

Native Sands

Taxa: 23

Species: 20

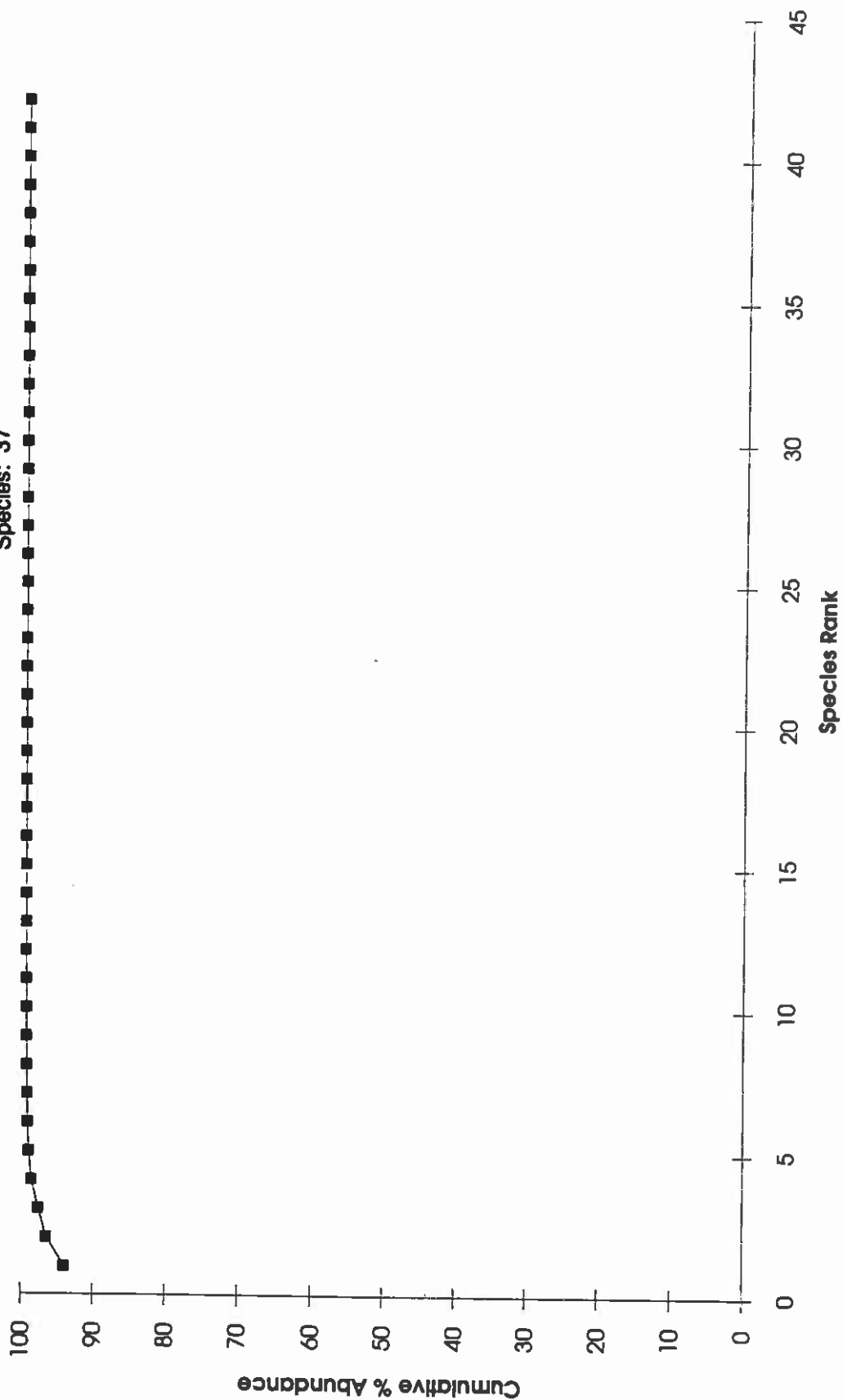


Replicate k Dominance Curve: Station 37B

Native Sands

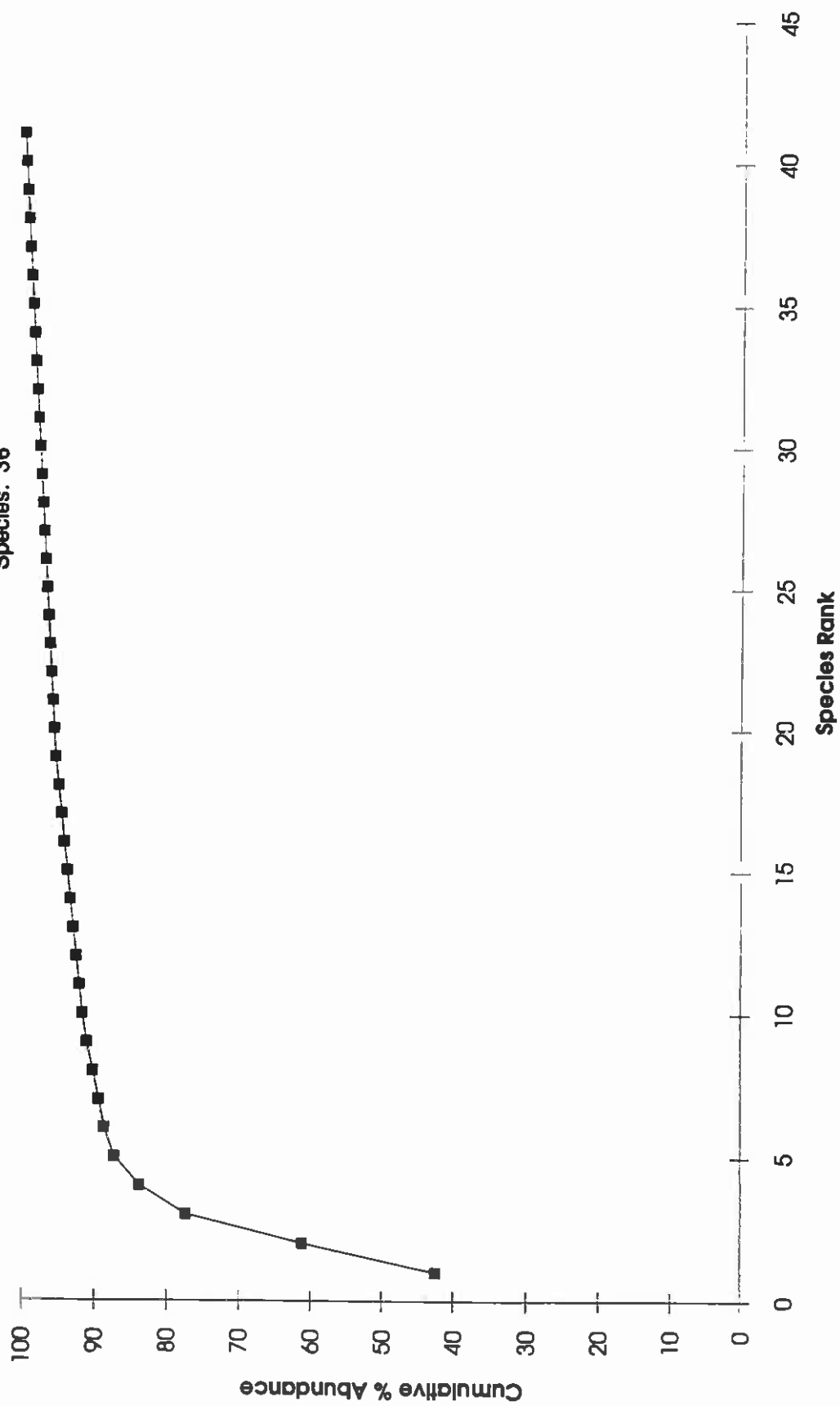
Taxa: 43

Species: 37



Replicate k Dominance Curve: Station 37B (Alt)

Native Sand
Taxa: 42
Species: 36

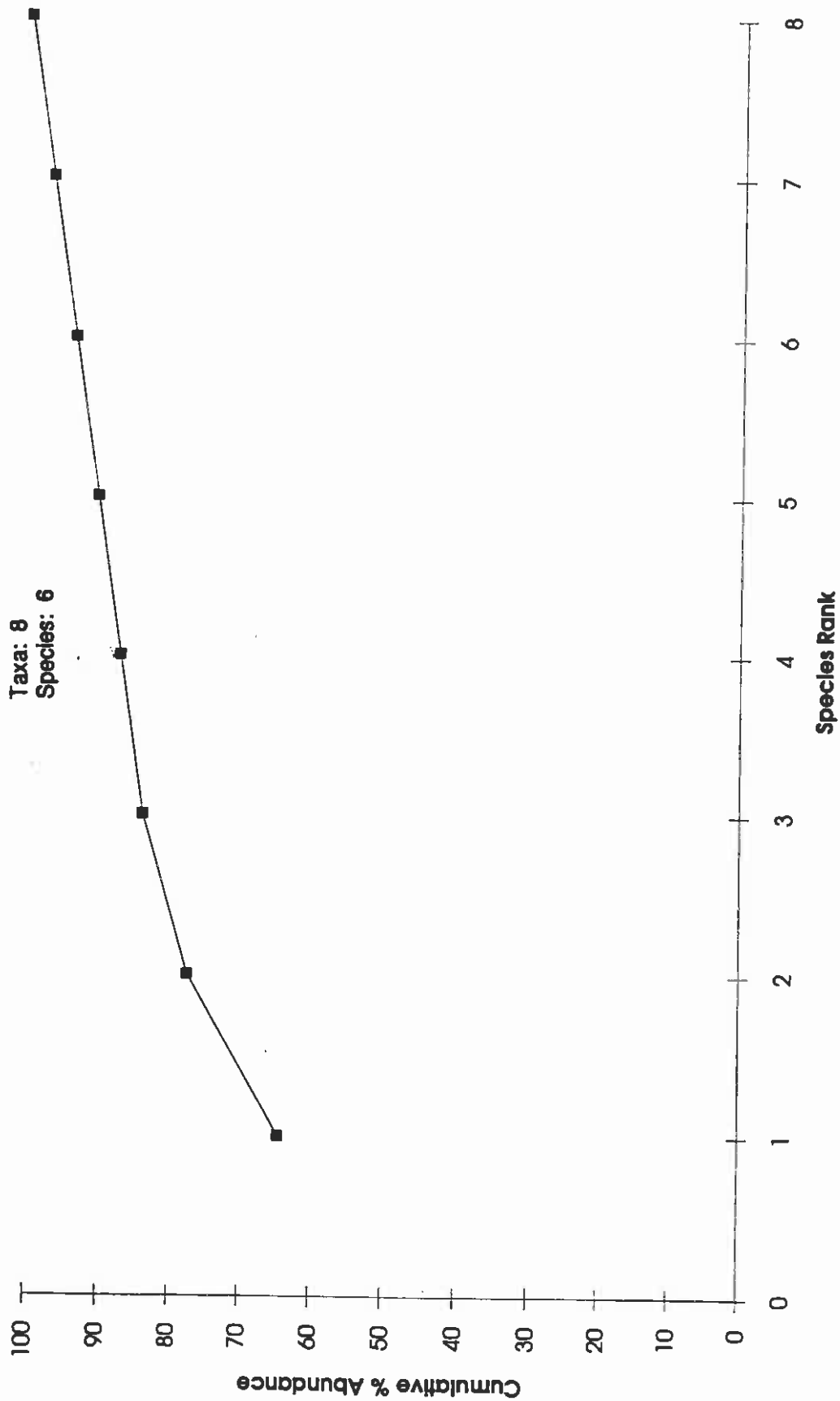


Replicate k Dominance Curve: Station 398

Dredged Material

Taxa: 8

Species: 6

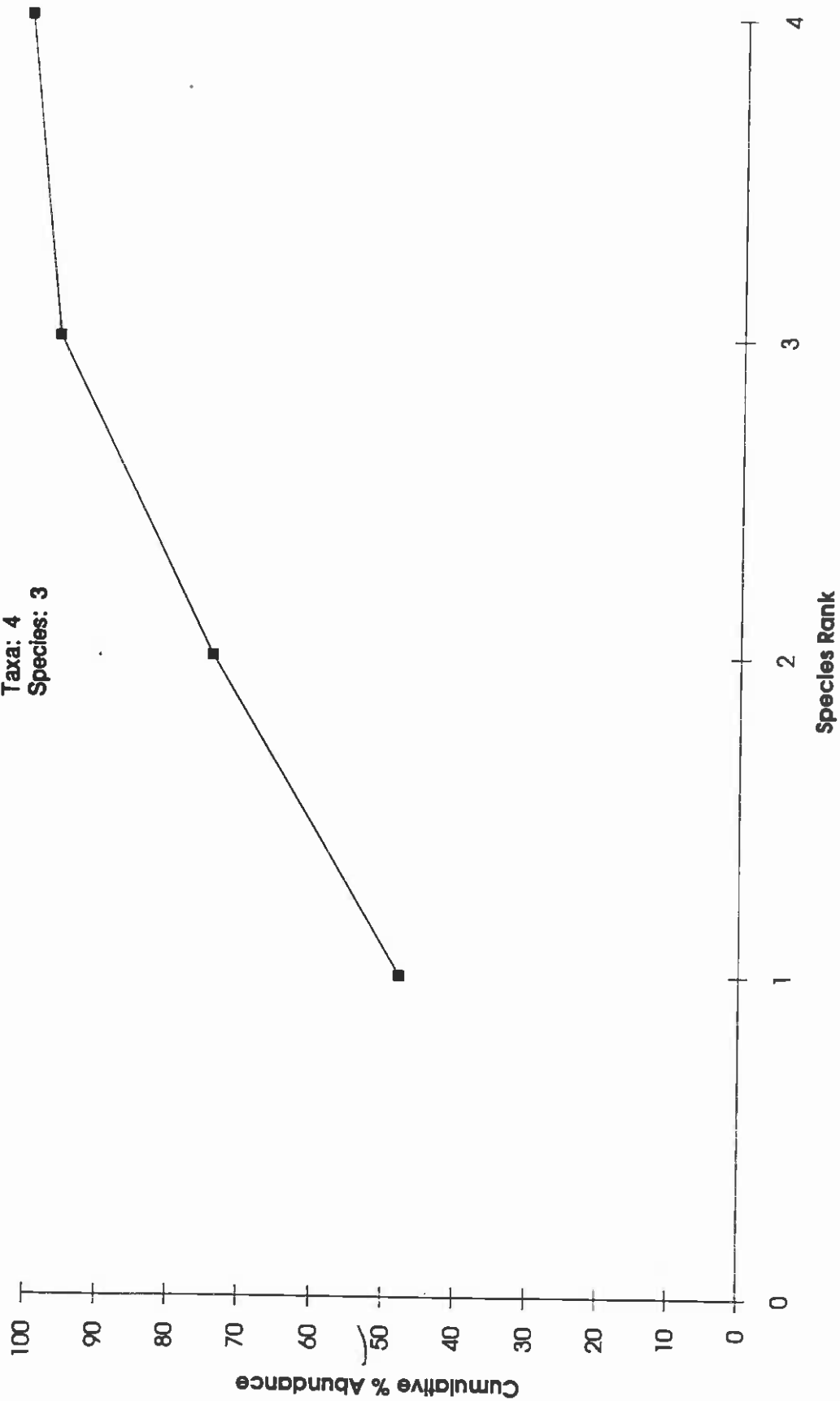


Replicate k Dominance Curve: Station 50B

Native Sands

Taxa: 4

Species: 3

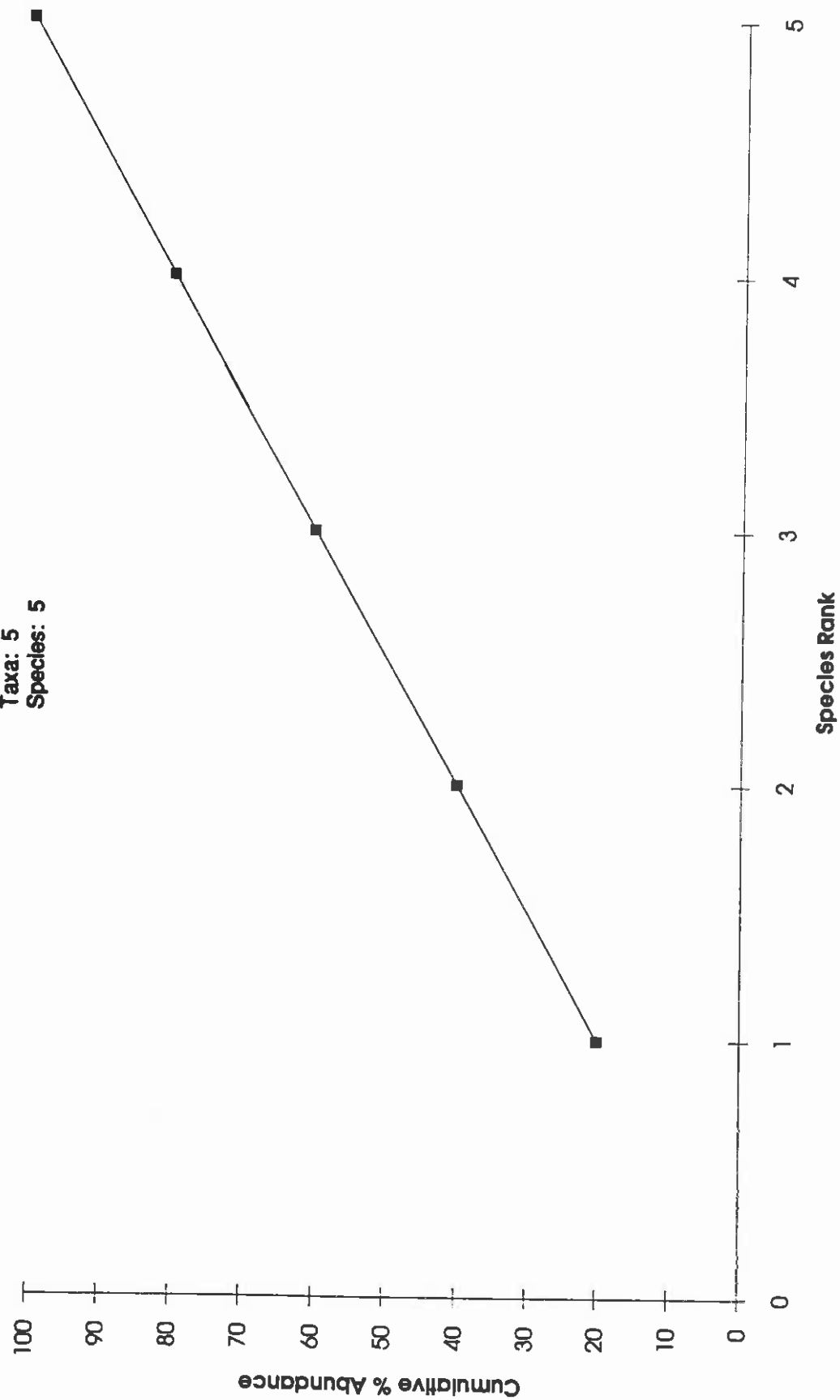


Replicate k Dominance Curve: Station 58B

Native Sands

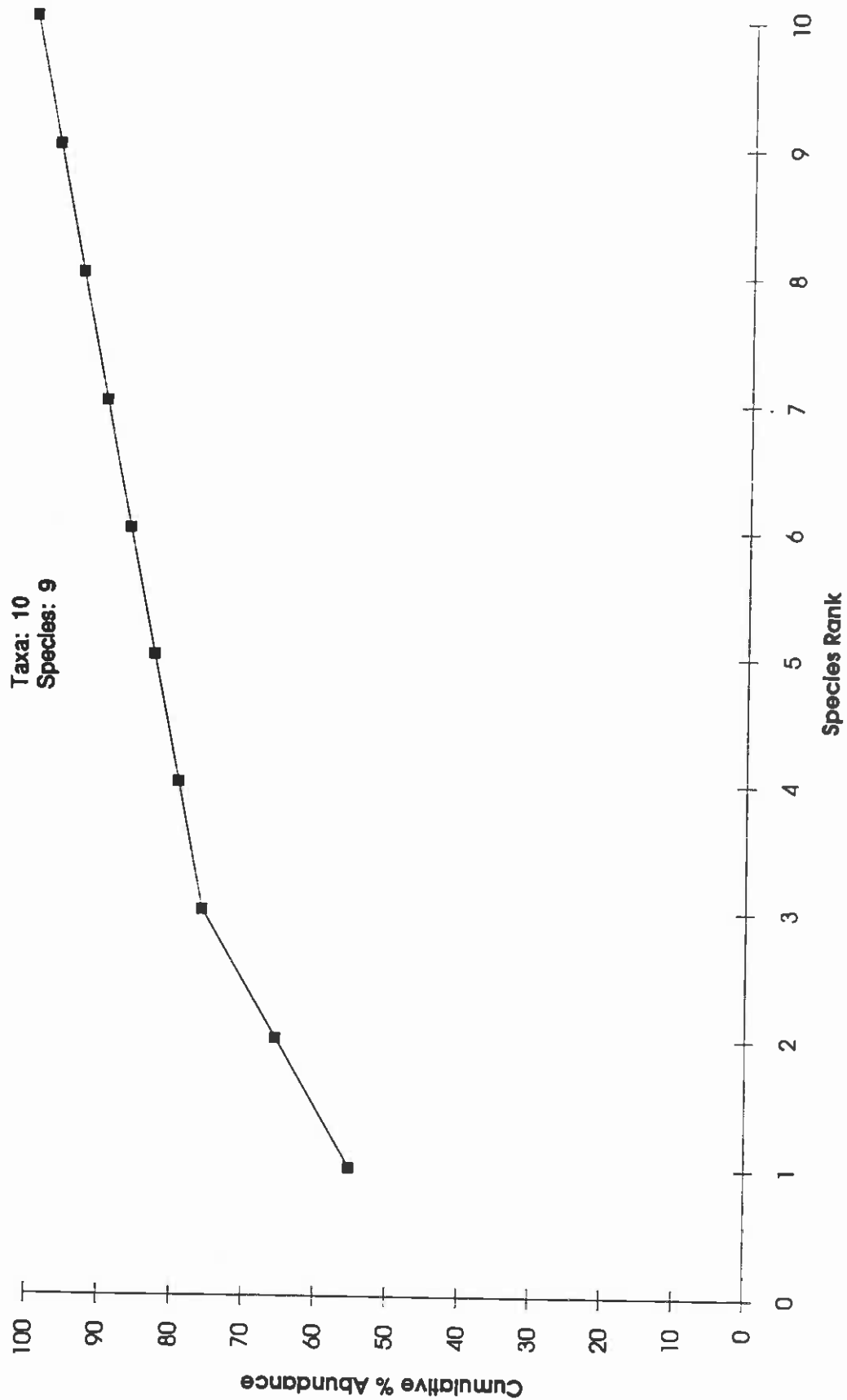
Taxa: 5

Species: 5



Replicate k Dominance Curve: Station 598
Dredged Material

Taxa: 10
Species: 9

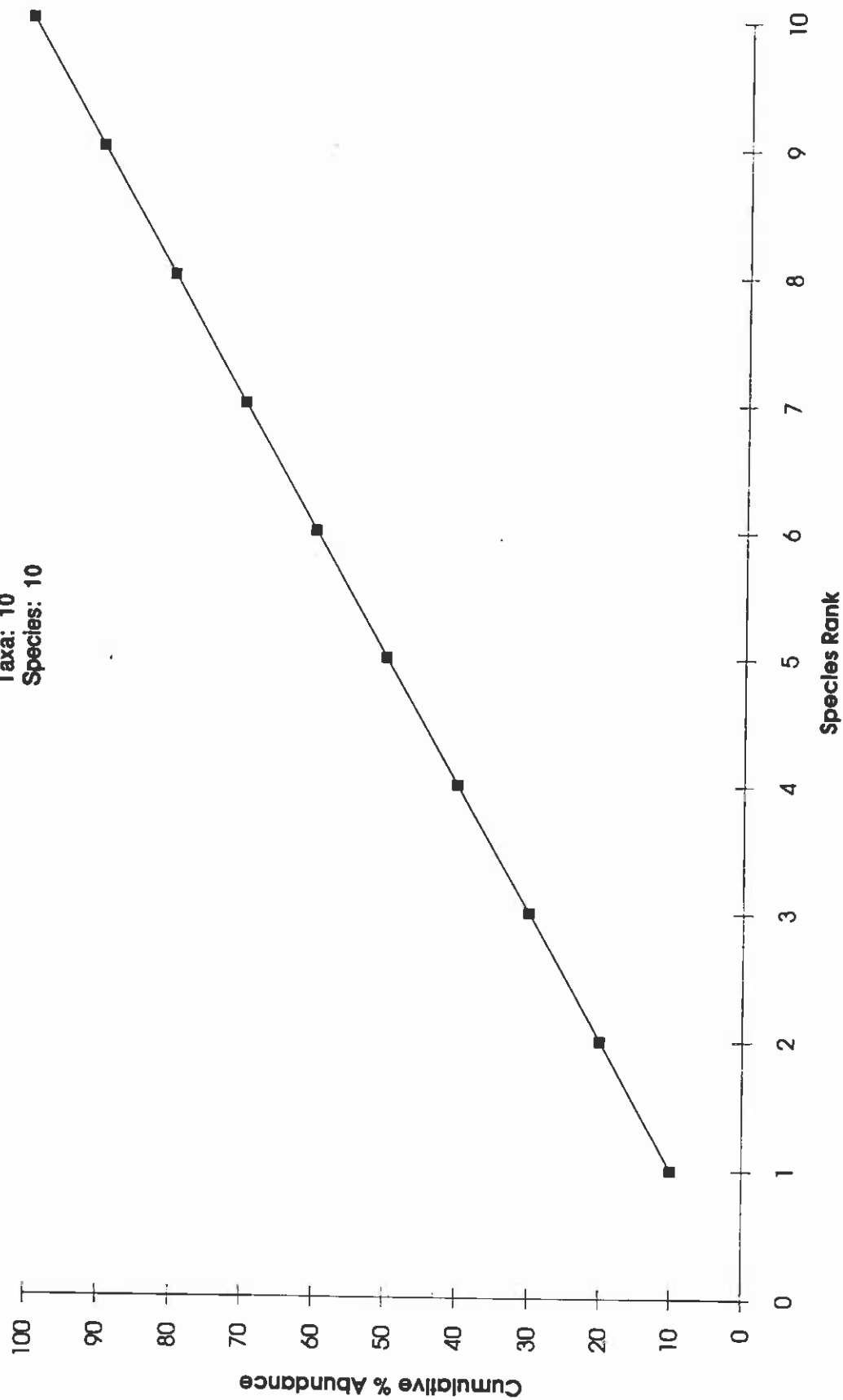


Replicate k Dominance Curve: Station 60B

Native Sands

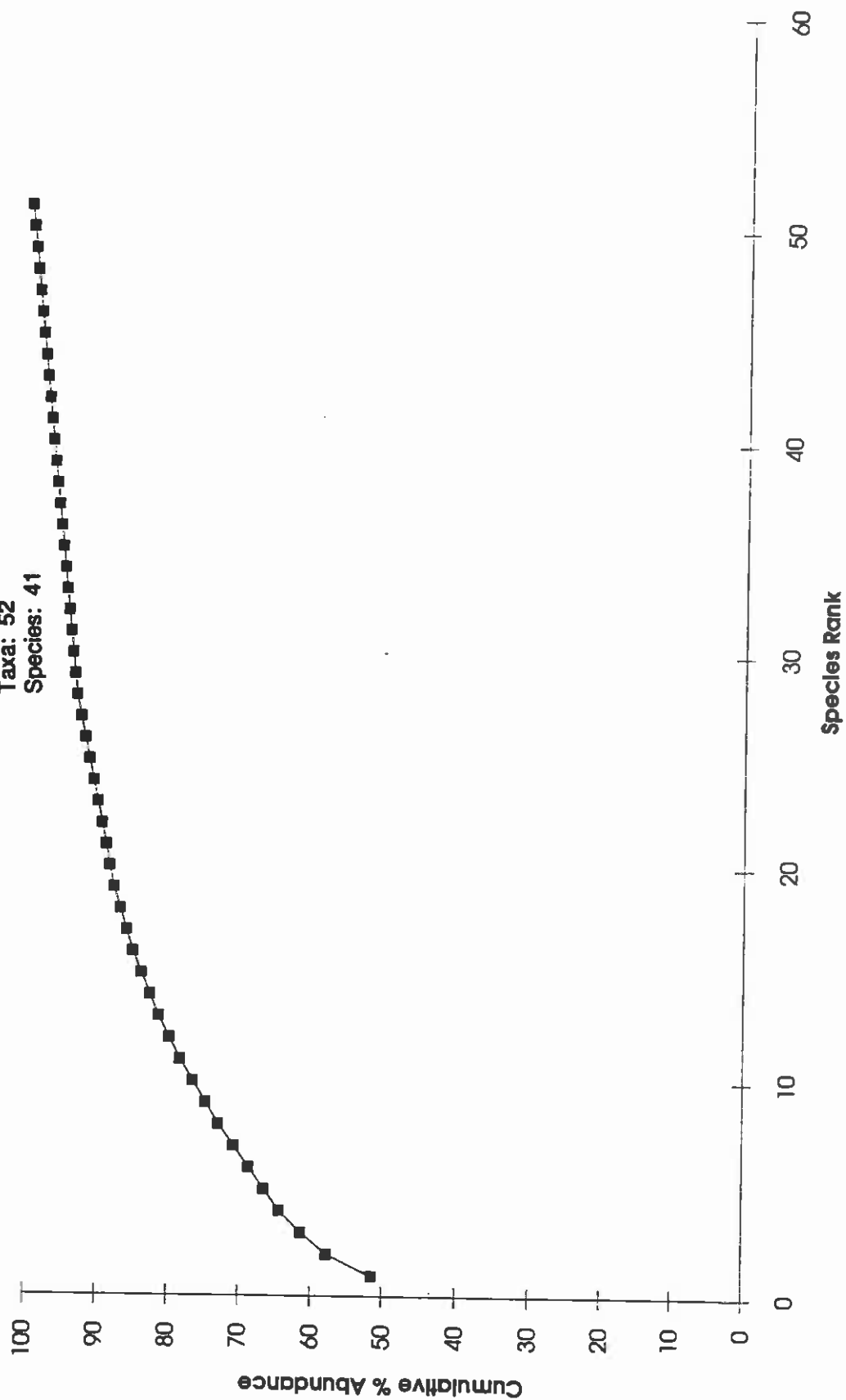
Taxa: 10

Species: 10



Replicate k Dominance: Station 61B
Dredged Material

Taxa: 52
Species: 41



Appendix D: Organic Carbon Analysis

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		Weight		Cumulative	
Microns	Phi	grams	Percent	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 ***

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 10B
 Total sample weight: 31.639 grams

Size	Phi	Weight grams	Percent	Cumulative 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	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	1.308	5.131	5.131
1414.214	-0.5	0.152	0.596	5.727
1000.000	0.0	0.111	0.435	6.162
707.107	0.5	0.108	0.424	6.586
500.000	1.0	0.210	0.824	7.410
353.553	1.5	3.674	14.412	21.822
250.000	2.0	3.586	14.067	35.888
176.777	2.5	2.891	11.340	47.229
125.000	3.0	0.859	3.370	50.598
88.388	3.5	0.190	0.745	51.344
62.500	4.0	0.227	0.890	52.234
31.250	5.0	0.974	3.819	56.054
15.625	6.0	1.826	7.161	63.215
7.812	7.0	1.095	4.297	67.512
3.906	8.0	1.379	5.411	72.923
1.953	9.0	0.893	3.501	76.424
< 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	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	1.551	5.925	5.925
1414.214	-0.5	0.190	0.726	6.651
1000.000	0.0	0.128	0.489	7.140
707.107	0.5	0.087	0.332	7.472
500.000	1.0	0.221	0.844	8.317
353.553	1.5	1.423	5.436	13.753
250.000	2.0	5.797	22.146	35.899
176.777	2.5	2.638	10.078	45.977
125.000	3.0	1.033	3.946	49.923
88.388	3.5	0.169	0.646	50.569
62.500	4.0	0.235	0.898	51.466
31.250	5.0	1.623	6.199	57.666
15.625	6.0	1.907	7.284	64.950
7.812	7.0	1.663	6.354	71.305
3.906	8.0	1.014	3.875	75.179
1.953	9.0	1.014	3.875	79.054
< 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 ***

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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 21B
 Total sample weight: 33.201 grams

Size	Weight	Cumulative
Microns	grams	Percent
Phi	Percent	Percent
2000.000	0.020	0.060
1414.214	0.018	0.114
1000.000	0.037	0.226
707.107	0.060	0.407
500.000	0.168	0.913
353.553	7.359	23.078
250.000	8.725	49.357
176.777	11.362	83.579
125.000	3.234	93.320
88.388	0.199	93.919
62.500	0.025	93.995
31.250	0.041	94.117
15.625	0.162	94.606
7.812	0.081	94.850
3.906	0.041	94.972
1.953	0.041	95.094
< 1.953	> 9.0	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

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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 23B
 Total sample weight: 29.976 grams

Size	Weight	Cumulative
Microns	grams	Percent
2000.000	5.525	18.432
1414.214	0.910	21.467
1000.000	0.727	23.893
707.107	0.446	25.380
500.000	0.594	27.362
353.553	1.566	32.586
250.000	4.226	46.684
176.777	4.592	62.003
125.000	3.761	74.550
88.388	0.610	76.585
62.500	0.400	77.919
31.250	0.974	81.168
15.625	0.730	83.604
7.812	0.365	84.822
3.906	0.527	86.581
1.953	0.730	89.018
< 1.953	3.292	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
Microns				
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	Phi	Weight grams	Percent	Cumulative Percent
2000.000	-1.0	0.009	0.028	0.028
1414.214	-0.5	0.004	0.012	0.040
1000.000	0.0	0.004	0.012	0.053
707.107	0.5	0.011	0.034	0.087
500.000	1.0	0.042	0.130	0.217
353.553	1.5	0.782	2.425	2.642
250.000	2.0	2.415	7.488	10.130
176.777	2.5	14.308	44.363	54.493
125.000	3.0	11.604	35.979	90.472
88.388	3.5	1.061	3.290	93.761
62.500	4.0	0.140	0.434	94.195
31.250	5.0	0.081	0.252	94.447
15.625	6.0	0.162	0.503	94.950
7.812	7.0	0.041	0.126	95.076
3.906	8.0	0.203	0.629	95.705
1.953	9.0	0.041	0.126	95.831
< 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	Phi	grams	Percent	Percent
2000.000	-1.0	1.172	3.561	3.561
1414.214	-0.5	0.521	1.583	5.144
1000.000	0.0	1.007	3.059	8.203
707.107	0.5	3.300	10.026	18.229
500.000	1.0	10.764	32.703	50.932
353.553	1.5	13.507	41.037	91.969
250.000	2.0	1.367	4.153	96.123
176.777	2.5	0.577	1.753	97.876
125.000	3.0	0.207	0.629	98.505
88.388	3.5	0.034	0.103	98.608
62.500	4.0	0.006	0.018	98.626
31.250	5.0	0.041	0.123	98.749
15.625	6.0	0.041	0.123	98.873
7.812	7.0	0.041	0.123	98.996
3.906	8.0	0.081	0.247	99.242
1.953	9.0	0.041	0.123	99.366
< 1.953	> 9.0	0.209	0.634	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 (Flumb, 1981)
 Sample Identification: Station 59B
 Total sample weight: 18.775 grams

Size	Weight	Cumulative
Microns	grams	Percent
2000.000	1.646	8.767
1414.214	0.273	10.221
1000.000	0.308	11.861
707.107	0.252	13.204
500.000	0.304	14.823
353.553	0.352	16.697
250.000	0.614	19.968
176.777	0.543	22.860
125.000	0.463	25.326
88.388	0.251	26.663
62.500	0.213	27.797
31.250	0.811	32.119
15.625	0.893	36.873
7.812	2.799	51.782
3.906	0.041	51.998
1.953	8.073	94.999
< 1.953	0.939	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	Phi	Weight grams	Percent	Cumulative 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	Phi	Weight grams	Percent	Cumulative Percent
Microns				
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 E: Grain Size 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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