BASELINE STUDIES AND EVALUATION OF THE PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF NEARSHORE DREDGE SPOIL DISPOSAL, PEARL HARBOR, HAWAII

FINAL SUMMARY REPORT
May 19, 1978

Prepared for
Pacific Division Naval Facilities Engineering Command
Honolulu, Hawaii

Contract Number
N62742-76 C-0050

Submitted by
Environmental Center
University of Hawaii

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INTRODUCTION

The environmentally acceptable location for the disposal of dredge spoil is a matter of continuing concern particularly by those faced with the responsibility for maintenance of harbors, marinas, canals, and protected coastal embayments. The Corps of Engineers' nationwide Dredged Material Research Program (DMRP) is an example of the effort that has been, and continues to be provided at the national level to address the problems of dredge spoil disposal. Hawaii's unique geographical position and geological structure do not lend themselves readily to extrapolation of environmental considerations addressed and observed in many of these mainland dredge spoil disposal site studies. For the most part, disposal of sediments along the continental margins of the mainland involves disposal in shallow waters on the continental shelf, or at most the somewhat deeper continental borderland found off the Pacific coast. In either case, transportation time and the attendant costs necessitate disposal within a few miles offshore, at depths generally less than 40 fathoms and frequently depths less than 15 fathoms.

In contrast, the State of Hawaii, which rises abruptly from the deep sea floor, is characterized by exceedingly deep water within a few miles of most of the shoreline. Environmental considerations for the selection and evaluation of suitable offshore dredge spoil disposal sites must, therefore, be considered in terms of deep water (~200 fathoms) and oceanic conditions.

The rate of accumulation of sediment in Hawaiian harbors is such that major maintenance dredging is required approximately every ten years. Minor dredging of peripheral waterways, docking areas, etc., continues on a more regular, year-round basis. Since 1959, the following volumes of sediment have been removed from Pearl Harbor:

1959-1967	800,000 yd^3	(minor dredging)
1968-1969	3,100,000 yd^3	(major dredging)
1969-1976	315,000 yd^3	(minor dredging)
Total	4,215,000 yd^3	
1977	716,000 yd^3	(initial volume current major dredging)

Of the 4,215,000 cubic yards dredged from 1959-1976, 3,946,000 were dumped at a disposal site one nautical mile due south of the Pearl Harbor entrance channel buoy number 1 (Figure 1).

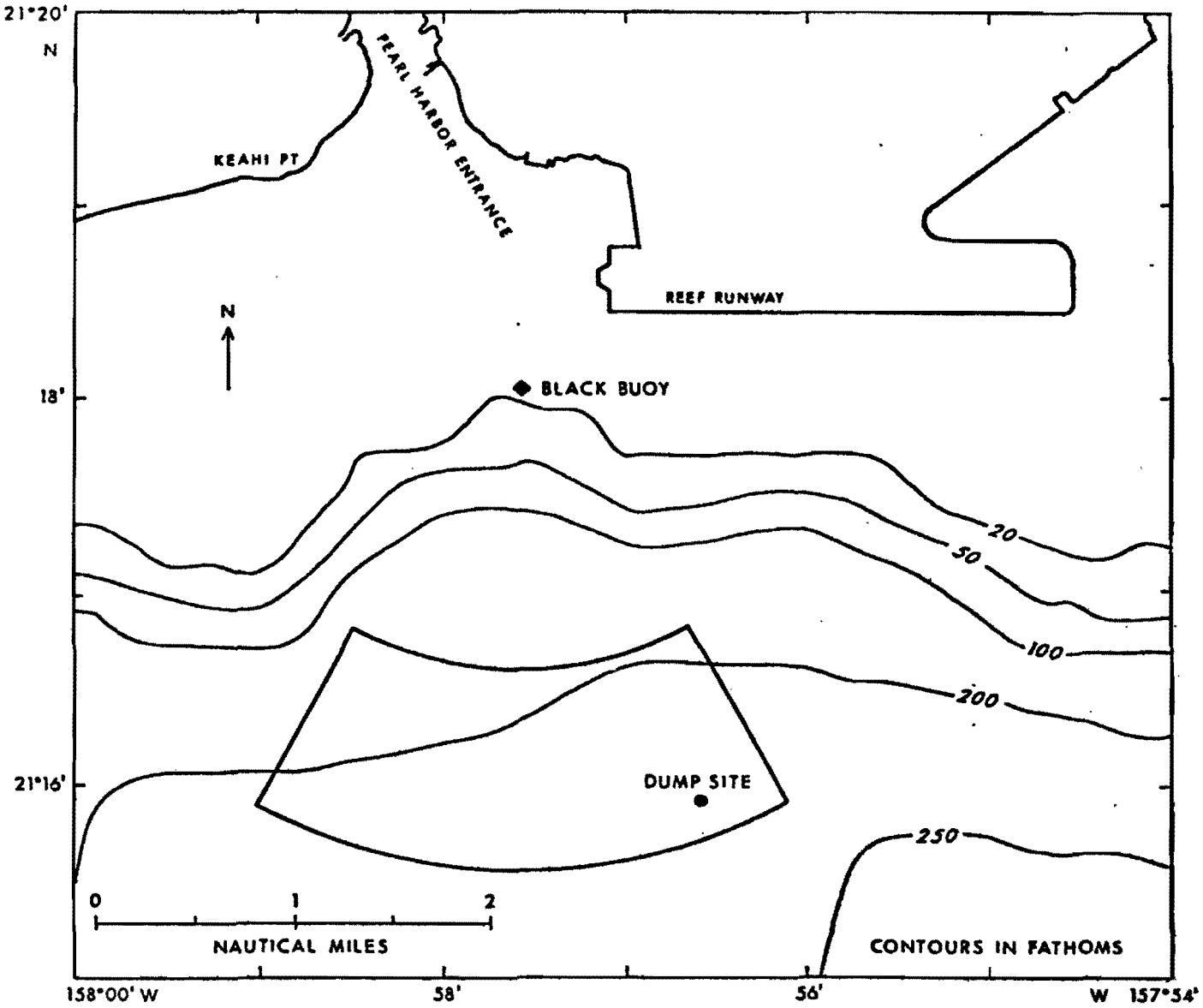

Figure 1. Location of study area.

The present study represents a major effort to evaluate the essentially unique environmental considerations required for the safe disposal of dredge spoil in deep, near-shore, coastal waters off of Pearl Harbor, Hawaii. The present study site (Figure 1) lies 1½ nautical miles south of the Pearl Harbor black entrance buoy and was initially proposed by the Navy on the basis of existing information on bottom types, physical and biological conditions, and proximity to the harbor entrance. The earlier disposal of almost 4,000,000 cubic yards of material at a site approximately one-half mile directly north of the disposal area with apparently minimal environmental effects also supported the proposed site selection.

The project as proposed, was conducted in three phases: Part A involved the collection of certain baseline data in the area originally proposed by the Navy. The data were analyzed in terms of identifying the existing water quality, benthic and pelagic biological communities, sediment characteristics and ocean current regimes. On the basis of the results obtained, the originally proposed area was recommended as a dredge spoil disposal site. The second phase of the study (Part B) addressed the actual dumping operations and included monitoring of the spoil on release and its distribution in the water column, on the bottom, and its immediate effects on the biota. The final phase (Part C) emphasized the longer term, postdisposal effects. Of particular concern during this phase was the horizontal extent of the spoil with time and any long-term effects on the biota.

It should be recognized that in the selection of any disposal site the environmental conditions must receive primary consideration. However, economic considerations cannot be ignored. If studies indicate similar, minimal, or no significant environmental concerns at two or more sites, then the economic considerations of transportation cost must surely be a major element in the final site selection.

The basic goal of the project, therefore, was to analyze and evaluate the environmental conditions in an offshore area to estimate the impacts on the marine environment of dredge spoil disposal.

The three phases of this study have been documented in detail separately as to their objectives, methods, results and conclusions. The purpose of this report is to provide a summarized general overview of the total project.

Field Methods

Field work was conducted off of several research vessels, including the Kana Keoki, Machias, Easy Rider, Valiant Maid and El Greco. Bottom sediment samples were obtained with Petersen and clam grab samplers. Coring with both gravity and modified piston cores was attempted but was largely unsuccessful due to coarse, hard substrates. Bottom bathymetry and substrates were analyzed using seismic reflection profiling and bottom photography. Water samples at various depths were taken with Niskin bottles. Benthic fauna was taken by trapping and a small screen dredge. A one meter, 333μ mesh, plankton net was used for zooplankton samples. Micronekton was sampled with a 6 foot Isaccs-Kidd Mid-water trawl.

Long line fishing in the study area was attempted with no success, so fisheries data were obtained for analysis from the records of the State Division of Fish and Game.

Details of the various field methods used during each of the phases of this study are presented in the final reports on each part. In general, the methods used throughout the study were similar to facilitate comparisons between results obtained in each phase.

Geology and Physical Oceanography

Bathymetry

The baseline survey augmented considerably the bathymetry of the area as shown on the National Ocean Survey Chart No. 19364. The area ranges in depth from 164 fathoms (300 m) at the northwest corner of the site to a maximum depth of 240 fathoms (440 m) at the sourtheastern corner. In general, the bottom is a smoothly sloping surface with little or no discernable topographic escarpments, depressions, or major relief. Geologically speaking, it could be described as a basically featureless terrain. The slope of about 1:100 is from northwest to southeast. In the many traverses over the area in route to sampling stations, the fathometer traces gave no evidence of submarine drainage patterns or prominent bottom irregularities in excess of a few meters.

A comparison of the photos obtained during the baseline studies with those taken during Part C are most notable for their similarity, particularly in the immediate area of the dump site. Photos taken along two traverses of the

disposal site show similar sand and coral rubble areas in each track. The photos taken after disposal of spoil from an area approximately 200 meters north of the specific dump site show no evidence of fine grained material or mounds of spoil. There is a certain amount of rubble and small rocks in the area, but similar bottom types were observed in the photos from the baseline studies.

Bathymetric surveys for each of the three phases of this project based on fathometer records for sounding track lines and sampling stations have been compared and are in very close agreement with two exceptions. The location of the 190-194 fathom figures shown in the upper northwestern corner of the disposal area as shown in the Part A report, Figure III-4 was found to be in error and has been discarded. Evidence from three independent additional bottom depth records for this area corroborate the U.S.G.S. charts that the actual depth in this area lies between 160 and 165 fathoms. If the baseline bathymetric survey is compared with the bathymetry taken in Part B we find only one area along the southeastern boundary where depths of 222-223 fathoms were recorded during Parts B and C as compared to approximately 230 fathoms, 100 meters north of the southern border of the site recorded during Part A. The explanation of this 7 fathom difference is uncertain. A minimum of 5 million cubic yards of material would have to have been deposited to account for the most conservative estimates of areal extent and shoaling. A more realistic estimate of the apparent areal extent and shoaling would require four or five times that volume of spoil to be deposited. In any case the volumes required are some 7 or more times the volume of 700,000 cubic yards actually dumped. The apparent 7 fathom difference seems more likely to reflect possible sediment transport in a southerly direction, not necessarily related to dredge spoil.

Substrate

Grain size and mineralogical analyses performed during the baseline studies combined with the photographs taken across the disposal area indicated a generally sandy substrate with predominately carbonate (calcite and aragonite) mineral composition. Coral rubble and man-made products were either observed in the bottom photos or taken in the grabs, indicating previous offshore disposal in the area. Substrate examined during the Part B and the follow-up Part C studies showed no significant changes which could be attributed

to the 760,000 cubic yards of spoil material disposed during the present dredging operation. No areas of soft silt or mud sediments were encountered in all of our sampling, either before, during, or after disposal. A comparison of the average grain size of surface sediments and the Pearl Harbor sediments shows a significant difference in bottom substrate. Sediments from Pearl Harbor were approximately 75 percent silt and clay. Those at the disposal site ranged from 10 percent silt and clay during the baseline study to about 5 per cent six months after disposal had ceased. The quantities of silt and clay recovered in the grab samplers used are admittedly subject to some loss during the transit of the sampler to the surface. However, sampling error could not account for the large differences observed. The lack of soft substrate in our multiple coring attempts and with the clam grab whose configurat-on significantly impedes sample loss, lends support to the conclusion that the bottom substrate remains basically free of soft fine sediments. Measured bottom currents of 30 to 40 cm/sec are sufficient to inhibit most fine grained deposition and to transport the finer materials from the site southwestward.

Mineralogical analyses show the spoil spreading out during the post-depositional period to cover essentially all of the designated disposal area. Strong and variable bottom currents are considered responsible for the observed distribution.

Water Quality

Baseline studies of water quality parameters (salinity, dissolved oxygen, ph, suspended solids, turbidity, total Kjeldahl nitrogen, total phosphorus, total organic carbon and heavy metals) indicated essentially pristine conditions at all stations, with characteristics typical of open ocean rather than coastal conditions.

During disposal operations the water quality parameters in the immediate vicinity of the dump site returned to predisposal conditions within 24 hours after dumping had ceased. Based on the heavy metals distribution, the bulk of the coarser spoil material was initially deposited within a half-mile radius of the dump site. The spoil material was low in metals and pesticides (with the exception of lindane); hence tracing the movement of spoil on the bottom was difficult. Bottom sediment from areas characterized by spoil deposition in Part C showed a marked increase in total metals concentrations (632 mg/kg)

over Part B studies (407 mg/kg) dry weight. Since spoil had not been dumped between the time of the Part B and Part C studies, it was postulated that sewage from the recently opened Sand Island Sewage Treatment Plant outfall could be the significant source of metals to bottom sediments in the area. Measurement of heavy metal concentrations in shrimp (Heterocarpus ensifer) and zooplankton gave no significant difference in heavy metal body burdens between animals taken at the dump site and a control site 2 miles westward.

Benthic Biology

Benthic biota in the general disposal area was documented during the baseline studies. Areas of apparently stable and unstable sediments were defined, based on the degree of weathering of the faunal elements and the relative abundance of shallow and deep water micromollusks and foraminifera. The distributions so obtained were then compared with similarly obtained distributions during subsequent collections. Populations immediately after disposal showed a higher percentage of shallow water animals indicating spoil origins. Six months after dumping, the tracer species and fecal pellets covered a much smaller area of the disposal site than noted immediately after Part B. In addition the number of fecal pellets decreased by a factor of ten in most of the stations. Fecal pellets were not found in the Part A baseline studies and were extremely common during disposal operations. The relative percentages of species present before, during and after disposal has led to the conclusion that the area is rapidly recovering to postdisposal populations with the single exception of the area directly at the specific dump site.

Zooplankton

Zooplankton and micronekton populations in the disposal area were sampled before dumping to determine baseline community structure and population sizes. The micronekton was considered to be insignificant in numbers and was not further sampled. Zooplankton populations at the time of dumping were substantially larger than their baseline values. Kona weather at the time of dumping seems to have accounted for the initial increase in zooplankton numbers through increased nutrient runoff from land. The relocation of the Sand Island sewer outfall in December, 1976 may have caused a permanent increase in the zooplankton standing crop in the disposal area. Effects of dredge spoil disposal on the zooplankton appear to have been minimal.

Fisheries

Commercially valuable species that might be affected by dredge spoil in the disposal area included the shrimp Heterocarpus ensifer, the schooling fishes opelu and akule, and the demersal fishes west of the disposal area on the Ewa (Barbers Point) ledge. Catch records for the fishes were too sparse to show any effects of spoil disposal. The shrimp population increased somewhat as a result of spoil disposal, but at no time was the population large enough to constitute an economically viable fishery. No deleterious effects of sediment were noted on the gills of the shrimp. Thus, disposal of dredge spoil in the disposal area has had little effect on the commerical fisheries off Oahu.

Conclusions

The evaluation of the data obtained during the three phases of this study has resulted in a recommendation for continued disposal of dredge spoil at the specific dump site: 21°15.9'N., 157°56.7'W. The two year study has produced no evidence of significant long-term effects, either positive or negative, on the geological conditions, water quality, or biological communities that can be attributed to the disposal of dredge spoil in this area.