United States
Environmental Protection
Agency

Office of Water
Criteria and Standards Division
Washington DC 20460

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EPA

Environmental Impact Statement (EIS)

Draft

Atchafalaya River Bar Channel Ocean Dredged Material Disposal Site Designation

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT
FOR
ATCHAFALAYA RIVER BAR CHANNEL
OCEAN DREDGED MATERIAL DISPOSAL SITE

(x) Draft
( ) Final
( ) Supplement to Draft

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER REGULATION AND STANDARDS
CRITERIA AND STANDARDS DIVISION

1. Type of Action
   (x) Adminstrative/Regulatory action
   ( ) Legislation action

2. Brief background description of action and purpose.

The proposed action is the final designation of the Atchafalaya River Bar Ocean Dredged Material Disposal Site (ODMDS). The ODMDS is off the mouth of the Atchafalaya River and is adjacent to and parallel to the Atchafalaya Bar Channel. The purpose of the action is to provide an environmentally acceptable area for disposal of dredged material, in compliance with EPA Ocean Dumping Regulations.

3. Summary of major beneficial and adverse environmenal and other impacts.

An important beneficial effect of this action is the provision of an environmentally and economically acceptable location for disposal of dredged material. A specific area for the ocean disposal of dredged material will be available as one alternative in planning for dredged material disposal. Adverse impacts include the burial of benthic organisms, formation of a mound, and development of a plume during disposal operations. The adverse impacts will be temporary and occur within the site boundaries.

4. Major alternatives considered.

The alternatives considered in this EIS are (1) no action, which would continue the interim designation of the existing site without a decision on its status, (2) final designation of the interim designated site for continuing use, and (3) relocation of the existing site to an alternative ocean location (e.g., nearshore, midshelf, off the continental shelf),

5. Comments have been requested from the following:

Federal Agencies and Offices

Council on Environmental Quality
Department of Commerce
    National Oceanic and Atmospheric Administration
    National Marine Fisheries
    Maritime Administration
Department of Defense
    Army Corps of Engineers
Department of Health, Education, and Welfare
Department of the Interior
    Fish and Wildlife Service
    Bureau of Outdoor Recreation
    Bureau of Land Management
    Geological Survey

Department of Transportation

Coast Guard

National Science Foundation

States and Municipalities

State of Louisiana

Governor's Office

Department of Wildlife and Fisheries

Terrebonne Parish

Private Organizations

American Littoral Society

Audubon Society

Center for Law and Social Policy

Environmental Defense Fund, Inc.

National Academy of Sciences

National Wildlife Federation

Sierra Club

Water Pollution Control Federation

Academic/Research Institutions

Louisiana State Unversity

6. The Draft statement was officially filed with the Director, Office of Environmental Review, EPA.

7. Comments on the Draft EIS are due 45 days from the date of EPA's publication of Notice of Availability in the Federal Register which is expected to be ______________________.

Comments should be addressed to:

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Copies of the Draft EIS may be obtained from:

Criteria and Standards Division (WH-585)
Office of Water Regulations and Standards
Environmental Protection Agency
401 M Street, SW
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The Draft may be reviewed at the following locations:

Office of Federal Activities
Room 2119
Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20024

Environmental Protection Agency
Region VI
1201 Elm Street
Dallas, Texas 75270

Library
U.S. Army Corps of Engineers
New Orleans District
Foot of Prytania Street
New Orleans, Louisiana 70118

SUMMARY

PURPOSE OF AND NEED FOR ACTION

This Environmental Impact Statement provides information regarding the final designation for continuing use of the Atchafalaya River Bar Channel Ocean Dredged Material Disposal Site (ODMDS). The Environmental Protection Agency (EPA) approved the ODMDS for interim use in 1977 (40 CFR 228), based on historical use of the site. The purpose of the proposed action is to provide the most feasible and environmentally acceptable ocean location for the disposal of materials dredged from the Atchafalaya River Channel System.

A disposal site in the ocean is needed to receive materials dredged from the Atchafalaya River Channel System. Without dredging, operating depths would decrease due to the heavy sediment load of the Atchafalaya River and limit economically important ship traffic utilizing the Channel.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Three alternatives were considered during the studies regarding the proposed action of site designation. These were no-action, final designation of the interim designated ODMDS, and relocation of the ODMDS. Non-ocean disposal alternatives were not considered in the EIS. The designation of an environmentally acceptable ocean disposal site is independent of individual project requirements. Non-ocean alternatives for disposal of dredged material must be evaluated for each Federal project or permit application. Designation of an ocean disposal site provides an alternative in the range of options for the disposal of dredged material.

If no action is taken, the interim designation of the ODMDS would continue since there is no specific termination date. However, approval of the site was conditional, pending completion of any necessary studies and evaluation of its suitability for continued use. The environmental studies are completed with the results presented in the EIS. Thus, in accordance with §228.5(c) of the ODR, a decision regarding the continued use of the site is required and no action is considered an unacceptable alternative.

The interim designated site was evaluated according to criteria established in the ODR. The site has been in use for the disposal of dredged material for over forty years without resulting in adverse environmental effects outside the site boundaries. Only minimal effects are apparent within the site boundaries. The site is in the high-energy inshore area where waves, currents, wind, and tidal actions constantly mix and redistribute the sediments. Thus, the disposed dredged material is dispersed gradually over the area. Burial of bottom organisms during disposal operations will occur within the site, however, the biotic community of this area is highly adapted to perturbation. Continued use of the site is not expected to interfere with the biological life of the area or with other uses of the ocean.

Relocation of the ODMDS to another nearshore area, a mid-shelf area, or off the Continental Shelf was considered. It was determined that relocation of the ODMDS to any of these alternative areas would not result in environmental advantages, but would increase the dredged material disposal costs. Because of this, relocation of the ODMDS was not considered to be a viable alternative. Final designation of the existing interim designated ODMDS was determined to be the preferred alternative.

AFFECTED ENVIRONMENT

The Atchafalaya River Bar Channel ODMDS is located off the Louisiana Coast roughly in the middle of the chenier plain physiographic region to the west and the deltaic plain to the east. The coast is a complex mixture of wetlands, uplands, and open water influenced by sediment deposition from the Mississippi and Atchafalaya Rivers. The coast is marked by many inlets that allow connection with numerous shallow bays such as the Atchafalaya Channel.

The climate of the Louisiana coast is a mixture of tropical and temperate conditions with moderate temperatures and abundant rainfall. The annual mean air temperature is about 23°C with July and August being the warmest months and January the coldest month. While precipitation occurs throughout the year, it is generally intense in summer and early autumn with the greatest amount of rainfall being associated with tropical storms. The annual precipitation in New Orleans is about 137 cm. Hurricanes occur in the area on a average of one in four years.

Circulation in the Gulf of Mexico is complex and influenced by the Loop Current, tides, winds, and river discharge. The major feature of broad scale circulation in the Gulf is the Loop Current which, as a continuation of the Yucatan Current, enters the Gulf through the Yucatan Strait. Local currents in the vicinity of the ODMDS are predominantly influenced by winds, and to a lesser degree, tides, Loop Current intrusions, and river flow. Net flow is to the northwest throughout most of the year. However, rapid flow reversals to the southeast occur periodically and are well correlated with similar changes in wind direction. Current speeds generally range from 10 to 40 cm/sec at the ODMDS. Minimum speeds of 5 to 30 cm/sec occur during June, July, and August; whereas, the highest recorded current speeds range from 70 to 140 cm/sec and occur during strong winter storms.

Plankton communities at the ODMDS are typical of nearshore Continental Shelf waters in the Gulf of Mexico. Both marine and fresh water phytoplankton species exist in the nearshore region off Atchafalaya Bar. Dominant species are generally marine diatoms, except during summer when marine dinoflagellates occur in large numbers. Dominant zooplankton species vary seasonally near the ODMDS. Copepods are the most common zooplankton collected throughout the year. Other zooplankton that are periodically present in large numbers include pteropods, ctenophores, cladocerans, and chaetognaths.

Two general types of demersal fish communities occur on the continental shelf of the northern Gulf of Mexico; the white shrimp grounds community and the brown shrimp community. The range of the white shrimp community generally extends from depths of 3m to 22m, whereas the brown shrimp community generally occurs in depths from 22 to 90m. The Atlantic croaker and other sciaenids, including sand and silver seatrout and various species of drum, are the dominant demersal fish in the white shrimp community. The longspine porgy, inshore lizardfish, blackfin searobin, and spot are typical species of the brown shrimp community.

Extensive oil and gas development occurs in the Atchafalaya area. Within three areas off Atchafalaya Bay, i.e., South Marsh Island, Eugene Island, and Ship Shoal, 26.9% of Louisiana oil and gas fields occur. A portion of the ODMDS is located within leased blocks, and one platform is located in the southern corner of the ODMDS. Other activities that occur in the vicinity of the ODMDS include recreational and commercial fishing, marine recreation and navigation.

ENVIRONMENTAL CONSEQUENCES

In general, few significant adverse impacts have resulted from previous dredged material disposal in the Atchafalaya ODMDS. Increases in turbidity, releases of nutrients or trace metals, and reductions of benthic faunal abundance and diversity are short-term effects which would occur within the ODMDS. Results from the Dredged Material Research Program indicate that impacts within the disposal site are minimized when dumping occurs in naturally variable, high-energy environments. The ODMDS is situated in a dynamic, nearshore environment, thus, long-term or cumulative impacts will be minimal.

Limited interferences with nearshore fisheries may occur during and in the immediate vicinity of the dredged material dumping. The ODMDS is located within passage areas of nekton that seasonally migrate to and from the estuaries, bays, and Gulf during their life cycle. Any such interferences would be of short duration and limited because the ODMDS represents a small percentage of the total nearshore fishing grounds.

Since pipelines are used for disposal of dredged material at the ODMDS, there may be some temporary blockage of the navigation channel during dredging operations. Cooperation between the dredgers and vessel operators can minimize navigational interruptions. This same type of cooperation can minimize any conflicts with oil and gas exploration and production as well as with other ocean activities in the area.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

The proposed action (chapter 1) is the final designation of the Atchafalaya Ocean Dredged Material Disposal Site (ODMDS). The Ocean Dumping Regulations and Criteria (40 CFR 220-229, amended December 1980) approved certain historically used ocean sites for disposal of dredged materials, including the Atchafalaya site. Approval was on an interim basis "pending completion of baseline or trend assessment surveys." The ODR states in part "....§228.5(3) If at anytime during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the citerial for site selection set forth in §§228.5-228.6, the use of such sites will be terminated as soon as suitable alternative disposal sites can be designated....."

This EIS presents the findings from site evaluation studies of the Atchafalaya interim designated ODMDS. Utilizing these findings, three alternatives were considered. These alternatives presented below include: (1) No Action; (2) Final Designation for Continuing Use of the Interim Designated Sites; and (3) Relocation of the ODMDS.

Non-Ocean disposal alternatives were not evaluated since the selection and designation of an environmentally acceptable ocean disposal site is independent of individual project requirements. This does not mean that land-based disposal or any other feasible alternatives mentioned in the Environmental Protection Agency's (EPA) Ocean Dumping Regulations and Criteria (40 CFR §227.15) are being permanently set aside in favor of ocean disposal. The need for ocean disposal must be evaluated for each Federal project or permit application. These evaluations include considerations of the availability and environmental acceptability of other feasible alternatives. Designation of an ocean disposal site presents one option for the disposal of dredged material.

NO ACTION ALTERNATIVE

The interim designation of the Atchafalaya ODMDS does not have a specific termination date. If no action is taken, the interim designation of the existing ODMDS would continue for an indefinite period. However, the interim status provided in the ODR was not intended to remain indefinitely. The site was approved for dredged material disposal pending completion of any necessary studies and evaluation of its suitability for continued use. The environmental studies of the site have been completed and, in accordance with §228.5(c) of the ODR, a decision on its use is required. Thus, the no action alternative is not considered to be an acceptable alternative.

ENVIRONMENTAL EVALUATION OF EXISTING SITE

An environmental evaluation was made of the interim designated ODMDS to determine its suitability for continued use. The eleven specific criteria (§228.6) and the five general criteria (§228.5) of the EPA Ocean Dumping Regulations and Criteria (ODR) were used to conduct the evaluation. The evaluation was based on data obtained in the EPA/IEC site surveys and other available information. Any station numbers in the text reference the survey report contained in the Appendix. The results of the evaluation were as follows:

Specific Criteria (228.6)

(1) Geographical position, depth of water, bottom topography, and distance from coast;

The Atchafalaya ODMDS is located east of and parallel to the Atchafalaya River Bar Channel. Its corner coordinates are 29°20'50"N, 91°24'03"W; 29°11'35"N, 91°31'10"W; 29°11'21"N, 91°31'37"W; and 29°20'36"N, 91°23'27"W. The coordinates as stipulated in the ODR correctly describe the boundaries of the site historically used for the disposal of dredged material (see Figure 1-1).

The Continental Shelf is approximately 100 miles wide off the Atchafalaya Basin. It is a gentle sloping (less than 1°) submarine plain with many isolated sea knolls and sea mounts (Weissberg et al., 1980a, 1980b; DOI, 1978). The Atchafalaya ODMDS is located in the nearshore area of the plain. The site gently slopes at about 0.01° from about 2m depth at its nearshore end to about 6.6m at its seaward end. Except for being located adjacent to the dredged channel, the small area occupied by the ODMDS is typical in depth and bottom topography to a much larger area off the mouth of the Atchafalaya River.

The center of the Existing ODMDS is approximately 14 nmi from the mainland shore. However, in the broadest sense, the site must be considered to be much closer to the "coast". North Point of Point au Fer Island is about 2 nmi east of the northern end of the Existing Site. Point au Fer is a massive shell reef that lies about 3 nmi shoreward of the Existing ODMDS; this reef is roughly 0.5 nmi wide and extends nearly 20 nmi across the mouth of Atchafalaya Bay (CE, 1978). The Existing

ODMDS extends along the Atchafalaya Bar Channel about 12 nmi seaward from the nearest point within the site to Point au Fer.

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

The northwestern Gulf of Mexico is a breeding, spawning, nursery, and feeding area for shrimp, menhaden, and bottomfish. Seasonal migration between the estuaries and the Gulf is a localized passage activity and is most intensive in the spring and fall.

Two general types of demersal fish communities occur on the continental shelf of the northern Gulf of Mexico: the white shrimp grounds community and the brown shrimp grounds community (Chittenden and McEachren, 1976). The range of the white shrimp community in the northern Gulf of Mexico extends from depths of 3m to 22m. Species in the white shrimp community are highly estuarine dependent. The Atlantic croaker and other sciaenids, including sand and silver seatrout and various species of drums, are the dominant demersal fish (ibid.).

The brown shrimp community generally occurs in depths from 22m to 90m, although the range is somewhat deeper in the central Gulf (Chittenden and McEachren, 1976). The longspine porgy, inshore lizardfish, blackfin searobin, and spot are typical species of the brown shrimp community. There can be considerable intermingling of fish and shellfish species between the two communities. Brown shrimp and fish from the brown shrimp community can occur well inside the white shrimp grounds, sometimes in relatively high abundance.

White and brown shrimp compose the bulk of the shrimp fishery in the northern Gulf of Mexico. The penaeid shrimp lifecycle is centered around numerous productive estuaries which are used as nursery areas during the larval and juvenile stages. Adult penaeid shrimp spawn in nearshore waters, producing many microscopic, semibuoyant eggs. White shrimp spawn from May to September, whereas, the brown shrimp spawning period appears to extend throughout the year, with peaks in spring and fall (DOE, 1981). The eggs hatch within several hours into planktonic nauplii, develop rapidly through a series of larval stages, and are transported landward toward estuaries. Three to five weeks generally elapse between hatching and entry of the postlarval shrimp into brackish estuaries (Kutkuhn, 1966). Once in the estuaries, the postlarvae rapidly metamorphose into juvenile shrimp, growing quickly, and reaching commercial size in two to four months. The adult shrimp then leave the estuaries and return to the Gulf (Kutkuhn, 1966). The major offshore movement of white shrimp occurs in the late summer and autumn (DOE, 1981). Brown shrimp begin their return to the Gulf in the late May-early June; their migration continues at least until August when offshore populations peak (DOE, 1981; Barrett and Gillespie, 1973).

The Existing ODMDS represents a very small area (8.57 nmi^2) of the total range of the white and brown shrimp and their related communities. During their migration to and from the Atchafalaya River estuarine area, they may use one of a number of passages through Point au Fer Reef. During periods of active dredging and disposal this one passage route would be partially restricted. However, the restriction would only be in the vicinity of the dredging and disposal operation and alternative migration routes would be available.

Six species of endangered marine mammals (sperm whale, black right whale, humpback whale, sei whale, fin whale, and blue whale) have been sighted in the northern Gulf of Mexico (Weissberg et al., 1980a). Most were chance sightings and do not indicate the presence of indigenous populations (DOI, 1977). All of the endangered marine mammals are rare in the northern Gulf of Mexico (ibid.). Several threatened or endangered species of marine reptiles also occur in the northern Gulf of Mexico

(Weissberg et al., 1980a). Endangered brown pelicans nest along the Louisiana shoreline. A colony of brown pelicans presently exists at Queen Bess Island, 65 nmi east of the Existing Site (Schreiber, 1980; Blus et al., 1979).

The Existing Site is quite small in comparsion to the overall range of the known threatened or endangered species. While some may visit the Existing Site as transients, they should not be affected by disposal of dredged material at the Existing Site.

(3) Location in relation to beaches and other amenity areas;

There are no known recreational parks or beaches in close proximity to the Existing ODMDS. The nearest point of land is North Point of Point au Fer Island; about 2 nmi from the north end of the Existing ODMDS. It may be possible to observe the disposal plume from the Point or from boats that may be in the vicinity during the active period of dredged material disposal within the site. The plume is expected to quickly disappear after completion of the disposal operations. Except for the minor effects of these limited observations, there should be no effects on the aesthetics of the area.

Recreational fishing and boating occur throughout the area in the vicinity of the Existing ODMDS. Ship Shoal is located approximately 25 nmi east of the Existing ODMDS, and Trinity Shoal and Tiger Shoal are located about 25 nmi west of the site. Smaller fishing shoals are located within 2.5 nmi of the Existing ODMDS (DOC, 1980a,b); Point au Fer Reef is located shoreward of the Existing Site (CE, 1978).

There will be some interference with the recreational activities during disposal operations and in the immediate vicinity. This interference will be restricted to the relatively small area of the Existing Site being utilized at the particular time for dredged material disposal. The area affected will be quite small im comparsion with the total area available for recreational activities.

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release including methods of packing the waste, if any;

Over a 10-year period, the average volume of material dredged from the Atchafalaya every 2 - 2 1/2 years was 8,625,000 yd^3 (Pendergraft, 1982)*. The dredged material generally consisted of approximately 39 to 44% silt and 50 to 56% clay with a small amount 4 to 6% of fine-grained sand (CE, 1978). The material is removed from the Atchafalaya River Channel using a cutterhead pipeline dredge and released as a uncohesive slurry within the Existing Site.

It is expected that the bulk of future dredged material disposals will follow the past disposal pattern respect to types, quantities, and methods of release. However, from time to time, minor amounts of dredged material from other areas in the general vicinity may be considered for disposal in the site. This material would be transported and released from barges.

Any material disposed of at the site would be required to comply with the criteria of the Ocean Dumping Regulations and any other appropriate requirements. None of the material will be packaged in any way.

(5) Feasibility of Surveillance and Monitoring;

The Existing ODMDS is close to shore which facilitates surveillance of the site. Operational observations can be made using shore base radar, aircraft, shipriders, and day use boats.

*Thomas Pendergraft, U.S. Army Corps of Engineers, New Orleans District, Personal Communication.

In addition to being close to shore, the Existing ODMDS is shallow. These features minimize travel time and operations time for most sampling. Monitoring also will be facilitated by the data base that has been established for the Site.

(6) <u>Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction, if any;</u>

Current patterns in the vicinity of the Existing ODMDS are highly complex. While tides, Loop Current intrusions, and river flow may affect the local currents, these currents are predominantely influenced by winds. Thus, the direction and velocity of the currents varies throughout the year.

Winds are a particularly strong driving force in the late autumn, winter and early spring. Net water flow in the winter is to the northwest, however, rapid flow reversals to the southeast occur periodically and are well correlated with similar changes in wind direction (Weissberg et al., 1980a,b; Crout and Hamiter, 1981). Nearshore current patterns are somewhat more complex in summer. In the absence of strong winds and the presence of a stratified water column, current patterns become considerably less distinct. Net flow in summer can be either to the east or the west (ibid.). Spin-off eddies from the Loop Current occasionally enter the region, producing flows to the southeast near the Existing Site (Weissberg et al., 1980a,b).

Current speeds generally range from 10 to 40 cm/sec in the vicinity of the Existing Site. Minimum speeds of 5 to 30 cm/sec occur in June, July, and August, whereas, the highest recorded current speeds in the vicinity range from 70 to 140 cm/sec and occur during strong winter storms (Weissberg et al., 1980a,b). Stagnant periods with little or no current motion have been recorded in April, May and July and may last for as long as six days (ibid.). One study during dredged material disposal operations indicated currents may range from 2 to 25 cm/sec in a southeast direction (Schubel et al., 1978). Current speeds may reach 200 cm/sec during hurricanes which occur about once every four years (Weissberg et al., 1980a; DOI, 1978).

In the absence of strong currents, the bulk of the dredged material being disposed settles on the bottom of the particular area of a site being used at that time. A portion of the plume (fines) will be transported in the direction of the current over a wider area of the site and to some extent outside the site. This material will eventually settle over a wide area.

Currents in the area reach velocities sufficient to resuspend the disposed dredged material. The resuspended material will be transported in the direction of the current causing the resuspension. During these periods, constant mixing of the dredged material and sediments originally in the area takes place. The mixed dredge material and background sediments settle as the velocity decreases and are resuspended when some event again raises the current velocity.

The dredged material represents a small portion of the material carried into the general area by the runoff of the Atchafalaya River. Initially, during the dredged material disposal, a mound may be formed within the Existing Site. However, periodic resuspension of the dredged material will result in the disappearance of the mound through dispersal and horizontal transport. The net result will be the remixing of dredged material with other materials from the original source. Thus, while there will be dispersal and horizontal transport of the dredged material from the site, it is not expected any long term detrimental effects on the environment of the area will occur.

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

No mounds within the site were detected during EPA/IEC surveys performed during December 1980 and May-June 1981(Appendix). While there were spacial and temporal differences in the results for various parameters, no material differences between sampling stations within the site and control stations both east and west of the site were detected. No effects from dredged material disposal could be identified in the water column, sediments, or benthos of the site. The most recent dredged material disposal prior to the surveys took place during February 1979.

SEDIMENT CHARACTERISTICS

Surficial sediments during both surveys were predominantly silts and clays at all stations, but exhibited some temporal and spatial textural variability. Results were similar to previous observations within and adjacent to the ODMDS (CE, 1978). Overall ranges for percentages of sand, silt and clay were 0.1 to 17.1%, 31.7 to 55.1%, and 28.1 to 68.2%, respectively. Gravel content was minimal at all stations. Clay content increased somewhat at most stations between the December and May-June surveys, whereas percentages of sand and silt usually decreased.

Chemical

Concentrations of trace metals in surficial sediments generaly exhibited little variation over the survey area. Mean (n=40) concentrations (and ranges) over both surveys were 3.0 ug/g (1.8 to 4.4 ug/g) for arsenic, 0.15 ug/g (<0.08 to 0.33 ug/g) for cadmium, 1.9 ug/g (0.8 to 2.9 ug/g) for chromium, 10 ug/g (7.5 to 16 ug/g) for copper, 0.055 ug/g (0.037 to 0.078 ug/g) for mercury, 590 ug/g (250 to 950 ug/g) for manganese, 5.5 ug/g (3.9 to 9.1 ug/g) for nickel, 16 ug/g (9.7 to 24 ug/g) for lead, and 25 ug/g (17 to 45 ug/g) for zinc.

Total organic carbon (TOC) concentrations in sediments, determined only for the December survey, also showed little variability and were generally low. Values ranged from 0.15 to 8.2 mg/g, with an overall mean of 1.84 mg/g. No spatial patterns were apparent.

Concentrations of cyanide and phenols were generally below detectable levels. Cyanide was detected at low levels (<0.7 ug/g) at a few stations, both inside and outside the ODMDS, during each survey; no spatial trends were evident. Cyanide levels were also low (<0.5 mg/g) in a previous study of the ODMDS and vicinity (CE, 1978). Phenols, determined only in December, were not detected in any of the samples.

Sedimentary CHC concentrations at stations inside and outside the ODMDS were generally low, and only detectable for dieldrin, pp'DDE, pp'DDD, and PCBs (Arochlors 1016 and 1254). PCB (1254), DDE, and DDD were present in measurable quantities during both December and May-June surveys; concentrations ranged from 2.2 to 5.6 ng/g, and were similar between stations and surveys. Dieldrin (2.2 to 4.7 ng/g) was detected only in December, whereas PCB (1016) was present only during May-June (26 to 74 ng/g).

Oil and grease concentrations were high (8 and 15 mg/g) at one station during December 1980; concentrations at the remaining stations ranged only from 0.4 to 2.2 mg/g over both surveys. The reason for the elevated levels at the one station is unclear.

Total hydrocarbon concentrations ranged from 98 to 125 ug/g, and did not vary systematically between stations or surveys. Saturated hydrocarbon levels (55 to 77 ug/g) were somewhat higher during May-June than December, whereas aromatic and olefinic hydrocarbon concentrations were similar during the two surveys (40 to 65 ug/g). No obvious differences existed between sediments from the ODMDS and control areas.

As described above, sediment physical and chemical characteristics were generally similar within and adjacent to the ODMDS. No effects of dredged material disposal could be identified; however, a few relatively high concentrations for sedimentary chemical constituents (zinc, oil and grease) were measured within the ODMDS. The survey area is influenced by shallow water depths, frequent resuspension of bottom sediments by winds and waves, and inputs of large quantities of fine sediments from riverine sources. Furthermore, dredged materials released at the ODMDS are similar to background sediments in the vicinity, and are probably widely distributed by natural processes after deposition.

Elutriate Tests

Elutriate tests were made on sediments collected during the May-June EPA/IEC survey. Results were similar from a station inside the ODMDS (1) and a station outside the ODMDS (6). Where differences occurred between the two stations, releases were generally greater from the station sediments outside the ODMDS. For example, manganese releases were indicated in all replicates at both stations, but were a factor of two greater from sediments outside the ODMDS. Zinc release occurred in one replicate from each station and, again, was substantially greater for the station outside the ODMDS. For the remaining trace metals, small or no releases were detected. Arsenic and cadimum were released in comparatively small quantities in all replicates. Chromium, copper, mercury, nickel, and lead were retained and/or scavenged from solution by the solid phase.

TISSUE CHEMISTRY

Concentrations of trace metals and CHCs in organisms collected in trawls in the vicinity of the ODMDS were measured. Trace metal (cadimum, chromium, copper, mercury, manganese, nickel, lead, and zinc) levels in two species of penaeid shrimp (Xiphopenaeus kroyeri in December and Trachypenaeus similis in May-June) were low, and within or below previously reported ranges for these species in the general area of the ODMDS (Tillery, 1980). Of the trace metals examined, concentrations were highest for zinc (9.4 to 14 ug/g) and copper (5.1 to 8.9 ug/g); a similar situation was indicated by Tillery's (1980) data. Arsenic concentrations ranged from 5.9 to 8.5 ug/g; no historical data were available for comparison. Mercury concentrations (0.007 to 0.015 ug/g) were low. Trace metal concentrations were generally comparable for organisms collected inside versus outside the ODMDS. Since different species were collected during the two surveys, temporal comparisons are not warranted.

CHC levels were determined in shrimp (X. kroyeri) during the December survey and in crabs (Callinectes similis) during May-June. Of the compounds examined, only dieldrin, pp'DDE, and PCB (Arochlor 1254) were detected. Concentrations in shrimp were substantially lower than those in crabs although all values were well below FDA action/tolerance levels for edible marine organisms. CHC levels in crabs were somewhat greater inside, relative to outside the ODMDS; data are insufficient to define any cause for this difference. Levels were similar for shrimp collected inside versus outside the ODMDS. No historical data for CHCs in these species were available for comparison; however, levels were comparable to those summarized by Atlas (1981) for other Gulf of Mexico marine organisms.

MICROBIOLOGY

Low counts of total and fecal coliform bacteria were measured in sediments during both surveys at the Atchafalaya River ODMDS. In December, total coliforms ranged from 9 MPN/100g at one station (9) to 189 MPN/100g at another station (10). Fecal coliforms ranged from nondetectable (stations 3, 8 and 9) to 99 MPN/100g at one station (10). During the May-June survey only two stations (5, 10) were sampled for coliforms in sediments; both yielded very low numbers (Table A-20).

Crabs and shrimp collected in trawls contained low numbers of total coliforms during both surveys. Fecal coliforms were not detected in any of the tissue samples.

(8) <u>Interference with shipping, fishing, recreational, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;</u>

The Existing ODMDS is outside the navigational channel and thus not in the path of ocean going vessels. Some smaller boats may pass over the site; however, since any mounds are expected to be short-lived, there should be no interference with this passage. Pipeline dredges and disposal pipelines may interfere with some shipping traffic by blocking sections of the channel. This interference can be mitigated by close coordination between the dredging operators and the shipping interests.

Recreational and commercial fishing occurs throughout the year over the large region. The Existing Site covers a very small area of the region. There will be some interference with these activities during the dredge material disposal operations. However, this interference should be of short duration and only in the vicinity of the disposal operation. Once this temporary interference subsides, fishing in the area of the site should return to that typical of the region.

Recreation in the area generally consists of fishing and boating. Except for a temporary interference during disposal operations, there should be no interference with these activities. There are no recreational beaches in the near vicinity of the site.

There is active oil and gas development in the area occupied by the Existing Site. Platforms are located to the east, south, and west of the site. Past experience with use of the site for dredged material disposal has not indicated interference with the oil and gas exploratory or production operations. The Existing Site is located adjacent to the channel which minimizes the transport distance to the disposal site. Other types of mineral extraction do not occur within the site.

No desalination or artificial fish and shellfish culture facilities occur within the site. Naturally occurring fish and shellfish within the site, particularly bottom dwelling types, will be affected by the dredged material disposal. Some of these may be trapped and smothered. Dispersion and transport of the dredged material outside the site should not adversely affect the fish and shellfish. The material dispersed from the site will settle in very thin layers and be mixed with the naturally occurring sediments of the region.

Oyster beds occur on the shell reefs north of the ODMDS. Since transport of the suspended materials in the water should be to the southeast, any affects on the oysters will be minimized.

Nothing of special scientific interest is located within the Existing Site. Periodically, scientific studies are carried out in the offshore region and the bays of the area. Use of the site should not interfere with these studies. It is not expected that use of the site for disposal of dredged material will interfere with any other legitimate use of the ocean.

(9) <u>The existing water quality and ecology of the site as determined by available data or by trend assessment of baseline surveys</u>;

The water quality and ecology of the Existing ODMDS is generally reflective of that of the nearshore region off the Louisiana Coast affected by discharges from the Atchafalaya River. The variations in the water quality depend on the amount and mixing of fresh water runoff occurring at the time which is highly variable. Data developed during the EPA/IEC surveys were generally comparable to historic data for the area (see Appendix).

WATER COLUMN

In the EPA/IEC surveys, salinities varied widely during both the December 1980 (15.0 to 26.6^{o}/oo) and the May-June 1981 (4.9 to 35.5^{o}/oo) surveys. Mid-depth dissolved oxygen levels during December ranged from 9.5 to 10.3 mg/l, whereas May-June values ranged from 6.8 to 8.9 mg/l. A wide range of TSS concentrations (10 to 102 mg/l) were recorded during the December survey when stormy weather was encountered; during the May-June survey the range was smaller (23 to 60 mg/l).

With the exception of the maximum of 250 NTU at one station in December, turbidity levels were similar for May-June (7 to 55 NTU) and December (14 to 34 NTU) surveys. Values for pH were slightly higher in December relative to May-June with all values ranging between 8.1 and 8.5.

In waters off southeastern Louisiana, concentrations of particulate trace metals within a given volume of water are largely a function of the quantity of particles present (Heaton, 1978; Schubel et al., 1978; Tillery, 1980). As expected, maximum concentrations for most particulate metals were measured at station 1 in December, where the Total Suspended Solids (TSS) level was also greatest (102 mg/liter). Overall ranges were 0.20 to 0.62 ug/liter for arsenic, 0.02 to 0.07 ug/liter for cadimum, 0.27 to 0.82 ug/liter for chromium, 0.40 to 1.2 ug/liter for copper, 0.004 to 0.016 ug/liter for mercury, 6.6 to 72 ug/liter for manganese, 0.32 to 0.91 ug/liter for nickel, 0.46 to 1.9 ug/liter for lead, and 2.0 to 4.9 ug/liter for zinc.

Concentrations of most dissolved metals during the surveys were somewhat greater in May-June relative to December. Concentrations ranges for dissolved metals over both surveys were 1.0 to 1.2 ug/liter for arsenic, <0.07 to 0.16 ug/liter for cadimum, <0.11 to 1.0 ug/liter for chromium, 0.94 to 2.5 ug/liter for copper, <0.033 to 0.073 ug/liter for mercury, 0.16 to 18 ug/liter for manganese, 0.38 to 2.0 ug/liter for nickel, 0.05 to 3.2 ug/liter for lead, and 1.4 to 3.2 ug/liter for zinc.

Concentrations of most dissolved chlorinated hydrocarbons (CHCs) examined were below detectable levels at the two stations measured during both surveys. Only dieldrin (0.1 to 4.1 ng/liter), the DDT derivative pp'DDE (24 to 53 ng/liter), and the PCB Arochlor 1254 (0.4 to 0.6 ng/liter) were present in measurable quantities. Dieldrin and pp'DDE levels were substantially greater during May-June relative to December; the higher levels may have been derived from coastal sources.

None of the water column parameters measured during the surveys indicated that dredged material disposal has a permanent measurable effect on water quality in the area of the ODMDS. Waters off southeastern Louisiana are generally turbid because of shallow depths and riverine influences. Levels of most parameters appeared to be typical of the study area.

BIOLOGICAL INVESTIGATION

Benthic samples were taken and trawls made during the December 1980, and the May-June 1981, EPA/IEC surveys. The results indicated the species were representative of the area with no major differences inside or outside the Existing ODMDS.

Macrofauna

During benthic investigation in both December and May-June polychaetes dominated the macrofauna, particularly Mediomastus californiensis, Paraprionospio pinnata, and Cossura spp. During the December survey the Little surf clam Mulinia lateralis was very abundant at three stations (7,8, and 9) probably as a result of seasonal recruitment characteristic of this species (Parker et al., 1980). By the following survey in late spring (May-June), M. lateralis was abundant only at one station (5; and Table A-14). Other common members of this assemblage were the carnivorous ribbon worms Cerebratulus cf. lacteus (and other unidentified rhynchocoel) and the snail Nassarius acutus.

The overall abundance of individuals (individual/m^2) generally increased from December to May-June due to greater densities of polychaetes. However, several sharp declines occurred between surveys at two stations due to reductions in numbers of Mulinia lateralis.

The ODMDS is a shallow area periodically disturbed by storms. The benthic assemblage is dominated by species that live for about 1 year and undergo rapid population expansions (Parker et al., 1980). Results of the surveys indicated that most macrofaunal species were patchily distributed throughout the study area and several, such as Mediomastus spp. and Paraprionospio pinnata, are considered opportunistic. Because of the ability of the endemic species to cope with natural disturbances to their sedimentary habitat, any effects on densities of these organisms which may been caused by dredged material disposal could not be discerned.

Epifauna

Approximately 600 individuals representing 8 invertebrate and 14 fish species were collected from otter trawls in the vicinity of the Atchafalaya River ODMDS. Macrocrustaceans (shrimp and crabs) comprised the bulk of the invertebrate catch; particularly important were the Seabob shrimp Xiphopenaeus kroyeri in December, and the Broken-necked shrimp Trachypenaeus similis and the Lesser blue crab Callinectes similis in May-June. More fish were collected during May-June relative to December; the Atlantic croaker Micropogon undulatus was most abundant.

Macroinvertebrates and demersal fish collected during both surveys are characteristic of the area. Furthermore, relative numbers of dominant organisms collected, such as large numbers of sciaenids (drums and croakers), were similar to results of other studies conducted in the area (Landry and Armstrong, 1980; Weissberg et al., 1980a,b).

(10) Potentiality for the development or recruitment of nuisance species in the disposal site;

Past disposals of dredged material at the Existing ODMDS have not resulted in the development or recruitment of nuisance species. It is not expected that continued dredged material disposals will result in such development or recruitment.

(11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance;

Various shipwrecks exist in the general area of the Existing ODMDS. However, no shipwrecks exist within the site. There are no known other features of historical importance within the site.

GENERAL CRITERIA (228.5)

(a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

The Existing ODMDS is located adjacent to and along the Atchafalaya Channel. This location, involving only short transport of the dredged material, tends to minimize any interference with other activities in the marine environment. There may be some interference with fishing and navigation during the dredging and disposal activities. It is not expected that there will be interference with these or other marine activities outside these brief periods.

(b) Locations and boundaries of the disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminants or effects before reaching any beach, shoreline, marine sanctuary, or known geographical fishery or shellfishery.

There will be a turbidity plume during the actual dredged material disposal operations. This plume should quickly be dispersed to the point where it is undetectable from the turbidity naturally occurring in the area. The nearest point of land is North Point of Point au Fer; some 2 nmi from the north end of the disposal site. It is not expected that turbidity resulting from dredged material disposal will be detectable from the natural turbidity at North Point.

There are no marine sanctuaries in the immediate vicinity of the Existing Site. Shell Keys and Marsh Island Wildlife refuges are approximately 25 nmi West of the Existing ODMDS. Fishnet Bank, the closest protected area of Biological Significance, is approximately 90 nmi south of Existing ODMDS. Commercial fisheries and shellfisheries exist throughout the region. The Existing ODMDS is extremely small in comparsion with the total fishing and shellfishing area of the region.

(c) If at anytime during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in §§228.5 - 228.6, the use of such sites will be terminated as soon as suitable alternative disposal sites can be designated.

The studies to date indicate that the Existing ODMDS meets the requirements of both §228.5 and §228.6. Surveys of the site indicated that water quality, sediments, and biological life were generally similar inside and outside the site. No adverse environmental effects outside the site boundaries were detected.

(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

The configuration of the Existing ODMDS probably resulted from ease of disposal from the Atchafalaya channel dredging areas. The proximity led to the establishment of a long narrow site paralel to the Channel. Regardless of the original considerations, the site lends itself to surveillance of individual dredged material disposal operations and long term monitoring of the site.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

The Existing Site has been historically used for disposal of dredged material.

OTHER FACTORS CONSIDERED

The Existing Site represents an economical location in terms of disposal costs. Its location adjacent to and parallel with the Atchafalaya Channel lends itself to the use of pipeline for dredged material disposal. An alternate location would result in increased costs due to both the increased transport distances and need to use different types of equipment.

There should be no interference with military training, testing, and research activities which are restricted to specifically designated areas. The Existing Site is located well inshore from these areas.

RELOCATION OF EXISTING SITE

The EPA Ocean Dumping Regulations and Criteria (ODR) state in part "§228.5---(e) EPA will wherever feasible, designate ocean dumping sites beyond the continental shelf and other such sites that have been historically used." In addition to an alternate location off the continental shelf as stipulated, relocation of the ODMDS to alternative shallow-water and mid-shelf sites were considered to evaluate relative feasibility.

Relocation of the ODMDS would necessitate changes in dredged material disposal methods. The location of the existing ODMDS in the near vicinity of the dredging areas lends itself to the use of pipelines for transporting the dredged material to the disposal site. Alternative locations of any distance would require the use barges or hopper dredges.

Shallow-Water Alternative Site

Productive fishing banks are located east of the existing ODMDS. Oil and gas development is present throughout the nearshore area. The ODMDS is partially located in the western edge of an oil and gas lease tract which extends to the east. Oil and gas pipelines are located directly west of the ODMDS and platforms are located to the east, south and west. In addition, fishing banks are located throughout the nearshore area. After considering the foregoing, it was determined that an alternative shallow-water ODMDS could be located approximately eight nmi south and two nmi east of the center of the existing ODMDS.

The alternative shallow-water site would be deeper overall (6 m+) than the existing ODMDS (2 to 6.6m). This variance in depth would not be great enough to materially change the physical stresses on the bottom sediment at the two locations. The bottom sediment and biological characteristics of two locations are practically identical. Thus, the environmental effects of dredged material disposal at the alternate shallow-water site would probably be quite similar to those at the existing ODMDS.

Surveillance and monitoring aspects of an alternative shallow-water site would also be similar to those at the existing site.

Relocation of the ODMDS to an alternative shallow water site would subject a new area of the ocean to the effects of dredged material disposal while offering no environmental advantage over the interim site.

Mid-Shelf Alternative Site

The Mid-Shelf area off the coast of Louisiana is a biologically productive area. Oil and gas lease tracts and pipelines are located throughout the mid-shelf area. Since the entire area is biologically productive the selection of an alternative mid-shelf site was based principally on avoidance of the oil and gas lease tracts and pipelines. It was determined that an alternative site with center coordinates of approximately 28°47'00"N, 91°21'00"W would accomplish this avoidance.

Depths in the area of the alternate mid-shelf site range from 3.6m in the northeastern corner to 21.6m. Use of the site would need to be limited to the deeper portions of the area. The site would be approximately 52 km from shore and somewhat closer and due west of Ship Shoal.

The Mid-Shelf area in the vicinity of the proposed alternate site is characterized by a gentle slope with no prominent bottom features. Sediments range from silty clay to silty sand (Weissberg, et al., 1980a).

The Mid-Shelf area, being of greater depth, is less dynamic than the shallow-water area containing the existing ODMDS. The disposed dredged material would be subjected to a slower rate of erosion and transport. The slower rate of transport could result in the depositing of thicker layers of mixed site sediments and dredged material outside the site boundaries than occurs at the existing site.

The effects on the bottom organisms within a mid-shelf site would be similar to those at the existing site. Some bottom organisms would be covered by the dredged material and smothered. Others would be able to work their way through the sediment layers and recolonize. Some phytoplankton and zooplankton could be trapped in the decending plume and destroyed. Nekton should be able to avoid the plume. Considering the large area occupied and range of the bottom organisms, phytoplankton, zooplankton, and nekton, the effects of dredged material disposal in the relatively small area of the mid-shelf site would be minor.

There would be increased costs associated with a mid-shelf alternative site. A cutterhead pipeline dredge would no longer be feasible due to the distance and hopper dredges or barges would be required. Dredged material would be transported by the hopper dredge or barge and released while the vessel passes slowly through the site.

Although surveillance and monitoring methods would be similar to those necessary at the interim site, costs would be increased due to the increased travel and sampling time. The greater distance and depths of water may require use of larger vessels and special equipment.

Deep Water Alternative

The deep water region is considered to be the area seaward of the 92 m water depth contour. While this area is beyond the white and brown shrimp grounds, it contains the royal red shrimp grounds and major fish harvest areas. Fishing banks are located in the area. A deep water site should be located well beyond the shelf-break (Pequegnat et al., 1978); a distance from shore of over 100 nmi. It was postulated a deep water site could be located off the Continental Shelf directly south of the existing site. No specific site within the area was selected for evaluation.

The disposed dredged material would probably be dispersed over a larger area than at a mid-shelf site or the existing site due to of breakup of the descending plume. Once the sediments reached bottom, they would tend to remain in place with slow erosion and transport. However neither of the foregoing assumptions can be confirmed without specific information on the upper water and bottom currents of the specific site.

The effects of dredged materials disposal on bottom organisms, phytoplankton, zooplankton, and nekton within the site would be similar to that at the existing site or the mid-shelf alternative site. Some bottom organisms, phytoplankton, and zooplankton would be trapped and perish. Nekton would be affected to the extent of having to avoid the descending plume.

The safety hazards of dredged material disposal would be materially increased. The barges containing the dredged material would be operating in open ocean waters for long periods of time. In addition, they would need to navigate through dense oil and gas fields with their associated traffic. The possibility of emergencies developing which would necessitate dumping the dredged material prior to reaching the disposal site would increase dramatically.

While surveillance and monitoring could be accomplished, these activities would be difficult and costly. Surveillance could be accomplished through reports, ship riders, and overflights. Monitoring would require special equipment because of the open ocean operation and the great water depths.

The annual dredged material disposal costs would be greatly increased due to the necessity of acquiring a hopper dredge and perhaps barges. In addition, dredging costs would be increased because of lost time waiting for return of the barges.

Relocation Summary Findings

- An alternate to the interim ODMDS could be located in the shallow-water area, the mid-shelf area, or off-the Continental Shelf.

- No material environmental advantage would result from relocation of the existing site to alternate shallow-water or mid-shelf areas, or off-the-Continental Shelf.

  - The environmental effects on biological life within the site boundaries would be similar at all sites.

- Because of the dynamic nature of the area, erosion and transport of the mixed site sediments and dredged material would occur at a relatively fast rate at the existing and alternative shallow-water site. The transport would result in dispersion of the mixed materials over a wide area in very thin layers; thus, bottom organisms are not likely to be smothered. The nearshore benthos is adapted to a shifting substrate.

- Erosion and transport of the mixed sediments at a mid-shelf site would be slower than in the shallow-water area due to its less dynamic nature.. The transported mixed sediments would settle over a smaller area in thicker layers. While the possibility of smothering of bottom organisms outside the site would be minimal, some increased smothering might occur within the site boundaries.

- Erosion and transport of the mixed sediments at a site off the Continental Shelf, if it occurs, would be quite slow. Bottom organism outside the site would not suffer smothering because of the slow nature of the dispersion. However, the benthic organisms are not adapted to a dynamic environment.

o Surveillance and monitoring could be accomplished at all sites. They would be more time-consuming and costly at a mid-shelf alternative site. They would be difficult and very time-consuming and expensive at a site off-the Continental Shelf.

o The costs of transporting the dredged material to the disposal site would increase with the distance of the site from the dredging area particularly as new equipment would be necessary. An increased annual cost could become prohibitive, particularly in connection with an alternate site off-the-Continental Shelf.

Based on the above considerations, relocation of the existing interim designated ODMDS to an alternate ocean area offers no environmental advantage over designation of the existing site.

PREFERRED ALTERNATIVE

The foregoing evaluation results in the following observations regarding the final designation of the interim Atchafalaya ODMDS for dredged material disposal.

1. No-action would leave the status of the Existing ODMDS undetermined, thus, the suitability of the site for disposal of dredged material would remain in question. The ODR require the final designation or de-designation of an interim ODMDS upon completion of evalutive studies.

2. Relocation of the ODMDS would subject new ocean areas to the effects of dredged material disposal without resulting in environmental advantages over the Interim Site. Relocation also would result in increased cost for dredged material disposal.

3. The interim site is located in an unstable environment characterized by high variability in physical factors. Correspondingly, the organisms which occur there are adapted to natural stresses and are able to recover more rapidly than those organisms adapted to stable conditions.

4. The Existing ODMDS has been historically used for the disposal of dredged material. Continued use of the site would subject the area within the site boundaries to the same environmental effects that have existed for a number of years. Except for the periodic burial of bottom organisms and the temporary existence of a disposal plume, these effects have been minimal.

5. No adverse environmental effects due to dredged material disposal outside the boundaries of the Existing Site were detected during the surveys of the site; nor were they indicated by the evaluation. It is not expected that adverse environmental effects outside the site boundaries will result from continued use of the site.

Based on the studies and analysis, the preferred alternative is the final designation of the interim designated Atchafalaya ODMDS (boundary coordinates

29° 20'50"N, 91° 24'03"W; 29° 11'35"N, 91° 32'10"W; 29° 11'21"N, 91° 31'37"W; 29° 20'36"N, 91° 23'27"W) for disposal of dredged materials.

USE OF THE SITE

Future use of the Atchafalaya River Bar Channel ODMDS for disposal of dredged material must comply with the EPA Ocean Dumping Regulations and Criteria. The site designation evaluation was based on the disposal of sediments dredged from the Atchafalaya River Bar Entrance Channel for channel maintenance. Other dredged material must be evaluated to ensure its compliance with EPA criteria as set forth in the ODR and its suitability for disposal at the Site.

Dredged material disposal at the Existing Site has averaged 8,625,000 yd^3 every 2-2 1/2 years without significant adverse impacts. The amount of material would be representative of an annual disposal rate since it generally results from the dredging operation during a calendar year rather than a series of smaller operations over 2-2 1/2 years. The disposal of dredged material at the Existing Site at a rate not exceeding of 8.6 million yds^3 per year is acceptable. Any increased rates should be evaluated to ensure such rates are within the capacity of the site. Disposal operations should be timed to avoid the spring and fall migration of species between the estuaries and Gulf of Mexico.

The current methods being used by the CE for disposal are acceptable for continued use. Other generally used methods of disposal may also be acceptable after review through the permitting process.

Monitoring of the Site

The Ocean Dumping Regulations require that effects of disposal on a disposal site and surrounding marine environment be evaluated periodically. Information used in making the disposal impact evaluation may include data from monitoring surveys. Thus, "if deemed necessary," the CE District Engineer (DE) or EPA Regional Administrator (RA) may establish a monitoring program to supplement historical site data. The monitoring plan is developed by determining appropriate monitoring parameters, frequency of sampling, and areal extent of the survey. Factors considered in making this determination include frequency and volumes of disposal, physical and chemical nature of the dredged material, dynamics of the site physical processes, and life histories of the species monitored.

The primary purpose of the monitoring program is to determine whether disposal at the sites is significantly affecting areas outside the sites, and to detect any unacceptable long-term adverse effects occurring in or around the sites. Consequently, the monitoring study should survey the sites as well as surrounding areas, including control sites and areas which are likely to be affected (as indicated by environmental factors, such as prevailing sediment transport). Results of an adequate survey will provide early indication of potential adverse effects outside the site.

Monitoring for movement of materials into estuaries or onto beaches or shorelines is minimized because the dredged material is environmentally acceptable for disposal in the ocean and is similar to sediments of the surrounding waters. Many physical parameters will be unaffected significantly by dredged material disposal. Physical parameters that show large variations after disposal and return quickly to ambient levels do not require monitoring. Selected parameters which occasionally vary widely (e.g., sediment characteristics) may be monitored to separate natural environmental fluctuations from those caused by disposal of dredged material.

Lease oyster grounds are located at the mouth of Atchafalaya Bay and the increased turbidity during dredging may stress the oysters if the dredged material is transported shoreward. Monitoring of the effects of dredged material disposal on the oyster beds is recommended.

The Existing Site is in a productive fishing area. Although there are no data to suggest that the existing fishery has been affected adversely as a result of previous disposal operations, the monitoring program should include methods for detecting possible effects on the surrounding fisheries.

The monitoring plan should be designed to detect changes from the historic characteristics of the site and its immediate surrounding area, and possible long-term effects on the surrounding area.

Chapter 3

AFFECTED ENVIRONMENT

Environmental characteristics that may be affected by dredged material disposal off the Louisiana Coast are described in this chapter. Characteristics potentially affected by ocean disposal are generally categorized as geological, chemical, or biological. Ancillary information, such as physical oceanography and meteorology, is presented because these natural physical processes influence the fate and effects of released dredged material. Commercial and recreational resources that may be affected by dredged material disposal are also discussed herein.

ENVIRONMENTAL CHARACTERISTICS

Climate

Climatic parameters of interest at an ODMDS are air temperature, rainfall, wind, storm occurrences, and fog. Air temperature interacts with surface waters and, particularly during warm periods, influences the vertical stability of the water column. Rainfall increases coastal freshwater runoff, thereby decreasing surface salinity and intensifying vertical stratification of the water column. Coastal runoff also contributes suspended sediments and various chemical pollutants. Winds and storms can generate wave and currents which resuspend and transport dredged material. A high incidence of fog during particular seasons might affect navigational safety and limit disposal operations.

The Bermuda High, an extensive and persistent high-pressure cell located over the southwestern part of the Atlantic Ocean dominates spring and summer weather in the northern Gulf. By autumn, high pressure systems over the North American continent strengthen and strongly influence weather patterns, allowing periodic intrusions of polar air and storm fronts into the area (DOC, 1980b; Weissberg et al., 1980b). No specific meteorological data are available for the Atchafalaya Site; however, the proximity of the Site to the Louisiana coast is such that it has a climate similar to the central Louisiana shore and Mississippi Delta.

Coastal Louisiana has an annual mean air temperature of 23°C (Weissberg et al., 1980b). July and August are the warmest months, with a mean temperature of 29°C; January is the coldest month with a mean temperature of 17°C (ibid.). Minimum and maximum temperatures ranged between -1°C and 38°C over a 19 year period.

Precipitation during late autumn, winter, and early spring is generally associated with northern frontal activity. Precipitation in summer and early autumn originates from scattered showers, thunderstorms, and occasional tropical storms. Measurable precipitation falls 3-4% of the time from November to March and in August and September. Winter precipitation generally falls as a slow steady rainfall. Precipitation is intense in summer and early autumn; the greatest amount of rainfall is associated with tropical storms in August, September, and October (DOC, 1980b; Weissberg et al., 1980b; Brower et al., 1972). Mean annual precipitation in New Orleans is 137 cm (Weissberg et al., 1980b). Snowfall is rare along the coast and the frequency decreases with increased distance offshore (DOI, 1978).

Coastal fog, formed by warm moist Gulf air blowing over the cooler Louisiana shoreline, or by the seaward drift of land fog, may be encountered in nearshore regions. Heavy fog (with visibilities less than 0.5 nmi) is most common from December to April (DOC, 1980b). Fog occurs 3-5 times per month in October and November, 5-6 times per month in December, January and February, and about 3 times per month in March (Fernandez-Partagus and Estoque, 1981). Visibility under 2 nmi occurs about 1% of the time from December to April and less than 0.5% of the time during the rest of the year (DOC, 1980b); visibility is less than 0.5 nmi between 0.2 and 0.6% of the time from December to April (U.S. Naval Weather Service Command, 1970).

The Bermuda High produces weak but consistent spring and summer winds from the east and southeast (Table 3-1). During winter and late autumn, wind patterns are highly influenced by continental high pressure systems, which result in mean winds from the north and northeast (Table 3-1; DOC, 1980b; Wells et al., 1981). Strong winds from the north and northwest may occur for brief periods throughout the year; however, they are most common during the winter months (Weissberg et al., 1980b). Winds are more variable near the coast than over the open Gulf because of the influence of land and sea breezes, which are produced by differential heating of the shore and sea and superimposed over general wind patterns in coastal regions (DOC, 1980b).

Winds are strongest from November to March, with average speeds of 13 kn (Table 3-1). Gale force winds along coastal Louisiana typically result from polar air masses penetrating the Gulf from the North American continent. Gales occur between 0.6 and 1.3% of the time from September to March, and less than 0.5% of the time during the remainder of the year (DOC, 1980b). Highest wind speeds, up to 175 kn, have been measured during the passage of hurricanes (Weissberg et al., 1980b).

Two major types of storm systems occur in the northern Gulf of Mexico. Late autumn and winter storms are generally extratropical cyclones (northers), whereas summer and early autumn storm activity is dominated by tropical cyclones. Northers typically occur between November and March and result from polar air masses penetrating from the North American continent (DOC, 1980b). Minimum wind speed during a norther is generally 20 kn; severe northers have wind speeds ranging from 25 to 50 kn (ibid.). From 1 to 6 severe northers may occur each year, typically lasting 1.5 days; however, the more severe storms may persist from 3 to 4 days (ibid.).

TABLE 3-1

MEAN MONTHLY WIND SPEED AND DIRECTION FOR THE CENTRAL GULF COAST AREA, 1952-1971

Source: Weissberg et al., 1980b

Month	Wind Speed kn	Direction
January	13.3	N
February	13.3	E
March	12.9	SE
April	12.4	SE
May	10.4	SE
June	9	SE
July	8.1	SE
August	8.5	SE
September	11.4	E
October	11.9	NE
November	13.1	N
December	13.4	E
Annual	11.5	SE

A tropical cyclone is a warm-core, low-pressure, closed circulation system that develops over warm waters of tropical ocean, and has rotary, counter-counterwise circulation in the Northern Hemisphere. A tropical storm is a cyclone with wind speed from 34 to 63 kn. The storm is classified as a hurricane when wind speeds reach 64 kn or higher.

Tropical storms typically move into the Gulf of Mexico from the southeast and turn to a northerly direction as they approach the Louisiana coast (Crutcher and Quayle, 1974). Tropical storms occur most frequently between June and October, with a peak frequency in the Louisiana coastal and offshore region in September (Table 3-2). Between 1899 and 1971, 45 tropical cyclones occurred in the region; 18 of the storms were hurricanes, with an average occurrence of one event per 4 years (Weissberg et al., 1980b). The most severe storm to impact the Louisiana coastal area in recent history was Hurricane Camille, which struck in August 1969 with wind speeds of 175 kn (ibid.).

Physical Oceanography

Physical oceanographic parameters determine the extent of water column mixing and sediment transport and affect the chemical environment at an ODMDS. Strong temperature or salinity gradients inhibit mixing of surface and bottom waters, whereas waves aid mixing. Waves also resuspend bottom sediments, thereby affecting the turbidity of the water and contributing to sediment transport. Currents, especially bottom currents, determine the direction and influence the extent of sediment transport in and out of an ODMDS. Tidal currents may contribute to the transport of disposal material, but usually do not add net directional effects.

TABLE 3-2
AVERAGE MONTHLY NUMBER OF TROPICAL STORMS AND HURRICANES IN THE 5° SQUARE BOUNDED BY 25°N-30°N and 90°W-95°W. Modified from Crutcher and Quayle, 1974

Month	June	July	August	September	October	November
Dates	1 - 30	1 - 31	1 - 15 16 - 31	1 - 10 11 - 20 21 - 30	1 - 15 16 - 31	1 - 30
Numbers of storms or hurricanes	0.19	0.19	0.14 0.12	0.15 0.31 0.17	0.12 0.10	0.02

WATER MASSES

Water masses in the nearshore Louisiana area are influenced by freshwater discharge from the Mississippi and Atchafalaya Rivers and, locally, from coastal estuaries, and by intrusions of Loop Current water (Comiskey and Farmer, 1981). Influences from riverine and estuarine discharges are greater in nearshore than in mid-shelf areas. Conversely, characteristics of water masses in the mid-shelf region are influenced to a greater extent by open Gulf waters and broad scale circulation patterns.

River and tidal discharges influence the temperature and salinity, as well as concentrations of nutrients, trace metals, and suspended sediments in nearshore waters (Murray, 1976). Maximum combined seasonal discharge from the Mississippi and Atchafalaya Rivers occurs in April (52,000 m^3/sec), with minimum discharge occurring in September (6,400 m^3/sec), (Barrett et al., 1978). Runoff volumes from other tributaries feeding the north-central Gulf are highest in May.

Low salinity waters derived from coastal rivers may form a distinct nearshore boundary layer whose width varies with respect to discharge volumes and turbulent mixing (Murray, 1976). The extent of vertical and horizontal mixing within the boundary layer will vary seasonally depending upon current and wind velocities and density differences between the freshwater plume and ambient nearshore waters.

Vertical stratification may occur in waters (c.f., Turgeon, 1981; Fotheringham and Weissberg, 1979). Density stratification results from low salinity waters, discharged from coastal rivers, overlying colder, saline bottom waters during a period of minimal vertical mixing (Fotheringham and Weissberg, 1979). Prolonged vertical stratification during summer can promote oxygen depletion in bottom waters, resulting in mass mortalities of infaunal and epifaunal organisms throughout large areas of the western and central Louisiana Shelf (Fortheringham and Weissberg, 1979; Harper et al., 1981).

Water masses at the Existing Atchafalaya ODMDS are predominantly influenced by freshwater discharges from the Atchafalaya and Mississippi Rivers, and by intrusions of saline offshore water (Weissberg et al., 1980a; Murray, 1976; Hall and Bouma, 1976; Fotheringham and Weissberg, 1979). The Atchafalaya River is the major tributary of the Mississippi River, and transports thirty percent of the total Mississippi River discharge (Weissberg et al., 1980a). This massive influx of freshwater has a strong effect on coastal waters in the area.

The coastal zone near the Site is vertically stratified in summer and well-mixed during winter (Weissberg et al., 1980a,b). Salinity increases with distance from shore and reflects the dilution of brackish riverine water with greater volumes of saline Gulf water. Consequently, salinities are generally higher further offshore than at the Existing Site (Weissberg et al., 1980a). Summer intrusions of high salinity bottom waters occur in the mid-shelf area (Fotheringham and Weissberg, 1979); a strong halocline is evident during the summer at a depth of 7 to 8m. (Weissberg et al., 1980a). Whether these intrusions are strong or occur frequently in the Existing Site is not clear.

CIRCULATION AND CURRENTS

Circulation in the Gulf of Mexico is complex and influenced by the Loop Current, tides, winds, and river discharge (DOI, 1978). The major feature of broad scale circulation in the Gulf is the Loop Current which, as a continuation of the Yucatan Current, enters the Gulf through the Yucatan Strait, penetrates up to 29°N in summer, turns clockwise, and exits through the Florida Straits. During winter the Loop Current is confined to the southeastern Gulf, and passes through the Straits of Florida with little intrusion into the central Gulf (Hubertz, 1967; Leipper, 1970). Eddy-like rings pinched off from the Loop Current, carrying momentum, high salinity water, and nutrients, are major contributors to circulation in the central and western Gulf (Sturges and Horton, 1981).

Local currents in vicinity of the Atchafalya ODMDS are predominantly influenced by winds and, to a lesser degree, tides, loop current intrusions, and river flow. Net flow is to the northwest throughout most of the year (Wells et al., 1981; Weissberg et al., 1980a,b).

Winds are a particularly strong driving force in the late autumn, winter, and early spring. Net water flow in the winter is to the northwest near the Site, however, rapid flow reversals to the southeast occur periodically and are well correlated with similar changes in wind direction (Weissberg et al., 1980a,b; Crout and Hamiter, 1981). Tides may dominate current direction during winter periods of slack winds; however, tidal influences result in little or no net water or sediment displacement at the Site. Periods of tidal dominance are periodically interrupted by wind-induced water movements which may last for several days (ibid.).

Nearshore current patterns are somewhat more complex in summer. In the absence of strong winds and the presence of a stratified water column, current patterns become considerably less distinct. Net flow in summer can be either to the east or the west (Crout and Hamiter, 1981; Weissberg et al., 1980a).

Current speeds generally range from 10 to 40 cm/sec (0.2 to 0.8 kn) at the Existing Site. Minimum speeds of 5 to 30 cm/sec (0.1 to 0.6 kn) occur during June, July, and August, whereas, the highest recorded current speeds in the vicinity of the Site range from 70 to 140 cm/sec (1.4 to 2.8 kn) and occur during strong winter storms (Weissberg et al., 1980a,b). Current speeds of up to 200 cm/sec (4 kn) may occur during hurricanes off Atchafalaya Bay, about once every four years. Vertical shear stress generally causes current speeds to decrease with depth; this effect is particularly common when wind is the primary driving force and the water column is stratified. Stagnant periods with little or no current motion have been recorded in April, May, and July, and may last for as long as six days (Weissberg et al., 1980a,b).

WAVES AND TIDES

Waves in Northern Gulf are a combination of wind-generated waves and swell entering from the open Gulf. Wave direction generally follows the wind direction and its seasonal patterns; wind and wave directions are similar during 80% of the year (Wiseman et al., 1975: cited in Wells et al., 1981). Ninety-three percent of the waves are under 1.5m high, and 41% of these approach from the southeast quadrant (Table 3-3). Tides are relatively weak in the Gulf of Mexico.

TABLE 3-3
SUMMARY OF ANNUAL WAVE CLIMATE ALONG LOUISIANA COAST
Source: Wells et al., 1981

Wave*		Direction				
Height (m)	Period (sec)	E (%)	SE (%)	S (%)	SW (%)	Total (%)
1.0	4.5	13	21	8	5	47
1.5	6.0	9	20	9	8	46
2.0	7.0	1	1	1	0	3
2.5	8.0	1	0	2	1	4
		24	42	20	14	100

GEOLOGY

Geological information relevant to an ODMDS includes bathymetry, sediment characteristics, and dredged material characteristics. Bathymetric data provide information on bottom stability, persistence of sediment mounds, and shoaling. Sediment characteristics strongly determine the composition of the resident benthic biota. Differences in sediment size distribution between natural ODMDS sediments and dredged material may be used as a tracer to determine the area of influence of the dredged material. Changes in sediment size at the ODMDS which may be induced by disposal can produce changes in chemical characteristics and in the composition of the benthic biota.

*Percentages cited are relative to the percentage of time during the year when wind velocities exceed 10 km/hr; this occurs an average of 43.3% of the year.

The Louisiana coastline can be divided into two broad segments: the chenier plain and the deltaic plain; Atchafalaya Bay lies roughly in the middle of these two physiographic regions (Wells et al., 1981). The chenier plain, extending west from Marsh Island, Louisiana to East Bay, Texas has a relatively smooth and regular shoreline fronted by intermittent mudflats and breached by small inlets that connect with shallow marshy estuaries (Wells et al., 1981; Gosselink et al., 1979). The chenier plain system is a unique sedimentary deposit zone consisting of beach and dune ridges lying on muddy marsh deposits that have been overlapped by newly developed mudflat marshes (Shepard, 1973; Weissberg et al., 1980a). The deltaic plain shoreline is highly irregular and dotted with numerous bays and small lakes (Wells et al., 1981).

Most of Louisiana is located in the vicinity of the Gulf coast geosyncline, the axis of which generally corresponds to the trend of the present coastline (Weissberg et al., 1980a,b). This geosyncline has been gradually subsiding since the Cretaceous period because of the large amount of deltaic sedimentation and deposition from the Mississippi River and its tributaries.

The continental shelf off eastern Louisiana has been completely overlapped by the Misissippi Delta during the past 500 years (Fisk et al., 1954). West of the Delta, a trough extends about 20 nmi to the shelf edge and can be traced down the gentle outer slope over 50 nmi until it emerges into the broad fan of the Mississippi Cone (Shepard, 1973). Adjacent to this trough, the shelf off Atchafalaya Bay extends offshore about 100 nmi and to the shelf-break, which occurs at a depth of 150m (ibid.). The shelf grades gently (about 0.04°) out to the continental slope.

Louisiana's coastal zone is predominantly covered by late Quaternary sediments (Hall and Bouma, 1976). The continental shelf west of the Mississippi Delta is blanketed by a thick layer of terrestrial sediments that grade from sand near the shore to silt and clay further offshore (Uchupi and Emery, 1968).

Two major types of deposition occur in the Louisiana coastal area (Coleman, 1966; cited in Hall and Bouma, 1976). One is a result of sediment input from present and former Mississippi River tributaries; examples of this type of deposition are the Mississippi Delta and the present prograding Atchafalaya River Delta. The other depositional regime is a result of coastal sediment transport processes, which have produced features such as mud flats and the chenier plain west of Marsh Island.

Sediment distribution off Atchafalaya Bay can be attributed to transport and deposition of suspended sediments from the Atchafalaya and Mississippi Rivers. Resuspension and redistribution of sediments by currents and winter storms probably exert a large influence on nearshore sediments through resuspension and winnowing of fine components.

The Atchafalaya River is a distributary of the Mississippi and presently carries about 30% of the Mississippi River's total water and sediment load (Wells et al., 1981). Increasing sediment load in the Atchafalaya River has resulted in a rapid progradation of the Atchafalaya River Delta (Van Heerden and Roberts, 1980; Roberts et al., 1980; Wells et al., 1981). Eventually the Delta is expected to expand throughout Atchafalaya Bay forming extensive marshlands (Van Heerden and Roberts,1980). The remainder of the river's suspended sediment load is carried out beyond the Point au Fer Shell Reef, and a portion is deposited in the vicinity of the Existing Site.

Almost 150 million m^3/yr of fine sediments are brought to the Gulf of Mexico by the Atchafalaya River (Wells et al., 1981). A mud plume extends from the mouth of the Atchafalaya River into the Gulf throughout the year, and trails to the west about 75% of the time (Wells and Kemp, 1981). On the order of 50 million m^3 of sediment are carried to the west at about 10 cm/sec in the coastal mud stream; a portion of these sediments are deposited along the rapidly growing eastern flank of the chenier plain (Wells et al., 1981). The coastal mud stream transports about an order of magnitude more sediments than can be accounted for in yearly mud flat accretion along the chenier plain; the remainder of the sediments may be spread across the inner shelf for as much as 50 nmi (Wells and Kemp, 1981). Spring storm activity can enhance this sediment transport system and result in suspended sediment transport for more than 125 nmi to the west (Crout and Hamiter, 1981).

The nearshore coastal area off Louisiana is characterized by a shallow, gently sloping plain punctuated by sand and shell shoals. Several shoals are located off Atchafalaya Bay: (1) Ship Shoal, located 25 nmi east of the Existing Site, (2) Trinity Shoal, approximately 25 nmi west of the Existing Site, and (3) Tiger Shoal, located inshore of Trinity Shoal (DOC, 1980a,b). Two unnamed shoals are located immediately west of the seaward end of the Existing Site (DOC, 1980a). The nearshore shoals typically rise 2 to 4m from the bottom to a depth of 2 to 4m below the water surface (DOC, 1980a). Point au Fer reef is a massive shell reef that lies about 3 nmi shoreward of the Existing Site; this reef is roughly 0.5 nmi wide and extends nearly 20 nmi across the mouth of Atchafalaya Bay (CE, 1978).

The Existing Site lies in 2 to 7m of water. The Site is shallowest near the entrance to Atchafalaya Bay and slopes gently at about 0.01° to the southwest. Recent navigation charts of the area show no evidence of mounding (DOC, 1980a). There is a small unidentified obstruction near the center of the Site (ibid.).

Sediments on the shelf off Atchafalaya Bay range from sand to clayey silt to silty clay. Nearshore sediments are predominately (>95%) silt and clays. Sediments become increasingly coarse in the seaward direction; at approximately the 10m contour sediments are predominately (>70%) sand (Hausknecht, 1980; Weissburg et al., 1980b). Seaward of the 10m contour, sediments consist of clayey silts and silty clays. Grain-size generally becomes coarser during the winter months due to the resuspension of silts and clays by storm turbulence (Hausknecht, 1980).

Sediments over this region are chiefly of terrigenous origin, containing less than 30% calcium carbonate (Uchupi and Emery, 1968). The shelf also contains numerous hills largely composed of salt domes and partly of mud diapers (Uchupi and Emery, 1968; Shepard, 1973).

During EPA/IEC surveys, surficial sediments in the Existing Site were predominantly silts and clays. In December 1980 and May-June 1981, the percentage of fines (silt and clay) and sand ranged from 82 to 100% and from 0 to 1% respectively. The clay fraction was slightly higher in May-June than in December. This was probably a function of lower wave current energy in late spring and summer relative to winter, and inputs of fines from the river in spring. Sediment types were generally the same inside and outside the Existing Site, and no effects were evident that could be related to dredged material disposal.

Water Column

The chemical parameters pertinent to evaluation of an ODMDS include suspended solids, nutrients important to phytoplankton growth (e.g., nitrates and phosphates), dissolved and particulate trace elements (e.g., Cd, Hg. and Pb), and organics (e.g., PCBs, DDT's, and phenols). High levels of suspended solids can reduce light penetration through the water column, and inhibit phytoplankton productivity or clog respiratory structures of fishes and other organisms. Nutrients are essential for growth and reproduction of phytoplankton, however, under certain conditions and at elevated levels, these nutrients can promote eutrophication and subsequent depletion of dissolved oxygen.

Several trace elements are necessary micronutrients for life processes of organisms; however, metals such as mercury and cadmium can be toxic when present in relatively high levels in water or in food sources. Many chlorinated and petroleum hydrocarbons are also toxic and can be bioaccumulated if ingested in sufficient quantity by marine organisms.

TEMPERATURE

Average winter surface water temperature in the Gulf of Mexico grade from 18°C in the northern Gulf to 24°C in the southern Gulf, with strong onshore-offshore temperature gradients over the shelf area. During the summer surface temperatures are nearly uniform across the Gulf and average 29°C (DOI, 1978).

Temperatures in shallow coastal water areas closely follow seasonal changes in air temperature (Hall and Bouma, 1976; DOI, 1978). Typical summer temperatures range from 27 to 30°C; winter temperatures are between 12 to 22° (Weissberg et al., 1980a, 1980b). Vertical temperature stratification may periodically occur in shelf waters during summer following intrusions of cooler, more saline Gulf waters (Weissberg et al., 1980a).

SALINITY

Salinity distribution in the Gulf of Mexico is influenced by the Loop Current, precipitation, river discharge, evaporation, circulation, and mixing (DOI, 1978). Open Gulf salinities are generally around 35°/oo (Arthur D. Little, Inc., 1973). Discharge from the Mississippi and Atchafalaya Rivers, however, create a nearshore band of lower salinity water (DOI, 1978).

Salinity varies considerably in the nearshore area. Surface salinities in the Mid-Shelf area range from 20.4°/oo in early April to 29.9°/oo in November; bottom salinities range from 22°/oo in early

April to 30.9°/oo in March (Weissberg et al., 1980a). Salinity stratification, resulting from a brackish layer of mixed river and Gulf water overlying highly saline Gulf Water, is common in the Louisiana nearshore zone during spring and summer (Weissberg et al., 1980a,b). In winter, wind and wave induced turbulence mixes the shallow coastal waters, disrupting summer haloclines.

Salinities varied widely during the EPA/IEC surveys of the Atchafalaya ODMDS and its immediate vicinity. Mid-water salinity values ranged from 15.0 to 26.6°/oo in December 1980 and 4.9 to 35.5°/oo in May-June 1981. The low salinity (4.9°/oo) in May-June 1981 was measured at a nearshore station west of the Existing Site. A value of 15.0°/oo was measured at this station in December 1980. Salinities at all other stations tended toward the higher end of the range in both the winter and summer surveys.

DISSOLVED OXYGEN

Dissolved oxygen (DO) concentrations in Louisiana shelf waters may vary with season and depth (Reitsema, 1980; Landry and Armstrong, 1980). For example, during summer freshwater discharge and/or intrusions of open Gulf waters may cause density stratification of the water column. Restricted vertical mixing and oxidation of organic matter in surficial sediments promotes oxygen depletion in bottom waters. Anoxic or hypoxic conditions in shelf bottom waters may be an annual phenomenon off Louisiana (Parker et al., 1980; Reitsema, 1980; Harper et al., 1981). During winter shelf waters are typically well-mixed vertically due to increased storm turbulence and reduced river runoff, resulting in relatively higher oxygen concentrations.

EPA/IEC surveys conducted within and around the Atchafalaya ODMDS found the water at mid-depth to be well oxygenated. DO concentrations were somewhat higher in winter than spring, with values ranging from 9.5 to 10.3 mg/l and 6.8 to 8.9 mg/l, respectively.

Shallow waters in the Vermilion Bay - Atchafalaya Bay complex are typically well-oxygenated; DO concentrations over a two year period averaged 8.2 mg/l with no depth related trends noted (Juneau, 1975). Offshore from Atchafalaya Bay, at approximately the 10m contour, DO levels range from 7.5 mg/l at the surface to 0.1 mg/l in bottom waters during summer stratification (Parker et al., 1980; Fotheringham and Weissberg, 1979). In winter, the water column is well- mixed and DO levels may range from 10 mg/l at the surface to 8 mg/l in bottom waters (Parker et al., 1980; Weissberg et al., 1980b).

pH

Coastal waters may experience some fluctuations in pH values resulting from photosynthetic activity and river runoff. Thus, there can be seasonal and non-seasonal fluctuations.

During EPA/IEC surveys the pH within and around the Existing Site was slightly higher in winter relative to spring. However, all values (8.1 to 8.5) fell within the normal range for seawater. The lower pH values may have reflected runoff from the coastal marshes where acid formation is known to occur. pH values measured in waters further offshore in the mid-shelf area range from 6.7 to 9.3 with an average value of 8.1. (DOT, 1976).

NUTRIENTS

Nutrient concentrations in open Gulf and shelf waters off Louisiana are typically low, except in localized nearshore areas in the vicinity of coastal rivers and embayments (Brooks, 1980; Barnard and Froelich, 1981; Ho and Barrett, 1977). Factors influencing nutrient concentrations in shelf waters include river discharge, coastal currents and winds, biological activity, rainfall, and proximity to coastal marshes (Ho and Barrett, 1977; Brooks, 1980). Typical nutrient concentrations for northern Gulf coastal waters are listed in Table 3-4.

TABLE 3-4
NUTRIENTS RANGES (ug-at/liter) FOR THE NORTHERN GULF COASTAL WATERS

	Mean	Minimum	Maximum	Surface Mean
PO_4	0.10 - 0.40	0.01 - 0.17	0.21 - 4.74	0.03 - 0.32
NO_3	0.5 - 2.7	0.1 - 0.2	3.5 - 13.8	0.1 - 0.8
SiO_2 (dissolved)	1.7 - 4.6	0.1 - 2.3	4.7 - 13.9	1.2 - 5.6

Source: Brooks, 1980

TURBIDITY AND SUSPENDED SOLIDS

Turbidity in coastal Louisiana waters is influenced by resuspension of surficial sediments and runoff from the Atchafalaya and Mississippi Rivers; discharge plumes from the Atchafalaya River have been detected as far as 18 miles offshore. Secchi disk measurements have ranged from 0.5 to 6.5m in the Atchafalaya area (Weissberg et al., 1980a, 1980b).

Total suspended solid (TSS) levels vary within Louisiana coastal waters, but are generally many times higher than levels off the east and west coasts of the United States (Wells et al., 1981). Wave climate, bottom texture, and proximity to the Mississippi and Atchafalaya Rivers and local bayous are factors influencing TSS levels (Wells et al., 1981; Hausknecht, 1980; Harris, 1972). TSS levels decrease with distance from shore. For example, nearshore, surface waters within the Atchafalaya River plume may have TSS concentrations ranging from 200 to 500 mg/l; whereas offshore waters may contain 30 mg/l (Wells et al., 1981) and open Gulf surface waters have TSS levels as low as 0.6 mg/l(Harris, 1972).

EPA/IEC surveys measured high turbidity within and around the Atchafalaya ODMDS; values ranged from 7 to 55 nephelometric turbidity units (NTU) in late spring and from 14 to 34 NTU in winter. A wide TSS range (10 to 102 mg/l) was measured during December at the Existing Site when stormy weather was encountered. A smaller TSS range (23 to 60 mg/l), with a generally decreasing offshore trend, occurred during the May-June survey.

TRACE METALS

Distributions and concentrations of trace metals in the Gulf of Mexico are variable and related to land runoff, biological activity, anthropogenic inputs, and physical processes mixing Gulf waters (Frey et al., 1981; Trefry, 1981). The major source of dissolved and particulate trace metals to the Gulf is discharge from the Mississippi and Atchafalaya Rivers and, to a lesser extent, from coastal embayments. In general, dissolved and particulate trace metal concentrations decrease with increased distance from the input source (Bahr and Hebrard, 1976). A significant portion of the trace metal concentration is in the particulate fraction (Trefry, 1981).

Maximum concentrations for most particulate metals at the Atchafalaya ODMDS were measured during EPA/IEC surveys at Station 1 (center of site) for December, where the TSS level was also greatest (102 mg/liter). Particulate trace metal values were slightly lower at control Station 6 (east of site) during May-June (TSS = 58.7 mg/liter), followed by roughly equivalent concentrations for Station 1 in May-June and Station 6 in December (TSS = 23.0 and 18.5 mg/liter, repectively). Overall ranges were 0.20 to 0.62 ug/liter for arsenic, 0.02 to 0.07 ug/liter for cadimum, 0.27 to 0.82 ug/liter for chromium, 0.04 to 1.2 ug/liter for copper, 0.004 to 0.016 ug/liter for mercury, 6.6 to 72 ug/liter for manganese, 0.32 to 0.91 ug/liter for nickel, 0.46 to 1.9 ug/liter for lead, and 2.0 to 4.9 ug/liter for zinc. All concentrations were comparable to ambient levels reported for nearshore waters in the area (Heaton, 1978; Schubel et al., 1978; Tillery, 1980).

Concentrations of most dissolved metals during the surveys were somewhat greater in May-June relative to December. Dissolved metal concentrations appeared to be inversely related to TSS and particulate metal levels; this inverse relationship may be caused by scavenging of metals from solution onto sediment particles (Heaton, 1978). Concentration ranges for dissolved metals over both surveys were 1.0 to 1.2 ug/liter for arsenic, <0.07 to 0.16 ug/liter for cadmium, <0.11 to 1.0 ug/liter for chromium, 0.94 to 2.5 ug/liter for copper, <0.033 to 0.073 ug/liter for mercury, 0.16 to 18 ug/liter for manganese, 0.38 to 2.0 ug/liter for nickel, 0.05 to 3.2 ug/liter for lead, and 1.4 to 3.2 ug/liter for zinc. Although concentrations of certain metals (e.g., manganese and lead) varied widely, all data were comparable to results of previous studies off southeastern Louisiana (CE, 1978; Heaton, 1978; Fortheringham and Weissberg, 1979; Weissberg et al., 1980a,b). No consistent differences in dissolved metals levels between ODMDS Station 1 and control Station 6 were observed.

ORGANICS

Chlorinated hydrocarbons (CHC) levels are typically low in Gulf of Mexico waters (Table 3-5). Two main sources of CHC are riverine and atmospheric inputs (Atlas, 1981).

TABLE 3-5

CONCENTRATIONS OF DDT AND PCB (ng/liter) IN WATERS FROM THE GULF OF MEXICO

Samples	No. of Samples	DDT Mean	DDT Range	PCB Mean	PCB Range
Mississippi Delta	14	1.70	0.01-2.9	2.45	1.7-3.3
Gulf Coast	10	0.35	0.01-0.6	1.60	0.1-3.1
Open Gulf	7	0.25	<0. 1-0.6	1.40	<0.1-2.8

(From Giam et al., 1978a. Cited in Atlas, 1981)

Concentrations of most dissolved CHCs examined at the Atchafalaya ODMDS were below detectable levels during both surveys. Only dieldrin (0.1 to 4.1 ng/liter), the DDT derivative pp'DDE (24 to 53 ng/liter), and the PCB Arochlor 1254 (0.4 to 0.6 ng/liter) were present in measurable quantities. Dieldrin and pp'DDE levels were substantially greater during May-June relative to December; the higher levels may have been derived from coastal sources. The maximum dieldrin concentration measured during the May-June survey (4.1 ng/liter) was somewhat greater than reported previously (CE, 1978) for the area of the ODMDS (0.5 to 3 ng/liter); Concentrations of DDTs determined previously in Mississippi River water and in nearshore waters off Louisiana (CE, 1978; Giam et al., 1978), were somewhat lower than those reported here. PCB concentrations (detected during the December survey only) were within or below ranges for the region reported in the literature (CE, 1978; Giam et al., 1978).

Sediment Chemistry

A variety of trace contaminants, such as trace metals, petroleum and chlorinated hydrocarbons, and organic material (commonly expressed as total organic carbon [TOC]), can accumulate in sediments. Elevated levels of marine sediment contaminants generally result from anthropogenic inputs such as municipal and industrial waste, urban and agricultural runoff, atmospheric fallout from urban centers, and accidental spillage. Silty and clayey sediments have a greater absorptive capacity for trace contaminants, and typically have higher TOC levels than coarser material because of their large surface area to volume ratio and charge density.

Accumulation of trace elements and chlorinated and petroleum hydrocarbons in sediments can have negative short term or long term effects on marine organisms. Many benthic organisms are deposit feeders which ingest substantial quantities of bottom sediments. The potential for bioaccumulation of persistent trace contaminants such as mercury, lead, and chlorinated hydrocarbons by these organisms is of particular environmental concern.

High concentrations of organic materials can produce anoxic conditions in sediments resulting in the production of sulfides. Oxidation of these sulfides is responsible for much of the initial consumption of oxygen immediately following dredged material disposal. Significantly lowered oxygen levels in sediments or near bottom waters can adversely affect marine organisms.

SEDIMENT HYDROCARBONS

The major sources of hydrocarbons to sediments in the northern Gulf are discharges from the Mississippi River and other coastal runoff, and atmospheric and anthropogenic inputs (Atlas, 1981). Concentrations of sediment hydrocarbons are highest near the Mississippi Delta and other source areas, and typically decrease with increased distance from shore (ibid.).

TOC concentrations ranged from 0.15 to 8.2 mg/g within and around the Atchafalaya ODMDS during the EPA/IEC winter survey, and were not significantly correlated with any other sediment parameters. Spring TOC concentrations were not measured.

CHC levels in sediments within and around the Existing Site are low or non-detectable (CE, 1979). During EPA/IEC surveys, only dieldrin (4.77 ng/g), pp'DDE (2.15 to 4.51 ng/g), pp'DDD (2.23 to 4.05 ng/g), and the PCBs Arochlor 1016 (ND to 74.1 ng/g) and Arochlor 1254 (5.19 to 22.9 ng/g) were present in measureable quantities.

Concentrations of cyanide and phenols were generally below detectable levels during the EPA/IEC surveys. Cyanide was detected at low levels (<0.7 ug/g) at a few stations, both inside and outside the ODMDS, during each survey; no spatial trends were evident. Cyanide levels were also low (<0.5 mg/g) in a previous study of the ODMDS and vicinity (CE, 1978). Phenols, determined only in December, were not detected in any of the samples.

Oil and grease concentrations were high (8 and 15 mg/g) in both Station 1 ODMDS (center of site) replicates during December 1980, EPA/IEC survey; concentrations at the remaining stations ranged from 0.4 to 2.2 mg/g over both surveys. The reason for the elevated levels at Station 1 is unclear. Since this station is located within the ODMDS, dredged material disposal must be considered a possible cause. The most recent disposal to occur prior to the surveys, however, took place during February 1979. Considering the transient nature of surficial sediments in this area (Hausknecht, 1980), it is unlikely that any contaminated dredged material deposits would remain intact for nearly 2 years. This assumption is supported by the reduced oil and grease concentrations (<0.5 mg/g) present at Station 1 during the May-June 1981 survey. Additionally, CE (1978) found oil and grease concentrations to be low (<0.1 mg/g) in adjacent dredging areas.

TRACE METALS

Discharge from the Mississippi and Atchafalaya Rivers is the primary source of trace metals to sediments in the western Gulf of Mexico (Tillery, 1980). The major portion of the metal flux into Gulf waters is associated with the suspended sediment fraction (Presley et al., 1980). Highest concentrations of most sediment metals are associated with terrigenous silts and clays on the outer shelf and slope off Central Louisiana (Holmes, 1973). Within the surficial sediments on the Louisiana Shelf, trace metal concentrations are variable; however, levels are often higher in the fine seiments at nearshore areas, and lower in coarser (sandy) sediments from areas further offshore (DOE, 1978; Comiskey and Farmer, 1981; Tillery, 1980).

Concentrations of trace metals in surficial sediments at the Atchafalaya ODMDS generally exhibited little variations over the survey area (EPA/IEC surveys). Mean (n = 40) concentrations (and ranges) over both surveys were 3.0 ug/g (1.8 to 4.4 ug/g) for arsenic, 0.15 ug/g (<0.08 to 0.33 ug/g) for cadmium, 1.9 ug/g (0.8 to 2.9 ug/g) for chromium, 10 ug/g (7.5 to 16 ug/g) for copper, 0.055 ug/g (0.037 to 0.078 ug/g) for mercury, 590 ug/g (250 to 950 ug/g) for manganese, 5.5 ug/g (3.9 to 9.1 ug/g) for nickel, 16 ug/g (9.7 to 24 ug/g) for lead, and 25 ug/g (17 to 45 ug/g) for zinc.

Biology

Described in this section, water column biota include phytoplankton, zooplankton, and nekton. Benthic biota is composed of infaunal and epifaunal organisms that are generally sedentary and cannot readily migrate from an area. The infauna can therefore be important indicators of environmental conditions. Dredged material disposal will have only short-term effects on plankton communities because of the transient nature of the watermasses they inhabit. Nekton generally are not adversely affected by dredged material disposal because of their high mobility.

PHYTOPLANKTON

The phytoplankton community in Louisiana coastal waters is diverse and productive containing both marine and freshwater species (Table 3-6) marine diatoms generally dominate, except during the summer when marine dinoflagellates occur in large numbers. The abundance of freshwater species increases in autumn through mid-winter when river discharge volumes increase. Phytoplankton biomass undergoes large spatial and temporal fluctuations. Cell density is highest in coastal bays and the neritic zone, and decreases seaward (Weissberg et al., 1980b). Both the mid-shelf area and nearshore areas have similar patterns of phytoplankton composition and biomass (Loop Inc., 1975; Weissberg et al., 1980b).

TABLE 3-6
SEASONAL CHANGES IN DOMINANT PHYTOPLANKTON SPECIES IN LOUISIANA COASTAL WATERS

GENUS	SEASON		
Dinoflagellates	Late Spring and Summer	Winter	Autumn
Ceratium	X		
Exuviella	X		
Goniaulax	X		
Gymnodinium	X		
Diatoms			
Asterionella	X		X
Biddulphia	X	X	
Coscinodiscus	X		
Cyclotella	X		
Fragillaria			X
Guinardia			X
Lithodesmium	X		
Navicula	X	X	
Nitszchia		X	
Porosira			X
Rhizoselenia		X	X
Skeletonema	X		X
Thalassiosira	X		X

Source: Loop Inc., 1975

ZOOPLANKTON

Zooplankton in the northern Gulf can be characterized as inhabitants of any of five zoogeographic zones: oceanic, continental slope transition, central continental shelf, coastal neritic, and estuarine zone. These zones are geographically variable, and their boundaries may reflect influences from water masses and current patterns. Zooplankton communities in each of the five zones are dominated by copepods; however, the dominant species may vary between zones. For example, within coastal areas temporate copepod species (e.g., Acartia tonsa, Paracalanus crassirostis, Eucalanus pileatus) are typically dominant, whereas tropical-subtropical species (e.g., Euchaeta marina, Copilia mirabilis) are dominant in oceanic regions (Comiskey and Farmer, 1981). Zooplankton densities generally decrease with increased distance from shore (DOE, 1978; Comiskey and Farmer, 1981).

Dominant zooplankton species vary seasonally in the waters near the ODMDS (Table 3-7). Copepods are most commonly collected (Weissberg et al., 1980a, 1980b; Reitsema, 1980). Other zooplanton that are periodically present in large numbers include pterpods ctenophores, cladocerans, and chaetognaths (ibid.).

TABLE 3-7
DOMINANT ZOOPLANKTON ORGANISMS, BY SEASON
AT WEEKS ISLAND SITE A

	Spring	Summer	Fall	Winter
Dominant Species	Acartia sp. (>90%)[1]	Cladocera (>60%)[3]	Tempora sp. (>80%)[1]	Acartia sp. (>40%)[1]
(% of total)	Sagitta sp. (2.5%)[2]	Tempora sp. (7%)[1]	Sagitta sp. (6%)[2]	Labidocera sp. (27%)[1]
				Sagitta sp. (10%)[2]

1: Copepod
2: Chaetognath
3: Cladoceran (Glass Crustacea)

Source: Reitsema, 1980

FINFISH AND SHELLFISH

Two general types of fish communities occur on the continental shelf of the northern Gulf of Mexico: the white shrimp grounds community and the brown shrimp grounds community (Chittenden and McEachren, 1976). The range of the white shrimp community in the northern Gulf of Mexico extends from depths of 3m to 22m. The community is more developed in the central Gulf off the coast of Louisiana where some species typical of this community are found at depths of 100m (ibid.). Species in the white shrimp community are highly estuarine dependent. The Atlantic croaker and other sciaenids, including sand and silver seatrout and various species of drums, are the dominant fish (ibid.) (Table 3-8).

The brown shrimp community generally occurs in depths from 22m to 90m, although the range is somewhat deeper in the central Gulf (Chittenden and McEachren, 1976). The longspine porgy, inshore lizardfish, blackfin searobin, and spot are typical species of the brown shrimp community. These common species may also occur in the deeper parts of the white shrimp grounds, (Table 3-9).

There can be considerable intermingling of fish and shellfish species between the two communities. Brown shrimp and fish from the brown shrimp community can occur well inside the white shrimp grounds, sometimes in relatively high abundance.

Seasonally dominant demersal fish near the Existing Site include sea catfish, banded and star drum, bighead searobin, and fringed flounder. The Atlantic cutlassfish, sand seatrout, and banded drum dominated demersal fish catches in the December EPA/IEC survey. During the May-June survey, the Atlantic croaker was the most abundant demersal species (Appendix). Major food items of common demersal fish in the area include polychaetes, gastropod and bivalave mollusks, shrimps, decapods, and copepods (Landry and Armstrong, 1980).

TABLE 3-8

SCIENTIFIC NAMES OF FISH TYPICALLY FOUND OFF THE LOUISIANA COAST

Common Name	Scientific Name
Atlantic bumper	Chloroscombrus chrysurus
Atlantic croaker	Micropogon undulatus
Atlantic cutlass fish	Trichiurus lepturus
Atlantic spadefish	Chaetodipterus faber
Atlantic threadfin	Polydactylus octonemus
Banded drum	Larimus fasciatus
Bay anchovy	Anchoa mitchilli
Bighead searobin	Prionotus tribulus
Blackfin searobin	Prionotus rubio
Blue fish	Pomatomus saltatrix
Blue runner	Caranx fusus
Cobia	Rachycentron canadum
Crevalle jack	Caranx hippos
Fringed flounder	Etropus crossotus
Great barracuda	Sphyraena barracuda
Greater amberjack	Seriola dumerili
Gulf butterfish	Peprilus burti
Gulf menhaden	Brevoortia patronus
Inshore lizardfish	Synodus foetens
King mackerel	Scomberomorus cavalla
Ladyfish	Elops saurus
Longspine porgy	Stenotomus caprinus
Mexican flounder	Cyclopsetta chittendeni
Pompano	Trachinotus carolinus
Rock seabass	Centropristic philadelphica
Sand seatrout	Cynoscion arenarius
Scaled sardine	Harengula pensacolae
Sea catfish	Arius felis
Sheepshead	Archosargus probatocephalus
Silver seatrout	Cynoscion nothus
Southern king fish	Menticirrhus americanus
Spanish mackerel	Scomberomorus maculatus
Spot	Leiostomus zanthurus
Star drum	Stellifer lanceolatus
Striped anchovy	Anchoa hepsetus

TABLE 3-9
SPECIES THAT CONSTITUTED FIVE PERCENT OR MORE OF THE AVERAGE INCIDENTAL CATCH OF DEMERSAL FISHES CAUGHT OFF LOUISIANA WITH A SHRIMP TRAWL, 1962-1964
Source: Moore et al., 1970

Seasons

	Winter (Jan-Mar)		Spring (Apr-June)		Summer (July-Sept)		Fall (Oct-Dec)		All seasons (Jan-Dec)	
Depth zone	Species	% of total catch	Species	% of total catch	Species	% of total catch	Species	% of total catch	Species	% of total catch
Inner zone 7-14 m. (4-7.5 fm)	Atlantic croaker	51	Atlantic croaker	49	Atlantic croaker	48	Atlantic croaker	66	Atlantic croaker	52
	Sea catfish	10	Sea catfish	14	Sea catfish	8	Sea catfish	8	Sea catfish	10
	Southern kingfish	7	Sand sea-trout	6	Sand sea-trout	8			Sand sea-trout	6
	Longspine porgy	5	Atlantic cutlassfish	5	Spot	7			Spot	5
			Spot	5	Atlantic cutlassfish	6				
Middle zone 27-46m (15-24 fm)	Atlantic croaker	39	Longspine porgy	27	Longspine porgy	29	Atlantic croaker	40	Atlantic croaker	31
	Longspine porgy	22	Atlantic croaker	20	Atlantic croaker	21	Longspine porgy	20	Longspine porgy	24
			Inshore lizardfish	10	Blackfin seatrout	5	Silver searobin	6	Silver seatrout	6
			Atlantic cutlassfish	7			Blackfin searobin	5	Blackfin searobin	5
			Blackfin searobin	7			Spot	5		
			Sand seatrout	6						
Outer zone 64-110m (35-60 fm)	Longspine porgy	31	Longspine porgy	38	Longspine porgy	54	Longspine porgy	23	Longspine porgy	35
	Inshore lizardfish	10	Blackfin searobin	11	Mexican flounder	6	Atlantic croaker	12	Blackfin searobin	9
	Atlantic croaker	9	Atlantic croaker	9	Rock sea bass	6	Blackfin searobin	9	Atlantic croaker	8
	Blackfin searobin	8	Rock sea bass	9	Blackfin searobin	5	Sand sea-trout	9	Rock sea bass	7
	Rock sea bass	5					Rock sea bass	7	Inshore lizardfish	6
							Spot	7		
Entire shelf 7-100m (4.60 fm)	Atlantic croaker	36	Atlantic croaker	28	Atlantic croaker	33	Atlantic croaker	41	Atlantic croaker	35
	Longspine porgy	20	Longspine porgy	19	Longspine porgy	17	Longspine porgy	16	Longspine porgy	18
			Sea catfish	6	Sand sea-trout	6	Blackfin searobin	6	Sand sea-trout	5
			Sand seatrout	5	Sea catfish	6	Sand seatrout	5	Sea catfish	5
			Inshore Lizard	5	Spot	5				
			Blackfin robin	5						
			Atlantic cutlassfish	5						

The bay and striped anchovy, Gulf butterfish, and scaled sardine are typical non-demersal fish harvested in and near the Existing Site (Appendix; Weissberg et al., 1980b). Other fish that are abundant in the region of the site, but generally not caught in slow trawls, include ladyfish, bluefish, Spanish mackerel, rock seabass, Gulf menhaden, Atlantic bumper, and Atlantic threadfin (Weissberg et al., 1980a, b). Oil rigs in the Gulf provide reef-like environments for cobia, crevalle jack, greater amberjack, sheepshead, great barracuda, king mackerel, blue runner, and Atlantic spadefish (Weissberg et al., 1980a).

More than 42 species of shellfish inhabit coastal waters of Louisiana. Abundant species include seabob shrimp, white shrimp, brown shrimp, broken-necked shrimp, and blue crab (Table 3-10).

Shrimp are typically the most abundant crustaceans near the Existing Site throughout the year, although brief squid are also common (Weissberg, et al., 1980b). Shrimp, crab, and squid made up the bulk of macroinvertebrates collected at the Existing Site during EPA/IEC surveys. Seabob shrimp and brief squid were dominant in December, whereas broken-necked shrimp and the lesser blue crab were the major macroinvertebrates caught in May-June.

Table 3-10

COMMON AND SCIENTIFIC NAMES OF SHELLFISH TYPICALLY FOUND OFF LOUISIANA COAST
Source: Landry and Armstrong, 1980

Common Name	Scientific Name
Blue Crab	_Callinectes sapidus_
Lesser blue crab	_Callinectes similis_
Broken-necked shrimp	_Trachypenaeus similis_
Broken-necked shrimp	_Trachypenaeus constrictus_
Brown shrimp	_Penaeus aztecus_
Swimming crab	_Portunus_ spp.
Seabob shrimp	_Xiphopenaeus kroyeri_
White shrimp	_Penaeus setiferus_

Seasonal shellfish abundance near the Existing Site followed a pattern similar to demersal fish abundance (Landy and Armstrong, 1980). The number of individuals and mean biomass of captured macrocrustaceans were highest in winter and lowest during summer.

Waters off central and western Louisiana shoreward of the 20 fm (36m) isobath comprise one of the most heavily fished areas in the world (Kutkuhn, 1966). In 1978 commercial fish and shellfish landings for Louisiana central fishing district (which includes the Atchafalaya area) were over 817 million pounds, or 48.8% of Louisiana total landings, and valued at $90 million (NMFS, 1980b). The most valuable species caught in waters off central Louisiana include penaeid shrimp (P. setiferus and aztecus), menhaden (Brevoortia patronus), several species of bottom fish, blue crab (Callinectes sapidus), and oysters (Crassostrea virginica).

Shrimp are caught throughout the shelf and in adjacent coastal estuaries over clayey silt substrates (Barrett and Gillespie, 1973). The offshore fishing grounds extend from the shoreline to the 50 fm (90m) contour off Louisiana and comprise 15.3 million surface-acres (23,000 square miles). The inshore shrimp fishing ground extends from the shoreline to the approximate northern boundary of the estuarine zone, and contains 3.4 million surface-acres (5,300 square miles). Most of the fishing for white shrimp occurs shoreward of the 14 fm (25m) depth contour, from the Mississippi River to Freeport, Texas. Brown shrimp grounds extend westward from Southwest Pass to the east coast of Texas and Mexico, primarily in depths of 12 to 29 fm (22 to 52m) (Hildebrand, 1954). Greatest inshore catches of brown shrimp occur in the high salinity waters of Breton Sound, Barataria, Caminada, and Timbalier Bays. The greatest offshore brown shrimp catches are from the saline nearshore waters south of Timbalier and Terrebonne Bays, while the lowest cathes are in the low salinity waters near the Mississippi and Atchafalaya Rivers. The largest white shrimp catches occur in areas off western coastal Louisiana, coinciding with the high brown shrimp production, but typically in less saline waters (Barrett and Gillespie, 1973). The shrimp catch from inshore waters averaged 25.9 million pounds per year, whereas the offshore waters averaged 31.3 million pounds per year between 1967 and 1972 (Barrett and Gillespie, 1973). The highest monthly inshore brown shrimp catch occurs in June, while the largest offshore catch occurs in August. In contrast, the greatest inshore and offshore catches of white shrimp occur in October (ibid.).

Temperature, salinity, and river discharge are environmental factors which regulate the production of shrimp (Barrett and Gillespie, 1973). "...[T]he greatest concern to future shrimp supplies are the long-range effects of man-induced environmental changes in the estuaries" (DOE, 1981; pg. 1-16). Site-specific declines in shrimp productivity have negligible impact on the total shrimp productivity because moderate losses in the stock will be compensated for in adjacent areas (ibid.).

Menhaden (Brevoortia patronus) is the second most valuable fisheries species, but represents the largest fishery in Louisiana waters in terms of weight. Menhaden typically are caught in coastal estuaries and waters shoreward of the 20 fm (36m) depth contour (DOE, 1981). In 1980, the Gulf Menhaden catch was 1.55 billion pounds, of which 1.31 billion pounds were taken from waters within 3 miles of the coast; the value of the catch was $69.1 million (ibid.).

The states of Alabama, Mississippi, and Louisiana close the menhaden fishery during winter months to protect the spawning stock. This fishery has obtained or exceeded the maximum sustained yield, with the restricted season probably the greatest factor preventing over-exploitation (DOE, 1981).

Large volumes of industrial or commercial fish are harvested from shelf waters off Louisiana and processed for fish protein concentrate, pet food, and fertilizer (Moore et al., 1970; Dunham, 1972). The principal components of this fishery are Atlantic croaker (Micropogon undulatus), longspine porgy (Stenotomus caprinus), sand seatrout (Cynoscion arenarius) and sea catfish (Arius felis). The greatest catches are made in winter and summer in depths of 7 to 40m (Moore et al., 1970).

Other important fisheries resources include blue crabs and oysters, both of which are harvested from coastal bays and estuaries (Bahr and Hebrard, 1976; Van Sickle et al., 1976).

BENTHOS

Macrofaunal assemblages in Louisiana Shelf areas are composed of euryhaline organisms characteristic of the open bay and mud bottom habitats from Port Arkansas, Texas to Mobile, Alabama (Parker et al., 1980). Polychaetes and, to a lesser extent, phoronids and pelecypods generally are the most abundant macrofaunal groups, comprising approximately 95% of the benthic population off Louisiana (Weissberg et al., 1980).

Nearshore benthic organisms respond to seasonal changes in the hydrological regime, especially to winter and summer pulses of dissolved nutrients, which result in increases in plankton populations and subsequent increases in food supply. Variability in the abundance and composition of the benthos reflect seasonal changes in the nearshore environment. In contrast, the offshore hydrographic regime is more constant. Consequently, seasonal abundance patterns are less distinct in offshore regions (Comiskey and Farmer, 1981).

Macrofaunal assemblages near the Atchafalaya River ODMDS have been examined during benthic investigations of several proposed salt dome brine diffuser sites (Parker et al., 1980; Weissberg et al., 1980a,b). These studies characterized nearshore assemblages as typical of estuarine areas. Communities were dominated by annual species, the majority of which were polychaete worms (particularly Mediomastus, Aglaophamus, Paraprionospio, Magelona, and Owenia), small molluscs (Mulinia and Nassarius), and macrocrustaceans (shrimp and crabs). The macrofaunal organisms consist mainly of deposit and suspension feeders; however, omnivores and carnivores are also well represented (Parker et al., 1980). The dominant organisms are small-bodied, opportunistic species capable of rapid recolonization of disturbed sediments. Most of these species complete their life cycle in a year or less. Recruitment occurs during late autumn, winter, and early spring, allowing the larvae of polychaetes and molluscs to settle before the onset of stressful summer conditions which may be associated with low dissolved oxygen concentrations and high water temperatures (Parker et al., 1980). Population densities generally peak in late spring and early summer, and later decline to the winter minimum (Parker et al., 1980; Weissberg et al., 1980a,b).

Benthic communities along the Louisiana coast are susceptible to periodic disturbances from storms. Tropical storm Debra passed through a sampling station near the Existing Site in August 1978 causing considerable turbulence and sediment transport, and resulting in a drastic reduction in the abundance of benthic infauna. Organisms such as pericarid crustaceans and suspension feeding molluscs, that are particularly sensitive to poor water quality were most effected (Parker et al., 1980).

Stations sampled by EPA/IEC in the vicinity of the Atchafalaya River ODMDS were further inshore and shallower than the proposed brine diffuser sites; however, the same general macrofaunal assemblage was found. During both surveys polychaetes dominated the macrofauna, particularly Mediomastus californiensis, Paraprionospio pinnata, and Cossura spp. During the December survey the Little surf clam Mulinia lateralis was very abundant at a station west of the site probably as a result of seasonal recruitment characteristic of this species (Parker et al., 1980). By the following survey in late spring (May-June), M. lateralis was abundant only at a station within the site. Other common members of this assemblage were the carnivorous ribbon worms Cerebratulus cf. lacteus (and other unidentified rhynchocoela) and the snail Nassarius acutus.

MAMMALS, REPTILES AND BIRDS

The diversity of marine mammals and reptiles is typically lower in nearshore regions than in the adjacent offshore regions of the northern Gulf (Bahr and Hebrard, 1976). Several migratory bird species utilize nearshore areas for overwintering or breeding and nesting, whereas offshore areas may be inhabited by strictly pelagic species.

Five species of turtles occur in the northern Gulf: green (Chelonia mydas), Atlantic Ridley (Lepidochelys kempii), hawksbill (Eretmochelys imbricata), leatherback (Dermochelys coriacea) and loggerhead Caretta caretta (DOI, 1978). Feeding and nesting activities in the northcentral Gulf off Louisiana have been reported only for the Atlantic Ridley.

Numerous species of whales and dolphins occur in the northern Gulf (Table 3-11). The only species of marine mammal common to nearshore waters is the Atlantic bottlenosed dolphin (Tursiops truncatus), which occurs in the greatest numbers within tidal passes, and feeds on shrimp and larger fish (Bahr and Hebrard, 1976). The greatest numbers of mammals typically occur along the outer shelf and shelf-break. For example, the short-finned pilot whale (Globicephala macrorhyncus), sperm

TABLE 3-11
SPECIES OF MARINE MAMMALS KNOWN TO OCCUR IN THE GULF OF MEXICO

Common Name	Scientific Name
Whales	
Antillean-beaked	Mesoplodon europaeus
Black right	Balaena glacialis
Blue	Balaenoptera musculus*
Bryde's	B. brydei
Dwaft sperm	Kogia simus
False killer	Pseudorca cassidens
Finback	Balaenoptera physalus*
Goose-beaked	Ziphius cavirostris
Humpback	Megaptera novaeangliae*
Killer	Orcinus orca
Minker	Balaenoptera acutorostrata
Pygmy killer	Feresa antenuata
Pygmy sperm	Kogia breviceps
Sei	Balaenoptera borealis*
Short-finned pilot	Globicephala macrorhynchus
Sperm	Physeter catodon*
Dolphins	
Atlantic bottle-nosed	Tursiops truncatus
Bridled	Stenella frontalis
Gray's	S. coeruleoalba
Risso's	Grampus griseus
Rough-toothed	Steno bredanensis
Saddleback	Delphinus delphis
Spinner	Stenealla longirostris
Spotted	S. plagiodon
Pinnipeds	
California sea lion	Zalophus californianus

*Endangered species (Federal Register, 1979

Source: DOI 1977a

whale (Physeter catodon), and Atlantic spotted dolphin (Stenella plagiodon) are most common in outer shelf and open Gulf waters (DOE, 1978).

Several species of oceanic birds and waterfowl may occur throughout the year in the nearshore region off Louisiana. Southern coastal Louisiana is within the central north-south flyway and represents a stopping or over-wintering grounds for a number of migratory species: blue and green winged teal (Anas discors and A. carolinensis), widgeon (A. americana), and canvasback (Aythya valisineria). Permanent residents of waters off the Louisiana coast, including those of the vicinity of the Existing ODMDS, may include frigatebirds (Fregata magnificens), gannets (Morus bassanus), and Audubon's shearwaters (Puffinus lherminieri). Densities of birds are seasonally variable, generally increasing from October through December (DOE, 1978).

Bird populations further offshore may consist of pelagic species such as jaegers (Sterocoratius pomarinus and S. parasiticus), shearwaters (Puffinus griseus and P. lherminieri), and frigatebirds (F. magnificens).

THREATENED AND ENDANGERED SPECIES

Six species of endangered marine mammals have been sighted in the northern Gulf of Mexico (Table 3-12). Most were chance sightings and do not indicate the presence of indigenous populations (DOI, 1977). All of the endangered marine mammals are rare in the northern Gulf of Mexico (ibid), and not expected to commonly occur at the Existing Site.

Several threatened or endangered species of marine reptiles occur in the northern Gulf of Mexico (Table 3-12). The Atlantic Ridley and leatherback turtles may occur as transients at the Existing Sites.

TABLE 3-12

ENDANGERED AND THREATENED MARINE MAMMAL
AND REPTILE SPECIES AND CRITICAL HABITATS

Louisiana: Gulf of Mexico

Listed Species	Scientific Name	Status	Date Listed
MAMMALS			
fin whale	*Balaenoptera physalus*	E	12/2/70
humpback whale	*Megaptera novaeangliae*	E	12/2/70
right whale	*Eubaleana glacialis*	E	12/2/70
sei whale	*Balaenoptera borealis*	E	12/2/70
sperm whale	*Physeter catodon*	E	12/2/70
blue whale	*Balaenoptera musculus*	E	12/2/70
REPTILES			
green sea turtle	*Chelonia mydas*	E	7/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	E	6/02/70
Kemp's (Atlantic) ridley sea turtle	*Lepidochelys kempi*	E	12/02/70
leatherback sea turle	*Dermochelys coriacea*	E	6/02/70
loggerhead sea	*Caretta caretta*	Th	7/28/78

SPECIES PROPOSED FOR LISTING
None

CRITICAL HABITAT
None

CRITICAL HABITAT PROPOSED LISTING
None

Source: Charles A. Oravetz; Southeast Region, National Marine Fisheries Service Letter 10/18/83

Endangered brown pelicans Pelecanus occidentalis nest along the Louisiana shoreline. The native populations in Louisiana was extirpated in 1962 by poisoning from the pesticide endrin (Schreiber, 1980). A colony of brown pelicans, introduced from Florida, presently exists at Queen Bess Island (Schreiber, 1980; Blus et al., 1979).

Some threatened or endangered species may occur as transients at the Atchafalaya ODMDS. The Existing Site is small in relation to their total ranging areas and dredged material disposal at the site is not expected to affect any of the threatened or endangered species.

GENERAL RECREATION

Coastal regions off Louisiana are extensively used for recreational activities, including fishing, swimming, pleasure boating, beachcombing, and diving. In addition, camping, picnicking, and hunting occur along the shore. The Atchafalaya ODMDS is relatively close to shore; therefore, some recreational activities (boating, fishing, and diving) may occur within or near the site. Beachcombing, swimming, camping, and hunting activities are restricted to the immediate shore.

NAVIGATION

The dredged channel is used for navigation; dredging is necessary to keep the channel open. The volume of shipping in the Atchafalaya River Bar Channel has decreased from 4,786,737 tons in 1973 to 3,601,216 tons in 1978 (CE, 1979). Ship traffic using the channel consists primarily of oil field supply boats, offshore tugs, fishing boats, and barges. The majority of shipping is internal, within the area between Morgan City and the 20 ft. Gulf contour (ibid.). The vessel traffic travels primarily to Morgan City or eastward to an industrial complex on Bayou Chene. Major commodities shipped through the channel are menhaden, marine shells (unmanufactured), crude petroleum, clay, basic chemicals, distillate fuel oil, building cement, iron and steel pipe, miscellaneous manufactured products, and water (CE, 1979).

OIL AND GAS

Immense oil and gas reserves are contained within shelf and shelf-break regions off Louisiana. By the early 80's, 482 fields discovered in the northern Gulf had produced 5 billion barrels of oil and 48.7 trillion cubic feet of gas (Havran, 1981). Reserves in the western Gulf (west of the Mississippi Delta) contain an estimated 2.8 billion barrels of oil and 42.9 trillion cubic feet of gas on the shelf.

Extensive oil and gas development occurs off the Atchafalaya area. Within three areas off Atchafalaya Bay, i.e., South Marsh Island, Eugene Island, and Ship Shoal, 26.9% of Louisiana's oil and gas fields occur. A portion of the Existing Site is located within leased blocks, and one platform is located in the southern corner of the Site (Offshore, 1982; DOC, 1980a).

MARINE SANCTUARIES

No marine sanctuaries occur in the immediate vicinity of the Existing Site. Shell Keys and Marsh Island Wildlife refuges are approximately 25 nmi, west of the Existing Site. Fishnet Bank, the closest protected Area of Biological Significance, is approximately 90 nmi south of the Existing Site.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Effects of dredged material disposal, described in this chapter, are classified under two broad categories: (1) ecosystem and (2) public health and safety. The ecosystem section describes the environmental effects of dredged material disposal on water and sediment quality, and the biota. The public health and safety section discusses commercial fisheries, potential contamination of edible fish, development of nuisance species, and effects on navigation and aesthetics. Unavoidable adverse environmental effects and mitigating measures, short-term use versus long-term productivity, and irreversible and irretrievable commitments of resources also are discussed.

EFFECTS ON THE MARINE ECOSYSTEM

Short-Term and Long-Term Effects

Specific Long-term effects of dumping at the Atchafalaya ODMDS were not studied during the CE's Dredged Material Research Program (DMRP); however, specific short-term studies (during dumping) of nutrient and dissolved and particulate trace metal concentrations were conducted at the Existing Site (Schubel et al., 1978). The results of the DMRP Aquatic Field Investigation Studies provide insight regarding the effects of dredged material disposal; however, they must be applied carefully when predicting impacts, because local conditions affecting the fate and effects of impacts may vary from site to site depending on the composition of the dredged materials and the physical and biological characteristics of the disposal site. Chemical, geological, and biological oceanographic data were collected at the Existing Site during

EPA/IEC surveys to assess the effects of dredged material disposal on the marine environment, and determine whether any adverse effects of dredged material disposal identified within the Site were detectable outside the site boundaries.

Water Quality

Disposal of dredged material should not appreciably degrade water quality in regions adjacent to the Atchafalaya ODMDS. In general, changes in water quality associated with dumping are relatively short-term, and conditions return to normal within a period of minutes to hours. Results of several long-term studies at nearshore locations, summarized by Brannon (1978), indicate that dredged materials have limited chronic impacts on the water quality of the disposal site.

TURBIDITY

Dredged material disposal results in a temporary increase of turbidity levels and suspended solid concentrations in the water column (CE, 1980). The duration of a turbidity plume will depend on particle size and density, currents, and turbulent mixing (Wright, 1978). Dredged materials from the Atchafalaya Bar Channel contain appreciable quantities of fines (94 to 98%) which may remain suspended for periods of minutes to hours. Wright (1978, p. 48) concluded that at most dredged material disposal sites, increases in turbidity persisted for only a few hours and, in addition, "...storms, river discharge and other natural phenomena resulted in turbidity increases of much greater magnitude than those associated with disposal."

Studies conducted at the Atchafalaya ODMDS during dredged material disposal noted that turbidity plumes were of limited duration and areal extent (Heaton, 1978; Schubel et al., 1978). Concentrations of suspended sediments are lower in the offshore waters.

NUTRIENTS

Resolubilization of nutrients is common from both polluted and nonpolluted sediments dredged from coastal areas (Windom, 1976). Results of elutriate tests (Table 4-1) performed on dredged materials from the Atchafalaya Bay Channel demonstrated releases of soluble organic nitrogen (total Kjeldahl nitrogen [TKN]) and carbon (CE, 1978).

Releases of nitrogen, especially ammonia, are common from dredged materials (Windom, 1975). Coastal waters are characteristically limited with respect to nitrogen (Ryther and Dunstan, 1971); therefore, localized releases may temporarily stimulate phytoplankton productivity (ibid.). Elevated concentrations of ammonia, sufficient to cause toxicity to aquatic organisms, at the disposal site or adjacent areas are unlikely (Brannon, 1978). Increased ammonia concentrations in the water column are ephemeral, and subsequent decreases result from rapid dilution and mixing (Wright, 1978).

Localized increases in phosphorus concentrations following dumping are typically of short duration due to rapid adsorption onto suspended particulate matter, particularly clay particles (Wright, 1978; Windom, 1975). Chronic water quality problems resulting from long-term leaching of nutrients from dredged sediments are not expected (Brannon et al., 1978).

Studies conducted at the Atchafalaya ODMDS measured releases of ammonium and silicate species during dredged material disposal, however, concentrations were quickly diluted to background levels. Dissolved orthophosphate, ammonia, and silicate levels were not effected by disposal (Schubel et al., 1978; Heaton, 1978).

TABLE 4-1
ELUTRIATE TEST RESULTS FOR
ATCHAFALAYA BAR CHANNEL DREDGED MATERIAL*
Source: CE, 1978

	Elutriate Test	Native Water
As	4-7	2-4
Be	<0.5	<0.5
Cd	<0.5	<0.5
Cr	3-8	<10
Cu	3-4	2-4
Pb	6-9	3-6
Mn	1900-3100	30-50
Hg	<0.05	<0.05
Ni	3-5	2-10
Se	<0.5	<0.5
V	<0.05	NM
Zn	<0.5-10	<0.5-20
Cyanide (mg/l)	<0.005	<0.005
Phenol	<0.5	<0.5
COD (mg/l)	45-90	NM
TKN (mg/l)	3.0-3.7	NM

*Concentrations in ug/l unless otherwise stated.
NM = Not measured

DISSOLVED OXYGEN

Materials with potential oxygen demands are generally present in dredged material. Their release following disposal imposes both a chemical and biological oxygen demand (COD and BOD) on the water column.

However, Schubel et al., (1978) showed that the effects of adding oxygen demanding material to the water column are functions of the length of time the material resides in the water column and the amount of water available for dilution. In shallow water, such as the Atchafalaya ODMDS, approximately 95-99% of the dredged material is deposited close to the discharge source and within several minutes after release. The remaining 1-5% of the dredged material is deposited within a few hours after discharge (ibid.). Only a small percentage of the oxidizable components in dredged material is reactive on a time-scale comparable to the settling rate of the majority of the discharged particulate matter. The reduced forms of sulfur, iron, and manganeses present in sediment interstitial waters place an immediate oxygen-demand on the water column. The organic matter and sulfide minerals present in the dredged sediments also exert an oxygen-demand, but on a longer time scale. Most of the decomposition of organic matter is accomplished by bacterial degradation; oxidation of sulfide minerals is generally limited to surficial sediment layers. Once the dredged material is deposited, the oxygen demand on the overlying waters is dependent on the expulsion of interstitial water during compaction and, thereafter, is diffusion-limited (ibid.).

TRACE METALS

Nearshore sediments are a major sink for riverine and anthropogenic trace metals (Trefry, 1977). Sediments dredged from river mouths and coastal navigation channels therefore may contain levels of trace metals which are elevated relative to coastal abundance (Holmes, 1973). However, releases of trace metals from sediments, and subsequent changes in disposal site water quality, cannot be predicted solely on the basis of bulk chemical analysis of the dredged sediments (Windom, 1975; Brannon et al., 1978). For example, results of the DMRP (Brannon, 1978) and studies by Windom (1975, 1976) demonstrate that following dumping, the concentrations of certain dissolved metals (e.g., Zn, Cu, Cd, and Pb) in disposal site waters may be regulated by adsorption onto insoluble iron oxides.

Studies at the Atchafalaya ODMDS (Schubel et al., 1978; Heaton, 1978) found no well-defined plume of dissolved trace metals during dredged material disposal, and no linear relationship between dissolved and particulate trace metals. A few anomolously high levels of Mn were observed, however, these were associated with high TSS concentrations (approximately 1000 mg/l) near the discharge point. Concentrations of dissolved Zn, Cu, Cr, Cd, and Pb were low (usually below detection levels) throughout the Atchafalaya sampling area; comparisons between concentrations in the dredged material plume and in unaffected water showed no apparent differences. Therefore, it may be concluded that no substantial release of these metals occurred during dredged material disposal (Schubel et. al., 1978; Heaton, 1978).

Long-term solubilization of trace metals from dredged materials is minimal, and too small to produce significant adverse impacts to water quality (Brannon, 1978; Windom, 1975, 1976). For example, surveys conducted by EPA/IEC found the greatest particulate trace metal concentrations were associated with highest TSS concentrations. Dissolved trace metals exhibited an inverse relationship with TSS and particulate trace metal concentration which may be caused by scavenging of metals from solution onto sediment particulates (ibid.). Dissolved Mn and Pb levels varied widely throughout the survey area, however, concentrations were comparable to those from previous studies. Total (particulate plus dissolved) trace metal concentrations were below their respective EPA minimum marine water quality criteria (45 FR 79318 et sq.)

Elutriate tests are intended to indicate the potential for release of dissolved trace metals from dredged sediment when mixed with seawater. Elutriate tests (Table 4-1) conducted by CE (1978) on the dredged material from the Atchafalaya Bar Channel indicated little or no release of trace metals, except for Mn, which is generally released in the elutriate test (Brannon, 1978; Heaton, 1978). EPA/IEC conducted elutriate tests on sediments outside and within the Atchafalaya ODMDS. Except for zinc, which showed a slight release, results were similar to those of CE (1978). Metal released from sediments within and outside the ODMDS were similar.

HYDROCARBONS

Synthetic organics, such as pesticides and polychlorinated biphenyls (PCBs) do not occur naturally in sediments, but result from anthropogenic contamination (Brannon, 1978). Chlorinated hydrocarbons (CHCs) have low water solubility, are rapidly sorbed to sediments, and only small quantities are released to interstitial waters (Burks and Engler, 1978).

Concentrations of pesticides and PCBs in waters overlying the Atchafalaya ODMDS immediately following dumping have not been measured. However, EPA/IEC surveys within and around the Existing Site found most dissolved CHC levels in the water column to be below detectable limits; only dieldrin, the DDT derivative pp'DDE, and the PCB Arochlor 1254 were present in measurable quantities. All concentrations were below their respective EPA single measurement criterion (45 FR 79318 et seq/).

SEDIMENT QUALITY

Nearshore surficial sediments in the Atchafalaya region are affected by outflow from the Atchafalaya River, currents, and wave action. An estimated 53 million m^3/yr of fine-grained sediment, along with associated contaminants, are carried from Atchafalaya Bay and deposited on the western Louisiana shelf (Wells et al., 1981). These sediments are deposited in the channel, as well as in the ODMDS, resulting in similar grain size and chemical composition between the dredged material and ODMDS sediments.

Sediments within and around the Atchafalaya ODMDS are predominantely composed of silts and clays (82 to 99% fines) and similar in composition to the dredged material (94 to 98% fines) (CE, 1978). Clay content within the Existing ODMDS was lower during th EPA/IEC December survey than during the May/June surveys, illustrating the winnowing of the finer particles during winter. Since the dredged material is similar to the disposal site sediments, and sediment transport is known to occur in the area, long-term or persistent changes in grain-size at the ODMDS resulting from dredged material disposal should be negligable.

CHEMICAL COMPOSITION

Contaminants in dredged material are generally not released into the water following disposal, but remain associated with the sediments (Brannon, 1978). The greater proportion of the sediment trace metals and hydrocarbons will be associated with the mobile silt and clay fractions (Chen et al., 1976). Therefore, the extent of changes in the chemical compositon of the sediments depends on the persistence of the fine fractions within site boundaries. As stated previously, the Atchafalaya ODMDS is located in a dynamic area. Consequently, measurable long-term alterations or accumulations of contaminants in disposal site sediments are unlikely. Trace metal levels measured during EPA/IEC surveys within and around the ODMDS were similar during winter and spring, and exhibited no consistant spatial or temporal trends. The levels, including the relatively high levels of As, were also comparable to previously reported values for the nearshore region (Weissberg et al., 1980; CE, 1978). Chlorinated hydrocarbon concentration in sediments were low or non-detectable during EPA/IEC surveys. No effects of dredged material disposal on sediment parameters could be identified at the ODMDS.

BIOTA

In general, the disposal of dredged material presents four potential problems to aquatic organisms: (1) temporary increases in turbidity, (2) changes in physical or chemical characteristics of the habitat, (3) smothering by burial, and (4) introduction of pollutants (Hirsch et al., 1978). The magnitude of adverse impacts on the existing fauna depends on the similarity of the dredged sediments to existing sediments, frequency of disposal, thickness of the overburden, types of organisms affected, and physical characteristics of the habitat (Pequegnat et al., 1978). It is often difficult to distinguish adverse effects caused by sediment disposal from changes due to natural variability in habitat or species abundances.

PLANKTON

Effects of dredged material disposal on plankton are difficult to assess because of the high natural variability of populations. The influences of tidal and river discharges, as well as diel changes in zooplankton abundances, increase the difficulty of detecting disposal effects. Sullivan and Hancock (1977) concluded that for most oceanic areas natural plankton fluctuations are so large that field surveys would not be useful for detecting the impacts of dredged material disposal.

Disposal of dredged material creates a temporary turbidity plume consisting of the fine-grained silt and clay. Entrainment of phytoplankton, zooplankton, and ichthyoplankton within a turbidity plume has a potential for localized plankton mortality by exposure to decreased light transmittance, and prolonged exposure to suspended particulates and released contaminants (Wright, 1978). Elevated suspended particle concentrations may inhibit filter-feeding planktonic organisms, although the extent of this impact is unknown.

Changes in water quality following disposal are temporary, thus chronic exposure of organisms to trace contaminants is not expected. Winter bioassay test results with representative zooplankton species (Artemia salina) demonstrated no significant mortality in the liquid or suspended phase (Drawas et al., 1979b); summer tests were inconclusive (Drawas et al ., 1979a).

BENTHOS

Benthic organisms at the Atchafalaya ODMDS are exposed to increased suspended sediment concentrations, burial, and temporary reduction in water quality. The immediate effects of disposal on infauna at the ODMDS have not been investigated. The following discussion of potential impacts on the benthos is based on the results of the DMRP (summarized by Wright, 1978 and Hirsch et al., 1978), site specific infaunal data collected during EPA/IEC surveys, and bioassay and bioaccumulation tests (Drawas et al., 1979a,b).

Significant adverse impacts to marine organisms are not expected from uncontaminated or lightly contaminated particulates (Hirsch et al., 1978). No significant adverse impacts to benthic organisms, due to changes in water or sediment quality were detected during the DMRP (ibid.). Water quality changes resulting from dumping are short-term; no evidence of persistent alterations of water quality at the disposal site or adjacent waters were detected during EPA/IEC surveys.

Summer bioassay tests of dredged material from the Atchafalaya Bar Channel were inconclusive (Drawas et al., 1979a). No significant mortality to benthic organisms occurred in the liquid or suspended particulate phases of winter bioassay tests (Drawas et al., 1979b). Bioaccumulation of trace metals and hydrocarbons in representative benthic organsims was detected; however, for most organisms, concentrations were below FDA action levels during the winter bioaccumulation tests. The maximum mean mercury concentration in tissues of the bivalve mercenaria sp exceeded FDA action levels during the winter bioaccumulation tests. The observed mercury levels were thought to result from the low biomass of the test organisms and a heterogenous distribution of mercury within the sediments (ibid.). All concentrations of trace metals and CHCs reported for summer bioaccumulation tests were below FDA action levels (Drawas et a., 1979a).

Direct effects (i.e., burial of organisms) are restricted to the immediate areas of the disposal sites (Hirsch et al., 1978). Previous investigations of the effects of burial of benthic infauna demonstrated that adverse impacts are typically limited to non-motile species (Richardson et al., 1977). Active or motile species are capable of burrowing up through at least 32 cm of overburden (Mauer et al., 1978). Nevertheless, dredged material disposal at an ODMDS will likely smother some epifaunal and infaunal organisms. Consequently, densities and diversity will temporarily decline (CE, 1978). However, benthic assemblages in the northern Gulf experience high natural variability in abundances and diversity due to seasonal changes in adult mortality and larval recruitment rates (Parker et al., 1980).

Recently deposited sediment will be recolonized by motile infaunal organisms burrowing up through the overburden, by species migrating from adjacent undisturbed areas, and by recruitment of larvae and juvenile forms (Hirsch et al., 1978). Specific recolonization patterns will be influenced by the composition of the new sediment and adjacent benthic communities (Oliver et., 1977).

During EPA/IEC surveys, the macrofaunal assemblages within and around the Atchafalaya ODMDS were characteristic of the general region and dominated by polychaetes. Many of the dominant organisms were small-bodied, opportunistic species capable of rapid recolonization of disturbed sediments. Large macroinvertebrates (mainly shrimp and crab) were also common throughout the area. No effects due to disposal were found at the ODMDS.

The consequences of temporarily disrupting the benthic community within the disposal site cannot be easily evaluated (Wright, 1978). Hirsch et al. (1978; p.17) concluded that "the more naturally variable the environment, the less effect dredging and disposal will have, because animals and plants common to the unstable areas are adapted to stressful conditions and have life cycles which allow them to withstand the stresses imposed by dredging and disposal. Habitat disruption can also be minimized by matching the physical characteristics of the dredged materials to the substrate found at the disposal site." The Atchafalaya ODMDS is located in a naturally-disturbed nearshore environment, and the dredged sediment is physically similar to the ODMDS sediments. Therefore, short-term alterations of the habitat and adverse impacts on the biota within and adjacent to the Site will be minimized. Because of the dynamic nature of the environment, and the apparent absence of significant adverse effects on water or sediment quality, it is unlikely that previous disposal activity at the ODMDS has measurably altered the benthic habitat.

NEKTON

Data sufficient to characterize the effects of dredged material disposal on nekton inhabiting the Atchafalaya ODMDS are unavailable. DMRP results (Wright, 1978) suggest that fish usually are not directly affected by dredged material disposal. The mobility of nektonic organisms generally precludes adverse effects due to sediment inundation.

Summer series bioassay tests on nekton species were inconclusive (Drawas et al ., 1979b). Winter bioassay tests using nekton species detected no significant mortality for the liquid phase. However, significant mortality to Cyprinodon occurred in the 100% test medium for the suspended particulate phase (ibid.). Bioaccumulation of trace metals and hydrocarbons occurred in summer and winter tests, however, summer test concentrations were below FDA action levels (Drawas et al., 1979a). In winter bioaccumulation tests, maximum mean mercury concentration in tissues of the shrimp Paleomonetes exceeded FDA action levels. The observed mercury levels may have been the result of low biomass samples and a heterogenous distribution of mercury within the sediments (Drawas et al., 1979b).

Localized burial of benthic fauna may decrease the abundance of fish prey items, causing temporary declines in finfish abundances and diversity at the disposal site. Results of the DMRP studies assessing the effects of dredging on demersal fish were ambiguous. Wright (1978) reported that in some cases relatively higher numbers of fish occurred at an ODMDS after disposal. In other cases, short-term avoidance of disposal sites by finfish were observed after dumping. Wright (1978, p. 50) concluded "Some question exists as to whether this behavior represented avoidance of the (dredged) material or was the result of normal seasonality and the sampling techniques that were used."

No unique nekton habitats or spawning areas occur within the Atchafalaya ODMDS. Adverse effects on nekton resulting from intermittent and localized disposal operations at the Site would be negligible.

MAMMALS AND REPTILES

Specific effects of dredged material disposal on marine mammals and reptiles have not been studied. Because of their relatively large size and the mobility of most species, direct impacts should be negligible at the Atchafalaya ODMDS. In addition, the Site represents only a small portion of the total range of the mammal and reptile species occurring in the northcentral Gulf of Mexico. Dumping would not occur in geographically restricted feeding, breeding, or passage areas of any mammal, bird, or reptile species.

THREATENED AND ENDANGERED SPECIES

Infrequent and localized disposal at the Atchafalaya ODMDS would have no adverse impacts on the food source, migratory passage or breeding areas of endangered whales, birds, or turtles. A brown pelican colony is located at Queen Bess Island, Louisiana, 65 nmi east of the Atchafalaya area. Potentials for chlorinated hydrocarbons (especially dieldrin and endrin; c.f., Blus et al., 1979) desorbing from dredged materials and accumulating in food sources of brown pelicans are unknown.

Summary of Effects on the Ecosystem

Potential impacts associated with dumping at the Atchafalaya ODMDS may include burial of benthic infauna, temporary releases of nutrients and trace metals, formation of a temporary turbidity plume, and temporary depression of dissolve oxygen concentrations. Physical habitat disruptions resulting from disposal operations are minimized at sites having naturally variable or unstable substrates, and where dredged sediments are similar to disposal site sediments. Continual riverine inputs and resuspension by waves and periodic storm-induced turbulence at the ODMDS will redistribute dredged sediments and adjacent sediments; thus precluding permanent alteration of the substrate. Cumulative or long-term impacts on the ecosystem due to dumping would therefore be unlikely.

PUBLIC HEALTH AND SAFETY

Ensuring that public health and safety are not adversely affected by ocean disposal of dredged materials is a primary concern. Health hazards may arise if the chemical nature of the material has the potential for bioaccumulation of toxic substances in organisms. Potential impacts on human health can be inferred from bioassay and bioaccumulation tests performed on marine animals. The results of these tests performed on the Atchafalaya Bar Channel dredged materials (discussed earlier in this chapter) do not indicate any potential human health hazards.

Fisheries

Nearshore areas of the northern Gulf of Mexico support one of the most productive fisheries in the United States for shrimp, menhaden, and bottom fish including croaker, drum, and sea trout. Coastal areas with sand/silt substrates including the Atchafalaya ODMDS are used seasonally by many commercial species for feeding, breeding, and passage activities;

however, none of these activities are unique or restricted to the Site. Fishing activities for demersal and pelagic fish and shrimp extend throughout nearshore and shelf regions. Fishing occurs throughout the year but most activity occurs from March through October (Dugas, 1981*). Consequently, some interferences with commercial fishing and fisheries resources from dredged material disposal in nearshore regions are inevitable. The Atchafalaya ODMDS represents only a small portion of the total fishing grounds of the northern Gulf of Mexico. Any adverse effects are likely to be restricted to the disposal site. Therefore, dredged material disposal will potentially affect only a small percentage of this resource (e.g., DOE, 1981).

Tests of sediments dredged from the Atchafalaya Bar Channel demonstrated no significant bioaccumulation of trace metals or hydrocarbons in tissues of the shrimp Paleomonetes (Drawas et al., 1979a,b). Two species of penaeid shrimp collected within and around the ODMDS during the EPA/IEC surveys had low trace metal concentrations, and mercury concentrations were below FDA action/tolerance levels for edible marine organisms. One species of shrimp and one species of crab collected during the surveys had low quantities of dieldrin, pp'DDE, and PCB (Aroclor 1254); however, concentrations were well below FDA action/tolerance levels for edible marine organisms.

Navigation

The disposal of dredged materials could present two potential hazards to navigation: (1) mounding within the disposal site, and (2) interference of the dredge and/or pipeline with vessel traffic.

Mounding and/or shoaling may temporarily occur within the Atchafalaya ODMDS following dumping. NOS charts of the Atchafalaya area indicate long term shoaling has not occurred in the Existing Site (DOC, 1980a).

*Donald J. Dugas, Louisiana Department of Wildlife and Fisheries, Seafood Division, personal communication.

The pipeline dredges used for maintenance work at the Atchafalaya ODMDS may temporarily interfere with some shipping traffic by blocking sections of the channel. Barges or hopper dredges, if required, may also create interferences with shipping traffic in the Atchafalaya Bar Channel.

Aesthetics

Dredged material disposal at the Atchafalaya ODMDS will create a temporary turbidity plume. The plume would not be visable from shore, and would disperse after dumping ceases. The additional discoloration of naturally turbid waters will be minor. No excessive noises or odors are expected.

Summary of Effects on Public Health and Safety

Previous dumping at the Atchafalaya ODMDS has caused no detectable impacts on public health and safety. No shoaling or degradation of fisheries resources or aesthetics have been reported.

Limited potential exists for bioaccumulation of metals and hydrocarbons in shrimp or fish tissue as a result of exposure to dredged materials (Drawas et al., 1979a,b). However, exposure to transient species is typically of short duration; thus, potential harm to humans consuming locally caught seafood is low (ibid.).

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

In general, few significant adverse impacts result from dredged material disposal (Wright, 1978). Increases in turbidity, releases of nutrients or trace metals, and reductions of benthic faunal abundances and diversity are short-term effects which would occur. Results of the DMRP (Hirsch et al., 1978) indicate that impacts within the site are minimized when dumping occurs in naturally variable, high-energy environments. The Atchafalaya ODMDS is situated in a dynamic, nearshore environment, thus long-term or cumulative impacts will be minimal, and additional mitigating measures should be unnecessary. Results of EPA/IEC surveys at the Atchafalaya ODMDS suggest that previous dumping has not caused significant degradation of the water or sediment quality, or persistent changes in the composition of the fauna in areas adjacent to the ODMDS.

Limited interferences with nearshore fisheries may occur from dumping. The Atchafalaya ODMDS is located within passage areas of nekton that seasonally migrate to and from the estuaries, bays, and Gulf during various stages of their life cycle. Dredging and disposal could be restricted to periods of the year when these migrations are diminished or periods of greater turbulence (i.e., more rapid sediment dispersion). However, the ODMDS represents only a small percentage of the total nearshore fishing grounds. Therefore, mitigating measures to reduce interferences with commercial or recreational fishing are not warranted.

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG TERM PRODUCTIVITY

Long-term degradation of water or sediment quality, which might decrease the long-term productivity or value of resources, has not been detected within or adjacent to the Atchafalaya ODMDS. Commercial fishing and sportfishing, at and near the Site, should not be significantly impaired because the Site constitutes a small percentage of the total fishing grounds.

Adverse effects on the productivity of the nearshore region adjacent to the ODMDS due to localized and intermittent disposal activities, are considered negligible in comparison to the economic benefits derived from maintaining the Atchafalaya Bar Channel (CE, 1978).

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible or irretrievable resources committed to the proposed action of final designation of the Atchafalaya ODMDS include:

1. Energy resources will be used as fuel for dredges, pumps, and disposal vessels.

2. Economic resources will be committed to the costs of ocean disposal.

3. Benthic organisms will be buried by dredged material upon disposal.

Chapter 5

COORDINATION

This Draft EIS was prepared by William C. Shilling, P.E., Chief, and Janis Jeffers, Environmental Protection Specialist of the Ocean Dumping EIS Task Force. It is based on information prepared for EPA under contract by Interstate Electronics Corporation. Support in preparation of the Draft was provided by Edith R. Young. The Preliminary EIS has undergone internal review by EPA and the Corps of Engineers.

Endangered Species Act of 1973
Section 7 Coordination

Formal coordination has been initiated by letter to the Washington, D.C. National Marine Fisheries Service office and U.S. Fish and Wildlife Service office.

Coastal Zone Management Act
Federal Consistency Evaluation

The State of Louisiana, Department of Natural Resources, has been contacted and requested to provide this office with the elements of their State Coastal Zone Management Program which are applicable to the Atchafalaya ODMDS designation EIS consistency evaluation. They have responded by identifying the sections of the Louisiana Coastal Resources Program that are the basis for consistency review in Louisiana. An evaluation of consistency as it pertains to these sections, is summarized in Table 5-1.

Table 5-1

CONSISTENCY EVALUATION

Louisiana State and Local Coastal Resource Management Act	Evaluation
§213.2 Declaration of Public Policy	Protection of Louisiana's coastal resources (policy 1) will be enhanced by designation of an Ocean Dredged Material Disposal Site (ODMDS). Site designation limits the effects of dredged material disposal to one ocean location in the area while facilitating maintenance of the channel for shipping uses. Multiple use of the coastal zone (policy 3) will not be affected and is addressed in Chapter 2 of the EIS (Specific criteria 228.6(9)). Dredged material disposal will not interfere with recreational use of the coastal zone (policy 6) as noted in Specific criteria 228.6(a)(3) and (8) in chapter 2 of the EIS.
§213.10 Special Areas and Projects	The locations of areas of biological significance were considered in the EIS evaluation (General criteria 228.5(b); Specific criteria 228.6(a)(8)(11)).
Coastal Use Guidelines	
(1) Guidelines Applicable to all uses	Possible adverse impacts (1.7) of site Designation were identified and discussed in Chapter 4 of the EIS. Evaluation of the site for final designation is based on the Ocean Dumping Regulations issued pursuant to the Marine Protection, Research, and Sanctuaries Act of 1972 (86 Stat. 1052), as amended (33 U.S.C.A. §1401, et. seq.). The Act requires that "dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environments, or economic potentialities" §102(a). Future use of the site would be controlled through the permitting process in conformance with applicable regulations. Other uses for the dredged material were not evaluated in the EIS since that determination is appropriate in the project planning and permitting stages (1.6.).

Table 5-1 (Cont'd)

	Comments
(3) Guidelines for Linear Facilities	Although linear in configuration, the ODMDS is not a permanent linear structure. The dredged materials disposed within the site form a temporary mound which will be redistributed through littoral processes. The alignment of the ODMDS corresponds to the historically used site (3.5). The ODMDS parallels and is adjacent to the channel which will be the primary source of dredged material. The dredged material is similar in composition and size to the material in the site and is not suitable for fill. The site is not located in a wetland or estuarine area (3.2), nor does it traverse or intersect a barrier island (3.7), beach, tidal pass, reef or other natural gulf shoreline (3.8). Historical use of the ODMDS has not resulted in reports of the disruption of natural hydrologic and sediment transport patterns, sheet flow or water quality (3.9).
(4) Guidelines for Dredged Spoil Deposition	The site is located in an historically used dredged material disposal area. The evaluation summarized in the EIS resulted in a determination that there was no environmental advantage to alternative ocean sites. Upland disposal was not ruled out, but the comparative suitability should be determined in the permitting process (4.2). The ODMDS will not adversely affect wetlands, the oyster reefs, or submerged vegetation (4.3, 4.4). Effects on navigation and fishing (4.5) are addressed in Chapter 4 of the EIS.
(5) Guidelines for Shoreline Modification	Designation of an ODMDS is not intended to directly or indirectly change or prevent change to the shoreline (Guideline Definition; examples include bulkheading, piers, docks, and jetties).
(7) Hydrologic and Sediment Transport Modifications	The ODMDS is not intended to change water circulation, direction of flow, velocity, level, or quality or quantity of transported sediment (Guideline Definition, examples include locks, impoundments, dams and canals.

Chapter 6

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Appendix A

REPORT OF FIELD SURVEY

PREFACE

Interstate Electronics Corporation (IEC), under contract to the Environmental Protection Agency (EPA), Contract No. 68-01-4610, conducted two surveys of the Atchafalaya River Ocean Dredged Material Disposal Site (ODMDS). The survey plans were prepared by IEC and submitted to EPA in November 1980 and May 1981. The 1980 plan was approved by T. A. Wastler and the 1981 plan by W. C. Schilling (Chiefs, Marine Protection Branch, EPA). Field work was conducted during 3 and 4 December 1980 and 23 May to 1 June 1981. CTD measurements were not taken during the surveys; shallow depths at all stations required sampling from a small boat, from which the CTD could not be deployed. Due to shipboard error only one water temperature was taken (Station 8, December 1980).

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TABLES

CONTENTS (Continued)

A.1 INTRODUCTION

Interstate Electronics Corporation (IEC) conducted field surveys at the Atchafalaya River ODMDS during December 1980 and May-June 1981. Physical, chemical, biological, and geological oceanographic data were collected to assess the effects of dredged material disposal on the marine environment, and to augment historical information for the area. A major consideration of survey design was to determine whether any adverse effects identified within the ODMDS were detectable outside site boundaries.

Methods of collection, results, and interpretations of the survey data are presented in the following sections. Data are briefly compared with historical information; however, more comprehensive treatment is given in Chapter 3 of this EIS.

A.2 METHODS

Survey operations were conducted using the Ocean Survey Vessel ANTELOPE. Because of generally shallow depths, all samples (except trawls) were collected from a 16-foot Boston Whaler and processed aboard the Antelope. Loran-C or radar range and bearing positioning were used for navigation, providing accuracy within 0.25 nmi. (See Appendix B for Loran-C positioning, or ranges and bearings, for all sampling locations).

Stations 1 to 5 were located inside the ODMDS, and control Stations 6 to 10 were positioned in predominant upcurrent/downcurrent directions outside the site (Figures A-1 and A-2). Station locations were designed to determine whether transport of dredged material was occurring outside of the site boundaries. Samples collected, coordinates, and water depths for all stations are presented in Table A-1.

Microbiological analyses of sediments and tissues, and several chemical and physical oceanographic measurements were performed aboard the ANTELOPE; all other detailed chemical, geological, and biological analyses were performed at shore-based laboratories listed in Table A-2.

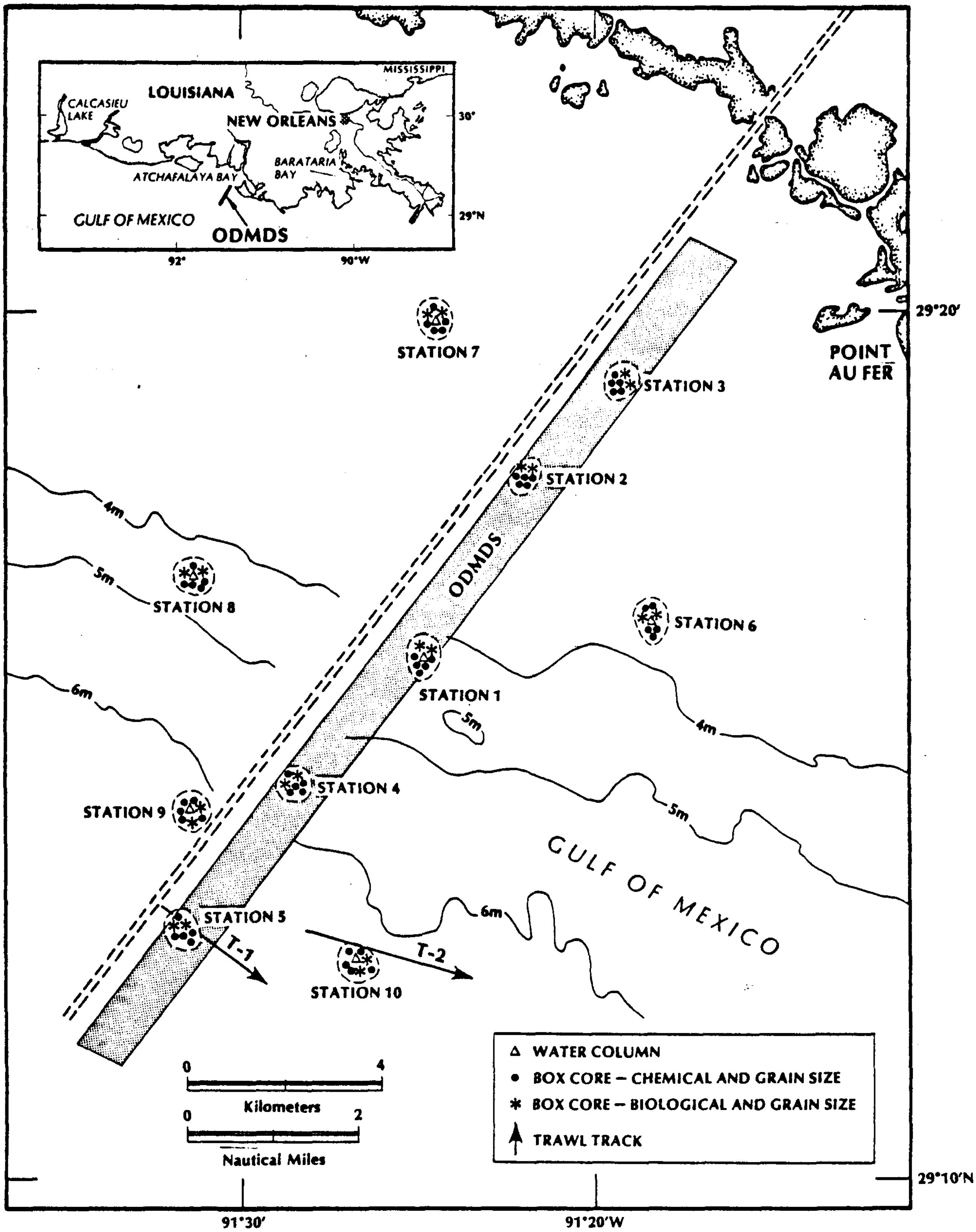


Figure A-1. Station Locations,
IEC Survey of Atchafalaya River ODMDS (December 1980)

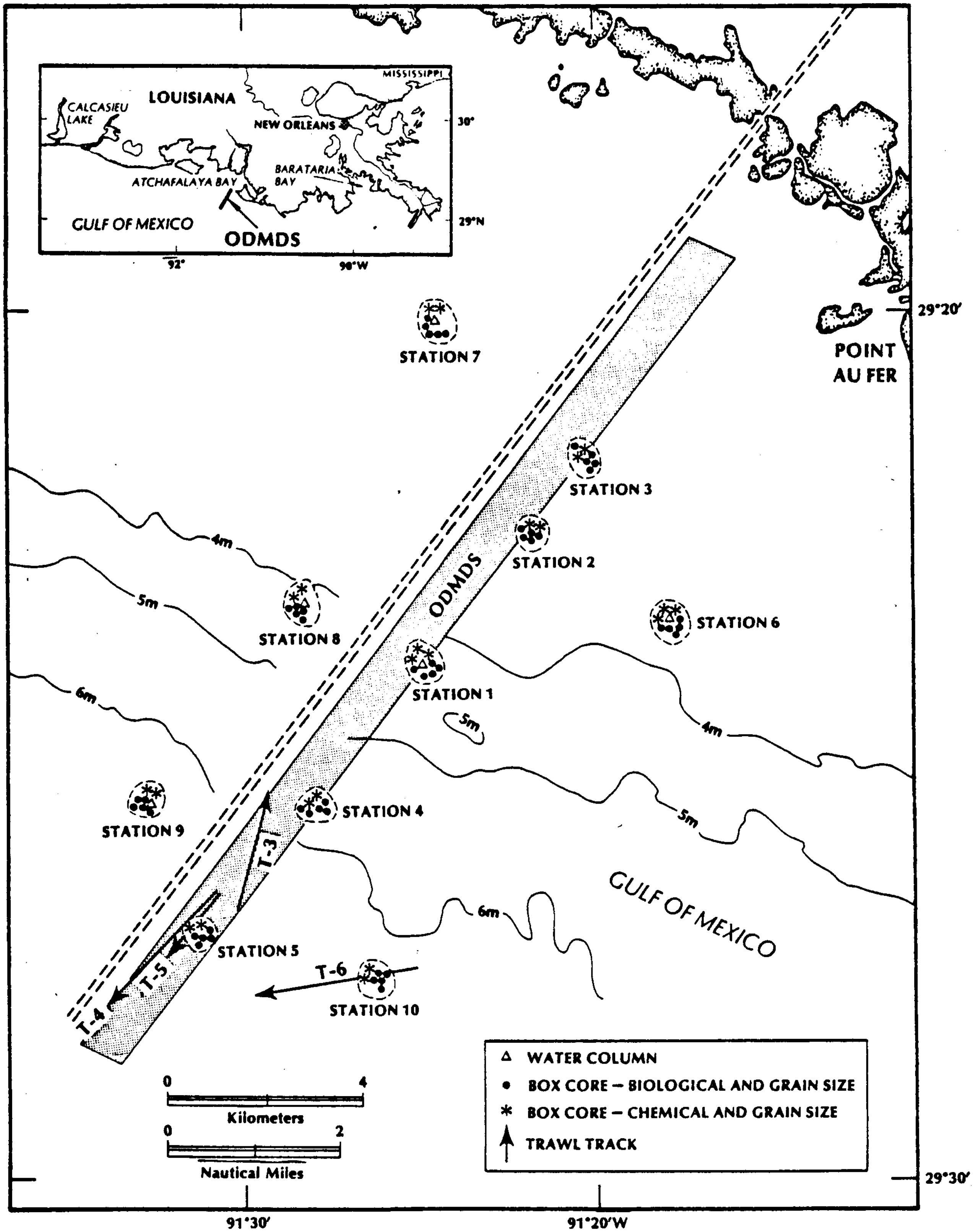


Figure A-2. Station Locations,
IEC Survey of Atchafalaya River ODMDS (May-June 1981)

TABLE A-1
SAMPLING REQUIREMENTS FOR ATCHAFALAYA RIVER ODMDS AND VICINITY (DECEMBER 1980 AND MAY-JUNE 1981)

	WATER COLUMN									SEDIMENT												BIOTA *		
	WATER SAMPLING ROSETTE									BOX CORER, 7 DROPS												DREDGE/TRAWL		
			GO-FLOW 1 SAMPLE PER MIDWATER STATION			GO-FLOW TEFLON-LINED 1 SAMPLE PER MIDWATER STATION				GEOLOGICAL-CHEMICAL 2 CORES PER STATION									1 CORE PER STA	BIOLOGICAL 5 CORES OR GRABS PER STATION		EPIFAUNA AND MACROINFAUNA TISSUES 2 TRAWLS PER SITE		
STATION NUMBER	SALINITY, TURBIDITY, pH, AND TEMPERATURE	DISSOLVED OXYGEN	DISSOLVED TRACE METALS (A)	PARTICULATE TRACE METALS (A)	CHLORINATED HYDROCARBON SCAN	SUSPENDED SOLIDS	ELUTRIATE SAMPLE	GRAIN SIZE AND ARTIFACTS	CYANIDE	TOTAL ORGANIC CARBON	TOTAL AND FECAL COLIFORMS	TRACE METALS (A)	PHENOLS	CHLORINATED HYDROCARBON SCAN (B)	C_{15}-C_{30} PETROLEUM HYDROCARBON SCAN (B)	OIL AND GREASE	ELUTRIATE SAMPLE	GRAIN SIZE AND ARTIFACTS	MACROINFAUNA, TAXONOMY	TRACE METALS (D)	CHLORINATED HYDROCARBON SCAN (C)	TOTAL AND FECAL COLIFORMS (C)	MACROFAUNA AND TAXONOMY	WORK VESSEL
001	●	●	QC	QC	QA	●	●	●	QC	●	●	QC	QC	●	●	●	●	●	●					SMALL BOAT †
002								●	●	●	●	●	●			●		●	●					SMALL BOAT
003								●	●	●	●	●	●			●		●	●					SMALL BOAT
004								●	●	●	●	●	●			●		●	●					SMALL BOAT
005								●	●	●	●	●	●			●		●	●	QC	QC	●	●	SMALL BOAT
006	●	●	●	Q	QC	QB	●	●	●	●	●	●	●	●	●	●	●	●	●					SMALL BOAT
007	●	●				●		●	●	●	●	●	●			●		●	●					SMALL BOAT
008	●	●				●		●	●	●	●	●	●			●		●	●					SMALL BOAT
009	●	●				●		●	●	●	●	●	●			●		●	●					SMALL BOAT
010	●	●						●	●	●	●	●	●			●		●	●	●	●	●	●	SMALL BOAT

STATIONS

NUMBER	1	2	3	4	5	6	7	8	9	10
LATITUDE	29°16'06"N	29°17'40"N	29°19'13"N	29°14'30"N	29°12'54"N	29°16'24"N	29°19'54"N	29°16'54"N	29°14'24"N	29°12'30"N
LONGITUDE	91°27'49"W	91°26'24"W	91°25'00"W	91°29'10"W	91°30'33"W	91°24'36"W	91°26'50"W	91°29'30"W	91°31'14"W	91°28'24"W
DEPTH	4m	3m	2m	3m	5m	3m	4m	3m	4m	5m
NUMBER	1	2	3	4	5	6	7	8	9	10
LATITUDE	29°16'06"N	29°17'40"N	29°19'13"N	29°14'30"N	29°12'54"N	29°16'24"N	29°19'54"N	29°16'54"N	29°14'24"N	29°12'30"N
LONGITUDE	91°27'49"W	91°26'24"W	91°25'00"W	91°29'10"W	91°30'33"W	91°24'36"W	91°26'50"W	91°29'30"W	91°31'14"W	91°28'24"W
DEPTH	2m	3m	3m	4m	4m	4m	3m	4m	3m	5m

QA = Filter clean seawater through one additional column to determine extraction efficiency (May-June Survey only)

QB = Rinsing efficiency for removal of sea salts from Nucleopore filters, in addition to samples collected at each designated station

QC = One quality control sample taken, in addition to samples collected at each designated station

QD = Handling blanks for trace metals plus sample

(A) Mercury, cadmium, lead, chromium, arsenic, zinc, nickel, copper, and manganese will be analyzed

(B) Composite sample from both box cores at each designated station

(C) Composite sample from all trawls, plus samples of opportunity from geological-chemical box cores. Species identified onboard ship before analysis or preservation, and specimens retained for verification

*All dredges/trawls conducted using OSV ANTELOPE

† 16-foot Boston Whaler

TABLE A-2
LABORATORIES PERFORMING ANALYSIS OF
SAMPLES COLLECTED AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Biology	Chemistry/Geology
Barry A. Vittor and Associates Mobile, Alabama	ERCO Cambridge, Massachusetts
La Mer* San Pedro, California	TAXON Salem, Massachusetts
	Jacobs Laboratories* Pasadena, California

* Denotes quality control laboratory

Sampling equipment, procedures, and preservation methods were in accordance with the "Oceanographic Sampling and Analytical Procedures Manual" (IEC, 1980). A summary of these methods is presented in the following sections.

A.2.1 WATER COLUMN MEASUREMENTS

A.2.1.1 Shipboard Procedures

Middepth water samples were collected in 5 liter or 30 liter Go Flow bottles for suspended solids, turbidity, dissolved oxygen, salinity, pH, dissolved and particulate trace metals, and dissolved chlorinated hydrocarbons (CHC). Water temperature was measured only at Station 8 during the December survey. Salinity samples were analyzed with a Beckman salinometer. Water temperature was measured using a bucket thermometer. Turbidity was measured with a Hach laboratory turbidimeter, and pH with a Beckman pH meter. Dissolved oxygen was determined using a modified Winkler method (Strickland and Parsons, 1972). Water samples for total suspended solids and trace metals (particulate and dissolved) analyses were transferred from Go-Flo bottles to 2-liter pressure filtration bottles, then filtered through Nucleopore filters. The filtrate was collected for dissolved trace metals analysis in precleaned bottles acidified with Ultrex nitric acid. Measured water volumes were pressure-fed directly from Go-Flo bottles through an Amberlite XAD resin column for extraction of CHCs (Osterroht, 1977). Filters for particulate trace metals and suspended solids, and resin columns for CHCs, were processed in a positive pressure clean hood and frozen prior to analysis.

A.2.1.2 Laboratory Methods

Total suspended solids were determined gravimetrically on an electrobalance (Meade et al., 1975). Filters containing particulate trace metal (arsenic, cadmium, chromium, copper, manganese, nickel, lead, and zinc) samples were leached for 2 hours with 1N Ultrex nitric acid; leachates were analyzed by flame or graphite furnace atomic absorption spectrophotometry (AAS). Mercury was determined by acid-permanganate digestion (95°C) of particulate matter, reduction of ionic mercury with hydroxylamine and stannous sulfates, and analysis by cold-vapor AAS (EPA, 1979).

Dissolved mercury was analyzed by cold-vapor AAS following acid-permanganate digestion (95°C) and reduction with hydroxylamine and stannous sulfates (EPA, 1979). Arsenic was determined by a hydride generation technique under addition of sodium borohydride and sodium hydroxide (Aandreae, 1977; EPA, 1979). Dissolved cadmium, chromium, copper, manganese, nickel, lead, and zinc were concentrated using a chelation-solvent extraction method (Sturgeon et al., 1980), and analyzed by graphite furnace AAS.

CHCs were eluted from resin columns with acetonitrile. The eluate was extracted three times with hexane, evaporated to near dryness, fractionated on a florisil column, and analyzed by electron-capture gas chromatography (Osterroht, 1977). The chromatogram was scanned for presence of polychlorinated biphenyl (PCB) mixtures (Arochlors 1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262), and various pesticides and derivatives (aldrin, dieldrin, endrin, heptachlor, β-BHC, DDT, DDD, DDE, and heptachlor epoxide).

A.2.2 GEOCHEMISTRY AND GRAIN SIZE ANALYSIS

A.2.2.1 Shipboard Procedures

Sediment sampling was performed with a 0.05 m^2 Ponar grab sampler. Seven 50g sediment samples were collected at each station and frozen for grain size analysis. Sediment samples for geochemical analyses (trace metals, oil and grease, total organic carbon [TOC], cyanide, phenols, petroleum hydrocarbons, and CHCs) were collected from the surface 2 cm of two cores per station, stored in acid-cleaned Teflon jars, and frozen.

A.2.2.2 Laboratory Methods

Sediment grain size was determined by washing sediment samples through 2,000 and 62 μm mesh sieves to separate gravel, sand, and silt/clay fractions (Folk, 1978). Sand/gravel fractions were separated with 1 phi (Ø) interval sieves, dried, and weighed. The silt/clay fractions were analyzed using a pipette method (Rittenhouse, 1933).

Trace metals (arsenic, cadmium, chromium, copper, manganese, nickel, lead, and zinc) were leached from 5g to 10g of sediments for 2 hours with 25 ml of 1N nitric acid, and analyzed by graphite furnace AAS or inductively coupled plasma emission techniques (ICP). Mercury was leached from 5g to 10g of sediment at 95°C with aqua regia and potassium permanganate, reduced using hydroxylamine sulfate and stannous sulfate, and analyzed by cold-vapor AAS (EPA, 1979).

Oil and grease were extracted from 100g sediment samples with an acetone-hexane mixture, dried, and quantified gravimetrically according to the method of APHA (1975). TOC in sediments was measured with a Perkin-Elmer Model 240 Elemental Analyzer (Gibbs, 1977). Analyses for total cyanide and total recoverable phenols were performed according to methods specified by APHA (1975) and EPA (1979), as modified for sediment samples.

CHCs were soxhlet extracted from sediment samples using a 1:1 acetone-hexane solvent. The extract was evaporated, cleaned on a florisil column, fractionated on a silicic acid column, and analyzed by electron-capture gas chromatography (EPA, 1974). An additional acid cleanup step was required for analysis of PCBs. Chromatograms were scanned for the same compounds listed above in Section A.2.1.2. Petroleum hydrocarbons were extracted from sediments with an acetone-hexane solvent and analyzed by column and glass-capillary gas chromatography (Farrington and Tripp, 1975; Boehm, et al., 1980).

Elutriate analyses were performed in accordance with the specifications of EPA/CE (1977). Sediments and unfiltered disposal site water were mixed at a 1:4 ratio by mechanical and air agitation for 30 minutes. After a 1-hour settling period, test water was filtered, acidified with Ultrex hydrochloric acid, and analyzed for dissolved trace metals (arsenic, cadmium, chromium, copper, mercury, manganese, nickel, lead, and zinc) using techniques described above.

A.2.3 BIOLOGICAL MEASUREMENTS (Including Tissue Chemistry and Coliform)

A.2.3.1 Shipboard Procedures

Five macrofaunal samples were collected at each station using a 0.05 m^2 Ponar grab sampler. Samples were washed through a 0.5 mm screen and organisms were preserved in 10% formalin in seawater prior to analysis.

A total of six 7.6m otter trawls were conducted to collect epifauna for analysis of tissue concentrations of CHCs, trace metals, and total and fecal coliforms. In December, single tows were performed inside (T-1) and outside (T-2) the ODMDS; in May-June three trawls were taken inside (T-3, T-4, and T-5), and one outside (T-6), the ODMDS (Figures A-1 and A-2). Information from the catch was also used to further characterize the benthic and nektonic communities.

Epifauna from the trawls were sorted in stainless steel trays and enumerated. Tissue was combined from at least three individuals of each of the commercially important species captured, aseptically homogenized in a blender, and cultured within 6 hours for total and fecal coliforms using a modified most probable number (MPN) technique (APHA, 1975; IEC, 1980). Other specimens were transferred from the trays to acid-rinsed plastic buckets, and then into clean plastic bags and frozen for trace metal analyses. Additional specimens were transferred to stainless steel buckets with stainless steel forceps, wrapped in aluminum foil, placed in polyethylene bags, and frozen for CHC analysis.

Total and fecal coliforms were determined in sediments from the two box core samples taken for sediment geochemistry. Approximately 30g of sediment from the surface 1 cm of each sample was collected aseptically; analysis was initiated within 6 hours after collection. Coliforms were determined using the MPN technique (APHA, 1975; IEC, 1980).

A.2.3.2 Laboratory Methods

Six dominant macrofaunal species were selected for enumeration in all samples. Selection of species was based on inspection of initial laboratory data (species abundance throughout the site), feeding types, and known association with environmental conditions, particularly substrates. Each of the six dominant species was enumerated in all five station replicates, and mean species abundances were calculated for each station. All samples were transferred to 70% alcohol for storage.

Analysis of cadmium, chromium, copper, manganese, nickel, lead, and zinc concentrations in tissues followed techniques described by EPA (1977). Approximately 5 to 10g of homogenized tissue were digested with nitric acid and hydrogen peroxide while heated. The digests were then evaporated, diluted to volume with deionized water, and analyzed by flame or flameless AAS. Determinations of mercury and arsenic levels in tissues required cold overnight digestion of a 5g sample with hydrogen peroxide and sulfuric acid, followed by additions of potassium permanganate and potassium persulfate, with digestion at 50 to 60°C (EPA, 1977). Mercury was analyzed by cold-vapor AAS, and arsenic by hydride generation or graphite furnace AAS.

Tissue analyses for CHCs required homogenization of 50g of tissue with sodium sulfate, extraction with hexane, cleanup, fractionation, and analysis with electron-capture gas chromatography (EPA, 1974).

A.2.4 COMPUTER DATA ENTRY AND ANALYSIS

All data were converted to a standard data format for entry into the Ocean Data Environmental Evaluation Program (ODEEP), a computerized data base management system developed by IEC. Statistical analyses included calculation of means, variances, correlations, and analysis of variance. Correlations were run between parameter values measured within individual sediment samples (replicates).

A.2.5 QUALITY CONTROL PROGRAM

Accuracy and precision of shipboard and laboratory procedures and data was assessed using the quality control program described in this section. Key elements of the program included:

- Collection of quality control samples (sample blanks) to identify sources of contamination resulting from shipboard handling

- Laboratory analysis of spiked (prepared samples having a series of trace metal concentrations) and replicate samples

- Determination of the validity of primary laboratory data through analysis of replicate field and National Bureau of Standards (NBS) samples by both the primary and quality control laboratories

A detailed description of quality control procedures is presented in the "Oceanographic Sampling and Analytical Procedures Manual" (IEC, 1980). A summary of these procedures is included in the following sections. A listing of quality control data is presented in Appendix C.

A.2.5.1 Interlaboratory Quality Control and Calibration (Appendix C-1)

(a) Analysis of Replicate Samples - The following replicate samples were collected for analysis by both primary and quality control laboratories: Nucleopore filters for analysis of particulate trace metals; water samples for dissolved trace metals; XAD resin columns for dissolved chlorinated hydrocarbons; sediment samples for analysis of trace metals, cyanide, phenols, and petroleum and chlorinated hydrocarbons.

Samples for analysis of tissue contaminants (trace metals and chlorinated hydrocarbons) were blended and split by the primary laboratory; half of the sample then was shipped to the quality control laboratory for analysis.

In addition, analyses were performed by both laboratories on NBS reference materials to determine extraction efficiencies for trace metals in sediments and tissues.

(b) Identification of Biological Specimens - Taxonomic identifications of approximately 10 specimens of selected species of macroinfauna were verified by a quality control laboratory.

A.2.5.2 Shipboard Quality Control Procedures (Appendix C-2)

(a) Comparison of Biological Data Collected Using Two Types of Sampling Gear - Five box core samples and five Ponar grab samples were collected at Station 6, Mississippi River-Gulf Outlet ODMDS (EPA, in preparation). Mean numbers of selected taxa were compared using a Mann-Whitney U-test to determine if there was a significant difference in the number of organisms captured by the two sampling methods. Samples were collected and analyzed using standard procedures described in Section A.2.3.

(b) Trace Metal Contamination From Shipboard Handling of Filters - Standard shipboard laboratory procedures were followed for handling Nucleopore filters used to collect trace metal samples. These filters were rinsed with ultrapure water and frozen prior to analysis for trace metals.

(c) Extraction Efficiency of the XAD Resin Column - Clean seawater was passed through the column and frozen prior to laboratory analysis for chlorinated hydrocarbons.

(d) Rinsing Efficiency for Removal of Salts from Nucleopore Filters - Filtered seawater was passed through a clean filter, frozen, and analyzed as a sample blank for total suspended solids and particulate trace metals.

A.2.5.3 Internal Quality Control for Primary Laboratory (Appendix C-3)

Analysis of Replicate Samples - Internal quality control analyses were performed by the primary laboratory on replicate samples for trace metals and chlorinated hydrocarbons in seawater, tissues, and sediments; and for total organic carbon, oil and grease, cyanide and phenols in sediments. In addition, analyses were performed on NBS reference materials to determine the extraction efficiency for trace metals in sediments and tissues.

A.3 RESULTS AND DISCUSSION

A.3.1 WATER COLUMN CHARACTERISTICS

Salinities varied widely over the study area during both the December 1980 (15.0 to 26.6^{o}/oo) and May-June 1981 (4.9 to 35.5^{o}/oo) surveys (Table A-3). The lowest salinity (4.9^{o}/oo) was observed in May-June at nearshore Station 7; however, values at the remaining stations were higher than during the December survey. The Atchafalaya River is the major source of freshwater to the area (Heaton, 1978; Schubel et al., 1978) and the general offshore increase in salinity observed during both sampling periods reflected this input. Spatial and temporal salinity variations similar to those reported here are typical of coastal Louisiana and appear to be functions of runoff, rainfall, and wind effects (Heaton, 1978; Schubel et al., 1978; Fotheringham and Weissberg, 1979; Weissberg et al., 1980a; Turgeon, 1981). Water temperature in the vicinity of the ODMDS was recorded only once during the surveys. The value of 19.0°C at Station 8 during December (Table A-3) is within the range reported for autumn and winter (about 10 to 22°C) by Turgeon (1981). Spring (May-June) water temperatures are warmer, ranging from approximately 22 to 32°C (Turgeon, 1981). Since salinity and temperature were recorded only at middepths during the surveys, the data provide no information regarding vertical water column structure. Fotheringham and Weissberg (1979) have reported, however, that

TABLE A-3
WATER COLUMN PHYSICAL AND CHEMICAL
PARAMETERS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Sample Depth (m)	Temperature (°C)	Salinity (°/oo)	Total Suspended Solids (mg/liter)	Turbidity (NTU)	Dissolved Oxygen (mg/liter)	Dissolved Oxygen (% Saturation)	pH
December 1980								
1	4	-	23.197	102	55	9.49	-	8.4
6	2	-	23.195	18.5	7	10.25	-	8.3
7	4	-	15.004	9.85	25	9.47	-	8.4
8	3	19.0	21.734	30.4	250	9.68	121	8.3
9	4	-	26.622	15.3	13	10.31	-	8.5
May-June 1981								
1	2	-	35.532	23.0	34	8.40	-	8.1
6	2	-	28.887	58.7	28	6.77	-	8.1
7	3	-	4.930	59.7	30	7.84	-	8.2
8	2	-	29.638	44.7	15	8.53	-	8.2
9	2	-	30.353	26.9	14	8.94	-	8.2

- Not determined because of shipboard error (determination of % saturation of dissolved oxygen requires water temperature)

stratification, primarily caused by salinity differences, is most intense in this area during spring and summer in response to high river discharge and limited vertical mixing.

Dissolved oxygen concentrations below the surface are generally highest off Louisiana during winter, when water column stratification is weak or absent (e.g., Fotheringham and Weissberg, 1979). Consistent with this observation, middepth dissolved oxygen levels during the December survey ranged from 9.5 to 10.3 mg/liter, whereas May-June values ranged from 6.8 to 8.9 mg/liter (Table A-3). Concentrations during both surveys were in the high portions of seasonal ranges reported for the area (Turgeon, 1981; Fotheringham and Weissberg, 1979). The data did not reflect the periodic oxygen depletion at depth, which has been observed in the general area by Fotheringham and Weissberg (1979).

Waters in the vicinity of the ODMDS are generally turbid because of shallow depths, sediment resuspension by waves and winds, and inputs of suspended particulates in runoff from the Atchafalaya River. Background concentrations of total suspended solids (TSS) have been reported to approach or exceed 100 mg/liter in the area, particularly during storms (Heaton, 1978; Schubel et al., 1978; Hausknecht, 1980). A wide range of TSS concentrations (10 to 102 mg/liter) were recorded during the December survey when stormy weather was encountered (Table A-3); the observed maximum at ODMDS Station 1 was likely the result of sediment resuspension. No inshore/offshore trends were indicated by the December results. During the May-June survey the range of TSS levels was smaller (23 to 60 mg/liter), but concentrations were still fairly high. The May-June TSS results indicated a generally decreasing offshore trend, probably reflecting inputs from the Atchafalaya River (Weissberg et al., 1980a). With the exception of the maximum of 250 NTU at Station 8 in December, turbidity levels were similar for the May-June (7 to 55 NTU) and December (14 to 34 NTU) surveys; no spatial turbidity trends were apparent, nor did spatial variations for turbidity and TSS values coincide. This dissimilarity may have resulted from either subsampling errors, or passage of water parcels with different characteristics during sampling.

Values for pH were slightly higher in December relative to May-June, (Table A-3) but all values (8.1 to 8.5) fell within the normal range for seawater (Horne, 1969). Since acid formation is known to occur in coastal marshes (Baas Becking et al., 1960), the lower pH observed during May-June may reflect terrestrial influence.

In waters off southeastern Louisiana, concentrations of particulate trace metals within a given volume of water are largely a function of the quantity of particles present (Heaton, 1978; Schubel et al., 1978; Tillery, 1980). As expected, maximum concentrations for most particulate metals (Table A-4) were measured at ODMDS Station 1 for December, where the TSS level was also greatest (102 mg/liter). Particulate trace metal values were slightly lower at control Station 6 during May-June (TSS = 58.7 mg/liter), followed by roughly equivalent concentrations for Station 1 in May-June and Station 6 in December (TSS = 23.0 and 18.5 mg/liter, repectively). Overall ranges were 0.20 to 0.62 μg/liter for arsenic, 0.02 to 0.07 μg/liter for cadmium, 0.27 to 0.82 μg/liter for chromium, 0.40 to 1.2 μg/liter for copper, 0.004 to 0.016 μg/liter for mercury, 6.6 to 72 μg/liter for manganese, 0.32 to 0.91 μg/liter for nickel, 0.46 to 1.9 μg/liter for lead, and 2.0 to 4.9 μg/liter for zinc. All concentrations were comparable to ambient levels reported for nearshore waters in the area (Heaton, 1978; Schubel et al., 1978; Tillery, 1980).

Concentrations of most dissolved metals during the surveys were somewhat greater in May-June relative to December (Table A-4). Dissolved metal concentrations appeared to be inversely related to TSS and particulate metal levels; this inverse relationship may be caused by scavenging of metals from solution onto sediment particles (Krauskopf, 1956; Heaton, 1978). Concentration ranges for dissolved metals over both surveys were 1.0 to 1.2 μg/liter for arsenic, <0.07 to 0.16 μg/liter for cadmium, <0.11 to 1.0 μg/liter for chromium, 0.94 to 2.5 μg/liter for copper, <0.033 to 0.073 μg/liter for mercury, 0.16 to 18 μg/liter for manganese, 0.38 to 2.0 μg/liter for nickel, 0.05 to 3.2 μg/liter for lead, and 1.4 to 3.2 μg/liter for zinc. Although concentrations of certain metals (e.g., manganese and lead) varied widely, all data were comparable to results of previous studies off southeastern Louisiana (CE, 1978; Heaton, 1978; Fotheringham and Weissberg, 1979; Weissberg et al., 1980a,b). No consistent differences in dissolved metal levels between ODMDS Station 1 and control Station 6 were observed.

Concentrations measured during the surveys for total (particulate plus dissolved) arsenic, cadmium, copper, chromium, and nickel were below their respective EPA minimum marine water quality criteria (45 FR 79318 et seq.). Total mercury levels at control Station 6 (0.075 and 0.089 μg/liter) exceeded the 24-hour average criterion of 0.025 μg/liter during both surveys, but were well below the single measurement criterion of 3.7 μg/liter (45 FR 79318 et seq.). Total mercury concentrations at ODMDS Station 1 were lower but

TABLE A-4
CONCENTRATIONS OF DISSOLVED AND PARTICULATE TRACE METALS AND DISSOLVED CHCs AT MIDDEPTH IN THE WATER COLUMN AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Depth (m)	Dissolved Trace Metals (μg/liter) As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn	Dieldrin	Dissolved CHCs (ng/liter) pp'DDE	PCB (Arochlor 1254)
December 1980													
1	4	1.0	0.04	<0.11	1.0	<0.033	0.39	0.38	0.09	1.4	0.1	ND	0.4
6	2	1.2	0.08	<0.12	1.7	0.073	0.16	0.48	0.05	2.3	0.2	ND	0.6
May-June 1981													
1	2	1.2	0.16	0.54	2.5	<0.033	18	2.0	3.2	3.2	4.1	53.0	ND
6	2	1.2	<0.072	1.0	0.94	0.068	0.84	0.84	0.29	1.4	ND	24.0	ND
		Particulate Trace Metals (μg/liter)											
		As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn			
December 1980													
1	4	0.62	0.02	0.82	1.2	0.014	72	0.91	1.9	4.9			
6	2	0.20	0.04	0.27	0.40	0.016	14	0.38	0.46	2.0			
May-June 1981													
1	2	0.34	0.07	0.33	0.70	0.004	6.6	0.32	0.47	2.1			
6	2	0.36	0.02	0.40	1.0	0.007	69	0.59	1.2	3.8			

ND = None detected

Note: Data represent single determinations; no other CHCs were detected (see Section A.2.1.2 for CHCs examined) indeterminate (<0.047 and <0.037 μg/liter). No criteria have been established for lead or manganese; however, total lead concentrations were below any known levels of toxicity to marine biota (45 FR 79318 et seq.), and manganese is not generally considered an element of environmental concern in marine waters.

Concentrations of most dissolved CHCs examined (see Section A.2.1.2) were below detectable levels at Stations 1 and 6 during both surveys (Table A-4). Only dieldrin (0.1 to 4.1 ng/liter), the DDT derivative pp'DDE (24 to 53 ng/liter), and the PCB Arochlor 1254 (0.4 to 0.6 ng/liter) were present in measurable quantities. Dieldrin and pp'DDE levels were substantially greater during May-June relative to December; the higher levels may have been derived from coastal sources (Lauer et al., 1966). For example, concentrations of both these compounds are relatively high in Mississippi River waters (Brodtman, 1976). The maximum dieldrin concentration measured during the May-June survey (4.1 ng/liter) was somewhat greater than reported previously (CE, 1978) for the area of the ODMDS (<0.5 to 3 ng/liter); however, it was within Brodtman's (1976) range for Mississippi River water (2 to 10 ng/liter). The May-June level exceeded the EPA 24-hour marine water quality criterion (45 FR 79318 et seq.) for dieldrin (1.9 ng/liter), but was well below the single measurement criterion (710 ng/liter). Comparison of the May-June DDE concentrations (24 and 53 ng/liter) with the EPA 24-hour (1 ng/liter) and single measurement (130 ng/liter) criteria for DDT and derivatives yielded similar results. Concentrations of DDTs determined previously in Mississippi River water (Brodtman, 1976), and in nearshore waters off Louisiana (CE, 1978; Giam et al., 1978), were somewhat lower than those reported here. PCB concentrations (detected during the December survey only) were well below minimum EPA criteria (45 FR 79318) and within or below ranges for the region reported in the literature (CE, 1978; Giam et al., 1978).

None of the water column parameters measured during the surveys indicated that dredged material disposal has had a measurable effect on water quality in the area of the ODMDS. The high TSS level at Station 1 during December was a possible exception; however, waters off southeastern Louisiana are generally turbid because of shallow depths and riverine influences. Levels of most parameters appeared to be typical of the study area.

A.3.2 SEDIMENT CHARACTERISTICS

A.3.2.1 Physical

Surficial sediments during both surveys were predominantly silts and clays at all stations, but exhibited some temporal and spatial textural variability (Table A-5). Results were similar to previous observations within and adjacent to the ODMDS (CE, 1978). Overall ranges for mean (n = 7) percentages of sand, silt, and clay were 0.1 to 17.1%, 31.7 to 55.1%, and 28.1 to 68.2%, respectively. Gravel content was minimal at all stations. Clay content increased somewhat at most stations between the December and May-June surveys, whereas percentages of sand and silt usually decreased. Generally finer grain size composition in May-June was probably the combined result of greater inputs of clays from the Atchafalaya River, and lower wave and current energies (i.e., less resuspension of fine bottom sediments) during spring relative to winter (Weissberg et al., 1980a). Sand content was greatest at Station 3 during both IEC surveys; this station was closest to the Point Au Fer Shell Reef, where increases in sediment sand content occur (CE, 1978). Since dredged materials released at the ODMDS are similar to natural sediments in the area (CE, 1978), no conclusions can be reached regarding disposal effects on sediment physical characteristics. Dredged material disposal did not occur between the IEC surveys.

A.3.2.2 Chemical

Concentrations of trace metals in surficial sediments generally exhibited little variation over the survey area (Tables A-6 and A-7). Mean (n = 40) concentrations (and ranges) over both surveys were 3.0 μg/g (1.8 to 4.4 μg/g) for arsenic, 0.15 μg/g (<0.08 to 0.33 μg/g) for cadmium, 1.9 μg/g (0.8 to 2.9 μg/g) for chromium, 10 μg/g (7.5 to 16 μg/g) for copper, 0.055 μg/g (0.037 to 0.078 μg/g) for mercury, 590 μg/g (250 to 950 μg/g) for manganese, 5.5 μg/g (3.9 to 9.1 μg/g) for nickel, 16 μg/g (9.7 to 24 μg/g) for lead, and 25 μg/g (17 to 45 μg/g) for zinc.

TABLE A-5
SEDIMENT GRAIN SIZE COMPOSITION AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Fines (%)
December 1980					
1	0.7 (0.0 - 2.0)	6.0 (2.6 - 8.2)	47.3 (40.1 - 54.6)	46.2 (40.9 - 55.3)	93.5 (89.8 - 97.4)
2	0.1 (0.0 - 0.3)	1.5 (1.1 - 2.1)	46.4 (36.7 - 50.7)	52.0 (47.5 - 61.4)	98.4 (97.9 - 98.9)
3	0.5 (0.1 - 1.6)	17.1 (3.0 - 30.0)	54.3 (47.0 - 65.7)	28.1 (21.8 - 33.1)	82.4 (69.7 - 96.8)
4	0.1 (0.0 - 0.4)	1.9 (0.2 - 3.1)	40.0 (31.8 - 49.2)	58.0 (47.7 - 67.1)	98.0 (96.8 - 99.8)
5	0.1 (0.0 - 0.4)	0.4 (0.1 - 1.0)	41.0 (33.2 - 51.2)	58.5 (48.6 - 66.2)	99.5 (98.6 - 99.9)
6	0.2 (0.0 - 1.1)	4.3 (1.0 - 11.7)	50.7 (46.2 - 57.9)	44.8 (36.6 - 52.8)	95.5 (87.2 - 99.0)
7	0.4 (0.0 - 0.9)	1.9 (0.5 - 3.8)	48.5 (42.6 - 59.1)	49.2 (39.9 - 54.8)	97.7 (95.4 - 99.4)
8	0.7 (0.0 - 2.1)	0.5 (0.2 - 1.2)	48.7 (42.2 - 53.5)	50.1 (46.2 - 55.3)	98.8 (97.4 - 99.8)
9	0.1 (0.0 - 0.2)	1.2 (0.5 - 2.1)	40.3 (28.5 - 61.7)	58.5 (37.4 - 71.0)	98.8 (97.7 - 99.5)
10	0.4 (0.0 - 2.3)	0.4 (0.0 - 1.1)	34.1 (30.0 - 39.4)	65.1 (60.2 - 70.0)	99.2 (96.6 - 100.0)
May-June 1981					
1	0.1 (0.0 - 0.1)	1.3 (0.6 - 3.4)	45.5 (34.1 - 64.0)	53.1 (34.6 - 64.5)	98.6 (96.5 - 99.4)
2	0.3 (0.0 - 0.6)	2.3 (1.4 - 2.7)	55.1 (49.2 - 67.2)	42.3 (30.2 - 48.8)	97.4 (96.0 - 98.5)
3	0.2 (0.0 - 1.3)	9.1 (2.7 - 20.3)	41.8 (35.4 - 46.5)	48.9 (38.1 - 57.1)	90.7 (78.4 - 97.2)
4	0.2 (0.0 - 0.9)	2.5 (1.2 - 4.7)	35.5 (26.7 - 43.3)	61.8 (55.1 - 68.4)	97.3 (95.2 - 98.4)
5	0.0 (0.0 - 0.2)	0.2 (0.2 - 0.3)	32.6 (23.2 - 37.7)	67.2 (61.9 - 76.6)	99.8 (99.5 - 99.8)
6	0.3 (0.0 - 1.0)	4.1 (0.7 - 14.5)	35.7 (29.2 - 41.4)	59.8 (43.5 - 70.1)	95.5 (84.5 - 99.3)
7	0.0 (0.0 - 0.0)	2.0 (0.5 - 6.5)	35.6 (21.4 - 44.2)	62.4 (49.3 - 77.4)	98.0 (93.5 - 99.5)
8	0.1 (0.0 - 0.4)	0.8 (0.3 - 2.0)	31.7 (28.4 - 36.6)	67.4 (61.4 - 71.1)	99.1 (98.0 - 99.5)
9	0.1 (0.0 - 0.3)	0.7 (0.3 - 1.1)	33.9 (27.2 - 44.6)	65.3 (54.3 - 72.1)	99.2 (98.6 - 99.7)
10	0.0 (0.0 - 0.0)	0.1 (0.0 - 0.1)	31.7 (20.6 - 39.3)	68.2 (60.6 - 79.4)	99.9 (99.9 - 100.0)

Values listed are mean (range) for seven replicate box cores at each station; fines = silt plus clay (<0.0625 mm)

TABLE A-6
CONCENTRATIONS OF TRACE METALS, TOC, OIL AND GREASE, CYANIDE, AND PHENOLS, AND PERCENTAGES OF FINES AND CLAY IN SEDIMENTS AT ATCHAFALAYA RIVER ODMDS AND VICINITY (DECEMBER 1980)

Station	Trace Metals (μg/g)									Cyanide (μg/g)	Phenols (μg/g)	TOC (mg/g)	Grease (mg/g)	Oil and Fines (%)	Clay (%)
	As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn						
1	2.7	0.20	1.9	9.4	0.055	650	6.1	16	29	0.67	<1.4	2.0	8.0	95.4	55.3
	2.9	0.19	2.4	10	0.059	670	6.6	17	30	0.61	<1.6	4.1	15	97.4	54.4
2	3.0	0.19	1.6	10	0.061	620	5.5	14	24	<0.50	<1.6	5.4	0.73	97.9	57.4
	3.0	0.17	1.8	10	0.053	640	5.8	14	24	<0.50	<1.4	3.3	1.5	98.5	49.3
3	2.3	0.19	0.8	7.5	0.037	420	4.3	9.7	18	<0.50	<1.1	1.1	0.64	71.8	24.2
	2.4	0.16	1.3	8.0	0.045	470	5.2	13	19	<0.50	<1.0	1.8	2.2	92.4	29.9
4	3.1	0.10	1.4	8.7	0.061	620	4.6	14	21	<0.50	<1.3	0.31	0.60	96.9	47.7
	3.4	0.12	1.6	9.8	0.075	670	4.8	16	22	0.58	<1.6	4.1	0.73	97.1	55.9
5	3.7	<0.078	1.8	8.2	0.053	660	4.8	15	22	0.57	<1.4	0.41	0.57	99.7	48.6
	4.4	<0.079	1.9	9.3	0.070	720	5.0	17	24	<0.50	<1.4	6.1	0.44	99.8	57.6
6	2.8	0.13	1.6	8.0	0.044	500	5.2	13	21	0.63	<1.2	8.2	1.3	95.1	37.2
	2.5	0.13	1.5	8.0	0.044	450	5.1	12	20	<0.50	<1.1	3.4	0.40	94.4	43.2
7	2.3	0.18	1.4	8.6	0.048	390	4.9	11	20	<0.50	<0.91	0.15	0.64	95.4	40.7
	2.6	0.19	2.0	11	0.052	560	6.2	14	24	<0.50	<0.97	3.7	0.94	97.6	47.5
8	3.2	0.13	1.7	9.5	0.078	570	5.5	14	23	<0.50	<1.0	4.3	1.4	99.5	50.4
	3.4	0.13	1.7	9.1	0.054	590	5.6	14	23	<0.50	<1.1	0.22	0.90	99.7	46.2
9	3.4	0.14	2.0	11	0.074	690	5.7	18	26	<0.50	<0.95	0.89	0.58	99.5	66.6
	3.9	0.13	1.9	11	0.056	690	5.5	18	25	<0.50	<1.3	0.98	1.2	99.5	71.0
10	3.5	0.11	1.8	9.7	0.065	620	5.0	14	23	<0.50	<1.3	0.63	0.67	99.7	60.8
	3.3	0.13	1.8	10	0.060	540	5.3	15	24	<0.50	<1.3	0.72	0.67	99.6	65.6

Notes: Data represent single determinations for duplicate box cores at each station; fines = silt plus clay (<0.0625 mm)

TABLE A-7
CONCENTRATIONS OF TRACE METALS, TOC, OIL AND GREASE, CYANIDE, AND PHENOLS, AND PERCENTAGES OF FINES AND CLAY IN SEDIMENTS AT ATCHAFALAYA RIVER ODMDS AND VICINITY (MAY-JUNE 1981)

Station	Trace Metals (μg/g)									Cyanide (μg/g)	Phenols (μg/g)	TOC (mg/g)	Oil and Grease (mg/g)	Fines (%)	Clay (%)
	As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn						
1	2.4	0.16	2.4	10	0.057	630	6.1	19	28	<0.15	-	*	0.53	98.7	57.0
	2.9	0.13	2.0	8.9	0.053	610	5.5	17	26	<0.14	-	*	0.43	98.9	53.8
2	2.2	0.20	1.9	8.3	0.046	550	5.5	15	26	<0.11	-	*	0.48	97.2	46.0
	2.7	0.12	1.9	7.6	0.043	600	5.0	16	24	<0.12	-	*	0.74	97.8	45.6
3	4.2	0.33	2.9	16	0.041	600	9.1	22	45	<0.11	-	*	0.48	90.6	45.4
	2.1	0.16	1.7	8.1	0.041	290	5.3	12	24	<0.11	-	*	0.39	85.4	45.6
4	2.9	0.12	1.8	7.7	0.051	560	5.0	16	24	<0.11	-	*	0.38	98.1	57.7
	2.8	0.13	2.1	8.5	0.050	590	5.5	17	26	<0.12	-	*	0.46	98.4	55.1
5	3.1	0.08	2.4	8.9	0.055	910	5.7	20	27	0.13	-	*	0.53	99.8	76.6
	3.0	0.09	2.1	8.4	0.053	610	5.6	17	25	0.15	-	*	0.43	99.7	61.9
6	3.3	0.20	2.3	12	0.064	550	5.9	20	28	<0.13	-	*	0.88	98.9	69.0
	3.4	0.22	2.5	13	0.069	580	6.7	21	31	<0.17	-	*	1.1	98.8	66.9
7	1.8	0.15	1.3	7.4	0.040	250	3.9	11	17	<0.12	-	*	0.44	93.5	49.3
	1.9	0.16	1.7	9.4	0.049	500	4.8	16	22	<0.12	-	*	1.0	96.6	62.1
8	2.6	0.18	2.0	9.8	0.055	590	5.8	19	25	<0.12	-	*	0.77	98.0	61.4
	2.7	0.17	2.2	9.9	0.058	660	5.9	20	26	<0.13	-	*	0.91	98.1	69.0
9	3.1	0.16	2.3	10	0.062	520	6.1	19	27	0.25	-	*	0.36	99.2	69.2
	3.0	0.18	2.1	9.9	0.060	480	5.8	18	26	<0.13	-	*	0.33	99.7	71.2
10	3.3	0.09	2.4	11	0.056	950	5.8	24	27	<0.14	-	*	0.56	100.0	75.3
	3.4	0.10	2.4	9.9	0.060	890	5.5	23	27	<0.15	-	*	0.55	99.9	79.4

- Not determined
* Not reported because of laboratory error

Notes: Data represent single determinations for duplicate box cores at each station; fines = silt plus clay (<0.0625 mm)

Levels of all metals were similar for the two surveys and exhibited no consistent spatial or temporal trends. During December 1980, concentrations of most metals were slightly higher at control Station 9, where clay percentages were greatest. During the May-June 1981 survey, however, most concentrations were maximal in one replicate from ODMDS Station 3, where clay percentages were among the lowest; the zinc concentration (45 μg/g) in this sample was particularly high. With the exception of this single zinc value, trace metal concentrations were generally comparable to those previously reported for sediments off southeastern Louisiana (CE, 1978; Tillery, 1980; Weissberg et al., 1980a,b). Arsenic concentrations were relatively high in most samples; CE (1978) reported similar findings for the area.

Most of the trace metals were significantly ($p < 0.05$) correlated with percentages of clay in the sediments; cadmium and nickel were exceptions (Table A-8). Different behavior for cadmium relative to other metals has been previously documented (Gambrell et al., 1977; Heaton, 1978); no such documentation exists for nickel, however. Substantially weaker correlations occurred between fines (silt plus clay) and metals (Table A-8). Apparently, the clay fraction provides some control over trace metal concentrations in sediments at the study area, a relationship reported previously for this area (Weissberg et al., 1980a) and elsewhere (Hallberg, 1974). The significant positive correlations of all metals (except cadmium) with manganese may indicate that manganese (and probably iron) oxyhydroxides exert an additional influence through scavenging and co-precipitation (e.g., Morgan and Stumm, 1964; Heaton, 1978). The trace metals were generally positively correlated with each other, possibly indicating similar sources and/or behavior in this environment. Intermetal correlations involving chromium, zinc, copper, and nickel were generally strongest (Table A-8).

Total organic carbon (TOC) concentrations in sediments, determined only for the December survey, also showed little variability and were generally low (Table A-6). Values ranged from 0.15 to 8.2 mg/g, with an overall mean of 1.84 mg/g. No spatial patterns were apparent. Previous measurements in the area have ranged up to approximately 20 mg/g; data from the IEC surveys were within the lower portions of historical ranges (Hausknecht, 1980; Weissberg et al., 1980b).

TABLE A-8
CORRELATION MATRIX FOR SEDIMENT PARAMETERS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

	As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn	Oil and Grease
Cd	-0.14^{NS}									
Cr	$0.44^{†}$	0.23^{NS}								
Cu	0.56^{**}	0.58^{**}	0.70^{**}							
Hg	$0.37^{†}$	-0.11^{NS}	0.27^{*}	0.28^{*}						
Mn	0.58^{**}	-0.35^{*}	0.56^{**}	0.33^{**}	$0.38^{†}$					
Ni	$0.39^{†}$	0.65^{**}	0.80^{**}	0.83^{**}	0.14^{NS}	0.28^{*}				
Pb	0.49^{**}	0.06^{NS}	0.89^{**}	0.63^{**}	$0.39^{†}$	0.71^{**}	0.60^{**}			
Zn	$0.46^{†}$	0.55^{**}	0.87^{**}	0.81^{**}	0.15^{NS}	$0.38^{†}$	0.93^{**}	0.72^{**}		
Oil and Grease	-0.05^{NS}	0.21^{NS}	0.14^{NS}	0.04^{NS}	0.08^{NS}	0.11^{NS}	0.24^{NS}	-0.00^{NS}	0.20^{NS}	
% Fines	$0.39^{†}$	0.36^{*}	0.49^{**}	0.20^{NS}	$0.43^{†}$	0.51^{**}	0.15^{NS}	0.48^{**}	0.18^{NS}	0.01^{NS}
% Clay	0.38†	-0.22^{NS}	0.65^{**}	$0.39^{†}$	$0.43^{†}$	0.61^{**}	0.22^{NS}	0.77^{**}	0.36^{*}	-0.06^{NS}

* $0.01 < p \leq 0.05$
† $0.001 < p \leq 0.01$
** $p \leq 0.001$
NS = Not significant ($p > 0.05$)

Notes: Values listed are Pearson's correlation coefficients (r) for data from both surveys (n=40); fines = silt plus clay (<0.0625 mm)

Concentrations of cyanide and phenols were generally below detectable levels (Tables A-6 and A-7). Cyanide was detected at low levels (<0.7 μg/g) at a few stations, both inside and outside the ODMDS, during each survey; no spatial trends were evident. Cyanide levels were also low (<0.5 mg/g) in a previous study of the ODMDS and vicinity (CE, 1978). Phenols, determined only in December, were not detected in any of the samples; no historical data were available for this parameter.

Sedimentary CHC concentrations at Station 1 and 6 (Table A-9) were generally low, and only detectable for dieldrin, pp'DDE, pp'DDD, and PCBs (Arochlors 1016 and 1254). PCB (1254), DDE, and DDD were present in measurable quantities during both December and May-June surveys; concentrations ranged from 2.2 to 5.6 ng/g, and were similar between stations and surveys. Dieldrin (2.2 to 4.7 ng/g) was detected only in December, whereas PCB (1016) was present only during May-June (26 to 74 ng/g). No explanation for these temporal differences can be provided from the limited data available. All CHC concentrations were within ranges reported by CE (1978) for the area.

Oil and grease concentrations were high (8 and 15 mg/g) in both Station 1 replicates during December 1980; concentrations at the remaining stations ranged only from 0.4 to 2.2 mg/g over both surveys (Tables A-6 and A-7). The reason for the elevated levels at Station 1 is unclear. Since this station is located within the ODMDS, dredged material disposal must be considered a possible cause. The most recent disposal to occur prior to the surveys, however, took place during February 1979. Considering the transient nature of surficial sediments in this area (Hausknecht, 1980), it is unlikely that any contaminated dredged material deposits would remain intact for nearly 2 years. This assumption is supported by the reduced oil and grease concentrations (<0.5 mg/g) present at Station 1 during the May-June 1981 survey. Additionally, CE (1978) found oil and grease concentrations to be low (<0.1 mg/g) in adjacent dredging areas. No other oil and grease data concerning the vicinity of the ODMDS were available for comparison with the survey results.

TABLE A-9
CHC CONCENTRATIONS IN SEDIMENTS
AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Dieldrin	pp'DDE	PCB pp'DDD	PCB (Arochlor 1016)	(Arochlor 1254)
December 1980					
1	4.77	2.21	2.53	ND	5.19
6	2.22	2.15	2.23	ND	5.55
May-June 1981					
1	ND	3.20	3.56	74.1	22.9
6	ND	4.51	4.05	26.3	15.2

ND = None detected

Notes: All data are ng/g; data represent single determinations; no other CHCs were detected (see Section A.2.1.2 for compounds examined)

Analyses for ODMDS Station 1 and control Station 6 determined that sedimentary hydrocarbons were derived from petrogenic and biogenic sources (Table A-10). Chronic petroleum contamination, as evidenced by the presence of quantities of unresolved high molecular-weight hydrocarbons, was the dominant source of hydrocarbons in all samples. Terrigenous biogenic hydrocarbons, represented by n-alkanes with odd-number carbon chains (nC27, nC29, nC31), were also present in all samples. The sediments contained minor amounts of components in the nC20 to nC21 range, which are presumed to be unsaturated compounds from marine algae (Blumer et al., 1970). The December sample taken from Station 6 contained a pattern of polynuclear aromatic hydrocarbons (in the f_2 chromatogram) normally associated with combusted fossil fuels.

TABLE A-10
SUMMARY OF PETROLEUM HYDROCARBON ANALYSES FOR
SEDIMENTS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Total Hydrocarbons ($f_1 + f_2$) (μg/g)	Total Saturated (f_1) Hydrocarbons (μg/g)	Total Aromatic and Olefinic (f_2) Hydrocarbons (μg/g)	Hydrocarbon Source Classification*
December 1980				
1 (Inside)	120	55	65	3, 1, 2
6 (Outside)	98	58	40	3, 1, 4, 2
May-June 1981				
1 (Inside)	111	71	40	3, 1, 2
6 (Outside)	125	77	48	3, 1, 2

* Sources

1 = Terrigenous biogenic materials (mainly plant waxes)
2 = Marine biogenic hydrocarbons (mainly from plankton)
3 = Chronic petroleum pollution (characterized by large unresolved envelopes on chromatograms)
4 = Pyrogenic sources (polynuclear aromatics from fossil fuel combustion)

Total hydrocarbon concentrations ranged from 98 to 125 μg/g, and did not vary systematically between stations or surveys (Table A-10). Saturated hydrocarbon levels (55 to 77 μg/g) were somewhat higher during May-June than December, whereas aromatic and olefinic hydrocarbon concentrations were similar during the two surveys (40 to 65 μg/g). No obvious differences existed between sediments from the ODMDS and control areas. Previous measurements for total hydrocarbons in somewhat coarser sediments further offshore yielded generally lower levels than those reported here (Boehm and Fiest, 1980; Weissberg et al., 1980a,b). The higher hydrocarbon concentrations in the survey area may be caused by several factors, including: (1) greater proximity of the IEC survey area to the shipping channel, and associated contamination from petroleum-powered vessels, (2) greater inputs of particles transported by the Atchafalaya River to sediments closer to shore, (3) finer grain size and greater absorptive capacity of sediments in the survey area relative to those sampled in the other studies, or (4) dredged material disposal. The data are insufficient to differentiate between or determine the relative importance of these influences.

As described above, sediment physical and chemical characteristics were generally similar within and adjacent to the ODMDS. No effects of dredged material disposal could be identified; however, a few relatively high concentrations for sedimentary chemical constituents (zinc, oil and grease) were measured within the ODMDS. The survey area is influenced by shallow water depths, frequent resuspension of bottom sediments by winds and waves, and inputs of large quantities of fine sediments from riverine sources. Furthermore, dredged materials released at the ODMDS are similar to natural sediments in the vicinity, and are probably widely distributed by natural processes after deposition. Considering the transient nature of surficial sediments in the survey area, it is not possible to differentiate among possible sources of contamination with the data collected.

A.3.3 TISSUE CHEMISTRY

Concentrations of trace metals and CHCs in organisms collected in trawls in the vicinity of the ODMDS are presented in Table A-11. Trace metal (cadmium, chromium, copper, mercury, manganese, nickel, lead, and zinc) levels in two species of penaeid shrimp (Xiphopenaeus kroyeri in December and Trachypenaeus similis in May-June) were low, and within or below previously reported ranges for these species in the general area of the ODMDS (Tillery, 1980). Of the trace metals examined, concentrations were highest for zinc (9.4 to 14 μg/g) and copper (5.1 to 8.9 μg/g); a similar situation was indicated by Tillery's (1980) data. Arsenic concentrations ranged from 5.9 to 8.5 μg/g; no historical data were available for comparison. Mercury concentrations (0.007 to 0.015 μg/g) were substantially lower than the action level (1.0 μg/g) established by the U.S. Food and Drug Administration (FDA, 1981). Trace metal concentrations were generally comparable for organisms collected inside

TABLE A-11
DRY WEIGHT CONCENTRATIONS OF TRACE METALS AND CHCs IN EDIBLE PORTIONS OF ORGANISMS COLLECTED IN TRAWLS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Trawl	Species	Trace Metals (µg/g)									CHCs (ng/g)		PCB (Arochlor 1254)
		As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn	Dieldrin	pp'DDE	
December 1980													
T-1 (Inside ODMDS)	Shrimp (*Xiphopenaeus kroyeri*)	*	0.011	<0.080	8.3	0.013	0.86	0.14	<0.021	14	2.40	2.76	11.2
T-2 (Outside ODMDS)	Shrimp (*Xiphopenaeus kroyeri*)	*	0.010	<0.011	8.9	0.015	1.6	0.13	<0.022	14	1.01	2.02	15.1
May-June 1981													
T-3 (Inside ODMDS)	Shrimp (*Trachypenaeus similis*)	8.5	0.008	<0.022	5.8	0.007	0.32	0.12	<0.044	12	-	-	-
T-3, T-5 (Inside ODMDS)	Crab (*Callinectes similis*)	-	-	-	-	-	-	-	-	-	28.7	23.5	80.6
T-6 (Outside ODMDS)	Shrimp (*Trachypenaeus similis*)	5.9	0.010	<0.022	5.1	0.007	0.38	0.07	<0.045	9.4	-	-	-
T-6 (Outside ODMDS)	Crab (*Callinectes similis*)	-	-	-	-	-	-	-	-	-	16.3	8.3	65.9

* Not reported because of laboratory error
\- Not determined because of insufficient sample
ND = None detected

Notes: Data represent single determinations; no other CHCs were detected (see Section A.2.1.2 for compounds examined)

(Trawls T-1, T-3, T-4, and T-5) versus outside (Trawls T-2 and T-6) the ODMDS. Since different species were collected during the two surveys, temporal comparisons are not warranted.

CHC levels were determined in shrimp (X. kroyeri) during the December survey and in crabs (Callinectes similis) during May-June. Of the compounds examined (see Section A.2.1.2), only dieldrin, pp'DDE, and PCB (Arochlor 1254) were detected. Concentrations in shrimp were substantially lower than those in crabs; however, all values were well below FDA action/tolerance levels for edible marine organisms (FDA, 1981; 21 CFR Part 109). CHC levels in crabs were somewhat greater inside, relative to outside the ODMDS; data are insufficient to define any cause for this difference. Levels were similar for shrimp collected inside versus outside the ODMDS. No historical data for CHCs in these species were available for comparison; however, levels were comparable to those summarized by Atlas (1981) for other Gulf of Mexico marine organisms.

A.3.4 ELUTRIATE TESTS

Elutriate test results for sediments collected during May-June 1981 are presented in Table A-12. The test is intended to indicate the potential for release of dissolved trace metals from sediments when mixed with seawater.

Results were similar for sediments from Stations 1 (inside ODMDS) and 6 (outside ODMDS). Where differences occurred between the two stations, releases were generally greater from Station 6 sediments. For example, manganese releases were indicated in all replicates at both stations, but were a factor of two greater from Station 6 sediments. Zinc release occurred in one replicate from each station and, again, was substantially greater for Station 6. For the remaining trace metals, small or no releases were detected. Arsenic and cadmium were released in comparatively small quantities in all replicates. Chromium, copper, mercury, nickel, and lead were retained and/or scavenged from solution by the solid phase.

TABLE A-12
RESULTS OF THE ELUTRIATE TESTS FOR SEDIMENTS
FROM INSIDE AND OUTSIDE ATCHAFALAYA RIVER ODMDS

Station	Sample	Concentrations in Test Water								
		As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn
1 (Inside)	Rep #1	4.1	3.0	<0.80	<0.80	<0.033	1,500	<0.80	<0.80	<2.0
	Rep #2	3.8	1.2	<0.70	<0.70	<0.033	1,100	<0.70	<0.70	15
	Rep #3	4.0	2.1	<0.57	1.0	<0.033	1,300	0.80	<0.57	<1.4
6 (Outside)	Rep #1	3.4	0.55	<0.69	<0.69	0.056	3,700	<0.69	<0.69	<1.7
	Rep #2	3.0	3.5	<0.52	0.93	0.038	3,900	0.62	<0.52	240
	Rep #3	3.5	0.43	<0.54	<0.54	<0.033	4,200	<0.54	<0.54	<1.4
		Pretest Concentrations*								
1	Seawater	1.2	0.15	<0.51	1.7	<0.033	25	0.71	1.1	<1.3
6	Seawater	1.5	0.10	<0.57	0.68	0.068	12	<0.57	<0.57	4.4

* Seawater collected at middepth at indicated station

Notes: Three replicate tests performed on each sediment sample; all concentrations are µg/liter in dissolved phase; sediment and water collected in May-June 1981

A.3.5 MACROFAUNA

Macrofaunal assemblages near the Atchafalaya River ODMDS have been examined during benthic investigations of several proposed salt dome brine diffuser sites (Parker et al., 1980; Weissberg et al., 1980a,b). These studies characterized nearshore assemblages as typical of estuarine areas. Communities were dominated by annual species, the majority of which were polychaete worms (particularly *Mediomastus*, *Aglaophamus*, *Paraprionospio*, *Magelona*, and *Owenia*), small molluscs (*Mulinia* and *Nassarius*), and macrocrustaceans (shrimp and crabs). Most species displayed seasonal population fluctuations. Recruitment occurred during winter and spring; populations declined during summer and autumn due to predation and environmental stresses such as sediment disturbance by storms or anoxic conditions in bottom waters.

Stations sampled by IEC in the vicinity of the Atchafalaya River ODMDS were further inshore and shallower than the proposed brine diffuser sites; however, the same general macrofaunal assemblage was found. During both surveys polychaetes dominated the macrofauna (Tables A-13 and A-14), particularly Mediomastus californiensis, Paraprionospio pinnata, and Cossura spp. During the December survey the Little surf clam Mulinia lateralis was very abundant at Stations 7, 8, and 9--probably as a result of seasonal recruitment characteristic of this species (Parker et al., 1980). By the following survey in late spring (May-June), M. lateralis was abundant only at Station 5 (Table A-14). Other common members of this assemblage were the carnivorous ribbon worms Cerebratulus cf. lacteus (and other unidentified rhynchocoelans) and the snail Nassarius acutus.

The overall abundance of individuals (individual/m^2) generally increased from December to May-June due to greater densities of polychaetes (Figures A-3 and A-4). However, several sharp declines occurred between surveys at Stations 7 and 8 due to reductions in numbers of Mulinia lateralis.

Based on the information presented in Tables A-13 and A-14, six dominant species were selected for further analyses. Five of those species, Mediomastus spp., Paraprionospio pinnata, Sigambra tentaculata, Cossura delta, and Cossura soyeri, are small-bodied (<2 to 3 cm) deposit feeding polychaetes (Fauchald and Jumars, 1979) characteristic of this area (Parker et al, 1980; Weissberg et al., 1980a,b). The sixth taxon, Amphinomidae, represent small (<1 to 2 cm) carnivorious polychaetes of the Linopherus-Paramphinome species complex. Numerical data for each of these species is presented in Table A-15.

Densities of each species were examined by analysis of variance (ANOVA) on log (x+1) transformed data. Two kinds of ANOVAs were used: (1) two-factorial test (two-way) conducted to examine simultaneously overall differences in density between surveys and stations, (2) single-factorial (one-way) ANOVA performed on each set of station data for each survey to examine more specific differences in patterns of spatial density. Following each one-way ANOVA, the Student-Newman-Keuls (SNK) multiple-range test (Zar, 1974) was used to

TABLE A-13
RANK OF DOMINANT SPECIES FOR STATIONS
AT ATCHAFALAYA RIVER ODMDS AND VICINITY (DECEMBER 1980)

Species	Station									
	1	2	3	4	5	6	7	8	9	10
Nemertina										
Cerebratulus cf. *lacteus*					4		3			4
Rhynchocoela sp. A			5		5			5		
Rhynchocoela sp. I						5	4			
Annelida										
Cossura delta	3			4	5	6			4	7
Cossura soyeri	1		6	2	3	3		2	2	1
Glycinde solitaria		5								
Linopherus-Paramphinome spp.	6	3	5	3	1	2	4	3	3	3
Magelona cf. *phyllisae*	5			5						
Mediomastus spp.	4	6	1	6	8	5	2	6	3	6
Parandalia americana			3				5			
Paraprionospio pinnata	2	1	4	1	2	1		4	4	2
Sigambra tentaculata	5	4	6	7	7	4		5	5	5
Streblospio benedicti		2	2							
Mollusca										
Mulinia lateralis						5	1	1	1	
Nassarius acutus					6		3			4
Arthropoda										
Ogyrides alphaerostris		4								

Note: Ranks are arranged in decreasing abundance (i.e., rank of 1 = most abundant species)

TABLE A-14
RANK OF DOMINANT SPECIES FOR STATIONS
AT ATCHAFALAYA RIVER ODMDS AND VICINITY (MAY-JUNE 1981)

Species	Station 1	2	3	4	5	6	7	8	9	10
Cnidaria										
Edwardsia sp. A								6		
Nemertina										
Cerebratulus cf. *lacteus*									5	3
Rhynchocoela sp. A	6						6	5		
Annelida										
Carazziella hobsonae						3			4	
Cossura delta	4		5	5	7	7		4	8	8
Cossura soyeri	2	8	6	1	6	4		1	1	6
Glycinde solitaria		6	5	6	8	6			9	7
Linopherus-Paramphinome spp.	5	7	4		4	2	2	7	3	2
Magelona cf. *phyllisae*		4		4					6	
Mediomastus spp	1	3	1	2	3	1	1	2	2	1
Owenia sp.		5								
Parandalia americana			5				4			
Sigambra tentaculata	7			7	9	8	5	8	10	9
Streblospio benedicti			3				5			
Mollusca										
Mulinia lateralis					1					
Nassarius acutus					5					
Nuculana concentrica					5					
Phoronida										
Phoronis spp.		2								4

Note: Ranks are arranged in decreasing abundance (i.e., rank of 1 = most abundant species)

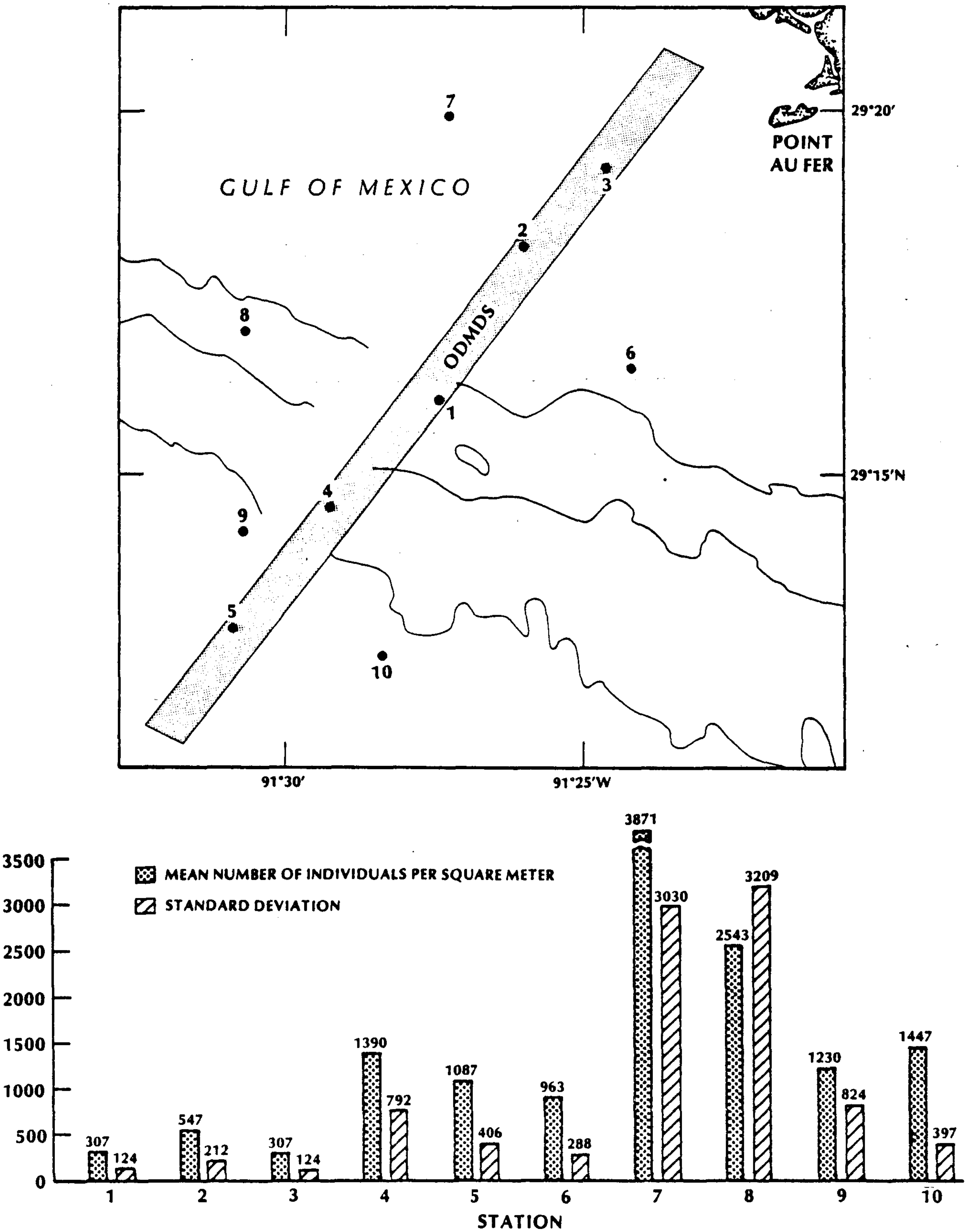
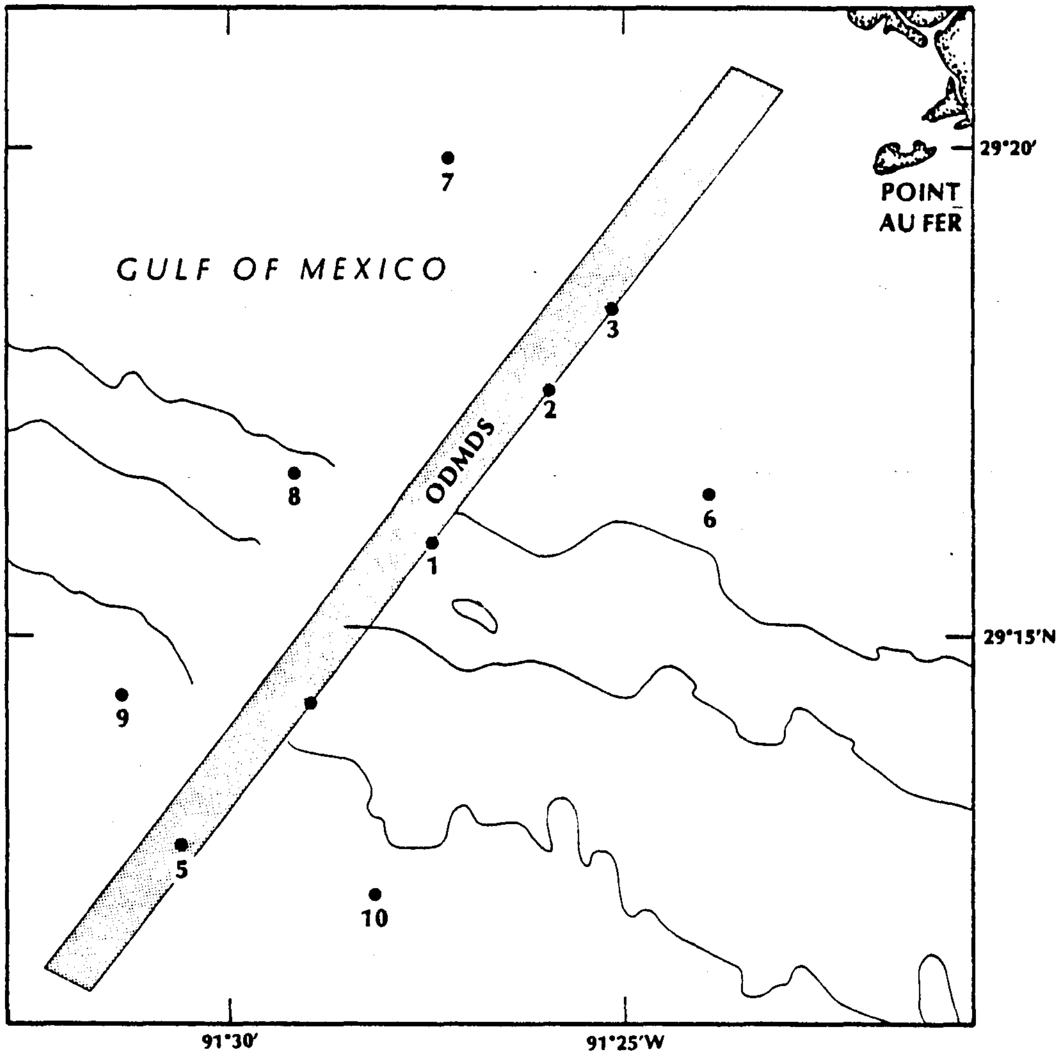


Figure A-3. Mean Number of Individuals at Each Station at Atchafalaya River ODMDS and Vicinity (December 1980)



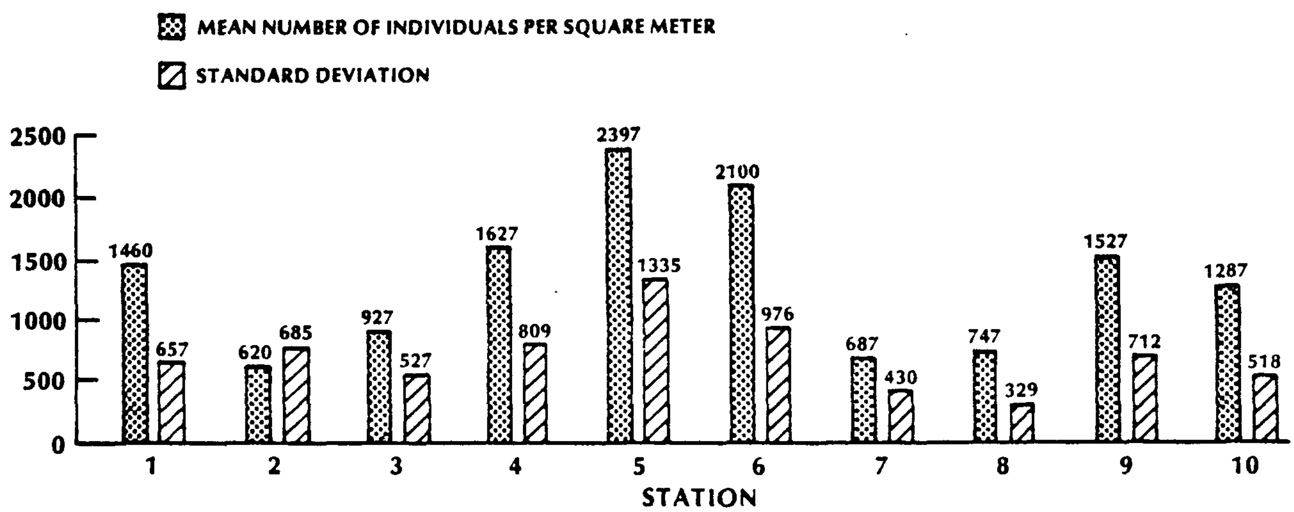


Figure A-4. Mean Number of Individuals at Each Station at Atchafalaya River ODMDS and Vicinity (May-June 1981)

TABLE A-15
NUMERICAL ABUNDANCE OF DOMINANT SPECIES AT EACH STATION AT ATCHAFALAYA RIVER ODMDS AND VICINITY

	Amphinomidae				*Cossura delta*				*Cossura soyeri*				*Mediomastus* spp.				*Paraprionospio pinnata*				*Sigambra tentaculata*			
Station	N	$\bar{x}$	SD	I	N	$\bar{x}$	SD	I	N	$\bar{x}$	SD	I	N	$\bar{x}$	SD	I	N	$\bar{x}$	SD	I	N	$\bar{x}$	SD	I
December 1980																								
1	2	0.4	0.5	0.8	16	3.2	1.6	0.8	37	7.4	5.0	3.4	6	1.2	0.8	0.6	17	3.4	2.7	2.1	3	0.6	0.9	1.3
2	8	1.6	0.9	0.5	0	0.0	0.0	0.0	0	0.0	0.0	0.0	1	0.2	0.4	1.0	131	26.2	12.1	5.6	3	0.6	0.5	0.5
3	4	0.8	0.8	0.9	0	0.0	0.0	0.0	1	0.2	0.4	1.0	50	10.0	10.4	10.8	7	1.4	1.7	2.0	1	0.2	0.4	1.0
4	47	9.4	13.0	17.9	36	7.2	5.0	3.4	99	19.8	13.2	8.8	20	4.0	4.1	4.1	108	21.6	16.1	12.1	16	3.3	4.0	4.9
5	99	19.8	10.4	5.5	18	3.6	3.2	2.9	46	9.2	8.8	8.4	7	1.4	1.5	1.6	97	19.4	7.4	2.9	9	1.8	1.8	1.8
6	38	7.6	8.0	8.3	4	0.8	1.3	2.1	25	5.0	2.5	0.7	6	1.2	1.8	2.7	171	34.2	20.1	11.8	9	1.8	0.8	0.4
7	2	0.4	0.9	2.0	0	0.0	0.0	0.0	0	0.0	0.0	0.0	32	6.4	9.2	13.1	0	0.0	0.0	0.0	0	0.0	0.0	0.0
8	15	3.0	3.1	3.2	0	0.0	0.0	0.0	62	12.4	12.4	12.4	8	1.6	1.1	0.8	10	2.0	3.4	5.8	9	1.8	1.6	1.5
9	36	7.2	2.2	0.7	14	2.8	2.4	2.0	74	14.8	3.3	0.8	36	7.2	7.4	7.5	14	2.8	4.8	8.1	3	0.6	0.5	0.5
10	56	11.2	10.3	9.4	7	1.4	1.1	0.9	171	34.2	7.4	1.6	14	2.8	3.1	3.5	91	18.2	7.9	3.4	20	4.0	1.2	4.6
ΣN	307				95				515				180				646				73			
May-June 1981																								
1	26	5.2	3.4	2.3	38	7.6	1.8	1.8	102	20.4	8.0	3.2	125	25.0	21.2	18.0	74	14.8	7.1	3.4	11	2.2	2.2	2.1
2	11	2.2	1.6	1.2	0	0.0	0.0	0.0	2	0.4	0.5	0.8	23	4.6	6.8	10.2	35	7.0	5.1	3.8	0	0.0	0.0	0.0
3	7	1.4	1.5	1.6	6	1.2	2.2	2.1	1	0.2	0.4	1.0	139	27.8	21.0	21.0	60	12.0	8.7	6.3	0	0.0	0.0	0.0
4	0	0.0	0.0	0.0	24	4.8	3.1	2.0	144	28.8	6.9	1.7	122	24.4	22.7	21.2	59	11.8	7.9	5.3	6	1.2	0.4	0.2
5	26	5.2	1.7	0.6	18	3.6	1.7	0.7	21	4.2	4.3	4.5	64	12.8	4.3	1.5	73	14.6	6.4	2.8	7	1.4	1.7	2.0
6	65	13.0	9.5	7.0	13	2.6	2.8	2.8	34	6.8	4.4	2.9	237	47.4	26.5	14.9	27	5.4	3.0	1.7	10	2.0	0.7	0.3
7	48	9.6	7.4	5.7	0	0.0	0.0	0.0	0	0.0	0.0	0.0	78	15.6	12.9	10.7	38	7.6	4.8	3.1	3	0.6	0.9	1.3
8	4	0.8	0.8	0.9	8	1.6	1.1	0.8	76	15.2	7.9	4.1	67	13.4	15.9	18.9	28	5.6	4.9	4.3	2	0.4	0.5	0.8
9	66	13.2	6.5	3.2	6	1.2	1.6	2.3	146	29.2	14.0	6.7	81	16.2	10.3	6.6	7	1.4	1.5	1.6	1	0.2	0.4	1.0
10	59	11.8	8.3	5.8	2	0.4	0.5	0.8	15	3.0	2.6	2.3	138	27.6	14.5	7.6	20	4.0	1.2	0.4	1	0.2	0.4	1.0
ΣN	312				115				541				1,074				421				41			

$\bar{x}$ = Mean number per replicate
I = Index of Dispersion (see text for explanation)
N = Total number of individuals for all replicates
SD = One standard deviation

determine where significant differences in densities occurred among station means. For example, if a species was most abundant at stations within the ODMDS, then those stations would form a subgroup significantly different from those formed by control stations where densities were lower.

Results of the two-way ANOVAs show that only Mediomastus spp. displayed a significant increase in density between surveys (Table A-16). Abundance of this polychaete rose from a total of 180 individuals collected during the December survey, to 1,074 individuals in collected May-June (Table A-15). Mediomastus, along with another of the dominant species, Paraprionospio have been shown to reproduce rapidly (Dauer and Simon, 1976; Pearson and Rosenberg, 1976; Dauer, 1980; Parker et al., 1980) and, as described by Gray (1979), are generally considered opportunistic. Amphinomidae, Cossura delta, and C. soyeri also were more abundant in May-June, but not significantly so. Several of the species (Amphinomidae, Paraprionospio pinnata, and Sigambra tentaculata) displayed significant interactions between the two treatment factors (survey date and station location), but the effect of each factor alone was not significant. As discussed by Simpson et al. (1960), when an ANOVA results in nonsignificant treatment factors, but the interaction term is significant, then factors other than those measured were the cause of the variance displayed in the data.

One-way ANOVAs demonstrate that nearly all dominant species were significantly different between stations; this result occurred for data from both surveys (Table A-17). The only exception was Mediomastus spp., which was not significantly different in its densities between stations during the December survey.

SNK tests showed that no discernable patterns in densities were apparent for most of the species (Table A-18). The exception was Cossura soyeri, where greater densities were found offshore. Pertinent to this study was the fact that no ODMDS stations formed unique subgroups; control stations were usually mixed with ODMDS stations.

TABLE A-16
RESULTS OF TWO-FACTORIAL ANOVAs FOR DENSITY OF DOMINANT SPECIES BETWEEN SURVEYS AND STATIONS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Species	Source of Variation	Degrees of Freedom	Mean Square	F-Ratio
Amphinomidae	Survey	1	0.112	0.193 NS
	Station	9	0.925	1.598 NS
	Interaction	9	0.579	6.238 *
	Residual	80	0.093	
Cossura delta	Survey	1	0.130	1.130 NS
	Station	9	0.803	6.983 *
	Interaction	9	0.115	1.911 NS
	Residual	80	0.060	
Cossura soyeri	Survey	1	0.001	0.002 NS
	Station	9	2.735	6.405 *
	Interaction	9	0.427	7.099 *
	Residual	80	0.060	
Mediomastus spp.	Survey	1	12.430	45.867 *
	Station	9	0.471	1.738 NS
	Interaction	9	0.271	1.618 NS
	Residual	80	0.167	
Paraprionospio pinnata	Survey	1	0.044	0.054 NS
	Station	9	1.069	1.307 NS
	Interaction	9	0.818	8.479 *
	Residual	80	0.096	
Sigambra tentaculata	Survey	1	0.200	1.834 NS
	Station	9	0.214	1.963 NS
	Interaction	9	0.109	2.169 *
	Residual	80	0.050	

*Significant ($p \leq 0.05$)
NS = Nonsignificant ($p > 0.05$)

Note: Both factors (i.e., survey, station) assumed random, Model II ANOVA employed when testing (see Zar, 1974, p. 168)

The ODMDS is a shallow area periodically disturbed by storms. The benthic assemblage is dominated by species that live for about 1 year and undergo rapid population expansions (Parker et al., 1980). Results of the IEC surveys showed that most macrofaunal species were patchily distributed throughout the

TABLE A-17
RESULTS OF ONE-WAY ANOVAs FOR DENSITY OF DOMINANT SPECIES AMONG STATIONS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

		December 1980			May-June 1981		
Species	Source of Variation	Degree of Freedom	Mean Square	F-Ratio	Degree of Freedom	Mean Square	F-Ratio
Amphinomidae	Stations	9	0.757	6.745*	9	0.746	10.172*
	Residual	40	0.112		40	0.073	
Cossura delta	Stations	9	0.439	6.882*	9	0.479	8.406*
	Residual	40	0.064		40	0.057	
Cossura soyeri	Stations	9	1.502	21.701*	9	1.659	32.497*
	Residual	40	0.069		40	0.511	
Mediomastus spp.	Stations	9	0.280	1.937 NS	9	0.463	2.427*
	Residual	40	0.144		40	0.191	
Paraprionospio pinnata	Stations	9	1.550	14.077*	9	0.336	4.066*
	Residual	40	0.110		40	0.083	
Sigambra tentaculata	Stations	9	0.177	2.733*	9	0.147	4.078*
	Residual	40	0.065		40	0.036	

* Significant ($p \leq 0.05$)
NS = Nonsignificant ($p > 0.05$)

study area and several, such as Mediomastus spp. and Paraprionospio pinnata, are considered opportunistic. Because of the ability of the endemic species to cope with natural disturbances to their sedimentary habitat, any effects on densities of these organisms which may have been caused by dredged material disposal could not be discerned.

A.3.6 EPIFAUNA

Appproximately 600 individuals representing 8 invertebrate and 14 fish species were collected from otter trawls in the vicinity of the Atchafalaya River ODMDS (Table A-19). Macrocrustaceans (shrimp and crabs) comprised the bulk of the invertebrate catch; particularly important were the Seabob shrimp Xiphopenaeus kroyeri in December, and the Broken-necked shrimp Trachypenaeus similis and the Lesser blue crab Callinectes similis in May-June. More fish were collected during May-June relative to December; the Atlantic croaker Micropogon undulatus was most abundant.

TABLE A-18
RESULTS OF SNK TESTS FOR DOMINANT SPECIES
AMONG STATIONS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Species	Stations									
December 1980										
Amphinomidae	7	1	3	2	8	6	4	9	10	5
Cossura delta	2	3	7	8	6	10	9	5	1	4
Cossura soyeri	2	7	3	6	1	5	8	9	4	10
Mediomastus spp.	(F-ratio nonsignificant; no SNK test done)									
Paraprionospio pinnata	7	3	8	9	1	4	10	5	2	6
Sigambra tentaculata	7	3	1	2	9	5	8	6	4	10
May-June 1981										
Amphinomidae	4	8	3	2	1	5	7	10	6	9
Cossura delta	2	7	10	3	9	8	6	5	4	1
Cossura soyeri	7	3	2	10	5	6	8	1	9	4
Mediomastus spp.	2	8	9	7	4	5	3	1	10	6
Paraprionospio pinnata	9	10	8	6	2	7	3	4	1	5
Sigambra tentaculata	2	3	9	10	8	7	5	4	1	6

Notes: Stations are arranged in order of increasing magnitude, homogeneous subsets are underlined; alpha (α) = 0.05 = experimentwise error rate (see Zar, 1974); see Table A-15 for actual mean values of each station

Macroinvertebrates and demersal fish collected by IEC during both surveys are characteristic of the area. Furthermore, relative numbers of dominant organisms collected, such as large numbers of sciaenids (drums and croakers), were similar to results of other studies conducted in the area (Landry and Armstrong, 1980; Weissberg et al., 1980a,b).

TABLE A-19
SPECIES OF INVERTEBRATES AND FISH COLLECTED IN OTTER TRAWLS AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Species	Common Name	December 1980		May-June 1981			
		ODMDS	CNTL	ODMDS		CNTL	
		T-1	T-2	T-3	T-4	T-5	T-6
INVERTEBRATES							
Mollusca							
Lolliguncula brevis	Squid	3	20	3	2	-	6
Polinices duplicatus	Moon snail	-	6	-	-	1	2
Arthropoda							
Callinectes similis	Lesser blue crab	3	2	10	36	12	50
Penaeus aztecus	Brown shrimp	-	-	-	-	5	-
Portunus sp. (juvenile)	Swimming crab	-	2	-	-	-	-
Squilla empusa	Mantis shrimp	-	-	-	1	-	-
Trachypenaeus similis	Broken-necked shrimp	-	-	7	27	-	16
Xiphopenaeus kroyeri	Seabob shrimp	25	155	-	-	-	-
FISH							
Clupeidae							
Harengula pensacolae	Scaled sardine	-	-	7	1	8	4
Engraulidae							
Anchoa mitchilli	Bay anchovy	12	-	2	2	4	-
Ophidiidae							
Ophidion welshi	Crested cusk-eel	-	-	1	1	-	-
Syngnathidae							
Syngnathus louisianae	Chain pipefish	-	1	-	-	-	-
Sciaenidae							
Cynoscion arenarius	Sand seatrout	1	6	-	-	-	-
Larimus fasciatus	Banded drum	-	6	-	-	-	-
Micropogon undulatus	Atlantic croaker	-	-	18	40	36	25
Ephippidae							
Chaetodipterus faber	Atlantic spadefish	-	1	-	-	-	-
Uranoscopidae							
Kathetostoma albigutta	Lancer stargazer	1	1	-	-	-	-
Trichiuridae							
Trichiurus lepturus	Atlantic cutlassfish	6	2	3	3	2	3
Stromateidae							
Peprilus burti	Gulf butterfish	1	-	4	2	3	8
Triglidae							
Prionotus rubio	Blackfin searobin	-	-	1	-	-	1
Cynoglossidae							
Symphurus plagiusa	Blackcheek tonguefish	-	4	3	2	-	1
Tetradontidae							
Lagocephalus laevigatus	Smooth puffer	-	-	3	-	-	-
	Number of Species	8	12	12	10	8	10
	Number of Individuals	52	206	62	117	71	116

Each pair of trawls was compared (Figure A-5) using Sorensen's quotient of similarity, QS:

$$QS = 2J/A + B$$

where QS is the quotient, A is the number of species in the first trawl, B is the number of species in the second trawl, and J is the number of species in common (Southwood, 1966). In December, trawls at ODMDS and control areas were 60% similar in terms of species present. Also, among the May-June trawls, similarity was usually high (≥60%). Conversely, similarity was only 50% or less between December and May-June trawls. These limited results suggest that the species composition of epifaunal organisms was temporally variable but statially homogeneous. QS values are based only on the presence or absence of species; abundance is not considered. More rigorous quantitative sampling and analyses would be required to determine if differences in epifaunal communities exist between ODMDS and control areas.

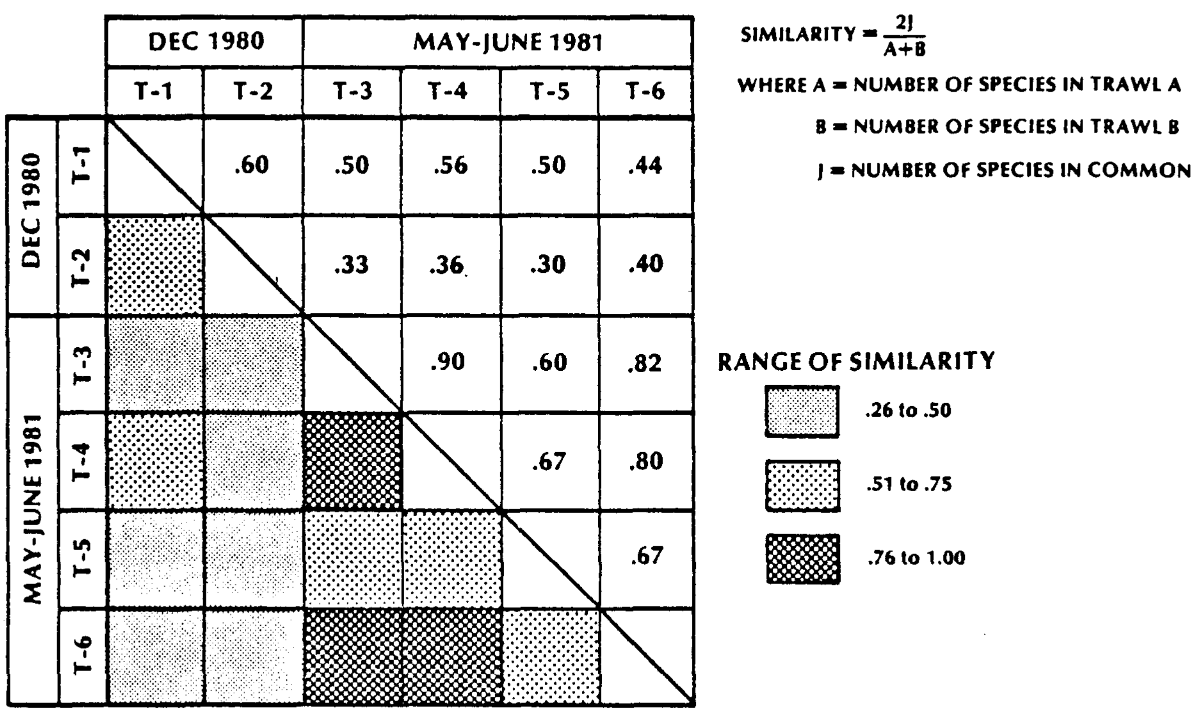


Figure A-5. Trellis Diagram Showing Similarity Between Trawls at Atchafalaya River ODMDS and Vicinity

A.3.7 MICROBIOLOGY

Low counts of total and fecal coliform bacteria were measured in sediments during both surveys at the Atchafalaya River ODMDS (Table A-20). In December, total coliforms ranged from 9 MPN/100g at Station 9 to 189 MPN/100g at Station 10. Fecal coliforms ranged from nondectable at Stations 3, 8, and 9 to 99 MPN/100g at Station 10. During the May-June survey only two stations were sampled for coliforms in sediments; both yielded very low numbers (Table A-20).

Crabs and shrimp collected in trawls contained low numbers of total coliforms during both surveys. Fecal coliforms were not detected in any of the tissue samples (Table A-20).

No clear explanation can be given for the presence of coliform bacteria in the survey area. Although Schwarz et al. (1980) studied bacterial populations at the nearby Weeks Island brine diffuser site, this study did not include coliform bacteria. Possible sources of coliform contamination to the ODMDS area include sewage residuals transported by the Atchafalaya River, or disposal of potentially contaminated dredged materials. However, no coliform analyses have been performed on dredged materials disposed at the ODMDS to determine if these bacteria are present.

A.4 SUMMARY

Salinities varied widely during both surveys and exhibited an increasing offshore trend as an apparent response to coastal runoff. Both the minimum ($4.9^{o}/oo$) and maximum ($35.5^{o}/oo$) salinities were measured during the May-June sampling period. Waters were relatively well-oxygenated during both surveys, but dissolved oxygen concentrations were slightly lower in May-June relative to December. Waters in the vicinity of the ODMDS are generally turbid, and this was reflected in the survey data. Trace metal and CHC levels were generally comparable to historical data for waters off southeastern Louisiana. DDE and dieldrin concentrations during May-June, however, exceeded previously

TABLE A-20
TOTAL AND FECAL COLIFORM COUNTS
AT ATCHAFALAYA RIVER ODMDS AND VICINITY

Station	Sediments		Species	Tissues	
	Total Coliforms (MPN/100g)	Fecal Coliforms (MPN/100g)		Total Coliforms (MPN/100g)	Fecal Coliforms (MPN/100g)
December 1980					
1	75	24			
2	181	42			
3	33	<11			
4	176	36			
5	40	10	*Callinectes similis*	200	<200
6	129	92			
7	33	10			
8	10	<10			
9	9	<9			
10	189	99	*Callinectes similis*	210	<54
May-June 1981					
5	9	<9	*Trachypenaeus similis*	114	<29
10	19	<10			

reported values for the area; these compounds are probably derived from coastal Louisiana sources. None of the water column parameters reflected any identifiable effects from dredged material disposal.

Surficial sediments throughout the survey area were predominantly silt and clay. Concentrations of sedimentary chemical constituents were relatively uniform, but appeared to be influenced to some degree by sediment grain size, particularly percentages of clay. Chronic petroleum inputs were determined to be the major source of hydrocarbons to sediments both inside and outside the ODMDS. No effects of dredged material disposal on sediment characteristics could be identified; however, a few relatively high concentrations for zinc (one sample) and oil and grease (two samples) were measured within the ODMDS. It was not possible to differentiate among possible sources of contamination (e.g., dredged material disposal, riverine inputs) with the data collected because of (1) the transient nature of surficial sediments in the area, and (2) the similarity between dredged materials and ambient sediments in the vicinity of the ODMDS.

The macrofaunal assemblage of the survey area was characteristic of the general region and dominated by polychaetes. Many of the dominant organisms were small-bodied, opportunistic species capable of rapid recolonization of disturbed sediments. Larger macroinvertebrates (mainly shrimps and crabs) and demersal fish were common throughout the area and probably represented important predators on populations of infaunal organisms. Any effects of dredged material disposal on benthic organisms at the ODMDS could not be identified.

Populations of coliform bacteria were present in the area, but in very low abundances. Although no explanation can be given for their occurrence, possible sources of contamination include materials derived from river outflow or dredged material disposal activities.

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Appendix B

LORAN-C COORDINATES AND RANGE AND BEARING FOR ALL CASTS

CASTS TAKEN DURING THE IEC SURVEY AT ATCHAFALAYA
(23 MAY THROUGH 1 JUNE 1981)

Station	Cast	Type	Loran-C Coordinates		Range (nmi)	Bearing (°True)
			X	Y		
001	001	W	-	-	4.78	231†
001	002	GC	-	-	4.78	231†
001	003	GC	-	-	4.78	231†
001	004	GCE	-	-	4.78	231†
001	005	B	-	-	4.78	231†
001	006	B	-	-	4.78	231†
001	007	B	-	-	4.78	231†
001	008	B	-	-	4.78	231†
001	009	B	-	-	4.78	231†
002	001	GC	-	-	5.71	227†
002	002	GC	-	-	5.71	227†
002	003	B	-	-	5.71	227†
002	004	B	-	-	5.71	227†
002	005	B	-	-	5.71	227†
002	006	B	-	-	5.71	227†
002	007	B	-	-	5.71	227†
003	001	GC	-	-	6.59	222†
003	002	GC	-	-	6.59	222†
003	003	B	-	-	6.59	222†
003	004	B	-	-	6.59	222†
003	005	B	-	-	6.59	222†
003	006	B	-	-	6.59	222†
003	007	B	-	-	6.59	222†
004	001	GC	-	-	1.68	262†
004	002	GC	-	-	1.68	262†
004	003	B	-	-	1.68	262†

Station	Cast	Type	Loran-C Coordinates X	Loran-C Coordinates Y	Range (nmi)	Bearing (°True)
004	004	B	-	-	1.68	262†
004	005	B	-	-	1.68	262†
004	006	B	-	-	1.68	262†
004	007	B	-	-	1.68	262†
005	001	GC	27609.2	46879.8	-	-
005	002	GC	27609.2	46879.8	-	-
005	003	B	27609.2	46879.8	-	-
005	004	B	27609.2	46879.8	-	-
005	005	B	27609.2	46879.8	-	-
005	006	B	27609.2	46879.8	-	-
005	007	B	27609.2	46879.8	-	-
005	008	TRWL	27606.4 (course 015°T)	46880.4 (course 015°T)	-	-
005	009	TRWL	27614.3 (course 220°T)	46880.9 (course 220°T)	-	-
005	010	TRWL	27615.0 (course 225°T)	46881.4 (course 225°T)	-	-
006	001	W	-	-	6.35	248†
006	002	GC	-	-	6.35	248†
006	003	GC	-	-	6.35	248†
006	004	GCE	-	-	6.35	248†
006	005	B	-	-	6.35	248†
006	006	B	-	-	6.35	248†
006	007	B	-	-	6.35	248†
006	008	B	-	-	6.35	248†
006	009	B	-	-	6.35	248†

Station	Cast	Type	Loran-C Coordinates		Range (nmi)	Bearing (°True)
			X	Y		
007	001	W	-	-	7.11	285†
007	002	GC	-	-	7.11	285†
007	003	GC	-	-	7.11	285†
007	004	B	-	-	7.11	285†
007	005	B	-	-	7.11	285†
007	006	B	-	-	7.11	285†
007	007	B	-	-	7.11	285†
007	008	B	-	-	7.11	285†
008	001	W	-	-	3.19	212†
008	002	GC	-	-	3.19	212†
008	003	GC	-	-	3.19	212†
008	004	B	-	-	3.19	212†
008	005	B	-	-	3.19	212†
008	006	B	-	-	3.19	212†
008	007	B	-	-	3.19	212†
008	008	B	-	-	3.19	212†
009	001	W	-	-	0.33	154†
009	002	GC	-	-	0.33	154†
009	003	GC	-	-	0.33	154†
009	004	B	-	-	0.33	154†
009	005	B	-	-	0.33	154†
009	006	B	-	-	0.33	154†
009	007	B	-	-	0.33	154†
009	008	B	-	-	0.33	154†
010	001	GC	27632.8	46878.1	-	-
010	002	GC	27632.8	46878.1	-	-
010	003	B	27632.8	46878.1	-	-
010	004	B	27632.8	46878.1	-	-

Station	Cast	Type	Loran-C Coordinates		Range (nmi)	Bearing (°True)
			X	Y		
010	005	B	27632.8	46878.1	-	-
010	006	B	27632.8	46878.1	-	-
010	007	B	27632.8	46878.1	-	-
010	008	TRWL	27627.0 (course 061°T)	46877.9 (course 061°T)	-	-

Note: Master station 7980

† Target is Seabuoy FLG "1" (NOAA Chart No. 11351)

<u>Cast Types</u>

B = Biological
GC = Geochemical
GCE = Elutriate sediment sample
TRWL = Otter trawl
W = Water column

CASTS TAKEN DURING THE IEC SURVEY AT ATCHAFALAYA (3 AND 4 DECEMBER 1980)

Station	Cast	Type	Loran-C Coordinates X	Loran-C Coordinates Y	Range (nmi)	Bearing (°True)
001	001	W	-	-	3.6	229[a]
001	002	GC	-	-	3.6	229[a]
001	003	GC	-	-	3.6	229[a]
001	004	GCE	-	-	3.6	229[a]
001	005	B	-	-	3.6	229[a]
001	006	B	-	-	3.6	229[a]
001	007	B	-	-	3.6	229[a]
001	008	B	-	-	3.6	229[a]
001	009	B	-	-	3.6	229[a]
002	001	GC	-	-	6.1	222[a]
002	002	GC	-	-	6.1	222[a]
002	003	B	-	-	6.1	222[a]
002	004	B	-	-	6.1	222[a]
002	005	B	-	-	6.1	222[a]
002	006	B	-	-	6.1	222[a]
002	007	B	-	-	6.1	222[a]
003	001	GC	-	-	2.3	235[b]
003	002	GC	-	-	2.3	235[b]
003	003	B	-	-	2.3	235[b]
003	004	B	-	-	2.3	235[b]
003	005	B	-	-	2.3	235[b]
003	006	B	-	-	2.3	235[b]
003	007	B	-	-	2.3	235[b]

Station	Cast	Type	Loran-C Coordinates X	Loran-C Coordinates Y	Range (nmi)	Bearing (°True)
004	001	GC	-	-	1.7	236[a]
004	001	GC	-	-	1.7	236[a]
004	003	B	-	-	1.7	236[a]
004	004	B	-	-	1.7	236[a]
004	005	B	-	-	1.7	236[a]
004	006	B	-	-	1.7	236[a]
004	007	B	-	-	1.7	236[a]
005	001	TRWL	11262.7 (course 127°T)	46880.5 (course 127°T)	-	-
005	002	GC	11264.4	46879.9	-	-
005	003	GC	11264.4	46880.0	-	-
005	004	B	11264.4	46880.0	-	-
005	005	B	11264.4	46889.9	-	-
005	006	B	11264.3	46880.1	-	-
005	007	B	11264.4	46880.0	-	-
005	008	B	11264.4	46880.8	-	-
006	001	W	-	-	5.0	070[c]
006	002	GC	-	-	5.0	070[c]
006	003	GC	-	-	5.0	070[c]
006	004	B	-	-	5.0	070[c]
006	005	B	-	-	5.0	070[c]
006	006	B	-	-	5.0	070[c]
006	007	B	-	-	5.0	070[c]
006	008	B	-	-	5 0	070[c]
007	001	W	-	-	1.6	112[d]
007	002	GC	-	-	1.6	112[d]
007	003	GC	-	-	1.6	112[d]

Station	Cast	Type	Loran-C Coordinates X	Loran-C Coordinates Y	Range (nmi)	Bearing (°True)
007	004	B	-	-	1.6	112[d]
007	005	B	-	-	1.6	112[d]
007	006	B	-	-	1.6	112[d]
007	007	B	-	-	1.6	112[d]
007	008	B	-	-	1.6	112[d]
008	001	W	-	-	3.4	185[a]
008	002	GC	-	-	3.4	185[a]
008	003	GC	-	-	3.4	185[a]
008	004	B	-	-	3.4	185[a]
008	005	B	-	-	3.4	185[a]
008	006	B	-	-	3.4	185a
008	007	B	-	-	3.4	185[a]
008	008	B	-	-	3.4	185[a]
009	001	W	-	-	0.7	200[a]
009	002	GC	-	-	0.7	200[a]
009	003	GC	-	-	0.7	200[a]
009	004	B	-	-	0.7	200[a]
009	005	B	-	-	0.7	200[a]
009	006	B	-	-	0.7	200[a]
009	007	B	-	-	0.7	200[a]
009	008	B	-	-	0.7	200[a]
010	001	W	11273.0	46878.3	-	-
010	002	GC	11273.1	46878.3	-	-
010	003	GC	11273.1	46878.2	-	-
010	004	B	11273.1	46878.2	-	-
010	005	B	11273.1	46878.2	-	-

Station	Cast	Type	Loran-C Coordinates		Range (nmi)	Bearing (°True)
			X	Y		
010	006	B	11273.1	46878.2	-	-
010	007	B	11273.1	46878.2	-	-
010	008	B	11273.1	46878.2	-	-
010	009	GCE	11273.1	46878.2	-	-
010	010	TRWL	11269.9 (course 115°T)	46879.3 (course 115°T)	-	-

Note: Master station 7980

a = Target is Seabuoy FLG "1" (NOAA Chart No. 11351)
b = Target is Seabuoy FLG "15" (NOAA Chart No. 11351)
c = Target is Seabuoy FLG "3" (NOAA Chart No. 11351)
d = Target is Seabuoy FLG "2" (NOAA Chart No. 11351)

Cast Types

B = Biological
GC = Geochemical
GCE = Elutriate sample
TRWL = Otter trawl
W = Water column

Appendix C

QUALITY CONTROL DATA

PURPOSE

This appendix contains quality control data for the IEC Survey of Atchafalaya River ODMDS. Quality control procedures are summarized in Appendix A. The following lists the contents of this appendix.

CONTENTS

TABLES

Section C-1

INTERLABORATORY QUALITY CONTROL

TABLE C-1-1
SAMPLE DATA LISTING

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
11/10/81

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SURVEY DATA REPORT

SURVEY 0720 DURATION: TO PRIMARY INVESTIGATOR: W. STEINHAUER

STATION = 1
SPHERE = WATER SAMPLER = PLESSEY CTD/ROSETTE SIZE = 30.0 LITERS DATE 08/04/24

SAMPLE INFO TIME (1)	DEPTH (2)	NO (3)	TAXONOMIC NAME	QUALIFIER	VALUE CODE (4)	VALUE	EXP. (5)	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			CADMIUM			DISSOLVED			
0121	7	01			L	0.30000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			CADMIUM			PARTICULATE SUSP			
0121	7	01			L	0.38200	- 2	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD			DISSOLVED			
0121	7	01				2.20000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD			PARTICULATE SUSP			
0121	7	01				4.58000	- 2	UG/L	NONE REQUIRED
PARAMETER = METALS			MERCURY			DISSOLVED			
0121	7	01				0.03000	0	UG/L	NONE REQUIRED

STATION = 1
SPHERE = SEDIMENT SAMPLER = BOX CORER SIZE = 500.0 CM2 DATE 08/04/24

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	QUALIFIER	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			CADMIUM			UNDIFFERENTIATED			
0720	15	03				3.30000	- 2	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			LEAD			UNDIFFERENTIATED			
0720	15	03				250.00000	- 2	MG/KG	UNSPEC DRY WT

(1) MILITARY TIME (IN THIS CASE, 1:21 A.M.)
(2) DEPTH IN METERS
(3) NO = SAMPLE NUMBER (IN THIS CASE, NUMBER 1)
(4) LESS THAN (<) THE VALUE GIVEN, IN THIS CASE <0.3000
(5) EXPONENT CONVERTED = −2; VALUE = 0.00382

TABLE C-1-2
REPLICATE ANALYSES PERFORMED BY QUALITY CONTROL LABORATORY

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
02/12/82

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DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0739 ATCHAFALAYA I — DURATION: 80/12/03 TO 80/12/04 — PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 1
SPHERE = WATER — SAMPLER = TEFLON-LINED GO-FLO BOTTLE — SIZE = 30.0 LITERS — DATE 80/12/04

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			DISSOLVED			
1650	4	01		00		0.28000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			ARSENIC			PARTICULATE,SUSP			
1650	4	01		00		1.70000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			CADMIUM			DISSOLVED			
1650	4	01		00		0.03300	0	UG/L	NONE REQUIRED
PARAMETER = METALS			CADMIUM			PARTICULATE,SUSP			
1650	4	01		00	L	0.11000	-01	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD			DISSOLVED			
1650	4	01		00		0.20000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD			PARTICULATE,SUSP			
1650	4	01		00		1.50000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			MERCURY			DISSOLVED			
1650	4	01		00	L	0.50000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			MERCURY			PARTICULATE,SUSP			
1650	4	01		00		0.40000	0	UG/L	NONE REQUIRED

TABLE C-1-2 (continued)

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
02/12/82

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DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0739 ATCHAFALAYA I | DURATION: 08/12/83 TO 08/12/84 | PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 1
SPHERE = SEDIMENT | SAMPLER = PONAR GRAVITY GRAB | SIZE = 500.0 CM2 | DATE 08/12/84

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			UNDIFFERENTIATED			
1655	4	02		00		10.00000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			CADMIUM			UNDIFFERENTIATED			
1655	4	02		00		0.30000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			LEAD			UNDIFFERENTIATED			
1655	4	02		00		26.00000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			MERCURY			UNDIFFERENTIATED			
1655	4	02		00		0.06600	0	MG/KG	UNSPEC DRY WT
PARAMETER = INORGANICS			CYANIDE			UNDIFFERENTIATED			
1655	4	02		00	L	0.67000	0	MG/KG	UNSPEC DRY WT
PARAMETER = ORGANICS			PHENOLS			UNDIFFERENTIATED			
1655	4	02		00	L	0.91000	0	MG/KG	UNSPEC DRY WT
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1655	4	02		00	L	0.01200	0	MG/KG	UNSPEC DRY WT

TABLE C-1-2 (continued)

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
02/12/82

DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0739 ATCHAFALAYA I DURATION: 80/12/03 TO 80/12/04 PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 6
SPHERE = WATER SAMPLER = TEFLON-LINED GO-FLO BOTTLE SIZE = 30.0 LITERS DATE 80/12/03

TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1621	4	01		00	L	0.50000	0	UG/L	NONE REQUIRED

STATION = 10
SPHERE = WATER SAMPLER = OTTER TRAWL SIZE = 7.6 M2 DATE 80/12/04

TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			UNDIFFERENTIATED			
1506	5	10	XIPHOPENAEUS KROYERI	00		3.40000	0	MG/KG	WET WT
PARAMETER = METALS			CADMIUM			UNDIFFERENTIATED			
1506	5	10	XIPHOPENAEUS KROYERI	00		0.02100	0	MG/KG	WET WT
PARAMETER = METALS			LEAD			UNDIFFERENTIATED			
1506	5	10	XIPHOPENAEUS KROYERI	00	L	0.01900	0	MG/KG	WET WT
PARAMETER = METALS			MERCURY			UNDIFFERENTIATED			
1506	5	10	XIPHOPENAEUS KROYERI	00		0.08400	0	MG/KG	WET WT
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1506	5	10	XIPHOPENAEUS KROYERI	00	L	0.02400	0	MG/KG	WET WT

— END 739 —

TABLE C-1-2 (continued)

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
82/12/02

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DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0746 ATCHAFALAYA II — DURATION: 81/05/23 TO 81/06/02 — PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 1
SPHERE = WATER — SAMPLER = TEFLON-LINED GO-FLO BOTTLE — SIZE = 30.0 LITERS — DATE 81/06/02

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			DISSOLVED			
1545	2	01		00		3.20000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			ARSENIC			PARTICULATE,SUSP			
1545	2	01		00		0.11000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			CADMIUM			DISSOLVED			
1545	2	01		00		0.47000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			CADMIUM			PARTICULATE,SUSP			
1545	2	01		00		0.15000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD *			DISSOLVED			
1545	2	01		00		91.00000 *	0	UG/L	NONE REQUIRED
PARAMETER = METALS			LEAD			PARTICULATE,SUSP			
1545	2	01		00		0.03000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			MERCURY			DISSOLVED			
1545	2	01		00	L	0.40000	0	UG/L	NONE REQUIRED
PARAMETER = METALS			MERCURY			PARTICULATE,SUSP			
1545	2	01		00	L	0.03800	0	UG/L	NONE REQUIRED

* Sample Contaminated

TABLE C-1-2 (continued)

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
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DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0746 ATCHAFALAYA II   DURATION: 81/05/23 TO 81/06/02   PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 1
SPHERE = WATER   SAMPLER = TEFLON-LINED GO-FLO BOTTLE   SIZE = 30.0 LITERS   DATE 81/06/02

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1545	2	01		00	L	0.06000	0	UG/L	NONE REQUIRED

STATION = 1
SPHERE = SEDIMENT   SAMPLER = PONAR GRAVITY GRAB   SIZE = 500.0 CM2   DATE 81/06/02

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			UNDIFFERENTIATED			
1552	15	02		00		3.60000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			CADMIUM			UNDIFFERENTIATED			
1552	15	02		00		0.13000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			LEAD			UNDIFFERENTIATED			
1552	15	02		00		20.00000	0	MG/KG	UNSPEC DRY WT
PARAMETER = METALS			MERCURY			UNDIFFERENTIATED			
1552	15	02		00		0.04000	0	MG/KG	UNSPEC DRY WT
PARAMETER = INORGANICS			CYANIDE			UNDIFFERENTIATED			
1552	15	02		00	L	0.05000	0	MG/KG	UNSPEC DRY WT

TABLE C-1-2 (continued)

INTERSTATE ELECTRONICS CORP.
OCEANICS ENGINEERING DIV.
ANAHEIM CA. (714)772-2811

ODEEP DATA BASE REPORTING SYSTEM
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DATA REPORT - QUALITY CONTROL VALUES

SURVEY 0746 ATCHAFALAYA II   DURATION: 81/05/23 TO 81/06/02   PRIMARY INVESTIGATOR: W. RICHARDSON

STATION = 5
SPHERE = WATER   SAMPLER = OTTER TRAWL   SIZE = 7.6 M2   DATE 81/05/25

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = METALS			ARSENIC			UNDIFFERENTIATED			
1745	15	08	TRACHYPENAEUS SIMILIS	00		0.94000	0	MG/KG	WET WT
PARAMETER = METALS			CADMIUM			UNDIFFERENTIATED			
1745	15	08	TRACHYPENAEUS SIMILIS	00		0.02100	0	MG/KG	WET WT
PARAMETER = METALS			LEAD			UNDIFFERENTIATED			
1745	15	08	TRACHYPENAEUS SIMILIS	00		0.94000	0	MG/KG	WET WT
PARAMETER = METALS			MERCURY			UNDIFFERENTIATED			
1745	15	08	TRACHYPENAEUS SIMILIS	00		0.03000	0	MG/KG	WET WT
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1840	17	09	CALLINECTES SIMILIS	00	L	0.02500	0	MG/KG	WET WT

STATION = 6
SPHERE = WATER   SAMPLER = TEFLON-LINED GO-FLO BOTTLE   SIZE = 30.0 LITERS   DATE 81/05/24

SAMPLE INFO TIME	DEPTH	NO	TAXONOMIC NAME	REPL CODE	VALUE CODE	VALUE	EXP.	UNIT OF MEASURE	UNIT MODIFIER
PARAMETER = CHLORINATED HYDROCARBONS			PESTICIDES			UNDIFFERENTIATED			
1616	2	01		00	L	0.06000	0	UG/L	NONE REQUIRED

*** TOTAL NUMBER OF RECORDS FOR THIS REPORT IS 41 ***

TABLE C-1-3
IDENTIFICATION OF BIOLOGICAL SPECIMENS

VOUCHER SPECIMENS: I.E.C. NEW ORLEANS SURVEYS

POLYCHAETA

Vittor & Assoc.			LaMer
Owenia fusiformis	743HO 009-005	(2)	Owenia sp.* (2)
	740SW 001-004	(1)	Owenia sp. (1)
	744BA 002-006	(5)	Owenia sp. (5)
	745CA 008-005	(1)	Owenia sp. (1)
	744BA 002-005	(1)	Owenia sp. (1)
Lumbrineris spp.	741GO 005-012	(10)	Lumbrineris spp. (6) Drilonereis longa** (4)
Glycinde solitaria	746AT 005-004	(4)	G. solitaria (4)
	742CA 003-003	(2)	G. solitaria (2)
	744BA 004-004	(1)	G. solitaria (1)
	740SW 006-005	(1)	G. solitaria (1)
	747HO 007-003	(1)	G. solitaria (1)
	746AT 006-005	(2)	G. solitaria (2)
Travisia hobsonae	741GO 002-006	(9)	T. hobsonae (9)
	741GO 002-005	(2)	T. hobsonae (2)
Nereis micromma	740SW 001-004	(3)	N. micromma (3)
	741GO 002-005	(1)	N. micromma (1)
	740SW 001-004	(3)	N. micromma (3)
	743HO 004-003	(1)	N. micromma (1)
	739AT 010-007	(1)	N. micromma (1)
	742CA 011-004	(1)	N. micromma (1)

Comments:

BAV specimens of Nereis micromma and Travisia hobsonae were compared to type material of those species deposited at the Allan Hancock Foundation.

*Owenia fusiformis : The BAV material is not O.fusiformis; it superficially resembles O. collaris in that a collar is present at the base of the tentacular crown.(absent in O. fusiformis). However, they are not Owenia collaris for the following reasons:a) the neurosetae are intermediate, with a suggestion of a shoulder in some b) BAV specimens have slightly deeper dorso-lateral clefts in the collar c) collar on BAV worms is generally more oblique than that of O. collaris d) on BAV specimens the notosetae of setiger 4 almost meet;O.collaris setal bundles are more separated e) different staining patterns in glandular areas with methyl green. Owenia collaris from Santa Catalina Island, California, the type locality, were used for comparison.

** Drilonereis longa were mixed with the Lumbrineris. This species belongs to the family Arabellidae; it has no hooded hooks(as in Lumbrineridae). Projecting acicular spines are present in posterior region. Body is thread-like, anterior parapodia small & inconspicuous, posterior parapodia bilabiate. (distinguishes D.longa from D. magna) See Pettibone,1963 (Polychaetes of New England)and Hartman,1945 (Marine Annelids of North Carolina).

TABLE C-1-3 (continued)

(cont)

BAV				LA MER	
Ogyrides alphaerostris	741GO	005-010	(9)	Ogyrides alphaerostris	(9)
Oxyurostylis smithi	(10) 750GO	007-005		Oxyurostylis smithi	(10)
Mulinia lateralis	(1) 744BA	002-006		Mulinia lateralis	(1)
Mulinia lateralis	(9) 744BA	007-004		Mulinia lateralis	(9)

TABLE C-1-3 (continued)

BARRY A. VITTOR & ASSOCIATES, INC.
ENVIRONMENTAL RESEARCH & CONSULTING

8100 Cottage Hill Road
Mobile, Alabama 36609
Phone (205) 661-7236

February 12, 1982

Dr. Andrew Lissner
Interstate Electronics Corporation
Oceanic Engineering
1001 East Ball Road
P. O. Box 3117
Anaheim, CA 92803

Dear Andy:

Please find enclosed comments concerning the identification and QC determination of the two polychaete species, Owenia fusiformis and Lumbrineris spp., which were sent to LaMer. I hope the comments are satisfactory.

Please call if you need further information.

Sincerely,

Kevin

J. Kevin Shaw

JKS/dc

Enc.

Mobile, Alabama - Slidell, Louisiana - Ocean Springs, Mississippi

TABLE C-1-3 (continued)

With regards to Owenia fusiformis vs. Owenia sp.: We believe LaMer is probably correct. We have suspected for some time that O. fusiformis, which is widely reported from the Gulf of Mexico (see Perkins and Savage, 1975:52), is not O. fusiformis. We have never been really sure because we have not compared our O. fusiformis with specimens from other localities. In fact, to clear up the problem completely one needs to examine type material, because the collar at the base of the tentacular crown could have been easily overlooked in delle Chiaje's (1841) original description. At any rate, since there is a problem, it is probably best to call our specimens Owenia sp. A. We feel our identifications of this taxon were consistent so the change, if necessary, is "merely" a paper change.

With regards to Lumbrineris spp: This happened because we had to go back into the sample to pull 10 specimens of Lumbrineris spp. since we do not maintain vouchers for indeterminable taxa. In so doing, we inadvertently included the 4 specimens of Drilonereis longa. This species was not reported in the New Orleans survey because it was never one of the dominant taxa. It seems we goofed but we believe it does not affect the data in any way.

Section C-2

SHIPBOARD QUALITY CONTROL

C-3-1 COMPARISON OF BIOLOGICAL DATA COLLECTED USING TWO TYPES OF SAMPLING GEAR

Two types of sampling gear were used to collect infaunal samples during surveys of six ocean disposal sites in the New Orleans region. A 0.06 m^2 box core was used at stations deep enough (greater than 18 ft) to be sampled from the ANTELOPE, while a 0.05 m^2 Ponar grab was used at shallow stations sampled from the small boat (Boston Whaler). To determine if there was a significant difference between the number of individuals collected using the two types of sampling gear, five replicate box core samples and five replicate Ponar grab samples were collected at Station 6, Mississippi River-Gulf Outlet ODMDS (EPA, in preparation). This station was selected on the basis of its location in a control area having a relatively homogeneous environment. Numbers of selected taxa were compared using a Mann-Whitney U test (Tables C-2-1 and C-2-2). These results indicate that when total numbers of individuals were compared, there was no significant difference between sampling methods for taxa exhibiting relatively high abundances (Table C-2-1). However, for one taxon (Platyschnopidae), which exhibited relatively low abundances, there was a significant difference between methods. When these data were normalized by conversion to numbers of individuals/m^2, there was no significant difference between sampling methods for any of the taxa tested (Table C-2-2). Based on these results all infaunal data were converted to numbers of individuals/m^2 so that differences attributable to sampling methods would be minimized prior to statistical analysis.

TABLE C-2-1
TOTAL NUMBER OF INDIVIDUALS COLLECTED USING A BOX CORE,
AS COMPARED TO A PONAR GRAB, AT STATION 6, MISSISSIPPI RIVER-GULF OUTLET ODMDS

Replicate	Total Individuals		Polychaetes		Arthropods		*Mediomastus* spp.		Platyschnopidae	
	N	R	N	R	N	R	N	R	N	R
Box Core										
1	111	5	44	6	51	1	16	7	29	1
2	115	4	73	4	32	7.5	47	4	19	3
3	181	1	124	1	47	2	79	1	14	7
4	151	2	99	2	39	4	69	2	15	6
5	89	7	41	7	35	6	14	8	13	8
ΣR_1		19		20		20.5		22		25
Ponar Grab										
6	33	10	17	10	12	9	3	10	4	10
7	99	6	54	5	32	7.5	27	5	12	9
8	37	9	19	9	10	10	10	9	21	2
9	142	3	84	3	40	3	56	3	18	4
10	85	8	39	8	37	5	26	6	17	5
ΣR_2		36		35		34.5		33		30
U		21		20		19.5		18		15
P	>0.20		0.20		0.10>p>0.05		0.10>p>0.05		0.01*	

R = Rank
N = Total number of individuals per replicate

$U_{0.05(2),5,5} = 23$

Source: EPA (in preparation)

TABLE C-2-2
NUMBER OF INDIVIDUALS/m^2 COLLECTED USING A BOX CORE AS COMPARED TO A PONAR GRAB AT STATION 6, MISSISSIPPI RIVER-GULF OUTLET ODMDS

Replicate	Total Individuals	Polychaetes	Anthropods	*Mediomastus* spp.	Platyischnopidae
			Box Core		
1	1,850	733	850	267	483
2	1,917	1,216	533	783	317
3	3,017	2,067	783	1,317	233
4	2,517	1,650	650	1,150	250
5	1,483	683	583	233	217
			Ponar Grab		
6	660	340	240	60	80
7	1,980	1,080	640	540	240
8	740	380	200	200	420
9	2,840	1,680	800	1,120	360
10	1,700	780	740	520	340
U	17	17	16	18	14
P	>0.20	>0.20	>0.20	>0.20	>0.20

Note: $U_{0.05(2),5,5} = 23$; data converted to m^2 using N/.06 for box core and N/.05 for Ponar grab

Source: EPA (in preparation)

TABLE C-2-3
PROCEDURAL BLANKS TO DETERMINE
TRACE METAL CONTAMINATION FROM HANDLING OF FILTERS

Survey	Station	Sample Number	Parameter	Value
739	6	N/A	TMPA	*

* Not reported; laboratory error

TABLE C-2-4
EXTRACTION EFFICIENCY OF XAD RESIN COLUMN

Survey	Station	Sample Number	Parameter	Value
739	1	1	Arochlor 1254	0.9 ng/liter
739	1	1	Dieldrin	0.03 ng/liter

TABLE C-2-5
RINSING EFFICIENCY FOR SALT REMOVAL FROM FILTERS

Survey	Station	Sample Number	Parameter	Value
739	6	1 (replicate 1)	TSSA	0.184 mg
739	6	1 (replicate 2)	TSSA	0.131 mg
746	6	1 (replicate 1)	TSSA	0.698 mg
746	6	1 (replicate 2)	TSSA	0.314 mg

Section C-3

INTERNAL QUALITY CONTROL
PERFORMED BY PRIMARY LABORATORY

C-3-1 DATA SUMMARY

This section contains internal quality control data developed by ERCO for two separate surveys of six New Orleans sites (EPA, in preparation). Collectively, these data represent a comprehensive quality control program, and as such, results are listed for both surveys conducted at Atchafalaya (AT), Barataria (BA), Calcasieu (CA), Houma (HO), Mississippi River-Gulf Outlet (GO) and Southwest Pass (SW).

Data presented include:

1. Trace metals (Seawater, Tissue, and Sediment)

   (a) Recovery of spikes to analyte solutions

   (b) Duplicate analyses

   (c) Efficiency of chelation/solvent extraction system for removing and preconcentrating metals from seawater

   (d) Analysis of NBS reference materials

   Note

   Data for arsenic in tissues (TMTB) from New Orleans I surveys are inaccurate as determined from low percent recoveries of NBS reference material using hydride generation AAS; use of graphite furnace AAS yielded excellent results for New Orleans II surveys.

   (e) Comparison of aqua regia (strong acid) and 1 N HNO_3 (weak acid) leach

   (f) Analytical blanks

2. Organohalogens (Seawater, Tissue, Sediment)

   (a) Recovery of spikes

   (b) Duplicate analyses

3. Total Organic Carbon

   (a) Duplicate analyses

   (b) Analysis of reference material

4. Oil and Grease

   (a) Duplicate analyses

   (b) Recovery of spikes

5. Cyanide and Phenol

   (a) Recovery of spikes (Distilled and sediment digestates)

6. Petroleum Hydrocarbons

   (a) Analyses of procedural blanks

   (b) Duplicate analyses

Coding for the parameters is listed below:

Code	Parameter
CNSA	Cyanide; sediment
ELSA	Elutriate test
OILA	Oil and grease; sediment
PCSA	PCB; sediment
PCTB	PCB; tissue
PCWA	PCB; seawater
TMDA	Trace metal; seawater (dissolved)
TMPA	Trace metal; seawater (particulate)
TMSA	Trace metal; sediment
TMTB	Trace metal; tissue
TOCA	Total organic carbon; sediment
TSSA	Total suspended solids; seawater

INTERNAL QUALITY CONTROL DATA FOR NEW ORLEANS I SURVEYS

3.2 Quality Control Data

3.2.1 Trace Metal Analyses

In this section, quality control analyses performed in conjunction with trace metal analyses are presented.

Recoveries of spikes to analyte solutions are summarized in Table 37. Ranges of spike recoveries to sediment samples were as follows: As, 87-103%; Cd, 92-99%; Cr, 87-92%; Cu, 99-106%; Mn, 101-107%; Ni, 97-104%; Pb, 85-91%; and Zn, 94-98%. Ranges of spike recoveries to seawater dissolved and particulate samples were as follows: As, 97-105%; Cd, 74-83%; Cr, 84-100%; Cu, 94-96%; Mn, 94-117%; Ni, 94-117%; Pb, 90-109%; and Zn, 103-105%. Ranges of spike recoveries for tissue samples were as follows: As, 100-101%; Cd, 87-95%; Cr, 93-94%; Cu, 99-100%; Mn, 100%; Ni, 83-116%; Pb, 76-92%; and Zn, 101-102%.

Duplicate analyses of seawater, tissue, and sediment samples are summarized in Table 38. All duplicates showed excellent agreement except Cu and Zn analyses of seawater (TMDA) and Cr analysis of tissue (TMTB).

The efficiency of the chelation/solvent extraction system for removing and preconcentrating metals from seawater is described in Table 39. The mean recoveries and standard deviations of metal spikes added to the seawater samples were: Cd, 46 $\pm$ 6%; Cr, 50 $\pm$ 26%; Cu, 79 $\pm$ 23%; Mn, 68 $\pm$ 33%; Ni, 56 $\pm$ 17%; Pb, 88 $\pm$ 8%; and Zn, 58 $\pm$ 54%.

Analyses of two National Bureau of Standards Reference Materials (SRMs) are shown in Table 40. Analyses of NBS SRM 1645 (River Sediment) using the 1 N HNO_3 leach procedure gave the following recoveries of metal from the sediment: As, 36%; Cd, 67%; Cr, 59%; Cu, 40%; Mn, 45%; Ni, 39%; Pb, 80%; and Zn, 73%. The total analysis for Hg was well within the stated error limits for the certified value. Analyses of NBS SRM 1566 (Oyster Tissue) showed excellent agreement with certified values for Cd, Cu, Hg, Mn, Pb, and Zn. Analyses for As, Cr, and Ni were less accurate due to under-recovery during digestion or analytical variability.

Table 41 compares results of the 1 N HNO_3 leach of 12 sediments (samples collected at Station 001 at each site) with results obtained using an aqua regia (strong acid) digestion. These results provide additional documentation on the extraction efficiency of the 1 N HNO_3 leach for removing metals from sedimentary material. Compared to the aqua regia digestion, the 1 N HNO_3 leach recovered the following amounts (expressed as mean and standard deviation) of metal from the sediments: As, 17 ± 4%; Cd, 115% (two samples only); Cr, 9 ± 3%; Cu, 54 ± 16%; Mn, 87 ± 29%; Ni, 27 ± 5%; Pb, 99 ± 19%; and Zn, 38 ± 6%.

Analytical blanks for all metal analyses are shown in Table 42. Blanks were detectable only for Cd, Hg, Mn, Ni, and Pb in seawater and As, Cr, Hg, and Ni in tissues. In all other samples, blanks were undetectable.

TABLE 37

RECOVERY OF METAL SPIKES FROM ANALYTE SOLUTIONS

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
As	739AT 001-003 TMSA	54 µg/l	53 µg/l	98
	739AT 006-003 TMSA	125 µg/l	129 µg/l	103
	740SW 004-002 TMSA	65 µg/l	58 µg/l	89
	740SW 007-006 TMSA	67 µg/l	60 µg/l	90
	741GO 003-002 TMSA	58 µg/l	58 µg/l	100
	741GO 008-002 TMSA	36 µg/l	31 µg/l	86
	742CA 004-002 TMSA	76 µg/l	70 µg/l	92
	742CA 008-003 TMSA	41 µg/l	39 µg/l	95
	743HO 005-003 TMSA	47 µg/l	48 µg/l	102
	743HO 008-002 TMSA	39 µg/l	34 µg/l	87
	744BA 003-002 TMSA	68 µg/l	67 µg/l	99
	744BA 005-002 TMSA	39 µg/l	39 µg/l	100
	740SW 006-001 TMPA	40 µg/l	40 µg/l	100
	744BA 006-001 TMPA	35 µg/l	34 µg/l	97
	741GO 001-001 TMDA	1.9 µg/l	2.0 µg/l	105
	742CA 001-001 TMDA	2.1 µg/l	2.2 µg/l	105
	744BA 002-001 TMDA	1.9 µg/l	1.9 µg/l	100
	741GO 003-008 TMTB	8.1 µg/l	8.2 µg/l	101
	743HO 006-010 TMTB	7.7 µg/l	7.7 µg/l	100
Cd	739AT 006-002 TMSA	5.20 mg/l	4.90 mg/l	94
	739AT 010-003 TMSA	5.20 mg/l	4.94 mg/l	95
	740SW 002-002 TMSA	5.19 mg/l	4.92 mg/l	95
	740SW 003-002 TMSA	5.22 mg/l	5.11 mg/l	98
	741GO 003-002 TMSA	5.19 mg/l	4.91 mg/l	95
	741GO 006-002 TMSA	5.18 mg/l	4.98 mg/l	96
	742CA 002-002 TMSA	5.19 mg/l	4.92 mg/l	95
	742CA 007-004 TMSA	5.19 mg/l	5.13 mg/l	99
	743HO 004-002 TMSA	5.18 mg/l	5.05 mg/l	97
	743HO 006-002 TMSA	5.19 mg/l	4.83 mg/l	93
	744BA 002-003 TMSA	5.18 mg/l	4.79 mg/l	92
	744BA 007-003 TMSA	5.19 mg/l	4.79 mg/l	93
	740SW 006-001 TMPA	3.1 µg/l	2.9 µg/l	83
	740SW 006-001 TMDA	4.5 µg/l	3.5 µg/l	78
	742CA 006-001 TMDA	5.0 µg/l	3.7 µg/l	74
	740SW 006-012 TMTB	3.9 µg/l	3.7 µg/l	95
	742CA 001-011 TMTB	3.1 µg/l	2.7 µg/l	87

TABLE 37 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Cr	739AT 009-003 TMSA	2.41 mg/l	2.19 mg/l	91
	739AT 010-003 TMSA	2.40 mg/l	2.15 mg/l	90
	740SW 003-002 TMSA	2.39 mg/l	2.21 mg/l	92
	740SW 008-003 TMSA	2.36 mg/l	2.17 mg/l	92
	741GO 007-003 TMSA	2.33 mg/l	2.14 mg/l	92
	741GO 009-004 TMSA	2.34 mg/l	2.15 mg/l	92
	742CA 003-002 TMSA	2.38 mg/l	2.14 mg/l	90
	742CA 015-001 TMSA	2.38 mg/l	2.17 mg/l	91
	743HO 005-003 TMSA	2.32 mg/l	2.07 mg/l	89
	743HO 007-002 TMSA	2.31 mg/l	2.11 mg/l	91
	744BA 003-002 TMSA	2.38 mg/l	2.14 mg/l	90
	744BA 007-002 TMSA	2.33 mg/l	2.03 mg/l	87
	740SW 006-001 TMPA	55 µg/l	55 µg/l	100
	740SW 006-001 TMDA	25 µg/l	25 µg/l	100
	742CA 006-001 TMDA	25 µg/l	21 µg/l	84
	740SW 006-012 TMTB	72 µg/l	67 µg/l	93
	742CA 001-011 TMTB	51 µg/l	48 µg/l	94
Cu	739AT 006-002 TMSA	6.03 mg/l	6.02 mg/l	100
	739AT 010-003 TMSA	6.29 mg/l	6.48 mg/l	103
	740SW 002-002 TMSA	5.23 mg/l	5.26 mg/l	101
	740SW 003-002 TMSA	6.45 mg/l	6.65 mg/l	103
	741GO 003-002 TMSA	5.44 mg/l	5.47 mg/l	101
	741GO 006-002 TMSA	5.14 mg/l	5.26 mg/l	102
	742CA 002-002 TMSA	5.82 mg/l	5.91 mg/l	102
	742CA 007-004 TMSA	6.12 mg/l	6.40 mg/l	105
	743HO 004-002 TMSA	5.17 mg/l	5.39 mg/l	104
	743HO 006-002 TMSA	5.73 mg/l	5.70 mg/l	99
	744BA 002-003 TMSA	5.19 mg/l	5.43 mg/l	105
	744BA 007-003 TMSA	5.28 mg/l	5.60 mg/l	106
	740SW 006-001 TMPA	43 µg/l	41 µg/l	95
	740SW 006-001 TMDA	50 µg/l	48 µg/l	96
	742CA 006-001 TMDA	53 µg/l	50 µg/l	94
	742CA 001-011 TMTB	58 µg/l	58 µg/l	100
	743HO 006-010 TMTB	1.17 mg/l	1.16 mg/l	99

TABLE 37 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Mn	739AT 006-002 TMSA	118.9 mg/l	122.6 mg/l	103
	739AT 010-003 TMSA	128.0 mg/l	127.9 mg/l	100
	740SW 002-002 TMSA	72.1 mg/l	74.8 mg/l	104
	740SW 003-002 TMSA	100.5 mg/l	105.9 mg/l	105
	741GO 003-002 TMSA	80.0 mg/l	81.4 mg/l	102
	741GO 006-002 TMSA	65.3 mg/l	66.4 mg/l	102
	742CA 002-002 TMSA	132.6 mg/l	142.1 mg/l	107
	742CA 007-004 TMSA	139.4 mg/l	146.4 mg/l	105
	743HO 004-002 TMSA	63.6 mg/l	67.1 mg/l	106
	743HO 006-002 TMSA	79.5 mg/l	82.4 mg/l	104
	744BA 002-003 TMSA	84.2 mg/l	86.8 mg/l	103
	744BA 007-003 TMSA	87.5 mg/l	88.4 mg/l	101
	742CA 001-001 TMPA	1.58 mg/l	1.58 mg/l	100
	740SW 006-001 TMDA	7.6 µg/l	8.9 µg/l	117
	742CA 006-001 TMDA	8.1 µg/l	7.6 µg/l	94
	739AT 010-010 TMTB	0.677 mg/l	0.675 mg/l	100
Ni	739AT 006-002 TMSA	5.60 mg/l	5.49 mg/l	98
	739AT 010-003 TMSA	5.63 mg/l	5.44 mg/l	97
	740SW 002-002 TMSA	5.53 mg/l	5.38 mg/l	97
	740SW 003-002 TMSA	5.78 mg/l	5.80 mg/l	100
	741GO 003-002 TMSA	5.54 mg/l	5.39 mg/l	97
	741GO 006-002 TMSA	5.57 mg/l	5.53 mg/l	99
	742CA 002-002 TMSA	5.42 mg/l	5.33 mg/l	98
	742CA 007-004 TMSA	5.48 mg/l	5.53 mg/l	101
	743HO 004-002 TMSA	5.22 mg/l	5.43 mg/l	104
	743HO 006-002 TMSA	5.43 mg/l	5.32 mg/l	98
	744BA 002-003 TMSA	5.59 mg/l	5.44 mg/l	97
	744BA 007-003 TMSA	5.55 mg/l	5.38 mg/l	97
	740SW 006-001 TMPA	40 µg/l	41 µg/l	103
	740SW 006-001 TMDA	50 µg/l	47 µg/l	94
	742CA 006-001 TMDA	58 µg/l	68 µg/l	117
	740SW 006-012 TMTB	46 µg/l	38 µg/l	83
	742CA 001-011 TMTB	32 µg/l	37 µg/l	116

TABLE 37 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Pb	739AT 009-003 TMSA	3.81 mg/l	3.46 mg/l	91
	739AT 010-003 TMSA	3.60 mg/l	3.17 mg/l	88
	740SW 003-002 TMSA	3.48 mg/l	3.10 mg/l	89
	740SW 008-003 TMSA	3.21 mg/l	2.80 mg/l	87
	741GO 007-003 TMSA	3.01 mg/l	2.55 mg/l	85
	741GO 009-004 TMSA	3.08 mg/l	2.63 mg/l	85
	742CA 003-002 TMSA	3.74 mg/l	3.37 mg/l	90
	742CA 015-001 TMSA	3.60 mg/l	2.23 mg/l	90
	743HO 005-003 TMSA	3.06 mg/l	2.74 mg/l	90
	743HO 007-002 TMSA	2.90 mg/l	2.63 mg/l	91
	744BA 003-002 TMSA	3.75 mg/l	3.55 mg/l	95
	744BA 007-002 TMSA	3.07 mg/l	2.71 mg/l	88
	740SW 006-001 TMPA	45 µg/l	47 µg/l	104
	740SW 006-001 TMDA	34 µg/l	37 µg/l	109
	742CA 006-001 TMDA	31 µg/l	28 µg/l	90
	740SW 006-012 TMTB	25 µg/l	23 µg/l	92
	742CA 001-011 TMTB	25 µg/l	19 µg/l	76
Zn	739AT 006-002 TMSA	8.17 mg/l	7.77 mg/l	95
	739AT 010-003 TMSA	8.71 mg/l	8.38 mg/l	96
	740SW 002-002 TMSA	7.07 mg/l	6.68 mg/l	94
	740SW 003-002 TMSA	8.98 mg/l	8.76 mg/l	98
	741GO 003-002 TMSA	7.44 mg/l	7.08 mg/l	95
	741GO 006-002 TMSA	7.44 mg/l	7.14 mg/l	96
	742CA 002-002 TMSA	7.84 mg/l	7.41 mg/l	95
	742CA 007-004 TMSA	8.35 mg/l	8.17 mg/l	98
	743HO 004-002 TMSA	6.63 mg/l	6.50 mg/l	98
	743HO 006-002 TMSA	7.73 mg/l	7.30 mg/l	94
	744BA 002-003 TMSA	8.49 mg/l	8.06 mg/l	95
	744BA 007-003 TMSA	8.00 mg/l	7.58 mg/l	95
	740GO 006-001 TMPA	0.282 µg/l	0.291 µg/l	103
	740GO 006-001 TMDA	0.257 µg/l	0.270 µg/l	105
	740SW 003-008 TMTB	0.667 µg/l	0.678 µg/l	102
	744BA 006-010 TMTB	0.329 µg/l	0.332 µg/l	101

TABLE 38

RESULTS OF DUPLICATE TRACE METAL ANALYSES

Sample Identification	Concentration[a]								
	As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn
743HO 006-001 TMDA	-	0.054, 0.055	<0.10, <0.11	0.78, 1.4	-	0.13, 0.16	0.33, 0.32	<0.12, 0.14	0.88, 2.6
743HO 006-010 TMTB*	0.10, 0.18	0.059, 0.044	0.091, 0.019	7.5, 7.0	0.012, 0.011	0.32, 0.26	0.11, 0.11	<0.021, <0.019	13, 13
739AT 003-002 TMSA	2.4, 2.5	0.16, 0.17	1.3, 1.3	8.0, 8.6	0.045, 0.047	470, 500	5.2, 5.4	13, 13	19, 20
740SW 003-002 TMSA	2.4, 2.3	0.27, 0.30	1.7, 1.7	10, 11	0.058, 0.065	330, 340	5.8, 6.1	12, 13	24, 25
741GO 006-003 TMSA	0.78, 0.92	<0.039, <0.039	0.44 0.43	0.42, 0.42	0.007, 0.010	41, 41	2.4, 2.5	2.0, 2.0	7.7, 7.8
742CA 011-002 TMSA	1.6, 1.9	<0.078, <0.079	0.92, 1.0	2.4, 2.4	0.030, 0.029	190, 200	2.1, 2.2	6.8, 7.1	16, 16
743HO 004-002 TMSA	1.1, 1.5	<0.078, <0.078	0.43, 0.43	1.0, 1.0	0.015, 0.025	79, 79	2.4, 2.4	3.7, 3.8	10, 9.8
744BA 004-002 TMSA	1.3, 0.95	<0.040, <0.040	0.53, 0.55	0.95, 0.90	0.012, 0.011	110, 100	2.3, 2.7	4.6 4.4	12, 13

KEY:

- = not analyzed

[a]Units are µg/l for TMDA and µg/g for TMSA and TMTB.

*See note, page C-3.3

TABLE 39

EVALUATION OF EXTRACTION EFFICIENCY OF PRECONCENTRATION METHOD FOR SEAWATER ANALYSES OF Cd, Cr, Cu, Mn, Ni, Pb, and Zn

Element	Sample Identification	Concentration Added (μg/l)	Concentration Recovered (μg/l)	% Recovery[a]
Cd	739AT 001-001 TMDA	0.73	0.33	
	741GO 006-001 TMDA	0.89	0.48	46 ± 6
	742CA 001-001 TMDA	1.1	0.45	
	743HO 001-001 TMDA	1.4	0.59	
Cr	739AT 001-001 TMDA	0.45	0.11	
	741GO 006-001 TMDA	0.53	0.45	50 ± 26
	742CA 001-001 TMDA	1.8	0.84	
	743HO 001-001 TMDA	2.3	0.98	
Cu	739AT 001-001 TMDA	1.8	1.5	
	741GO 006-001 TMDA	2.3	1.2	79 ± 23
	742CA 001-001 TMDA	2.5	2.6	
	743HO 001-001 TMDA	3.4	2.3	
Mn	739AT 001-001 TMDA	1.2	1.3	
	741GO 006-001 TMDA	1.3	1.0	68 ± 33
	742CA 001-001 TMDA	3.5	0.93	
	743HO 001-001 TMDA	4.3	2.7	
Ni	739AT 001-001 TMDA	1.3	0.94	
	741GO 006-001 TMDA	1.5	0.48	56 ± 17
	742CA 001-001 TMDA	5.9	3.5	
	743HO 001-001 TMDA	7.8	4.5	
Pb	739AT 001-001 TMDA	3.3	3.2	
	741GO 006-001 TMDA	3.9	3.2	88 ± 8
	742CA 001-001 TMDA	3.0	2.4	
	743HO 001-001 TMDA	3.6	3.3	
Zn	739AT 001-001 TMDA	1.9	2.6	
	741GO 006-001 TMDA	2.8	1.4	58 ± 54
	742CA 001-001 TMDA	8.4	2.4	
	743HO 001-001 TMDA	11	1.8	

[a]Mean and standard deviation.

TABLE 40

RESULTS OF ANALYSIS OF NATIONAL BUREAU OF STANDARDS REFERENCE MATERIALS

	Metal				
	As*	Cd	Cr	Cu	Hg
NBS SRM 1645 (River Sediment)					
- Certified value (μg/g)	(66)[a]	10.2 ± 1.5	1.96 ± 0.28%	109 ± 19	1.1 ± 0.5
- Measured value (μg/g)[b] (1 N HNO_3 leach)	24 ± 3	6.8 ± 0.6	1.76 ± 0.03%	44 ± 8	0.84 ± 0.06
Average % recovery	36	67	59	40	76
NBS SRM 1566 (Oyster Tissue)					
- Certified value (μg/g)	13.4 ± 1.9	3.5 ± 0.4	0.69 ± 0.27	63.0 ± 3.5	0.057 ± 0.015
- Measured value (μg/g)[b]	3.2 ± 0.7	3.8 ± 0.2	1.2 ± 1.7	62.5 ± 2.4	0.074 ± 0.012

	Metal			
	Mn	Ni	Pb	Zn
NBS SRM 1645 (River Sediment)				
- Certified value (μg/g)	785 ± 97	45.8 ± 2.9	714 ± 28	1,720 ± 169
- Measured value (μg/g)[b] (1 N HNO_3 leach)	351 ± 11	18.0 ± 1.6	573 ± 41	1,260 ± 23
Average % recovery	45	39	80	73
NBS SRM 1566 (Oyster Tissue)				
- Certified value (μg/g)	17.5 ± 1.2	1.03 ± 0.19	0.48 ± 0.04	852 ± 14
- Measured value (μg/g)[b]	19.0 ± 0.26	0.73 ± 0.79	0.53 ± 0.07	910 ± 17

[a]Not certified by NBS.

[b]Mean and 95% confidence interval based on 3 analyses.

*See note, page C-3.3

TABLE 41

COMPARISONS OF RESULTS OF 1 N HNO_3 LEACH WITH RESULTS OF AQUA REGIA DIGESTION OF SEDIMENT SAMPLES

Element	Sample Identification	Metal Concentration (μg/g) Aqua Regia Digestion (Total)	Metal Concentration (μg/g) 1 N HNO_3 leach	% Recovery (Leach/Total)
As	739AT 001-002 TMSA	22	2.7	12
	739AT 001-003 TMSA	34	2.9	9
	740SW 001-002 TMSA	17	2.7	16
	740SW 001-003 TMSA	18	2.8	16
	741GO 001-003 TMSA	5.5	-	-
	741GO 001-004 TMSA	4.7	1.2	26
	742CA 001-002 TMSA	26	4.5	17
	742CA 001-003 TMSA	24	4.1	17
	743HO 001-002 TMSA	2.8	0.54	19
	743HO 001-003 TMSA	4.3	0.55	13
	744BA 001-001 TMSA	11	2.0	18
	744BA 001-002 TMSA	12	2.3	19
			Mean recovery	17 ± 4

KEY

- = not analyzed

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (μg/g)		% Recovery (Leach/Total)
		Aqua Regia Digestion (Total)	1 N HNO_3 leach	
Cd	739AT 001-002 TMSA	<0.49	0.20	-[a]
	739AT 001-003 TMSA	<0.45	0.19	-[a]
	740SW 001-002 TMSA	0.24	0.23	96
	740SW 001-003 TMSA	0.21	0.28	133
	741GO 001-003 TMSA	<0.10	<0.04	-[a]
	741GO 001-004 TMSA	<0.10	<0.04	-[a]
	742CA 001-002 TMSA	<0.20	<0.19	-[a]
	742CA 001-003 TMSA	<0.20	<0.19	-[a]
	743HO 001-002 TMSA	<0.10	<0.04	-[a]
	743HO 001-003 TMSA	<0.10	<0.04	-[a]
	744BA 001-001 TMSA	<0.20	<0.08	-[a]
	744BA 001-002 TMSA	<0.20	<0.08	-[a]

[a]Not calculated due to sample concentrations below detection.

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (μg/g)		% Recovery (Leach/Total)
		Aqua Regia Digestion (Total)	1 N HNO_3 leach	
Cr	739AT 001-002 TMSA	19	1.9	10
	739AT 001-003 TMSA	26	2.4	9
	740SW 001-002 TMSA	24	1.9	8
	740SW 001-003 TMSA	15	2.1	14
	741GO 001-003 TMSA	6.3	0.36	6
	741GO 001-004 TMSA	4.5	0.23	5
	742CA 001-002 TMSA	22	2.9	13
	742CA 001-003 TMSA	26	2.9	11
	743HO 001-002 TMSA	4.3	0.36	8
	743HO 001-003 TMSA	6.3	0.32	5
	744BA 001-001 TMSA	8.9	0.63	7
	744BA 001-002 TMSA	9.5	0.63	7
			Mean recovery	9 ± 3

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (µg/g) Aqua Regia Digestion (Total)	1 N HNO_3 leach	% Recovery (Leach/Total)
Cu	739AT 001-002 TMSA	13	9.4	72
	739AT 001-003 TMSA	19	10	53
	740SW 001-002 TMSA	21	9.3	44
	740SW 001-003 TMSA	14	11	79
	741GO 001-003 TMSA	2.3	0.92	40
	741GO 001-004 TMSA	1.6	0.75	47
	742CA 001-002 TMSA	14	11	79
	742CA 001-003 TMSA	20	11	55
	743HO 001-002 TMSA	0.99	0.41	41
	743HO 001-003 TMSA	1.3	0.34	26
	744BA 001-001 TMSA	3.4	1.8	53
	744BA 001-002 TMSA	4.8	2.6	54
			Mean recovery	54 ± 16

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (μg/g)		% Recovery (Leach/Total)
		Aqua Regia Digestion (Total)	1 N HNO_3 leach	
Mn	739AT 001-002 TMSA	548	653	119
	739AT 001-003 TMSA	754	673	89
	740SW 001-002 TMSA	683	441	65
	740SW 001-003 TMSA	472	474	100
	741GO 001-003 TMSA	216	159	74
	741GO 001-004 TMSA	148	152	103
	742CA 001-002 TMSA	667	934	140
	742CA 001-003 TMSA	918	905	99
	743HO 001-002 TMSA	109	46	42
	743HO 001-003 TMSA	117	46	39
	744BA 001-001 TMSA	228	196	86
	744BA 001-002 TMSA	272	239	88
			Mean recovery	87 ± 29

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (μg/g)		% Recovery (Leach/Total)
		Aqua Regia Digestion (Total)	1 N HNO_3 leach	
Ni	739AT 001-002 TMSA	20	6.1	31
	739AT 001-003 TMSA	27	6.6	24
	740SW 001-002 TMSA	26	5.6	22
	740SW 001-003 TMSA	17	6.5	38
	741GO 001-003 TMSA	9.2	1.8	20
	741GO 001-004 TMSA	6.7	1.7	25
	742CA 001-002 TMSA	19	6.0	32
	742CA 001-003 TMSA	25	6.5	26
	743HO 001-002 TMSA	6.2	1.7	27
	743HO 001-003 TMSA	8.0	1.6	20
	744BA 001-001 TMSA	12	3.7	31
	744BA 001-002 TMSA	13	3.6	28
			Mean recovery	27 ± 5

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (ug/g) Aqua Regia Digestion (Total)	1 N HNO_3 leach	% Recovery (Leach/Total)
Pb	739AT 001-002 TMSA	13	16	123
	739AT 001-003 TMSA	18	17	94
	740SW 001-002 TMSA	13	13	100
	740SW 001-003 TMSA	14	13	93
	741GO 001-003 TMSA	4.0	3.5	88
	741GO 001-004 TMSA	3.3	3.1	94
	742CA 001-002 TMSA	16	22	138
	742CA 001-003 TMSA	18	21	123
	743HO 001-002 TMSA	2.9	2.4	83
	743HO 001-003 TMSA	3.2	2.4	75
	744BA 001-001 TMSA	8.0	7.0	88
	744BA 001-002 TMSA	9.1	8.5	93
			Mean recovery	99 ± 19

TABLE 41 (Cont.)

Element	Sample Identification	Metal Concentration (μg/g) Aqua Regia Digestion (Total)	1 N HNO_3 leach	% Recovery (Leach/Total)
Zn	739AT 001-002 TMSA	69	29	42
	739AT 001-003 TMSA	95	30	32
	740SW 001-002 TMSA	87	23	26
	740SW 001-003 TMSA	62	26	42
	741GO 001-003 TMSA	22	7.0	32
	741GO 001-004 TMSA	17	6.4	38
	742CA 001-002 TMSA	72	32	44
	742CA 001-003 TMSA	92	33	36
	743HO 001-002 TMSA	18	7.6	42
	743HO 001-003 TMSA	22	7.3	33
	744BA 001-001 TMSA	37	16	43
	744BA 001-002 TMSA	41	17	41
			Mean recovery	38 ± 6

TABLE 42

SUMMARY OF TRACE METAL ANALYTICAL BLANKS

Blank Type and Units	Replicate Number	Metal								
		As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn
Sediment (TMSA) (µg/g)	1	<0.08	<0.08	<0.10	<0.10	<0.001	<0.10	<0.20	<0.8	<0.10
	2	<0.08	<0.08	<0.10	<0.10	<0.001	<0.10	<0.20	<0.8	<0.10
	3	<0.08	<0.08	<0.10	<0.10	<0.001	<0.10	<0.20	<0.8	<0.10
	4	<0.08	<0.08	<0.10	<0.10	<0.001	<0.10	<0.20	<0.8	<0.10
	5	<0.08	<0.08	<0.10	<0.10	<0.001	<0.10	<0.20	<0.8	<0.10
Particulate metals (TMPA) (µg/filter)	1	<0.1	<0.005	<0.05	<0.05	0.006	<0.5	<0.05	<0.05	<0.2
	2	<0.1	<0.005	<0.05	<0.05	0.006	<0.5	<0.05	<0.05	<0.2
	3	<0.1	<0.005	<0.05	<0.05	0.006	<0.5	<0.05	<0.05	<0.2
Dissolved metals (TMDA) (µg/l)	1	<0.25	0.016	<0.10	<0.10	<0.03	0.038	0.14	0.12	<0.50
	2	-	0.011	<0.11	<0.11	<0.03	0.043	0.29	0.14	<0.45
	3	-	0.008	<0.13	<0.35	<0.03	0.027	0.43	0.24	<0.54
Tissue metals (TMTB) (µg/g)	1	0.006*	<0.002	0.18	<0.04	0.001	<0.2	0.036	<0.02	<0.08

*See note, page C-3.3

3.2.2 Organohalogen Analyses

Table 43 shows recovery of organohalogens from the three matrices of interest. Aroclor 1221 was spiked as this is the lightest of the PCB mixtures and recoveries of the other PCBs should be comparable to or greater than those observed for Aroclor 1221.

Recoveries of organohalogens from seawater are slightly lower in some cases than those of Junk et al. (1974) who reported recoveries ranging from 47% for Aldrin to 96% for DDT using XAD-2 resin and aqueous samples. A duplicate spike for single components showed excellent reproducibility.

Spiked sediment and tissue samples show acceptable recoveries with the exception of methoxychlor, and op'DDE, which were not found in any samples. The tissue spike was performed on a sample which contained significant amounts of organohalogens, necessitating a background correction before calculation of spike recovery. The high recovery for pp'DDT may have been caused by an artifact compound coeluting the pp'DDT in the spiked extract. Also, separate filets were analyzed, rather than a subsample of the homogenate.

Sample duplicate results are shown in Table 44. Sediment duplication is complicated in the case of dieldrin by interference in the sample f-2. Due to our lower sensitivity for a multicomponent mixture of PCBs relative to single component pesticides such as pp'DDE, the PCSA Aroclor 1254 duplicate is probably an accurate reflection of reproducibility as the limits of our sensitivity are approached.

TABLE 43

RECOVERY OF ORGANOHALOGEN SPIKES

Sample Identification	Pesticides									
	Aldrin	Dieldrin	Endrin	β BHC	Hepta-chlor	op'DDE	pp'DDE	pp'DDD	pp'DDT	Hept. Epox.
744BA 001-002 PCSA										
- spike level (ng/g)	16.5	12.2	15.9	10.2	7.43	81.0	17.2	31.5	11.9	9.22
- % recovery	66	60	82	82	70	113	59	79	82	78
740SW 001-001 PCWA										
- spike level (ng/l)	10.8	8.0	10.4	6.7	4.9	53	11.3	20.6	7.8	6.0
- % recovery	53	73	106	110	88	43	37	96	63	102
740SW 006-012 PCTB										
- spike level (ng/g)	30.7	22.6	29.3	19.0	13.8	150	31.9	58.4	22.1	17.1
- % recovery	66	71	85	65	52	50	80	96	191	79

Sample Identification	Pesticides		PCBs							
	Methoxy-chlor	Chlordane	1016	1221	1232	1242	1248	1254	1260	1262
744BA 001-002 PCSA										
- spike level (ng/g)	11.4	906	*	489	*	*	*	*	*	*
- % recovery	45	86	*	68	*	*	*	*	*	*
740SW 001-001 PCWA										
- spike level (ng/l)	7.4	593	*	320	*	*	*	*	*	*
- % recovery	85	78	*	75	*	*	*	*	*	*
740SW 006-012 PCTB										
- spike level (ng/g)	21.0	2,200	*	1,181	*	*	*	*	*	*
- % recovery	30	116	*	103	*	*	*	*	*	*

KEY:
* = none detected; β BHC = hexachlorocyclohexane; op'DDE = op'dichlorodiphenylethylene;
pp'DDE = pp'dichlorodiphenylethylene; pp'DDD = pp'dichlorodiphenyldichloroethane;
pp'DDT = pp'dichlorodiphenyltrichloroethane; Hept. Epox. = heptachlor epoxide

TABLE 44

RESULTS OF DUPLICATE ANALYSES FOR ORGANOHALOGENS[a]

Sample Identification	Pesticides									
	Aldrin	Dieldrin	Endrin	β BHC	Hepta-chlor	op'DDE	pp'DDE	pp'DDD	pp'DDT	Hept. Epox.
744BA 001-002 PCSA	*	0.40, 1.30	*	*	*	*	0.14, 0.18	0.31, 0.22	*	*
740SW 006-001 PCTB	*	5.50, 3.00	*	*	*	*	32.6, 32.2	45.4, 36.0	112, 102	*

Sample Identification	Pesticides		PCBs							
	Methoxy-chlor	Chlordane	1016	1221	1232	1242	1248	1254	1260	1262
744BA 001-002 PCSA	*	*	*	*	*	*	*	2.4, 1.0	*	*
740SW 006-001 PCTB	*	*	*	*	*	*	*	496, 388	*	*

KEY:
* = none detected; β BHC = hexachlorocyclohexane; op'DDE = op'dichlorodiphenylethylene; pp'DDE = pp'dichlorodiphenylethylene; pp'DDD = pp'dichlorodiphenyldichloroethane; pp'DDT = pp'dichlorodiphenyltrichloroethane; Hept. Epox. = heptachlor epoxide

[a]Duplicate analysis for PCWA samples was not possible since only a single XAD column was provided for each sample.

3.2.3 Total Organic Carbon Analyses

Quality control data associated with total organic carbon analyses are shown in Table 45. Duplicate analyses (Table 45a) were in excellent agreement with differences between replicates generally less than 10%. Analyses of certified reference materials agreed well with certified values.

3.2.4 Oil and Grease Analyses

Quality control data associated with oil and grease analyses are shown in Table 46. Duplicate analyses (Table 46a) showed reasonable agreement and spike recoveries of SAE 10 crude oil averaged 88% (Table 46b).

3.2.5 Cyanide Analyses

Quality control data associated with cyanide analyses are shown in Table 47. Recovery of cyanide spikes to sediments are shown in Table 47a. Recovery of distilled cyanide spikes (additions of cyanide to blank solutions which are processed in a manner identical to sediment samples) are shown in Table 47b. In all but three cases, recoveries were greater than 80%.

3.2.6 Phenol Analyses

Quality control data associated with phenol analyses are shown in Table 48. Recoveries of phenol spikes to sediment samples ranged from 74-96% (Table 48a). Recoveries of distilled spikes ranged from 93-130%.

TABLE 45a

RESULTS OF DUPLICATE ANALYSES FOR TOTAL ORGANIC CARBON

Sample Identification	TOC (mg/g)
739AT 010-002 TOCA	0.63, 0.58
744BA 002-002 TOCA	3.8, 3.6
744BA 003-001 TOCA	8.2, 7.9
739AT 001-002 TOCA	8.2, 7.9
741GO 006-003 TOCA	2.0, 2.0
739AT 004-002 TOCA	1.1, 1.2
739AT 004-002 TOCA	4.1, 3.9
740SW 008-002 TOCA	2.8, 2.5
742CA 004-001 TOCA	4.2, 4.5

TABLE 45b

RESULTS OF ANALYSES OF REFERENCE MATERIAL FOR TOTAL ORGANIC CARBON

Sample Identification	TOC (mg/g)
LECO-1	
- certified value	8.79 ± 0.08
- measured value	9.03
LECO-2	
- certified value	0.51 ± 0.02
- measured value	0.48

TABLE 46a

RESULTS OF DUPLICATE ANALYSES FOR OIL AND GREASE

Sample Identification	Oil and grease (mg/g)
739AT 010-003 OILA	0.67, 0.98
740SW 010-002 OILA	0.13, 0.22
742CA 009-003 OILA	0.11, 0.16
742CA 012-002 OILA	0.49, 0.50
742CA 014-002 OILA	0.22, 0.20
743HO 009-002 OILA	0.01, 0.01

TABLE 46b

RECOVERY OF SPIKES WITH SAE 10 LUBE OIL

	Concentration Added	Concentration Recovered	% Recovery
Spike 1	1.67	1.29	77
Spike 2	0.85	0.83	98

TABLE 47a

RECOVERIES OF CYANIDE SPIKES FROM SEDIMENT DIGESTATES

Sample Identification	Cyanide Added (μg)	Cyanide Recovered (μg)	% Recovery
739AT 001-003 CNSA	50	27	54
739AT 009-003 CNSA	50	23	46
740SW 009-002 CNSA	50	30.5	61
741GO 003-002 CNSA	50	41.5	83
741GO 010-002 CNSA	50	46.5	93
742CA 001-003 CNSA	50	45.5	91
742CA 011-002 CNSA	50	45	90
742CA 015-001 CNSA	50	40	80
742CA 004-001 CNSA	50	45	90
			76 ± 18

TABLE 47b

RECOVERIES OF DISTILLED CYANIDE SPIKES[a]

Spike Number	Cyanide Added (μg)	Cyanide Recovered (μg)	% Recovery
1	50	46	92
2	50	42.5	95
3	50	47	94
4	50	46	92
5	50	49.5	99
6	50	46.5	93
7	50	45	90
8	50	43	86
9	50	45.5	91
10	50	40.5	81

[a]Distilled spikes are additions of cyanide to the blank solution which are then distilled and analyzed as samples. These recoveries serve as a check on the accuracy of the method. One distilled spike was analyzed for each batch of samples.

TABLE 48a

RECOVERIES OF PHENOL SPIKES FROM SEDIMENT DIGESTATES

Sample Identification	Phenol Added (μg)	Phenol Recovered (μg)	% Recovery
739AT 006-003 OLSA	200	158	79
740SW 001-003 OLSA	200	148	74
740SW 006-002 OLSA	200	164	82
741GO 006-002 OLSA	200	154	77
741GO 007-003 OLSA	200	189	95
742CA 006-002 OLSA	200	177	89
742CA 013-002 OLSA	200	173	91
743HO 001-002 OLSA	200	192	96
743HO 010-002 OLSA	200	176	88

TABLE 48b

RECOVERIES OF DISTILLED PHENOL SPIKES[a]

Spike Number	Phenol Added (μg)	Phenol Recovered (μg)	% Recovery
1	200	194	97
2	200	260	130
3	200	201	101
4	200	396	99
5	200	201	101
6	200	198	99
7	200	197	99
8	200	201	101
9	200	191	96
10	200	190	95
11	200	205	103
12	200	205	103
13	200	212	106
14	200	185	93

[a]Distilled spikes are additions of phenol to the blank solution which are then distilled and analyzed as samples. These recoveries serve as a check on the accuracy of the method.

QUALITY CONTROL FOR PETROLEUM HYDROCARBON ANALYSES

3. Quality Assurance Data

One procedural blank and one replicate sample were analyzed in support of the 14 sediment samples. The procedural blank contained negligible amounts of total lipids (2 ug/g), total f_2 (1 ug/g), resolved f_1 (0.00 ug/g), total f_2 (1 ug/g) and resolved f_2 (0.03 ug/g). The reported values were not corrected for concentrations of hydrocarbons in the blank. No peaks in the blank chromatogram interfered with the quantitation of any individual components.

One sediment sample, 744-BA-001-001 was split into two replicate aliquots which were analyzed individually. The results of the duplicate analyses are shown in Table 2. The gravimetric concentrations agree to wihin 10 to 20 percent. However, the gas chromatographic concentrations agree to within 20 to 100 percent. This sample contained some of the lowest concentrations of hydrocarbons which might explain some of the discrepancy.

TABLE 2

QUALITY ASSURANCE DATA FOR PETROLEUM HYDROCARBON ANALYSIS

PARAMETER	SAMPLE 744-BA-001-001 REPLICATE 1	SAMPLE 744-BA-001-001 REPLICATE 2
Total Lipids (ug/g)	140	131
Total f_1 Grav (ug/g)	12	16
Resolved f_1 GC (ug/g)	0.34	0.63
CPI	6	3.5
ALK/ISO	-	-
Total f_2 Grav (ug/g)	13	16
Resolved f_2 GC (ug/g)	0.66	0.74
Source Classification	3,1	3,1
nC15	0.002	0.004
nC16	0.003	0.003
nC17	0.008	0.009
Pristane	0.007	0.011
nC26	0.009	0.017
nC27	0.038	0.064
nC28	0.008	0.022
nC29	0.052	0.105

3.2 Quality Control Data

3.2.1 Trace Metal Analyses

In this section, quality control analyses performed in conjunction with trace metal analyses are presented.

Recoveries of spikes to analyte solutions are summarized in Table 43. Ranges of spike recoveries to sediment samples were as follows: As, 98-137%; Cd, 92-97%; Cr, 82-88%; Cu, 97-102%; Hg, 83-132%; Mn, 102-107%; Ni, 89-98%; Pb, 88-94%; and Zn, 94-99%. Ranges of spike recoveries to seawater dissolved and particulate samples were as follows: As, 105-108%; Cd, 77-99%; Cr, 94-103%; Cu, 100-110%; Hg, 100%; Mn, 83-103%; Ni, 97-103%; Pb, 102-108%; and Zn, 100-106%. Ranges of spike recoveries for tissue samples were as follows: As, 80-95%; Cd, 100%; Cr, 90-105%; Cu, 104-105%; Mn, 106-107%; Ni, 103-104%; Pb, 100-104%; and Zn, 101-103%. Ranges of spike recoveries for elutriate samples were as follows: As - 86-100%; Cd, 86-106%; Cr, 71-95%; Cu, 86-113%; Hg, 88-108%; Mn, 98-106%; Ni, 81-103%; Pb, 42-126%; and Zn, 98-113%.

Duplicate analyses of seawater, tissue, and sediment samples are summarized in Table 44. All duplicates showed excellent agreement.

The efficiency of the chelation/solvent extraction system for removing and preconcentrating metals from seawater is described in Table 45. The mean recoveries and standard deviations of metal spikes added to the seawater samples were: Cd, 111 ± 50%; Cr, 33 ± 15%; Cu, 87 ± 24%; Mn, 107 ± 55%; Ni, 99 ± 25%; Pb, 98 ± 37%; and Zn, 46 ± 24%.

TABLE 43

RECOVERY OF METAL SPIKES FROM ANALYTE SOLUTIONS

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
As	745CA 006-002 TMSA	73 μg/l	80 μg/l	110
	745CA 010-003 TMSA	69 μg/l	74 μg/l	107
	746AT 004-002 TMSA	83 μg/l	85 μg/l	102
	746AT 008-003 TMSA	82 μg/l	87 μg/l	106
	747HO 002-001 TMSA	60 μg/l	69 μg/l	115
	747HO 009-001 TMSA	64 μg/l	74 μg/l	116
	748BA 001-001 TMSA	61 μg/l	60 μg/l	98
	748BA 006-002 TMSA	70 μg/l	96 μg/l	137
	749SW 004-001 TMSA	100 μg/l	121 μg/l	121
	749SW 010-001 TMSA	76 μg/l	83 μg/l	109
	750GO 005-002 TMSA	82 μg/l	92 μg/l	112
	750GO 007-003 TMSA	87 μg/l	96 μg/l	110
	745CA 001-004 ELSA Rep 2	6.3 μg/l	5.9 μg/l	94
	745CA 006-004 ELSA Rep 3	4.5 μg/l	4.3 μg/l	96
	746AT 001-004 ELSA Rep 2	6.3 μg/l	5.8 μg/l	92
	747HO 001-004 ELSA Rep 1	3.7 μg/l	3.7 μg/l	100
	748BA 006-004 ELSA Rep 2	9.8 μg/l	8.6 μg/l	88
	749SW 006-004 ELSA Rep 3	5.7 μg/l	5.0 μg/l	88
	749SW 001-004 ELSA Seawater	3.6 μg/l	3.8 μg/l	106
	750GO 006-004 ELSA Blank	4.0 μg/l	3.6 μg/l	90
	750GO 001-004 ELSA Seawater	3.5 μg/l	3.0 μg/l	86
	745CA 001-010 TMTB	62 μg/l	59 μg/l	95
	749SW 003-009 TMTB	82 μg/l	66 μg/l	80
	746AT 006-001 TMPA	51 μg/l	54 μg/l	106
	750GP 006-001 TMPA	32 μg/l	34 μg/l	106
	745CA 006-001 TMDA	3.7 μg/l	4.0 μg/l	108
	750GO 006-001 TMDA	4.4 μg/l	4.6 μg/l	105

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Cd	745CA 010-002 TMSA	2.56 mg/l	2.41 mg/l	94
	746AT 008-002 TMSA	2.59 mg/l	2.38 mg/l	92
	747HO 006-002 TMSA	2.56 mg/l	2.41 mg/l	94
	748BA 002-002 TMSA	2.57 mg/l	2.50 mg/l	97
	749SW 003-001 TMSA	2.57 mg/l	2.50 mg/l	97
	750GO 010-002 TMSA	2.57 mg/l	2.45 mg/l	95
	745CA 001-004 ELSA Rep 2	7.3 µg/l	7.1 µg/l	97
	745CA 006-004 ELSA Rep 3	8.2 µg/l	7.3 µg/l	89
	747HO 001-004 ELSA Rep 2	9.8 µg/l	10.2 µg/l	104
	748BA 002-004 ELSA Rep 3	8.65 µg/l	8.2 µg/l	95
	748BA 006-004 ELSA Rep 1	8.1 µg/l	8.8 µg/l	109
	749SW 006-004 ELSA Rep 2	575 µg/l	510 µg/l	106
	749SW 001-004 ELSA Sep 3	578 µg/l	603 µg/l	104
	740GO 006-004 ELSA Rep 3	697 µg/l	711 µg/l	102
	746AT 006-001 TMPA	3.6 µg/l	3.0 µg/l	83
	750GO 006-001 TMPA	3.3 µg/l	3.1 µg/l	94
	745CA 006-001 TMDA	15.1 µg/l	11.6 µg/l	77
	749SW 006-001 TMDA	6.7 µg/l	6.6 µg/l	99
	745CA 001-010 TMTB	3.5 µg/l	3.5 µg/l	100
	746AT 005-009 TMTB	3.6 µg/l	3.6 µg/l	100

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Cr	745CA 010-002 TMSA	2.65 mg/l	2.23 mg/l	84
	746AT 008-002 TMSA	2.76 mg/l	2.30 mg/l	83
	747HO 006-002 TMSA	2.16 mg/l	2.61 mg/l	82
	748BA 002-002 TMSA	2.28 mg/l	2.58 mg/l	88
	749SW 003-001 TMSA	2.45 mg/l	2.77 mg/l	88
	750GO 010-002 TMSA	2.21 mg/l	2.57 mg/l	86
	745CA 001-004 ELSA Rep 2	50 µg/l	39 µg/l	79
	745CA 006-004 ELSA Rep 3	50 µg/l	42 µg/l	84
	746AT 001-004 ELSA Rep 1	50 µg/l	36 µg/l	71
	746AT 006-004 ELSA Rep 2	50 µg/l	44 µg/l	89
	747HO 001-004 ELSA Rep 2	50 µg/l	47 µg/l	95
	748BA 002-004 ELSA Rep 3	50 µg/l	43 µg/l	85
	749SW 001-004 ELSA Sep 1	50 µg/l	47 µg/l	94
	749SW 006-004 ELSA Rep 3	55 µg/l	50 µg/l	91
	746AT 006-001 TMPA	54 µg/l	51 µg/l	94
	750GO 006-001 TMPA	30 µg/l	27 µg/l	90
	745CA 006-001 TMDA	31 µg/l	32 µg/l	103
	749SW 006-001 TMDA	31 µg/l	29 µg/l	94
	745CA 001-010 TMTB	34 µg/l	34 µg/l	91
	746AT 005-009 TMTB	38 µg/l	34 µg/l	90
	749SW 003-009 TMTB	39 µg/l	41 µg/l	105

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Cu	745CA 010-002 TMSA	2.85 mg/l	2.77 mg/l	97
	746AT 008-002 TMSA	3.87 mg/l	3.82 mg/l	99
	747HO 006-002 TMSA	3.19 mg/l	3.18 mg/l	100
	748BA 002-002 TMSA	2.93 mg/l	2.87 mg/l	98
	749SW 003-001 TMSA	3.52 mg/l	3.58 mg/l	102
	750GO 010-002 TMSA	2.63 mg/l	2.54 mg/l	97
	745CA 001-004 ELSA Rep 2	67 µg/l	69 µg/l	104
	745CA 006-004 ELSA Rep 3	50 ug/l	55 µg/l	110
	746AT 001-004 ELSA Rep 1	50 µg/l	46 µg/l	91
	746AT 006-004 ELSA Rep 2	59 µg/l	61 µg/l	102
	747HO 001-004 ELSA Rep 2	57 µg/l	48 µg/l	86
	748BA 002-004 ELSA Rep 3	50 µg/l	57 µg/l	113
	748BA 006-004 ELSA Rep 1	61 µg/l	64 µg/l	104
	750GO 001-004 ELSA Rep 1	69 µg/l	74 µg/l	108
	746AT 006-001 TMPA	101 µg/l	94 µg/l	93
	750GO 006-001 TMPA	36 µg/l	36 µg/l	100
	745CA 006-001 TMDA	69 µg/l	76 µg/l	110
	749SW 006-001 TMDA	56 µg/l	56 µg/l	100
	745CA 001-010 TMTB	1.67 mg/l	1.75 mg/l	105
	749SW 003-009 TMTB	2.33 mg/l	2.43 mg/l	104

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Hg	745CA 008-003 TMSA	0.018 μg	0.022 μg	122
	746AT 007-002 TMSA	0.019 μg	0.025 μg	132
	749SW 009-003 TMSA	0.018 μg	0.021 μg	115
	750GO 010-002 TMSA	0.100 μg	0.0083 μg	83
	747HO 006-004 ELSA Rep 3	0.050 μg	0.045 μg	90
	748BA 006-004 ELSA Rep 1	0.050 μg	0.054 μg	108
	749SW 001-004 ELSA Rep 1	0.025 μg	0.022 μg	88
	749SW 006-004 ELSA Rep 3	0.050 μg	0.052 μg	104
	746AT 001-001 TMDA	0.050 μg	0.050 μg	100

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Mn	745CA 010-002 TMSA	26.38 mg/l	27.03 mg/l	102
	746AT 008-002 TMSA	81.47 mg/l	83.83 mg/l	103
	747HO 006-002 TMSA	45.85 mg/l	47.54 mg/l	104
	748BA 002-002 TMSA	37.49 mg/l	38.81 mg/l	104
	749SW 003-001 TMSA	57.11 mg/l	60.87 mg/l	107
	750GO 010-002 TMSA	12.24 mg/l	12.53 mg/l	102
	745CA 001-004 ELSA Rep 1	3.34 mg/l	3.27 mg/l	98
	746AT 001-004 ELSA Rep 1	3.26 mg/l	3.42 mg/l	105
	747HO 006-004 ELSA Rep 3	3.95 mg/l	4.20 mg/l	106
	748BA 002-004 ELSA Rep 2	4.03 mg/l	4.22 mg/l	105
	749SW 006-004 ELSA Rep 2	3.51 mg/l	3.43 mg/l	98
	749SW 001-004 ELSA Rep 1	3.50 mg/l	3.47 mg/l	99
	746AT 006-001 TMPA	582 µg/l	601 µg/l	103
	750GO 001-001 TMPA	27 µg/l	28 µg/l	104
	746AT 006-001 TMDA	310 µg/l	320 µg/l	103
	750GO 006-001 TMDA	29 µg/l	24 µg/l	83
	745CA 001-010 TMTB	161 µg/l	173 µg/l	107
	749SW 003-009 TMTB	417 µg/l	444 µg/l	106

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Ni	745CA 010-002 TMSA	2.82 mg/l	2.69 mg/l	89
	746AT 008-002 TMSA	3.29 mg/l	3.07 mg/l	93
	747HO 006-002 TMSA	2.89 mg/l	2.70 mg/l	93
	748BA 002-002 TMSA	2.86 mg/l	2.80 mg/l	98
	749SW 003-001 TMSA	3.08 mg/l	2.99 mg/l	97
	750GO 010-002 TMSA	2.90 mg/l	2.72 mg/l	94
	745CA 001-004 ELSA Rep 2	68 µg/l	60 µg/l	88
	745CA 006-004 ELSA Rep 3	50 ug/l	49 µg/l	98
	746AT 001-004 ELSA Rep 1	50 µg/l	48 µg/l	96
	746AT 006-004 ELSA Rep 2	56 µg/l	45 µg/l	81
	747HO 001-004 ELSA Rep 2	50 µg/l	51 µg/l	102
	748BA 002-004 ELSA Rep 3	56 µg/l	55 µg/l	99
	748BA 006-004 ELSA Rep 1	58 µg/l	57 µg/l	99
	749SW 001-004 ELSA Rep 1	68 µg/l	63 µg/l	92
	749SW 006-004 ELSA Rep 3	61 µg/l	63 µg/l	103
	750GO 001-004 ELSA Rep 1	67 µg/l	64 µg/l	95
	746AT 006-001 TMPA	68 µg/l	68 µg/l	100
	750GO 006-001 TMPA	25 µg/l	24 µg/l	96
	745CA 006-001 TMDA	59 µg/l	57 µg/l	97
	749SW 006-001 TMDA	58 µg/l	60 µg/l	103
	745CA 001-010 TMTB	59 µg/l	61 mg/l	103
	749SW 003-009 TMTB	91 µg/l	95 mg/l	104

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Pb	745CA 010-002 TMSA	3.65 mg/l	3.26 mg/l	89
	746AT 008-002 TMSA	4.94 mg/l	4.55 mg/l	92
	747HO 006-002 TMSA	4.11 mg/l	3.61 mg/l	88
	748BA 002-002 TMSA	3.70 mg/l	3.39 mg/l	92
	749SW 003-001 TMSA	4.61 mg/l	4.33 mg/l	94
	750GO 010-002 TMSA	3.16 mg/l	2.77 mg/l	88
	745CA 006-004 ELSA Rep 3	50 µg/l	39 µg/l	79
	746AT 001-004 ELSA Rep 1	50 µg/l	47 µg/l	94
	746AT 006-004 ELSA Rep 2	50 µg/l	58 µg/l	116
	747HO 001-004 ELSA Rep 2	50 µg/l	63 µg/l	126
	748BA 002-004 ELSA Rep 3	50 µg/l	55 µg/l	110
	748BA 006-004 ELSA Sep 1	50 µg/l	44 µg/l	88
	749SW 006-004 ELSA Rep 3	50 µg/l	21 µg/l	42
	750GO 001-004 ELSA Rep 1	50 µg/l	50 µg/l	100
	746AT 006-001 TMPA	111 µg/l	93 µg/l	84
	750GO 006-001 TMPA	36 µg/l	34 µg/l	94
	745CA 001-001 TMDA	133 µg/l	135 µg/l	102
	749SW 006-001 TMDA	78 µg/l	84 µg/l	108
	745CA 001-010 TMTB	25 µg/l	25 µg/l	100
	746AT 005-009 TMTB	27 µg/l	28 µg/l	104

TABLE 43 (Cont.)

Element	Sample Identification	Concentration Added	Concentration Recovered	% Recovery
Zn	745CA 010-002 TMSA	5.24 mg/l	5.01 mg/l	96
	746AT 008-002 TMSA	6.17 mg/l	5.88 mg/l	95
	747HO 006-002 TMSA	4.99 mg/l	4.75 mg/l	95
	748BA 002-002 TMSA	4.84 mg/l	5.68 mg/l	97
	749SW 003-001 TMSA	5.86 mg/l	5.82 mg/l	99
	750GO 010-002 TMSA	4.31 mg/l	4.05 mg/l	94
	745CA 006-004 ELSA Rep 3	125 µg/l	122 µg/l	98
	746AT 006-004 ELSA Rep 1	125 µg/l	136 µg/l	109
	747HO 006-004 ELSA Rep 2	125 µg/l	141 µg/l	113
	748BA 006-004 ELSA Rep 2	288 µg/l	289 µg/l	100
	749SW 006-004 ELSA Rep 3	159 µg/l	166 µg/l	104
	750GO 001-004 ELSA Rep 1	125 µg/l	141 µg/l	113
	746AT 006-001 TMPA	400 µg/l	399 µg/l	100
	749SW 006-001 TMPA	125 µg/l	125 µg/l	100
	745CA 006-001 TMDA	190 µg/l	201 µg/l	106
	749SW 006-001 TMDA	226 µg/l	225 µg/l	100
	745CA 001-010 TMTB	3.65 mg/l	3.70 mg/l	101
	746AT 010-008 TMTB	3.55 mg/l	3.88 mg/l	101
	748BA 002-010 TMTB	3.95 mg/l	4.05 mg/l	103

TABLE 44

RESULTS OF DUPLICATE TRACE METAL ANALYSES

Sample Identification	Concentration								
	As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn
746AT 005-010 TMTB Shrimp	8.5, 6.7	0.008, 0.005	<0.022, <0.022	5.8, 5.6	0.007, 0.006	0.32, 0.43	0.12, 0.15	<0.044, <0.044	12, 12
747HO 001-001 TMDA	-, -	<0.072, <0.072	0.43, 0.26	1.3, 0.44	-, -	1.2, 0.40	0.45, 0.87	1.3, 0.65	1.8, 2.4
745CA 001-001 TMDA	-, -	-, -	-, -	-, -	<0.033, <0.033	-, -	-, -	-, -	-, -
750GO 006-001 TMDA	-, -	<0.072, <0.072	<0.21, 0.40	1.2, 0.28	-, -	2.2, 1.6	2.8, 0.47	0.18, <0.16	5.3, 1.6
745CA 008-002 TMSA	1.1, 1.1	<0.075, <0.079	0.86, 0.81	3.7, 3.3	0.024, 0.021	200, 180	2.4, 2.3	8.3, 7.3	13, 12
746AT 002-002 TMSA	2.7, 2.4	0.12, 0.12	1.9, 1.8	7.6, 8.0	0.043, 0.044	600, 600	5.0, 4.9	15, 17	24, 23
747HO 003-001 TMSA	0.25, 0.25	<0.039, 0.040	0.24, 0.23	0.24, 0.30	0.003, 0.003	24, 23	0.97, 1.1	1.3, 1.3	5.3, 5.4
748BA 002-002 TMSA	1.4, 1.8	<0.076, <0.076	0.81, 0.81	2.6, 2.8	0.025, 0.026	260, 270	2.9, 2.8	8.2, 8.7	15, 15
749SW 005-001 TMSA	3.2, 3.0	0.15, 0.16	2.5, 2.5	9.2, 9.8	0.065, 0.067	480, 480	4.9, 5.0	17, 17	27, 28
750GO 004-001 TMSA	0.67, 0.77	<0.037, <0.038	0.25, 0.31	0.22, 0.19	0.005, 0.004	24, 26	1.2, 1.3	1.4, 1.6	4.7, 4.8

TABLE 45

EVALUATION OF EXTRACTION EFFICIENCY OF PRECONCENTRATION METHOD FOR SEAWATER ANALYSES OF Cd, Cr, Cu, Mn, Ni, Pb, and Zn

Element	Sample Identification	Concentration Added (μg/l)	Concentration Recovered (μg/l)	% Recovery[a]
Cd	745CA 006-001 TMDA	1.5	1.2	
	747HO 006-001 TMDA	0.81	0.79	111 ± 50
	748BA 002-001 TMDA	0.80	0.70	
	748BA 006-001 TMDA	0.76	1.4	
Cr	745CA 006-001 TMDA	2.1	0.45	
	747HO 006-001 TMDA	0.68	0.33	33 ± 15
	748BA 002-001 TMDA	1.7	0.33	
	748BA 006-001 TMDA	0.56	0.24	
Cu	745CA 006-001 TMDA	3.1	3.7	
	747HO 006-001 TMDA	1.5	1.1	87 ± 24
	748BA 002-001 TMDA	1.9	1.7	
	748BA 006-001 TMDA	1.3	0.84	
Mn	745CA 006-001 TMDA	4.7	7.6	
	747HO 006-001 TMDA	1.0	0.87	107 ± 55
	748BA 002-001 TMDA	2.6	1.0	
	748BA 006-001 TMDA	0.79	1.1	
Ni	745CA 006-001 TMDA	7.0	5.7	
	747HO 006-001 TMDA	1.4	1.7	99 ± 25
	748BA 002-001 TMDA	4.9	3.7	
	748BA 006-001 TMDA	1.4	1.7	
Pb	745CA 006-001 TMDA	4.9	3.8	
	747HO 006-001 TMDA	3.5	2.8	98 ± 37
	748BA 002-001 TMDA	2.6	4.0	
	748BA 006-001 TMDA	3.2	2.6	
Zn	745CA 006-001 TMDA	10.5	3.1	
	747HO 006-001 TMDA	3.5	1.2	46 ± 28
	748BA 002-001 TMDA	9.0	3.0	
	748BA 006-001 TMDA	2.4	2.1	

[a]Mean and standard deviation.

Analyses of two National Bureau of Standards Reference Materials (SRMs) are shown in Table 46. Analyses of NBS SRM 1645 (River Sediment) using the 1 N HNO_3 leach showed excellent agreement with previous analyses. Analyses of NBS SRM 1566 (Oyster Tissue) showed excellent agreement with certified values for Cd, Cu, Hg, Mn, Pb, and Zn. Analyses for Cr and Pb were less accurate due to under-recovery during digestion or analytical variability. Arsenic recoveries were excellent and showed a marked improvement over previous analyses.

Analytical blanks for all metal analyses are shown in Table 47.

TABLE 46

RESULTS OF ANALYSIS OF NATIONAL BUREAU OF STANDARDS REFERENCE MATERIALS

	Metal				
	As	Cd	Cr	Cu	Hg
NBS SRM 1645 (River Sediment)					
- Certified value (μg/g)	(66)[a]	10.2 ± 1.5	1.96 ± 0.28%	109 ± 19	1.1 ± 0.5
- Measured value (μg/g)[b] (1 N HNO_3 leach)	23 ± 4	5.3 ± 0.4	1.60 ± 0.06%	44 ± 14	0.93 ± 0.12
NBS SRM 1566 (Oyster Tissue)					
- Certified value (μg/g)	13.4 ± 1.9	3.5 ± 0.4	0.69 ± 0.27	63.0 ± 3.5	0.057 ± 0.015
- Measured value (μg/g)	11.8 ± 2.6	3.9 ± 0.35	0.32 ± 0.12	67.6 ± 0.87	0.028 ± 0.010

	Metal			
	Mn	Ni	Pb	Zn
NBS SRM 1645 (River Sediment)				
- Certified value (μg/g)	785 ± 97	45.8 ± 2.9	714 ± 28	1,720 ± 169
- Measured value (μg/g)[b] (1 N HNO_3 leach)	312 ± 13	15.6 ± 1.4	446 ± 38	1,132 ± 16
NBS SRM 1566 (Oyster Tissue)				
- Certified value (μg/g)	17.5 ± 1.2	1.03 ± 0.19	0.48 ± 0.04	852 ± 14
- Measured value (μg/g)	16.9 ± 1.2	1.20 ± 0.05	0.63 ± 0.94	883 ± 94

[a]Not certified by NBS.
[b]Mean and 95% confidence interval based on 3 analyses.

TABLE 47

SUMMARY OF TRACE METAL ANALYTICAL BLANKS

Blank Type and Units	Replicate Number	Metal								
		As	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn
Sediment (TMSA) (µg/g)	1	<0.04	<0.08	<0.10	<0.10	<0.002	<0.10	<0.20	<0.8	<0.10
	2	<0.04	<0.08	<0.10	<0.10	<0.002	<0.10	<0.20	<0.8	<0.10
	3	<0.04	<0.08	<0.10	<0.10	<0.002	<0.10	<0.20	<0.8	<0.10
	4	<0.04	<0.08	<0.10	<0.10	<0.002	<0.10	<0.20	<0.8	<0.10
	5	<0.04	<0.08	<0.10	<0.10	<0.002	<0.10	<0.20	<0.8	<0.10
Particulate metals (TMPA) (µg/filter)	1	<0.1	<0.005	<0.05	<0.05	<0.005	<0.05	<0.15	<0.05	<0.2
	2	<0.1	<0.005	<0.05	<0.05	<0.005	<0.05	<0.15	<0.05	<0.2
	3	<0.1	<0.005	<0.05	<0.05	<0.005	<0.05	<0.24	<0.05	<0.2
Dissolved metals (TMDA) (µg/l)	1	<0.50	0.060	<0.20	0.69	<0.03	0.16	0.43	0.48	<0.40
Tissue metals (TMTB) (µg/g)	1	<0.040	<0.0020	0.088	<0.040	0.002	<0.080	<0.040	<0.040	<0.20
	2	<0.040	<0.0020	0.088	<0.040	0.002	<0.080	<0.040	<0.040	<0.20
	3	<0.040	<0.0020	0.088	<0.040	0.002	<0.080	<0.040	<0.040	<0.20

3.2.2 Organohalogen Analyses

Table 48 shows recovery of organohalogens from the three matrices of interest. Aroclor 1221 was spiked as this is the lightest of the PCB mixtures and recoveries of the other PCBs should be comparable to or greater than those observed for Aroclor 1221.

Recoveries of organohalogens from seawater are slightly lower in some cases than those of Junk et al. (1974) who reported recoveries ranging from 47% for Aldrin to 96% for DDT using XAD-2 resin and aqueous samples. A duplicate spike for single components showed excellent reproducibility. Spiked sediment and tissue samples show acceptable recoveries with the exception of methoxychlor.

Sample duplicate results are shown in Table 49. Sediment duplication is complicated in the case of dieldrin by interference in the sample f-2. Due to our lower sensitivity for a multicomponent mixture of PCBs relative to single component pesticides such as pp'DDE, the PCSA Aroclor 1254 duplicate is probably an accurate reflection of reproducibility as the limits of our sensitivity are approached.

TABLE 48

RECOVERY OF ORGANOHALOGEN SPIKES

Sample Identification	Pesticides: Aldrin	Dieldrin	Endrin	β BHC	Hepta-chlor	op'DDE	pp'DDE	pp'DDD	pp'DDT	Hept. Epox.
747HO 001-002 PCSA										
- spike level (ng/g)	7.6	5.6	6.3	4.7	3.4	3.4	7.9	14.5	5.5	4.2
- % recovery	82	94	71	104	74	124	95	114	102	111
748BA 006-001 PCWA										
- spike level (ng/g)	10.8	8.0	10.4	6.7	4.9	4.8	11.3	20.6	7.8	6.0
- % recovery	59	74	118	96	54	88	74	90	76	81
745CA 006-010 PCTB										
- spike level (ng/g)	278	205	266	172	125	124	289	529	200	155
- % recovery	84	85	123	97	83	106	81	84	81	96

Sample Identification	Pesticides: Methoxy-chlor	Chlordane	PCBs: 1016	1221	1232	1242	1248	1254	1260	1262
747HO 001-002 PCSA										
- spike level (ng/g)	5.2	522	*	63	*	*	*	*	*	*
- % recovery	68	99	*	81	*	*	*	*	*	*
748BA 006-001 PCWA										
- spike level (ng/g)	7.4	593	*	71.9	*	*	*	*	*	*
- % recovery	78	103	*	72	*	*	*	*	*	*
745CA 006-010 PCTB										
- spike level (ng/g)	191	15,200	*	2,910	*	*	*	*	*	*
- % recovery	47	97	*	95	*	*	*	*	*	*

KEY:

* = none detected; β BHC = hexachlorocyclohexane; op'DDE = op'dichlorodiphenylethylene; pp'DDE = pp'dichlorodiphenylethylene; pp'DDD = pp'dichlorodiphenyldichloroethane; pp'DDT = pp'dichlorodiphenyltrichloroethane; Hept. Epox. = heptachlor epoxide

TABLE 49

RESULTS OF DUPLICATE ANALYSES FOR ORGANOHALOGENS[a]

Sample Identification	Pesticides									
	Aldrin	Dieldrin	Endrin	β BHC	Hepta-chlor	op'DDE	pp'DDE	pp'DDD	pp'DDT	Hept. Epox.
750GO 001-002 PCSA	*	*	*	*	*	*	*	*	*	*
746AT 005-009 PCTB	*	28.7 23.9	*	*	*	*	23.5 14.7	*	*	*

Sample Identification	Pesticides		PCBs							
	Methoxy-chlor	Chlordane	1016	1221	1232	1242	1248	1254	1260	1262
750GP 001-002 PCSA	*	*	8.5 8.5	*	*	*	*	1.5 1.6	*	*
746AT 005-009 PCTB	*	*	*	*	*	*	*	80.6 63.9	*	*

KEY:

* = none detected; β BHC = hexachlorocyclohexane; op'DDE = op'dichlorodiphenylethylene; pp'DDE = pp'dichlorodiphenylethylene; pp'DDD = pp'dichlorodiphenyldichloroethane; pp'DDT = pp'dichlorodiphenyltrichloroethane; Hept. Epox. = heptachlor epoxide

[a]Duplicate analysis for FCWA samples was not possible since only a single XAD column was provided for each sample.

3.2.3 Total Organic Carbon Analyses

Quality control data associated with total organic carbon analyses are shown in Table 50. Analyses of certified reference materials agreed well with certified values.

3.2.4 Oil and Grease Analyses

Quality control data associated with oil and grease analyses are shown in Table 51. Duplicate analyses (Table 51a) showed reasonable agreement and spike recoveries of SAE 10 crude oil averaged 88% (Table 51b).

3.2.5 Cyanide Analyses

Quality control data associated with cyanide analyses are shown in Table 52. Recovery of cyanide spikes to sediments are shown in Table 52a. Recovery of distilled cyanide spikes (additions of cyanide to blank solutions which are processed in a manner identical to sediment samples) are shown in Table 52b. Recoveries of spike to elutriate samples are shown in Table 52c. In all but two cases, recoveries were greater than 80%.

TABLE 50

RESULTS OF ANALYSES OF REFERENCE MATERIAL FOR TOTAL ORGANIC CARBON

Sample Identification	TOC (mg/g)
LECO-1	
- certified value	8.79 ± 0.08
- measured value	9.03
LECO-2	
- certified value	0.51 ± 0.02
- measured value	0.48