

# MANAGEMENT OF CONTAMINATED HARBOR SEDIMENTS IN GUAM

## Coastal Zone Management Act Section 309

### GUAM HARBORS SEDIMENT PROJECT, PHASE III, FINAL REPORT

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**GUAM ENVIRONMENTAL PROTECTION AGENCY**

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## Introduction

The Island of Guam is an unincorporated territory of the United States which is viewed as a state by the U.S. Department of Commerce, National Oceanographic and Atmospheric Administration in its implementation of Section 309 projects of the Coastal Zone Management Act of 1972, as amended.

The Guam Bureau of Planning (BOP)'s Coastal Management Program plans for and administers the local use of Section 309 funds. As the third phase of investigations into pollution problems in Guam harbors, the Guam Environmental Protection Agency (GEPA) was funded through Section 309 to develop necessary rules, regulations and laws, public information material, and a dredge spoil disposal plan relative to contaminated sediments which had been identified in the previous two phases.

A scope of work and copy of the memorandum of understanding between BOP and GEPA for this third phase is included in Appendix B. Regulations developed by GEPA during this project are provided as the separate documents: Guam Soil Erosion and Sedimentation Control Regulations and Draft Guam Water Quality Regulations. Methods to manage dredging and dredge spoil disposal and policies recommended for Guam on dredging management and dredge spoil disposal are provided in the final sections of this report.

## Background

The following background information is derived from the latest Guam Water Quality Report to Congress by GEPA (GEPA, 1998a.)

Guam is the largest and southernmost of the Mariana Archipelago of islands and possesses an excellent major harbor as well as several smaller harbors. It is the westernmost point of the USA, lying at latitude 13E28' N and longitude 144E45' E, or about 3,700 miles west and slightly south of Honolulu (Figure 1.) Guam has an area of approximately 212 square miles and measures about 30 miles long with widths from 11 miles in the south to 4 miles in the center and 8 miles in the north (Figure 2.)

Guam's population is estimated by the U.S. Bureau of Census to be 154,623 at mid-year 2000. This has increased from 9,360 in 1901 and 58,754 counted in the 1950 census. Residents are culturally diverse with the native Chamorros outnumbered by the numerous other minorities, mostly from Asian and Micronesian ethnic backgrounds. Over one million tourists visit Guam annually, largely drawn by Guam's clean recreational waters and beaches.

Guam has a tropical oceanic climate, with warm temperatures and high humidity. Daily temperatures year-round consist of highs in the middle eighties (degrees Fahrenheit) and daily lows in the low seventies. Relative humidity ranges between 65 and 75% in the afternoon to between 85 and 90% at night. Seasonal changes relate to amounts of rainfall. Wet season normally extends from July to November and dry season from January to May, with transitional periods between. Annual average rainfall varies from about 110 inches in the higher areas to about 80 inches along the shores. Periodic El Nino/ Southern Oscillation large-scale weather events trigger decreased rainfall and higher risks of typhoons on Guam in certain years. The largest measured El Nino event occurred in 1997-98.

Guam is located in an area of the Western Pacific that experiences 38% of all the destructive tropical storms in the world. Frequently passing storms and typhoons are accompanied by torrential rains.

Guam is divided into two distinct geological formations by a central fault line. The northern half is mainly a broad sloping limestone plateau which is bordered by steep seaward cliffs and fringed by narrow coral reefs. The southern half is mountainous and composed of eroded volcanic formations. The bordering fringing reefs in the south are broader than in the north. Two large barrier reef systems occur at Cocos Lagoon and at Apra Harbor. Guam has a total of 116.5 miles of shoreline, including 39.5 miles of sandy beaches. The large harbor at Apra covers over three square miles, with the Navy's Inner Apra Harbor encompassing approximately 650 acres.

The northern half of Guam has no perennial streams because of the porosity of its coralline rock formation. Rainfall percolates rapidly through its limestone to the freshwater lens floating on seawater below. Therefore no estuaries or deep bays have formed in the north of Guam.

The southern half of Guam has its volcanic slopes deeply channeled by 97 streams in 40 drainages with varying sizes of bays breaching the shallow fringing coral reefs at the mouths of the streams. Western slope streams are short with steep gradients and drainage areas of less than three square miles each. The eastern slopes are steep in their upper reaches with long gently-sloping stream beds that terminate in wide flat valleys.

Guam's marine waters and bay sediments are generally pure and free of pollutants, except where very localized pollutant runoff or discharges from land or from vessels occur. Surface sea temperatures average close to 80 degrees Fahrenheit year-round. Rather than concentrating pollutants downstream, Guam's very deep surrounding seas rapidly dilute pollutant discharges.

Shallow fringing coral reefs with outer slopes and margins supporting live coral colonies surround most of Guam. The width of these reefs ranges from very narrow benches (as narrow as 10 to 20 feet) on the northeastern coast, to broad reef flats forming the popular recreational and fishing areas in Tumon, Agana, Agat, and Asan Bays and on the shoreside of Cocos Lagoon. These reefs are extremely valuable in terms of marine life, aesthetics, food supply, recreation and protection of Guam's highly erodable shorelines from storm waves, currents, and tsunamis. Barrier reefs occur at Apra Harbor and Cocos Lagoon, enclosing popular fishing and marine recreational waters. Cocos Island, Lagoon and its reefs form an atoll-like environment about four square miles in area. The much deeper lagoon of Apra Harbor is bounded by the uplifted limestone plateau of Orote, Cabras Island and a large artificial breakwater which was built on a shallow reef platform and adjacent submerged bank.

The North Equatorial Current, driven by northeast trade winds, generally sets in a western direction around Guam with a velocity of 0.5 to 1.0 knots. Guam tides are semi-diurnal with pronounced diurnal inequalities and with a mean range of 1.6 feet and diurnal range of 2.3 feet. Extreme predicted tide range is about 3.5 feet.

## **Guam Harbors, Past Uses**

In prehistoric times, Chamorros of Guam utilized passages through the shallow reefs surrounding the island to enter and exit between the shores and surrounding deep waters. Their famous proas, or sailing outrigger canoes were considered the fastest in the world by early European explorers. They also used smaller paddling canoes with outriggers. The harbor areas protected from waves were used for fishing but were not needed for anchorages because the traditional ocean-craft were hauled on shore and usually kept in canoe houses. Wastes generated in harbors before European influence were biodegradable without long term impacts.

In 1521, Chamorros first encountered Europeans and globe-circling ships, when Magellan and his starving and waterless crew arrived in Umatac Harbor, according to local legend (Guam Environmental Protection Agency, 1998a.). For the next four centuries, international trading, whaling, research, pirate and navy ships utilized the natural harbors of Guam without dredging or construction of breakwaters. The sailing ships of these centuries found protected anchorages inside the reefs at Pago, Ylig, Talofoto, Inarajan, Agfajan, Achang, Umatac, Cetti, Sella, Taleyfac, Agat, Piti and Agana Bays and in Manell and Mamaon Channels and Apra Harbor. The Spanish Manila Galleons crossing the Pacific between Asia and Mexico with gold and other rich cargoes utilized Guam as a replenishment port for hundreds of years. During Spanish colonial times, ships mainly anchored in Umatac Bay, Apra Harbor and Agana Bay, as evidenced by the persistent trash such as glass bottles and broken china found at these anchorages.

Under American administration since 1898, ships that burned coal and, later, petroleum products utilized Guam's ports, mainly in Apra Harbor. In World War I, the German warship *Cormoran* was sunk in Apra Harbor. In 1939 the U.S. Navy asked Congress for five million dollars to dredge Apra Harbor. But soon after, they decided it was better to not develop Guam at great expense and then lose it to Japan. During World War II the military development under Japanese control from 1941 to 1944 escalated the use of predominantly Apra Harbor, where Japanese warships and submarines were repaired and refueled. The liberation of Guam by the United States in 1944 introduced huge amounts of ordnance, wreckage and damage to the coastal environment and increased levels of pollution especially in Apra Harbor. (Farrell, D.A. 1984) The Navy News of March 21, 1945 noted that over 7,000 tons of explosives had been used in the previous year to clear ship passages in Guam and fifty pounds of these explosives usually blasted a volume of coral one hundred feet square by three feet deep.

The Glass Breakwater and inner Apra Harbor were built to support the US military activities at Apra Harbor after World War II. Apra Harbor served military as well as civilian shipping needs and included facilities for ship and nuclear submarine maintenance, repair, and supply; fuel transfer; nuclear and conventional weapon transfer; fishing, recreational and tourist ship support and import of all kinds of commercial and construction cargoes.

Guam Ship Repair Facility in Inner Apra Harbor dry-docks, repairs and maintains ships. It originally was developed and operated by the U.S. Navy after the War, but was recently leased to private

operators through agreements with the Government of Guam. Its operations have contributed to production of probably the most polluted sediments in any Guam harbor and possibly some of the most seriously polluted harbor sediments in the world (Denton et al. 1997 and U.S. Department of the Navy, 1993).

The Agana River channel in Agana Bay had been used as a small ship anchorage before World War II. The bombing and leveling of the capitol Agana after Guam's Liberation rerouted the Agana River to discharge on the shallow reef east of the deep channel, separated from its original mouth by the new peninsula on the filled-in former reef area of the Paseo De Susanna. The old channel was used as an entrance to a new Agana Boat Basin, a small harbor for recreational and fishing boats. This harbor adjacent to the deep channel was enlarged by a major dredging project in the mid-1970's which simultaneously used the dredged material to build a large artificial island on the west side of the channel to accommodate the new Agana Sewage Treatment Plant. A large breakwater to protect the plant and the harbor was built at that time (U.S. Army Corps of Engineers, 1973). Expansion of berthing areas and development of a deep draft harbor for international cruise ships at Agana have been proposed (Port Authority of Guam, 1986).

In East Agana Bay proposals have been made for dredging of swimming areas near the beach (Pacific Basin Environmental Consultants, 1992) and for creation of a small boat basin (Randall and Eldredge, 1974(b)), which never was implemented.

A new recreational boat harbor was built in Agat at Taleyfac Bay, on the north side of Nimitz Beach in the 1980's (U.S. Army Corps of Engineers, 1981). This Agat Marina development is heavily used but has not been exposed to the long term chronic pollutant levels that other Guam harbors have received.

The Merizo Pier area on Mamaon Channel has had relatively heavy use by local recreational, fishing and tourist transport boats, with localized pollution of sediments (Randall and Jones, 1972; Jones and Randall, 1973; and Randall and Eldredge, 1974(a)).

In the 1960's a shallow cut through the reef opposite San Vitores Beach was blasted by Government of Guam officials to allow passage of small boats into Tumon Bay. During hotel and park developments in the 1970's and 1980's small swimming holes near the beach, deep enough to allow swimming at low tides, were dredged at the Hilton Hotel, Ypao Beach Park, the Pacific Star (now Marriott) Hotel, and San Vitores Beach (Barrett Consulting Group, Inc. 1988). For the last decade, the Government of Guam Recreational Water Use Management Plan, under Public Law 23-78, has prohibited motorized watercraft from being used inside the reef in Tumon Bay, except for a narrow lane of passage for jet skis transiting from San Vitores Beach directly seaward through the shallow reef boat passage and for a dinner cruise boat operating along the beach. Only small recreational sailing and paddling craft now use the shallow lagoon inside the reefs in the rest of Tumon Bay. Fishing boats are banned from the lagoon by local laws enacted in 1999, making Tumon Bay a fishing preserve.

During the Vietnam War, when Guam was utilized intensively as a support base and transfer port for ammunition and military supplies, the Department of Defense planned to create a new ammunition wharf and harbor. Sella Bay, in the Guam Territorial Seashore Park, had been proposed to be the site of the new ammunition wharf and harbor development for the U.S. Navy in the early 1970's (U.S. Department of the Navy, 1972), but this site was rejected in response to strong local opposition. An alternative site on the Orote Peninsula near the harbor entrance in outer Apra Harbor was developed, instead, in the 1980's (VTN Pacific, 1981). Additionally, a military harbor to be located at the shallow reef cut at Tarague Beach at Andersen Air Force Base had been considered, but was not as practical as the Orote Peninsula site.

### **Future Harbor Uses**

Apra Harbor is the only planned site on Guam for future continued service and facilities for the types of trans-oceanic shipping currently in operation. This includes military use as well as commercial container and bulk cargo ships, fuel tankers, fishing boats, tourist ships, yachts, etc. Increases are expected in all these shipping uses plus in the ship repair industry, while demand is expected to increase for recreational fishing, watersports and conservation use (U.S. Pacific Command, 1999; Vision 2001 Task Force, 1996; Port Authority of Guam, 1991; Guam Code Title 16, Chapter 2, Subchapter B).

Both the U.S. Navy and the Port Authority of Guam are expected to require maintenance dredging in Apra Harbor in the near future. Any dredging in other existing small boat harbors on Guam would be initiated by the Port Authority of Guam.

Local recreation and charter boat use will continue at the existing Agana Boat Basin. When it was expanded in the mid-1970's, a breakwater was built that allows for future dredging to create an expanded berthing area more than doubling the present 42 boat slips. In the late 1980's a private proposal was made to redevelop the Agana Boat Basin to include 300 boat slips, a club, hotel, restaurant and shops (International Design Consortium Inc., 1988). Although this proposal was not approved, at some future date, further dredging may be funded to expand this harbor within the existing breakwater.

Of five Merizo sites considered for harbor development in the 1980's, including the Merizo Pier area, the preferred site was the shallow head end of Mamaon Channel, south of the Geus River mouth at Talona, Merizo (U.S. Army Corps of Engineers, 1983). Because it maximizes protection from storm winds and waves, it could become a better harbor than the more heavily used Merizo Pier area. But it lacks water deep enough for even small boats and would require a relatively large amount of dredging (estimated from 34,500 to 77,200 cubic yards) and land acquisition to be developed as a public harbor with a six foot deep berthing area. Contamination of sediments at the Talona proposed dredge site is unknown. The Merizo Pier, where sediment contamination has been studied, has water deeper than 80 feet adjacent to it and public land and a park along its shore.



Because of its high conservation value, preserve status and intensive recreational use, Tumon Bay is not expected to be dredged in the future to accommodate watercraft. However, proposals arise periodically to dredge additional swimming areas in Tumon (Barrett Consultants Group, Inc, 1988).

### Guam Coastal Management Program (GCMP) Harbor Sediment Project

To address concerns over contamination and dredging in Guam harbors, the Guam Coastal Management Program initiated a three-year study in 1996 with the University of Guam's Water and Environmental Research Institute and with GEPA. The study began with a first-year analysis of sediments, followed the second-year analysis of contaminants in harbor organisms and culminating in a study of controls on impacts of sediment contamination on Guam. The third phase has produced this report and the appended criteria and regulations. To explain impacts and their regulation, the report discusses harbor uses, harbor sediment contamination, uptake of contaminants by organisms, impacts of contaminated sediments on humans and natural resources, potential impacts of dredging the sediments, sources of the pollutants, controls over the pollutants, management of dredging under existing legal controls, revised regulations and recommended policies.

### Sediment Contamination Study

As Phase I of the Guam Coastal Management Program's Harbor Sediments Project, sediments of four selected harbors were studied. During 1997, a total of 46 sub-tidal sites in Agana Boat Basin, Outer Apra Harbor, Agat Marina and off Merizo Pier on Guam were examined for surficial sediment contamination. Sediment samples were analyzed for contamination by arsenic, cadmium, copper, chromium, mercury, nickel, lead, silver, tin, zinc, polychlorinated biphenyls (PCB's), and polycyclic aromatic hydrocarbons (PAH's). Results showed enrichment of all the contaminant groups at Agana Boat Basin, Outer Apra Harbor, and Merizo Pier. But the majority of sites were found to be relatively clean, compared to harbors world-wide. Agana Boat Basin had some high levels of copper, lead and zinc. The shallow waters close to shore at the Merizo Pier had heavy enrichment of copper, lead, tin and zinc, while deeper waters had clean sediments. The highest levels of contaminants were at Apra Harbor, where moderate to heavy enrichment of copper, lead, mercury, tin, zinc, PCB's and PAH's were identified in sediments collected near Hotel Wharf, Commercial Port and Dry Dock Island. The recently constructed Agat Marina had lowest contaminant levels, only showing light chromium contamination (Denton, et al., 1997).

The study did not measure release, diffusion or migration of contaminants into surrounding waters, nor uptake, accumulation, concentration, transformation or removal of contaminants by harbor organisms. It also did not examine contamination of sediments by organometallic compounds (such as tributyl tin), dioxins, furans, persistent organochlorine pesticides and alkylated PAH's. Inner Apra Harbor may have the highest levels of sediment contamination on Guam, based on limited sampling for the Navy which showed, for example, elevated levels of tin, probably related to antifouling tributyl tin on ships, which were several times as high as sampled in other Guam harbors (Marine Research Consultants, Inc., 1992). These tin levels rank among the highest concentrations ever recorded in harbor sediments world-wide (Denton *et al.*, 1997).

## Contaminant Bio-Uptake Study

As Phase II of the Harbor Sediments Project, marine organisms were sampled in Guam harbors and their tissues were analyzed for contaminants previously measured in sediments. During 1998 and '99, a total of 156 samples of organisms were collected at sites in Agana Boat Basin, Outer Apra Harbor, Agat Marina and off Merizo Pier on Guam and were examined for marine food chain contamination related to harbor sediment contamination. Biota sampled were a genus of brown alga, *Padina*; a genus of soft coral, *Sinularia*; ten species of sponges; five hard coral species; two sea cucumbers; five species of bivalve mollusk; two species of tunicates; thirty two species of bony fishes and a single specimen of octopus and one of a mantis shrimp. A wide variety of organisms was screened to help assess appropriateness of various possible indicator species. Of these, only the octopus and the bony fishes are regularly consumed on Guam, while the bivalves, mantis shrimp and one of the sea cucumbers are rarely harvested for food and none of the other organisms are eaten. Contaminants measured were arsenic, cadmium, copper, chromium, mercury, nickel, lead, silver, tin, zinc, PCB's (PCB homologues and congeners were addressed) and PAH's.

Mild increases in arsenic, copper, lead, mercury, tin and PCB's were recorded in certain biota at localized sites, mostly in Apra Harbor. Levels of contaminants in edible parts of consumed organisms were not significant or indicative of real health risks, except for copper and zinc in oysters in Apra Harbor and Agana Boat Basin and arsenic in the Apra Harbor octopus. Mercury was found in muscle tissue at a level above Canadian and Australian standards in three out of seventy-five fish sampled; two edible fishes and one lizardfish from Apra Harbor. Unfortunately the only enforceable U.S. standard for heavy metals in seafood is for organic mercury, which was not assessed. The only other enforceable U.S. food standard applicable to this study is the 2.0 Fg/g tolerance level for total PCB's, which is ten times the highest level recorded in this study. This study showed that Guam's harbor environments (excluding Inner Apra Harbor, which was not sampled) are generally clean, by world standards.

## Potential Impacts of Sediment Contaminants on Human Health

Physical contact with sediment contaminants found in Guam harbors, at the levels observed (Denton, et al. 1997), would not pose a notable health risk. Ingestion of measurable amounts of the contaminated sediments would not reasonably be expected. However, sources of health risk may arise through uptake of contaminated sediments or their pollutants by harbor organisms and passage through food chains to human consumers. Bio-accumulation of heavy metals and PCB's from sediments potentially can make marine organisms unacceptable for human consumption.

PCB's are potentially toxic even in very small concentrations, greater than an order of magnitude less than other contaminants studied in Guam sediments. They are linked to increased cancer risks, disruption of women's reproductive function and to neurobehavioral and developmental problems in children born to women exposed to PCB's and are also associated with other systemic effects (e.g., liver disease and diabetes, compromised immune function, and thyroid effects).

A comparative analysis of PCB levels in organisms in Guam harbors with levels in related species elsewhere (Denton, et al. 1999) indicates only mild enrichment extending to moderate levels in certain species at localized sites in Apra Harbor (*Caranx melampygus* at Dry Dock Island and *Monodactylus argenteus* at the western end of Commercial Port). The highest value of PCB's recorded from Guam samples is an order of magnitude below the US Food and Drug Administration's food standard.

The levels of copper and zinc in filter feeding oysters from Agana Boat Basin and parts of Apra Harbor exceed standards applied in Australia for fishery products (Denton et al., 1999). Although these metals are not usually causes of seafood poisoning, they might possibly have a health impact on someone who consumes quantities of oysters from these sites of harbor sediment contamination.

The single octopus from Apra Harbor had arsenic concentrations comparable to those found in related species in other countries, but could cause deleterious health effects to a person consuming in excess of 60 grams of this per day (Denton et al., 1999).

There have been no reported cases of shellfish contamination in recent years anywhere on Guam. Typical shellfish poisoning as seen in Palau, the Philippines and many temperate coastal areas is triggered by toxins produced in single celled planktonic dinoflagellates and related organisms filtered and concentrated by oysters and other bivalves, not by sediment contaminants.

Recent and more common seafood toxicity recorded in Guam involves bacterial toxicity (including histamine poisoning, from poorly handled fish catches) and ciguatera from reef fishes, both of which are unrelated to chemical contaminants in harbor sediments. Ciguatera causes serious and sometimes deadly toxins to enter the food chain from sources of benthic epiphytic dinoflagellates living on reef crest macroalgae at unpredictable localized sites. Damage to coral reef crest and reef margin zones and deposit of iron sources into these habitats have been suspected to contribute to ciguatera occurrence, but contaminated harbor sediments have not been linked to this toxicity, which arises in normal salinity, high wave action areas (Gawel, 1984).

### Potential Impacts of Sediment Contaminants on Natural Resources

The pollutant chemicals of concern in Guam harbor sediments may have adverse effects on the survival, development, growth or reproduction of marine organisms and can greatly modify diversity and composition of marine communities.

Copper and organic tin are well known inhibitors of fouling organisms and undoubtedly are toxic to marine invertebrates, especially their juvenile stages. The University of Guam's researcher, Heslinga, (1976) showed copper's impacts on larvae of a common species of sea urchin from Guam's reefs. Copper can be acutely or chronically toxic to aquatic organisms through exposure in water or in sediments. But if copper is not at levels of immediate toxicity, organisms tend to regulate its intake and use it as an essential nutrient (US EPA, 1997).

The main ecological threat of PCB's is not through direct exposure and acute toxicity, but through accumulations through food chains. Reproductive impairment in high trophic level species is the more typical negative impact of PCB's (US EPA, 1997). They have also been linked to deformities in wildlife. PCB congeners are known to induce catalyses that impact enzymatic activities in marine life, which may harm organisms directly or increase their sensitivity to other pollutants in their environment (Monosson and Stegeman, 1991).

Fish and many marine invertebrate species have the capacity to rapidly metabolize and excrete PAH's from their tissues, although bivalve mollusks have less of this capacity.

Storms and typhoons, which regularly impact Guam, may generate waves and currents which stir up harbor sediments as much as dredging, but preclude the controls and management measures that can be applied to permitted dredging. In other words, contaminated sediments in Guam harbors may lead to worse impacts than would be caused by dredging, even in the absence of dredging.

### Dredging Methodology and Water Quality

Historically, the dredging of harbors and shallow water areas was accomplished by utilizing such mechanical means as drag buckets, clamshell buckets and barge-mounted excavators. Unfortunately, these mechanical measures generate massive silt plumes and have an adverse impact on ambient water quality. Attempts to contain the suspended sediments utilizing marine turbidity curtains can prove to be very difficult, particularly so in harbors experiencing frequent ship traffic. Advances in dredging technology has led to the development of suction dredging. Suction dredging minimizes the volume of sediments generated through dredging. As a result, the use of suction dredging is typically required by natural resource managers when they issue permits for dredging activities. This is especially emphasized when areas with identified contamination are proposed for dredging.

### Potential Impacts of Dredging Contaminated Sediment on Human Health

The resuspension of contaminated sediments during dredging activities represents a potentially significant contamination source. The toxic materials can be released to the water column and be redistributed. They then can temporarily rapidly increase the input of pollution which has slowly accumulated over many years. These released toxins can enter the surrounding food chain, increasing the risks to human health from certain seafood consumption. The size, composition and distribution of the particles of sediment influence the impact of the contaminants. The concentrations of some metal contaminants have been seen to decrease with the increase in sediment particle size (Stone et al., 1993). This is due to the higher potential to adsorb chemicals, as finer grained sediments have relatively more available surface area. Analysis of sediments from the area of the Navy Ship Repair Facility in Apra Harbor showed finer grained fractions of sediment samples having higher concentrations than larger grained fractions for cadmium, cobalt, copper, mercury, nickel, lead and tin and, except for one out of six sites, also of zinc (Belt Collins Hawaii, 1994).

Some heavy metals found in Guam harbor sediments, such as mercury, lead and cadmium, are excreted very inefficiently by the human body and, if taken up in sufficient levels, can be toxic. Even if exposure to these metals is extremely minute, their levels may still exceed the quantity that the body can excrete and, consequently, toxic levels may be achieved after several years of chronic exposure.

In addition to lead poisoning, effects of these metals include chronic fatigue syndrome, fibromyalgia and multiple chemical sensitivity syndrome. Mercury has been recognized as the most significant metal contaminant derived from fish consumption. Even minute quantities of mercury are extremely toxic. When mercury from contaminated seafood accumulates to toxic levels, the immune system becomes weakened, the detoxification capacity of the liver and kidneys is diminished, hormones become poorly regulated, and the nervous system becomes impaired. Allergies, chemical sensitivities, gastrointestinal disturbances, depression, anxiety, headaches, muscle and joint pains, chronic fatigue, frequent infections, abnormal gastrointestinal flora and hormonal disturbances are just a few of the many symptoms which have been linked with chronic mercury toxicity. The symptoms of mercury toxicity vary widely from one person to another depending upon an individual's body burden of mercury, their body burden of other toxic metals and fat soluble organic toxins, their nutritional status and their individual susceptibility to toxicity. In addition, the effects of mercury are cumulative and may not be apparent for decades (Oceanside Functional Medicine Research Institute, 2000).

Although PCB's stay in bottom sediments rather than the water column because of their low water solubility, they bioaccumulate and concentrate through food chains leading to humans being exposed when they consume contaminated fish. Cancer risks can arise from PCB intake and maternal consumption of PCB contaminated fish is associated with adverse health of children (Fein et al., 1984 and Jacobson et al., 1990).

Certain polycyclic aromatic hydrocarbons (PAH's) are potentially carcinogenic. They are also released from sediments through dredging activities.

### Potential Impacts of Dredging Contaminated Sediment on Natural Resources

The contaminants associated with sediments in Guam's harbors would be dispersed and have more contact with water column inhabitants such as plankton when dredging disturbs the sediments. As noted above, the finer the size of the sediment particles, the greater the concentration of metal contaminants they may carry. When heavy metals exceed natural concentrations to certain levels, they inhibit enzymes, thus interfering with metabolism and essential life processes. In worst case scenarios, they can cause mass kills of sensitive species and disruption of food chains, lowering of diversity and other related impacts.

PCB's and PAH's also may be released to food chains as sediments are disturbed by dredging. In vertebrates, PCB's of sufficient doses can produce an immunosuppressive effect and induce hepatic microsomal enzyme systems. They have the ability to bioactivate relatively nontoxic compounds in cells to become cytotoxic or genotoxic metabolites. Some PAH's are carcinogenic to animals and have been linked with neoplasms in bottom dwelling fish (Denton et al., 1997).

When harbors are dredged, however, the physical impacts of substrate removal, siltation, sedimentation and turbidity on the living resources in Guam's waters is believed to be more damaging than impacts from the existing relatively stable chemical contaminants in harbor sediments, barring storm and typhoon movement of the sediments. Dredging temporarily removes surface-living and shallow-burrowing organisms, including algae, corals, sponges, worms, mollusks, crustaceans, echinoderms, tunicates and fishes. It also suspends silt and sediment which smother sea-bottom organisms and creates turbidity which blocks sunlight needed for photosynthesis by corals, algae, and other organisms. Heterotrophic suspension feeders attached to harbor substrata above the sediments, such as oysters, are not as adversely affected as demersal organisms. Suspended silt and sediments are selectively deposited according to their size and density along the path of water movement within a harbor. The finer fractions of particles remain in suspension longer than the coarser fractions. They would be carried further by currents and would have an effect at a greater distance from the dredging. Based on Guam studies (Amesbury, et. al., 1977), accumulation of finer sized sediment fractions has a greater inhibiting effect on the recruitment and growth of corals than does the larger sized fractions. It is not known whether the severity of impacts from pollutants in Guam harbor sediments would be distributed differentially with the size of sediment fractions. But sediment particle sizes in Guam harbors tend to be predominantly sand sized (greater than 0.063mm diameter) with less than 10% being smaller silt particles (Denton et al., 1997 and Belt Collins Hawaii, 1994).

### Sources of Pollutants in Sediments

Sediment contamination in other Pacific Island harbors has been linked to solid waste disposal, sewage discharge and heavy industry such as vehicle battery production and ship repair (Naidu and Morrison, 1994; Asquith, M., F. Kooge and R.J. Morrison, 1994; and Division of Environmental Quality, Commonwealth of the Northern Mariana Islands, 1998).

Except for incidental, temporary or accidental deposit of solid waste next to Guam harbors, there are no current or recent solid waste disposal sites impacting harbor sediments. Past garbage dumps by the U.S. Military on Guam included the Navy Orote Landfill, which from 1944 to 1969 deposited many tons of discarded metals, as well as residential, industrial and construction wastes in and adjacent to intertidal waters of the Philippine Sea (Navy Energy and Environmental Support Activity, 1983). Contaminants in this waste include PCB's, PAH's, organochlorine pesticides, dioxans, furans, and metals (Ogden Environmental and Energy Services Co., Inc., 1996). But this and other solid waste disposal sites on Guam are not adjacent to the four harbors studied for sediment contamination.

The currently used Navy sanitary landfill is located at the Orote Peninsula area of the Waterfront Annex, close to Inner Apra Harbor (U.S. Pacific Command, Department of Defense, 1997).

Following Typhoon Paka in 1997, metallic waste was temporarily stored at Cabras Island, next to the Commercial Port, prior to exporting it. Such short temporary use may have a slight risk of leached metallic pollution entering the harbor. Actual deposit of polluting materials into harbors and all Guam water bodies during typhoons is a real threat.

Industries on Guam that potentially can contribute to sediment contamination are very limited. Except for Apra Harbor, the only polluting industrial activities located near or at harbor areas are vehicle and small boat repair and maintenance activities. At or near Apra Harbor, ship repair, POL (petroleum, oil and lubricants) transfer and storage, electricity generation, and fish processing have been on-going for years, while an oil refinery had been operating nearby in the 1970's. The Navy supplied nuclear submarines and other surface ships at Apra Harbor, operated dry cleaning and printing plants, treated building materials with preservatives, stored and operated floating power plants, transferred ammunition and possibly nuclear weapons, etc. These major industrial sources of past pollution to Apra Harbor are not concerns at other Guam harbors. These activities are now carefully regulated to control pollutants but were not managed to minimize environmental impacts before environmental protection laws and regulations were passed since the 1970's.

Most shorelands bordering the study areas of Agana Boat Basin, Outer Apra Harbor, Agat Marina and Merizo Pier are serviced by public sewer systems, so that septic tanks do not occur on shoreside lots. However, fecal coliform and enterococci sampling regularly shows microbiological pollution in Agana Boat Basin and occasionally at Merizo Pier, Agat Marina and Apra Harbor (Guam Environmental Protection Agency, 1998a). Occasionally sewer failure and boat toilet discharges contribute to the problem. But it is believed that polluted stormwater runoff is the most common source of these contaminants in Agana, Merizo and Apra, as indicated by rainy season versus dry season data and linkage of highest pollution records with heaviest rain events (GEPA, 1998). Such polluted stormwater contributes additional contaminants which enter harbor sediments, such as lead from vehicle fuel or exhaust and tire wear on the roads. The finer sediment particles in stormwater may travel from relatively distant and untraceable sources, and are more likely to carry adsorbed metal contaminants (Stone et al., 1993). Larger grained particles carried from close sources to the harbors are less amenable to concentrating metal contaminants. Stormwater can also contribute PAH's and heavy metals and possibly PCB's.

Wind-blown dust is another unmeasured but probable source of some of the contaminants recorded from Guam harbor sediments.

Watercraft are assumed to be key sources of sediment pollution in harbors. Boat maintenance appears to be the main contributor to the boat-source pollutants found in the Guam harbor sediment contamination study (Denton, et al., 1999). However, the level of these studied contaminants from boat sources in the study areas, versus the obvious input from other sources noted above, are very difficult to separate. Stormwater sources appear to be most significant and will remain so in the future in Agana, Agat and Merizo and Outer Apra Harbor. Unfortunately, the Section 309 contamination studies were not conducted in Inner Apra Harbor, where ship repair and maintenance is believed to have been a major source of such sediment pollution.

Current controls on all sources of these pollutants to Guam waterways are described in the following pages. These are expected to minimize or eliminate additional significant pollutant input, without requiring additional new specific laws restricting boat operations, or seafood consumption. Many of the most serious past sources of contamination to Guam harbor sediments have already been

eliminated by Federal and local laws and regulations such as those prohibiting use of tributyltin on large size watercraft and banning PCB's. The careful management of sources of pollutants still in legal use is constantly improving as increasingly required by law. Mearns (1993) notes that under evolving U.S. laws and practices, the highest concentrations of contaminants (including metals, chlorinated hydrocarbons and petroleum hydrocarbons) in coastal sediments, shellfish and fish occurred during the 1960's and early 1970's. He observed that levels of most contaminants have declined, in some areas by as much as 99%, although hot spots remained in some harbors and marinas.

## Controls of Pollutants

### **Federal Laws and Regulations Governing Dredging and Contamination of Near Shore Waters of Guam**

The following laws apply to Guam and, through U.S. Federal Agencies, serve to regulate the impacts of contaminated sediments on Guam's environment.

#### *Clean Water Act (CWA) or Federal Water Pollution Control Act*

The purpose of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Under Section 404 of the CWA the Army Corps of Engineers (ACOE) authorizes discharges of dredged or fill material in waters of the U.S. through a permit program. (The Corps also conducts discharge activities in conjunction with its civil works program.) The Section 404(b)(1) Guidelines are the substantive criteria by which proposed dredged material discharge actions are evaluated. EPA also maintains general environmental oversight, including Section 404(c) permit veto authority if there will be an "unacceptable adverse effect." The ACOE office on Guam facilitates administration of the 404 permit process and coordinates with Government of Guam regulating authorities. Under Section 401, proposed discharges of dredged or fill material must comply with applicable state or territorial water quality standards. Dredging may not cause the concentrations of chemicals in the water column to exceed State (Guam) standards. The GEPA, through its Planning Division, administers the 401 permitting on Guam.

#### *Coastal Zone Management Act (CZMA) and Amendments*

The CZMA establishes a Federal-state partnership to provide for the comprehensive management of coastal resources. Coastal states and territories develop management programs based on enforceable policies and mechanisms to balance resource protection and coastal development needs. The Federal consistency provisions require that all Federal activities (including direct Federal actions, private activities requiring Federal licenses or permits, and Federal financial assistance to state, territorial and local governments) be consistent with the enforceable policies of a state's or territory's Federally-approved coastal management program. All dredging on Guam must comply with Federal consistency requirements. At the Federal level, the CZMA is administered by the Office of Coastal Resources Management (OCRM) within the National Oceanographic and Atmospheric



Administration's (NOAA's) National Ocean Service. Within Guam, the Bureau of Planning's Coastal Management Program coordinates the Federal consistency reviews.

*Endangered Species Act (ESA)*

The ESA states that all Federal departments and agencies shall seek to conserve threatened and endangered species and shall use their authorities to further the purposes of the ESA. In addition, all Federal departments and agencies must ensure that activities they fund, authorize, or carry out do not jeopardize the continued existence of threatened or endangered species or adversely modify or destroy designated critical habitat. The act is administered by the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) and requires these two federal agencies to formally evaluate proposals for Federal actions, including the issuance of permits for port dredging and dredged material disposal, that may affect species listed as threatened or endangered. Section 7 requires consultation of permitting agencies with FWS and NMFS.

*Fish and Wildlife Coordination Act (FWCA)*

The FWCA provides that water resources development programs must consider wildlife conservation. Under this act, Federal agencies proposing actions, including issuance of permits, which will affect any body of water, must consult with the FWS, the NMFS, and the affected state or territory's fish and wildlife management agency. Review agencies determine the possible damage to fish and wildlife resources by the proposed activity, and develop means and measures that should be adopted to prevent the loss or damage to fish and wildlife resources. The Corps is required to give full consideration to the review agencies' viewpoints (including those of the public) before making permit decisions. This act applies to Section 103 permits of the Marine Protection, Research, and Sanctuaries Act (see below). The Guam Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) serves as the territorial fish and wildlife agency.

*Marine Protection, Research, and Sanctuaries Act (MPRSA)*

This act regulates the transportation and ultimate disposal of material in the ocean, prohibits ocean disposal of certain wastes without a permit, and prohibits the disposal of certain materials entirely, including those containing radiological, chemical or biological warfare agents, high-level radiological wastes and industrial waste.

Under Title I of the MPRSA (also known as the Ocean Dumping Act), ocean dumping permits may be issued if the proposed dumping will not "unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. Under Title I, Section 103, the US Army Corps of Engineers is the permit issuing authority for authorizing the transportation of dredged material for the purpose of ocean dumping and is directed to use EPA-developed environmental impact criteria in its permit decisions. Title I further provides that the Corps' determinations to issue a permit are subject to EPA review and concurrence, and that the Corps is to utilize, to the maximum extent feasible, disposal sites which have been designated by the EPA rather than designating them on a case-by-case basis. EPA's regulations for ocean disposal are published in CFR 40, Parts 220-229.

The MPRSA and the Clean Water Act overlap for discharges to the territorial sea. CWA supercedes MPRSA if dredged material is dumped in the ocean for beach restoration or some other beneficial use. A separate title of the MPRSA (Title III) establishes the national marine sanctuaries program, which is implemented by NOAA.

#### *Merchant Marine Act*

This law empowers Maritime Administration (MARAD) to investigate causes of congestion at ports; to investigate the practicability and advantage of harbor, river, and port improvements in connection with foreign and coastwise trade; and to investigate any other matter which may tend to promote use by vessels of ports. If MARAD's recommendations concern areas within the purview of the Interstate Commerce Commission (ICC), the Secretary of Transportation may submit such findings to the ICC.

#### *National Environmental Policy Act (NEPA)*

NEPA is the national charter for protection of the environment which requires a full consideration of the environmental consequences of major Federal actions. This is accomplished through the use of either an environmental impact statement (EIS) or an environmental impact assessment (EIA). These documents provide a vehicle for the government to assess, before the fact, the effects of a potential action and provides an avenue for the public to review and comment on Federal agency projects and their potential expected environmental impacts. The federal government must conduct EIA/EIS documentation for certain federal actions including new construction, transfer or change in use of federal lands and for most federally financed programs and projects. NEPA regulations are published at Title 40 CFR, Part 6 and Army COE regulations for implementing NEPA are published at Title 33 CFR Part 220.

#### *Rivers and Harbors Act (RHA)*

The original purpose of the RHA was to establish the Federal interest in interstate navigation. Section 10 of the Act requires approval from the ACOE prior to placing obstructions, or excavating and/or depositing materials in navigable waters.

#### *Water Resources Development Acts (WRDA)*

Dredging projects are authorized by Congress through the WRDAs, which are reauthorized biennially. WRDA 86 introduced cost sharing for construction projects whereby the local sponsor pays between 20 and 60 percent of the construction cost based on the depth of the navigation channel. For projects over 45 feet in depth, the local sponsor must also pay 50 percent of the incremental cost of maintenance. Maintenance dredging of channels is Federally funded, with Corps' expenditures reimbursable through the Harbor Maintenance Tax. Cost-sharing in these situations generally takes the form of the non-Federal sponsor providing lands, easements, right-of-way and disposal areas (other than open water) for the maintenance dredging. WRDA's also contain provisions for beneficial use of dredged material such as beach nourishment (WRDA 86) and the protection, restoration and creation of aquatic habitat (WRDA 92) and for environmental dredging to remove, as part of operation and maintenance of a navigation project, contaminated sediments outside the boundaries of and adjacent to the navigation channel (WRDA 90).

### *CERCLA as amended by SARA*

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly called Superfund, was enacted to respond to sudden or otherwise uncontrolled releases of hazardous substances, pollutants or contaminants into the environment, particularly targeting the worst waste sites in the US. The reauthorization of CERCLA in 1986, the Superfund Amendments and Reauthorization Act (SARA) provided more funding and enforcement authority to EPA to clean up Superfund sites and created more involvement of the public and states in the process. The amendments allowed for the listing of federal property onto the National Priorities List of Sites, opening up federal requirements for clean-up at these sites. Under US Executive Order 12580, federal agencies are mandated to take the lead role in cleaning up federal Superfund sites on federal property. If highly polluted sediments require clean up to protect human health and the environment under CERCLA standards, these acts could support and regulate safe dredging and disposal of the sediments. Very detailed exposure and toxicity assessment procedures were developed by EPA for these acts, for measuring contaminants in sediments, water, and various exposure pathways, such as fish consumption, for their toxicities. These procedures may also be used as a basis of determining risks and impacts at dredge sites that are not Superfund sites.

### *RCRA*

The Resource Conservation and Recovery Act (RCRA) provides for abatement of hazards caused by the handling, storage, treatment, transportation or disposal of solid waste or hazardous waste. US EPA's policy is that sediments containing one or more listed hazardous wastes require their being handled as hazardous waste. But the policy of the Army Corps of Engineers is that dredged material is not a solid waste and is not under RCRA regulation. US EPA has delegated certain RCRA responsibilities to GEPA.

### *Toxic Substances Control Act (TSCA), with Amendments*

The TSCA gives EPA broad authority to regulate the manufacture, use, distribution in commerce, and disposal of chemical substances. TSCA is a federally-managed law and is not delegated to states. This act may be used by EPA as a basis of testing and evaluating the occurrence and impact of contaminants found in sediments as well as controlling their release to the environment. TSCA applies to dredged material that contains over 50 ppm of PCB's.

## **Guam Laws, Permits and Regulations Governing Dredging and Contamination of Near Shore Waters**

The following descriptions of laws, regulations, permits and policies of the Government of Guam related to dredging and contaminated sediments are mainly derived from the draft Environmental Permit Guide Book, by the Guam Environmental Protection Agency. Some apply directly to managing dredged sediment contamination and others relate to controlling the sources of pollutants that contribute to contamination of sediments. The overall application of these legal controls, as improved by GEPA's revision of Water Quality standards in 2000, can address the needs to control harbor sediment contamination and its impacts during dredging activities.

### *The U.S. Clean Water Act Section 401 Water Quality Certification*

A number of federal permits, most of which are identified in the Federal Clean Water Act, for construction, fill, dredging, and discharges to Waters of the United States and Territorial Waters require Territorial (GEPA) Section 401 Water Quality Certification. 401 WQC issuance identifies that construction or operation of a proposed project or facility will be conducted in a manner consistent with the Guam Water Quality Standards. All federal permits for work in marine waters, rivers, streams and wetlands require 401 WQC. Submission of a completed 401 WQC form is required and is available at the GEPA. Proposed New Water Quality Standards (appended) address Guam's administration of the CWA Section 401 Water Quality Certification by GEPA.

### *Guam Water Quality Standards*

The Guam Water Quality Standards were revised in 1999-2000, partly in response to the needs of the MOU (See Appendix A) for the Section 309 Guam Harbors Sediment Project, Phase III. These final revised regulations are appended as Appendix E. They include a revised and streamlined approach to the Section 401 Water Quality Certification process administered by GEPA.

### *Guam Environmental Protection Act*

Public Law 11-191 created the Guam Environmental Protection Agency in 1973, with responsibilities for comprehensive protection of Guam's land, water and air.

### *Guam Seashore Protection Act and Permit System*

The Guam Seashore Protection Act (GC Title 21, Chapter 63) establishes the Guam Seashore Reserve and the Guam Seashore Protection Commission, which must review and act on any applications for development, including any dredging, within the reserve. The reserve includes all subtidal areas down to ten fathoms and extends inland to within 100 meters (amended to ten meters) of the mean high highwater mark.

### *Guam Comprehensive Planning Law*

Public Law 20-147 created a Guam Planning Council with responsibility for developing a comprehensive plan for Guam incorporating at least seventeen identified master plan components, beginning with a Land Use Master Plan.

### *Guam Development Permit*

In April 1998, P.L. 24-171 adopted the I Tano'-ta Land Use Plan and Zoning Code which includes substantial environmental protection provisions as performance standards and requires Development Permits for all new proposed developments. The Zoning Code defines dredging seaward of the mean high water line as development requiring a major-level permit. Preparation and training to implement I Tano'-ta were hampered by unavailability of appropriated budgets, but the plan was finally implemented for about one month. Then implementation was delayed by a law of June 1999, which called for a task force to recommend amendments to it within 120 days. The Task Force's co-chairmen failed to forward recommendations as required by the Legislature. The Governor and the Legislature separately have proposed to continue work on I Tano'-ta amendments in FY 2000, but no results have been forthcoming.

### *Environmental Impact Assessments and Environmental Impact Statements*

Environmental Impact Assessments (EIA) are required by executive order to be conducted for all zone change, variance, wetland, seashore, golf course (conditional use) and similar type permits to the Guam Land Use Commission and Guam Seashore Protection Commissions (GLUC/GSPC). Environmental Impact Statements (EIS) may be required if anticipated impacts will cause the significant loss, damage or degradation of resources. Comprehensive mitigation must be identified. EIA's may be required for other significant development proposals on a case by case basis, outside the scope of the Executive Order, by the Administrator of GEPA. Water Quality Certification Section 401 review for dredging activities would require an EIA/EIS as established under Guam's Water Quality Standards, Appendix F. GEPA has developed guidance material for the preparation for EIA's and EIS's and a "short form" for small projects.

### *Guam Soil Erosion and Sedimentation Control Regulations/Permits*

The GEPA revised Guam's Soil Erosion and Sedimentation Control Regulations and had them legally adopted in 2000, in conformity with the needs of the MOU (See Appendix A.) for the Guam Harbors Sediment Project, Phase III.. These final revised regulations are appended as Appendix F.

Erosion Control Permits are issued by the GEPA while the Department of Public Works issues Clearing and Grading Permits. Since Clearing and Grading Permits require GEPA review for compliance with the Guam Soil Erosion and Sedimentation Control Regulations, GEPA actually assumes the lead in review and approval responsibility. For most clearing and/or grading permits there must be an accompanying Erosion Control Plan (ECP) to protect water quality of the affected water resources, fresh or marine. Any stockpiling of dredged material will now be regulated through the revised permitting system.

### *Wetland Development/Identification/Permits*

Wetlands are protected resource areas and as such require special identification, delineation and permitting activities prior to development. Both federal and local governments play important roles in wetland permitting and protection. All federal identification, protection, and permitting (enforcement) concerns are referred to the U.S. Army Corps of Engineers, Guam Office. The Department of Agriculture, DAWR, Department of Land Management, Bureau of Planning and GEPA are involved in local wetland protection and permitting. Guam Wetland Permits are issued following review, public hearings and approval by the Guam Land Use Commission. Field Wetland Identification services may be provided by the Department of Agriculture and GEPA to a limited extent in that preliminary determination and guidance is offered; however, the Guam agencies have elected not to make federal jurisdictional determinations or resource delineations in order to maintain regulatory objectivity. The official Wetland Inventory Map for Guam and local regulations on wetland protection are available for review at most of the above mentioned agencies.

### *Water Quality Monitoring Plan*

Water Quality Monitoring Plans (WQMP's) may be required to evaluate the effectiveness of any number of different environmental permits and/or performance standards. Monitoring plans are formulated to identify ambient or control conditions at a particular site and to capture deviations from those conditions resulting from a project or operations of a facility. WQMP's may range in complexity from visual inspections for sedimentation and protection measure failure to laboratory or

field analysis of chemical and biological effects on water quality or organisms (acute/chronic bioassay), dependent on a given water resource. WQMP's always include procedures for reporting results and observations to GEPA and provisions for corrective actions. Water quality monitoring is a standard requirement for all dredging, industrial point source discharges, municipal wastewater treatment plant discharges, thermal discharges, marine and underwater construction activities, aquaculture effluent discharges, and mass clearing and grading projects such as golf course construction.

#### *Spill Prevention Control and Counter Measure*

Public and private business organizations must comply with regulations requiring secondary containment areas if they store or use a minimum of 660 gallons of hazardous or petroleum products or wastes as a single above ground stored quantity or 1320 gallons if stored in multiple above ground containers. Storage facilities are frequently adjacent to harbor waters and increase risks of contaminating harbor sediments. The Spill Prevention Control and Countermeasure (SPCC) requirements are designed to prevent all manner of spillage from contaminating surface and ground waters as well as soil in and around a storage area which may lead to future environmental contamination. Although the above regulated quantities trigger management action, GEPA's Water Pollution Control Program will investigate and require remedial containment action in the event smaller quantity spills occur. Individual performance in the proper storage, use and disposal of hazardous and petroleum material is the best indication of the need for additional management measures. All facilities subject to SPCC requirements must develop a SPCC Plan identifying prevention procedures, methods, and equipment necessary to address operational spill prevention and countermeasures. The SPCC Plan and system must be approved by GEPA. The program is implemented through concurrent permit and plan reviews as well as periodic inspections of all known facilities. SPCC requirements may be identified and addressed concurrently through other permits issued or reviewed by the Agency.

#### *Environmental Protection Plan (EPP)*

Environmental Protection Plans (EPP's) are required for most clearing, grading, dredging and marine related construction work. The EPP should be developed by a project contractor who will be responsible for its implementation. EPP's describe the construction work to be undertaken including all methods of manual and mechanical work, the potential environmental impacts or problems that may be encountered and the environmental protection measures that will be employed to reduce, minimize, or eliminate impacts or problems. EPP's may include erosion and sedimentation control, vegetation, wildlife, and coral/marine resource protection measures, fugitive dust control, solid and hazardous waste management and disposal procedures, personnel safety procedures, work site maintenance, and typhoon contingency plans. EPP guidance is available through the GEPA's Water Program Division

#### *Hazardous Materials*

New local laws regulating the importing, storage, recording, monitoring and reporting of hazardous materials have been drafted for GEPA and are planned to be presented for adoption by the legislature in 2000.

*Storage of Hazardous Waste, Treatment of Hazardous Waste, Disposal of Hazardous Waste, and Notification of Hazardous Waste Activity.*

The Guam Hazardous Waste Management Regulations (GHWMR) were developed to guide individuals and organizations in the proper methods and procedures for handling, transporting, storing, disposing, and treating hazardous wastes. The regulations also establish a program which identifies hazardous wastes and provides for the regulation of the above mentioned activities to include the transport or transfer of wastes through program capabilities for inspection, permit review, and enforcement. The primary goal of the regulations is to protect human health and carry out management activities in an environmentally sensitive and sound manner. Certain sections of the Code of Federal Regulations dealing with hazardous wastes have been adopted under Guam's regulations, by reference, to provide for comprehensive coverage. Application of RCRA regulations promulgated up to July, 1991 have been delegated to GEPA. The Administrator of GEPA serves as the primary certification and regulatory authority for hazardous waste management in Guam.

Common to all hazardous waste management activities are certain standards for identification, labeling, containers/packaging, ownership and responsible parties, emergency planning, and other considerations that account for all aspects of management. This comprehensive system is commonly known as the "cradle to grave" management system.

Individual permits may be issued for any of the activities listed above for government or privately owned facilities. Larger integrated facilities such as the military bases may manage hazardous wastes through a combination of activities and therefore obtain composite permits to treat, store and dispose (TSD) of certain hazardous wastes on-island. GEPA is involved from the standpoint of tracking waste types and quantities transported and accepted across state lines and internationally between different facilities. A notification process ensures accurate tracking and accountability of various waste streams through registration with GEPA and USEPA.

*Transportation of Hazardous Wastes*

The transportation of hazardous wastes is regulated by the U.S. Department of Transportation through the Guam Department of Public Works, Highway Division.

The following activities require notification to GEPA and USEPA, and receipt of an EPA identification number:

- Transportation of hazardous waste.
- Treatment of hazardous waste.
- Storage of hazardous waste.
- Disposal of hazardous waste.

Notification Forms may be obtained from GEPA's Solid/ Hazardous Waste Management Program. Original completed forms must be submitted to GEPA for processing.

*Solid Waste Disposal Facility*

All solid waste to include municipal, commercial, industrial, land clearing debris, and demolition debris must be disposed of at a GEPA permitted Solid Waste Disposal Facility. Permit applications must specify the facility location, mode of operation, a detailed description illustrating compliance

with applicable laws and regulations and proposed closure requirements. At present, there are four (4) permitted Government of Guam facilities located at Ordot, Dededo, Agat and Malojojo. The Ordot facility is the island's only public municipal solid waste landfill, while the Dededo, Agat and Malojojo facilities are transfer stations supporting intermediate collection system efforts. The Government of Guam plans to develop a new sanitary landfill in the Guatali area, inland from Inner Apra Harbor, as soon as possible. Guam's Integrated Solid Waste Management Plan calls for a new landfill as well as recycling and possible incineration of solid wastes. In addition to public facilities, the Navy and Air Force operate smaller exclusive landfills on the military bases.

#### *Hazardous Waste Exclusions*

Hazardous waste is not permitted to be disposed of at solid waste disposal facilities from generators with a total hazardous waste production of 50 kilograms (1000 lbs.) per month or from generators with a total production of 1 kilogram (2.2 lbs.) of acutely hazardous wastes per calendar month. All hazardous waste in these quantities are subject to separate hazardous waste disposal regulations.

#### *National Pollution Discharge Elimination System*

The National Pollution Discharge Elimination Systems (NPDES) is a federal permit for all storm water and other point source pollution discharges. GEPA assists in the administration of these permits and reviews and certifies (401 WQC) the permit for compliance with all local regulations and policies and in accordance with the Guam Water Quality Standards. USEPA coordinates, drafts and issues the permit for facilities that require wastewater discharges such as sewage treatment plants, electrical power generation plants, industrial processing facilities, storm water outfalls, aquaculture facilities, aquariums, and similar operations must be permitted under this permit system.

#### *Pollution Discharge Permit*

For discharges similar to those covered by the NPDES permit, GEPA may require a Government of Guam Pollution Discharge Permit. This permit may be issued for any number of liquid, gaseous, solid or thermal discharges to Territorial waters that fall below the minimum criteria defined in the Federal Clean Water Act. Applicability is determined by the Administrator on a case by case basis.

#### *Sewer Construction*

A Sewer Construction Permit is required for all sewer related projects to include systems lateral extensions, lift stations, force mains, wastewater holding facilities, treatment works, and new sewer systems. Unless a private party is involved in constructing (financing) either an exclusive use system or is constructing a system for eventual transfer to the Guam Waterworks Authority (GWA), this permit is usually issued to GWA or the military (Air Force or Navy) as the main purveyor of all sewer systems in Guam. Permit issuance involves the prior review and approval of engineering and design plans by GEPA for compliance with all environmental requirements.

#### *Sewer Connection and Individual Wastewater Disposal*

As part of the building construction process, GEPA issues either a public Sewer Connection Permit through GWA or a separate permit for Individual Wastewater Disposal System (IWDS) and on-site septic tank/leaching systems. IWDS must be designed in strict accordance with the Individual Wastewater Disposal System Regulations which specify requirements for systems sizing; distance from surface water, seashore and from lot lines; materials; testing; inspection; maintenance; and health



considerations. Because this type of disposal system may contribute unacceptable levels of pollutants to surface or ground water, the Agency has developed policy standards in addition to the regulations which specify minimum lot sizes in order to control land use densities as appropriate.

### *Underground Injection*

Underground Injection permits may be issued to public utility agencies or private parties when all other methods of storm water or treated wastewater disposal have been investigated and exhausted.

This permit involves the disposal of wastewater at a considerable distance below the ground surface either by gravity or mechanically applied pressure. In areas where land surface disposal opportunities are extremely limited or where wastewater volumes are high the Agency may consider underground injection as a viable alternative; however, this disposal method requires a higher burden of justification and typically is issued with very strict pretreatment and/or monitoring requirements for the life of the injection well. Permits may be issued in approximately 60 days or longer depending on the complexity of the injection proposal.

### *Test Boring and Dewatering*

Individuals conducting soil test boring and measurements activities may be required to obtain a GEPA Test Boring Permit. Test boring activities include drilling and excavations deeper than six (6) feet deep for a number of soil and structural engineering analysis work. In addition, if the water table is encountered during excavation work for building foundations and similar construction activities, a Dewatering Permit may be required to control and treat water pumped from an excavation prior to final discharge. Dewatering permits may apply to dredging operations as well.

### *Marine Fisheries Regulations*

There are no officially designated shellfish collection areas for the island of Guam. Small quantities of dozens of species of marine shellfish are commonly collected from beaches, reef flats and harbors anywhere on Guam. The sizes and seasons for harvest are regulated by fishery regulations while locations are not limited, except that shellfish harvesting and most fish harvesting is prohibited in five new marine preserve areas (Guam Code Annotated, Title 16). Although dredging has been done in recent years in three of these preserves (Piti Bomb Holes, Tumon Bay and ManellChannel of Achang Reef Flat). Future dredging in these protected areas is not likely to be permitted. The fisheries preserve of Sasa Bay lies in Apra Harbor, between areas of Inner Apra Harbor and the Commercial Port and Navy Fuel Piers, which are expected to be dredged in the near future.

## Methods to Manage Dredging

### **National Requirements**

Management of dredging on Guam and throughout the United States falls under the jurisdiction and expertise of the US EPA and the US Army COE (See discussion above under the Clean Water Act, Rivers and Harbors Act and Water Resources Development Act). These agencies administer permitting systems with participation from the US Fish and Wildlife Service, the National Marine Fisheries Service, the US Office of Coastal Resources Management and others. They allow for local public hearings on permit applications and require Guam Government's Federal Concurrence and Water Quality Certification.

To evaluate the potential for contaminant-related impacts associated with the discharge of dredged material into inland and ocean waters, respectively, they follow the technical guidance found in the documents by US EPA and US Army COE (1994) “Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.B Testing Manual (Draft)” (the Inland Testing Manual) and (1991) “Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual” (the Ocean Testing Manual). These manuals have a companion document on quality assurance and quality control for reliably and accurately evaluating dredged sediments (US EPA and US Army COE, 1995).

## **Guam Requirements**

Guam does not have separate laws, regulations and permits that specifically address just dredging. However, the following existing Guam laws, regulations and permits are applied to proposed dredging activities in Guam, in addition to the Federal requirements, in the following manner.

When dredging is proposed by private or government entities, the applicant may have a pre-application meeting at the Guam One Stop Permit Office at the Department of Land Management (DLM). There, Guam agency representatives will provide information on requirements, depending on the particular activity proposed. The GEPA representative would note the need for Federal ACOE and EPA permits and the need for local Section 401 Water Quality Certification, Environmental Impact Assessment/Statement (EIA/EIS), Pollution Discharge Permit, Environmental Protection Plan (EPP), Dewatering Permit, and, if appropriate, a Wetlands Permit, Clearing and Grading Permit, Erosion Control Plan and various hazardous waste permits. The DLM representative would note the need for a Guam Seashore Protection Permit (including public hearing), Development Permit, Federal Consistency Concurrence (as administered by the Guam Coastal Management Program of the Bureau of Planning), and, if appropriate, zoning variance, and clearance with the Navy, Coast Guard, Port Authority of Guam, Department of Parks & Recreation (which administers Historic Preservation clearance and the Guam Recreational Water Use Management Plan), Department of Public Works and others. Application forms and information on the local permits are all available at the One Stop Permit Office. Local permit approvals may include imposing conditions which require (or prohibit) specific methods, timing, phasing, bonding, habitat avoidance, processing, mitigation and other modifications and restrictions on the approved dredging activity. Through the EIA/EIS requirements, Guam agencies may obtain environmental baseline, contaminant level, health risk, and environmental risk information similar to that addressed in Federal EPA and ACOE permit reviews.

If the federal permitting agencies are approached for dredging permits on Guam, they inform applicants of the need to meet local permit requirements, through the One Stop permit agencies.

## **Alternative Dredge Spoil Disposal Methods**

Various methods are regularly practiced to dispose of dredged sediment. The choices of methods are based on costs, benefits, volumes, impacts, availability of equipment, and other factors, unfortunately, sometimes tied to political influences. Most common disposal methods are here listed and discussed.

### 1. *Deep or Open Ocean Disposal*

Deep ocean disposal would be done by barging dredged sediments to deep sea sites off Guam and discharging them under planned controls. Federal requirements call for permits from EPA, studies of alternative sites and impacts and policies such as using historically used sites. Current Federal permitting practices tend to prioritize other disposal methods over this method.

### 2. *Submarine Containment or Underwater Confinement*

Capping or sealing of sediments underwater or at shorelines can limit the exposure of surrounding water and organisms to contaminants of sediments. Except in the case of beneficial creation of fast land with robust shore protection and containment of the deposited dredged materials, the amounts and quality of sediments dredged on Guam would not be expected to be amenable to this process.

Guam's typhoon incidence and earthquake vulnerability create a high risk of catastrophic failure to such confinement structures. Also the lack of suitable sites and of technical expertise on Guam and the need for long term maintenance detract from this being a preferred alternative.

### 3. *Sub-Aerial (Land-Based) or Upland Disposal*

Disposal on land without particular reuse or beneficial results. Because of the numerous opportunities for beneficial use of dredge spoils on Guam, disposing of sediments as a form of solid waste would not appear to be a preferred use.

### 4. *Re-use, Beneficial Uses*

#### a. Fill

A widespread and common practice elsewhere has been to fill low and floodable areas or back up flood dikes with material dredged from navigable waters. However, the limited floodable areas of Guam are usually best left as undeveloped floodplains, and often are protected from filling because of wetland status. Filling such areas would shift flood impacts to adjacent sites which otherwise would not suffer flooding. Filling sink holes on Guam also is not advisable because of their function in recharging Guam's aquifer, which has U.S. EPA protection as a sole source drinking water aquifer. Benefits have resulted from filling shallow water areas at Apra Harbor and Agana Boat Basin to create valuable usable fast land, e.g., the Agana Sewage Treatment Plant Island.

#### b. Beach Nourishment

Beach nourishment has not been a regular or routine activity on Guam in spite of the widespread uses and developments at beaches. As increased coastal development impacts on beach erosion and increasing tourism and recreational uses demand more beach area, a demand for beach nourishment is likely to arise. But harbor dredge spoils would not be expected to be consistent in quality and size with the sands that occur on Guam beaches. On a case by case basis, there may occur an opportunity to utilize dredged sand for beach nourishment in the future, but assessment of existing harbor sediments indicate that they are not likely to be desired for deposition on beaches.

c. Wetland Nourishment

Approximately 3.8% of Guam’s land is wetland, including freshwater marshes and very limited mangrove swamps. Dredged harbor sediments from the marine environment would not be practical for enhancing or creating freshwater wetlands on Guam. Guam’s mangrove forests are mainly located in Apra Harbor and near the head of Manell Channel, both sites for possible future dredging. The small-scale, long term, private dredging done slowly over many years in the 1970's to develop a marina at Achang Bay was planned to enhance mangrove growth and use the mangroves as protection from storm wave erosion. Permitting of similar dredging or filling in mangrove areas would probably not be allowed in the future, since the Sasa Bay and Achang Reef Flat areas have become fish preserves by recent Guam law. Expanding mangrove forests into areas ecologically suitable for their growth adjacent to planned dredging in Inner Apra Harbor and the Commercial Port would be a low priority for these industrial coastal areas.

d. Landfill Cover

If sediment is contaminated, even below levels considered hazardous or below levels needing removal, treatment or containment, its safest disposition would be to place it at a properly managed landfill. Guam’s landfills are always in need of cover material. The dewatering needs, toxicity levels, and other chemical and physical characteristics of sediments dredged from Guam harbors may make them amenable to use as landfill cover. The suitability of such use may be determined during preliminary studies done in the planning and EIA development stages of dredging permit applications. The close proximity of the new Gautali public landfill to Apra Harbor would support the practicality and cost/benefit of disposing of dredged sediments from Apra Harbor sites.

In most years, no dredging occurs on Guam due to the adequacy of Guam harbors and relatively slow sedimentation rates. In comparison, a huge amount of dredged spoil is generated annually in the United States. Within the United States in the Fiscal Year 2000, over 300 million cubic yards (MCY) of material will be dredged under the Army Corps of Engineers; more than 75% resulting from waterway maintenance dredging (Hilton, 2000). It is planned to be disposed of in the following manner:

<b>METHOD</b>	<b>AMOUNT (MCY)</b>
Overboard and Open Water	106.1
Confined (Dikes)	46.7
Beach Nourishment	38.7
Wetland Nourishment and Creation	38.4
Upland Disposal	25.6
Mixed Disposal	23.5
Open Water and Upland	18.2
Underwater Confined	0.9
Beach Nourishment and Upland	0.6
Undefined	11.1

## **Alternative Spoils Treatments**

### *1. Natural Attenuation*

Allowing contaminants in sediments to gradually disperse, break down, become chemically inert or biologically inactive, be diluted and moved through food chains or water circulation and storm generated movement, and other passive approaches can lessen their concentration and impacts. Natural attenuation typically would occur to dredged sediments that are disposed in the deep ocean and at a slower rate when utilized in wetland nourishment.

### *2. Active Treatment*

Active treatment of contaminated dredge spoils is being researched by the US EPA, but seems to be most appropriate for situations where large quantities of seriously contaminated spoils are causing major environmental and health risks, justifying high-cost solutions. The economics of such treatment would probably make it inappropriate for Guam.

Stern (1998) and Jones et al. (1999) report on efforts to commercialize dredged-material decontamination technologies for use in the New York/New Jersey Harbor underway by a public/private partnership involving the U.S.EPA-Region 2, the U.S. Army Corps of Engineers-New York District, the U.S. Department of Energy's Brookhaven National Laboratory, Rensselaer Polytechnic Institute, and private industry. Their continuing research leads the way for US assessment of latest technologies for dealing with contaminated dredged sediments. Through a step-wise, bench- and pilot-scale validation process, innovative and cost-effective technologies were assessed with progression to a production-scale facility capable of processing up to 500,000 cubic yards of dredged material per year. This project is conducted under the Water Resources Development Acts of 1992 and 1996.

Major contaminants of concern in the NY/NJ Harbor include heavy metals, chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls, and dioxins/furans. Levels of contamination vary widely, but range as high as 130,000 ppb for total PAHs; and 42, 631, and 4 ppm for arsenic, lead, and mercury, respectively.

In a sediment decontamination program such as this NY/NJ project, the physical characteristics of the sediment were deemed as important as contaminant concentrations because of the associated materials-handling problems and difficulty in dealing with fine-grained material. The physical characteristics of typical dredged material in the NYC/NJ Port include fine-grained silts and clays (80-95%), a small fraction of larger grain sizes, and large-size debris. The as-dredged material is characterized as having a 30-40% solids content consisting of 3-8% total organic carbon.

A treatment train comprising materials handling, decontamination, and beneficial reuse of material is required to treat the variety of contaminants and wide range of concentrations found in dredged material in the NYC/NJ Harbor. The project team determined that dredging/decontamination costs could be reduced significantly through the development and commercialization of a long-term,

sustainable, profit-making enterprise for decontaminating sediments with a beneficial reuse. Twelve technologies initially were evaluated in bench-scale tests. Based on results of bench-scale testing, the following six completed pilot-scale testing on up to 25 cubic yards of contaminated sediments:

- a. A thermochemical process using a gas-fired melter (rotary kiln) and modifiers. Operating temperatures ranging between 1,200° and 1,500° C achieved destruction of all organic contaminants to below detection limits, without any secondary waste streams. The end product is a pozzolanic material that can be mixed with portland cement (which immobilizes the metals) to make a marketable blended-cement product for use in the concrete and construction industries;
- b. A solvent-extraction process followed by solidification/stabilization using portland cement as the binding agent. Operating at temperatures of 38-60° C, this process resulted in a 90% average reduction in organic concentrations. Potential uses of the resulting soil-like material include construction fill, landfill cover, mine reclamation, and capping of brownfields and Superfund sites;
- c. Stand-alone solidification/stabilization using portland cement. This process serves to immobilize contaminants. Potential uses of the resulting soil-like material include construction fill, landfill cover, mine reclamation, and capping of brownfields and Superfund sites;
- d. A thermal vitrification process using a plasma melter. At temperatures of 1,316-1,371° C, the vitrification process resulted in a 99.9% reduction in organic and 63% reduction in metal concentrations. The end product is a glass-like material that contains the immobilized metals. This material could be used as construction aggregate or roadfill material, or could undergo further processing to make glass-fiber or glass-tile products;
- e. Manufactured soil production followed by phytoremediation. The U.S. Army Corps of Engineers, Waterways Experiment Station, has developed methods for producing manufactured soil from untreated sediment by mixing it with a cellulose material (such as wood chips, saw dust, or yard waste compost), cow manure, and lime and fertilizer, as needed. Commercial vendors are devising manufactured soil technologies using decontaminated material. Phytoremediation was used to reduce contaminant concentrations in both metals and organics. The suitability of the soil for growth of different plant species was tested for tomato, marigold, rye grass, and vinca, and it was found that the soil is most suitable for the growth of rye grass. The potential beneficial use is to serve as a topsoil layer supporting vegetative cover for landfill closure, mine reclamation, and capping of brownfields and Superfund sites;
- f. The BioGenesis<sup>sm</sup> Advanced Sediment Washing technology is an integrated treatment train approach to sediment decontamination being used for NY/NJ Harbor dredged materials. It involves removing the contaminated sediments, washing them with water containing selected chemicals that physically remove the contaminants and producing clean topsoil as a final product. The sediment washing process uses biodegradable surfactants, chelating agents, and oxidation. During tests, concentrations of metals and organics were reduced by approximately

90% in silts, clays, and sands. The treated material, which has the consistency and appearance of sediment, can be used to make a manufactured soil product to be used in agriculture, horticulture, forestry, parks and recreation areas, and habitat creation.

## Recommended Policies for Guam

### **Dredging Policies**

1. The Government of Guam should continue to apply the existing laws and regulations described earlier to any new proposed dredging. Through the existing comprehensive Federal and Guam permitting systems, requiring CWA 404 and 401, and Guam Seashore Protection Commission permits and Federal CZMA requirements for consistency with the Guam Coastal Management Program, adequate control on most dredging impacts exists. These systems should continue to employ EIA/EIS's, detailed technical reviews, public notification and public hearings as basic parts of the review and approval process.
2. The new Draft Guam Water Quality Standards (See Appendix E) should be adopted in final form by the Guam Legislature to further improve Guam's management of dredging impacts.
3. As Federal laws and regulations related to dredging are revised, the Guam Coastal Management Program, GEPA and the Division of Aquatic and Wildlife Resources of Guam's Department of Agriculture (or their successors, if they change with government re-organization) must provide input to ensure that Guam's needs are met. The National Dredging Team and their draft Action Plan should be followed by Guam officials.
4. Likewise, when Federal Sediment Quality Criteria (SQC) are being established by U.S. EPA, local concerns related to Guam's contaminated sediments must be considered. Results of Guam sediment contamination analyses should be provided to the US EPA National Sediment Inventory to aid in this. Numerical SQC for the ocean dumping of dredged harbor sediments on Guam were proposed by Denton *et al.* (1997), following completion of Phase I of this Guam Harbor Sediments Study. These SQC are presented, together with SQC from other areas in Appendix B.
5. Need for dredging and appropriate locations and methods and guidelines for dredging approval by the Guam Seashore Protection Commission should be addressed in the drafting of the Guam Seashore Reserve Plan.
6. Application of the Guam Natural Resources Commission approval process to dredging activities should be considered by Department of Land Management.
7. Dredging for beach replenishment should be discouraged, while elimination or prevention of causes of beach erosion should be supported, through guidelines developed for the Seashore Reserve Plan and through conditional approvals of the Seashore Protection Commission.

8. The 1994 Amendment to the Coastal Management Plan and Final Environmental Impact Statement should be used during dredging planning. Guam's Coastal Management Plan should be amended to include dredging policies and dredging guidelines noted here and in the Guam Seashore Reserve Plan.

9. No extended time periods for repeated maintenance dredging are indicated in Guam permit laws or policies nor are they justified. However, conditions may be included in the local permit approvals that refer to time limits for actions or repeating of actions, on a case by case basis.

10. Latest US EPA protocols and those sampling and analytical methods recommended by the NOAA National Status and Trends Program for Marine Environmental Quality should be applied in future sediment testing as bases of dredging permit review and approval.

11. No specific methodologies for dredging are indicated in Guam permit laws or policies nor should they be. However, conditions may be included in the local permit approvals that refer to preferred or prohibited methods and best available technology, on a case by case basis.

12. In applying conditions to dredging permits, Guam agencies should continue to require that applicants prioritize beneficial use of spoils and apply best management practices and best available technology, based on their evaluation of health risks, environmental risks, levels of contaminants present, impacts on human uses, impacts on habitats and health of native or valued organisms, oceanographic conditions (including ambient water quality, currents, tides, weather impacts, etc.) and not just economic costs.

13. Use of Environmental Protection Plans specifying location and dynamics of silt barriers and other impact controls and use of Water Quality Monitoring Plans should continue to be applied as permit conditions for dredging.

14. During Guam's review of EIA/EIS's and Water Quality Certification applications for proposed dredging, any possible accidental takings of organisms should be considered and best management practices to prevent accidental taking of organisms on a case by case basis may be included in any permit conditions.

15. In regard to the imminent maintenance dredging project on Guam of dredging Inner Apra Harbor by the Navy, the following policies are recommended:

a. An EIS should be completed by the Navy and reviewed by appropriate officials and the public.

b. Thorough scientific sampling of sediments to be dredged must be made and samples must be analyzed for potential contaminants before an EIS is developed and before dredging methods and dredged sediment treatment, disposal or storage alternatives are selected.

c. Public hearings under Section 404 and the Guam Seashore Protection permits must be held.



- d. An expert on dredging permitting and management of dredging impacts should be provided to the Guam Government from US EPA or NOAA, to assist in reviews of 401, Federal Consistency and Seashore Protection permits for the Navy dredging.
- e. If impacts of this dredging project are not satisfactorily managed by existing laws and new regulations, then appropriate revisions to Guam laws and regulations or introduction of new laws addressing dredging should be pursued through the Coastal Management Program.

### **Dredge Spoil Disposal Policies**

1. As part of the established permitting, review and approval systems mentioned above, EIA/EIS's for dredging must address and evaluate alternative disposal and treatment methods and sites for dredged spoils.
2. Beneficial uses of dredged materials should be prioritized over deep ocean or other disposal approaches. For example, the fast land to support the Agana Sewage Treatment Plant was produced from the material dredged to expand Agana Boat Basin. There is no local definition for beneficial use of dredged materials. Such definition should be developed in the next year, relative to the proposed Seashore Reserve Plan.
3. The option of utilizing dredged sediments as cover for the new public sanitary landfill at Gautali (or the Ordot Landfill) should be prioritized, contingent upon the suitability of the dredged materials and that any environmental impacts of such use are minimized.
4. Temporary storage of dredged materials destined for landfill cover or other beneficial uses should be permitted and encouraged at suitable sites.
5. As the various options for beneficial uses, disposal and treatment of dredged sediments continue to be evaluated by the US EPA and NOAA, the Guam Coastal Management Program should review the results with the intention of applying appropriate practices to future Guam dredging.
6. Although Section 404 of the Federal Water Pollution Control Act allows the Governor to propose Guam's own permit program for discharge of dredged material into navigable waters and seek the US EPA Administrator's approval of this, it is not advisable to do this at this time. Guam lacks the expertise to develop and implement such a program and the very limited and infrequent need of dredging makes such a special program impractical under current conditions.
7. The selection of alternatives for dredged materials' disposition, during the EIA/EIS process required for dredging in Guam, should be based on economic benefits versus environmental costs.
8. Because of the priority to use dredged sediments for beneficial uses and because of the frequent typhoons and earthquakes on Guam, confined submarine disposal facilities should be avoided or of lowest priority.

9. Dewatering of dredged materials and its impacts must be assessed in the permitting process for proposed dredging. Impacts of dewatering on natural resources, especially coral reefs, mangroves, and wetlands must be addressed and minimized.

10. If the deep sea disposal of dredged material is being considered for Guam, the Sediment Quality Criteria for contaminating metals, PCB's and PAH contaminants proposed by Denton *et al.* (1977) should be applied. Sediments exceeding any of these limits, may only be disposed of at sea following the appropriate treatment to lower concentrations, accordingly.

### **Consumption Advisories**

Guam issues consumption advisories to protect residents from the health risks of consuming contaminated noncommercially caught fish and shellfish. These advisories recommend that the public limit or avoid consumption of certain species from specific waters. When instances or risks of human health impacts arise from consuming contaminated seafood, individual consumption advisories should be made jointly by GEPA and PH&SS. The weekly GEPA press release covering microbiological contamination of coastal waters has been regularly used to warn consumers of contaminated seafood from certain sites and can continue to serve as a means of consumption advisories (see Appendix C).

Special advisories related to risks arising from dredging operations should be developed on a case by case basis. These may be required to be produced by the responsible party, such as was done by the Department of the Navy in April, 2000, for fish contaminated in Agana, Guam by PCB's from Navy power plant operations (copy included in Appendix C). Articles in the Coastal Management Program's Man Land and Sea periodical and a program on the Man Land and Sea television show have been produced to educate about marine sediment contaminants on Guam. When funding is available, educational materials on ciguatera, *Vibrio* contamination and future risks that may arise from eating seafood on Guam, whether or not related to contaminated sediments, can be produced through the Coastal Management Program.

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