The San Francisco Bay is unique since it's opening to the ocean is central and divides the Bay into north and south sections. The Bay is also unique because the north has more freshwater input and the south has less. This freshwater input and the depths and surfaces of the sub-bays create different oceanographic conditions in the Bay.

The Bay has two geological units: bedrock of Franciscan Formation and Recent Bay sediments consisting of older bay mud from 0 to 200 feet thick, fine grain sand deposits, and young bay muds over these which form a blanket over the Bay floor. Sedimentation and natural filling of the Bay have been shown by various studies to average a net sediment deposition (total sediment inflow minus outflow) of about 2.4 to 5.2 million cubic yards per year. Processes affecting sedimentation are tidal currents, winds, freshwater inflow and salinity-density currents. Also affecting local sedimentation are prop wash and shoreline structures.

Sources of chemical contaminants in the Bay are: municipal and industrial wastewater discharge; agriculture drainage with fertilizers, pesticides, animal waste, and nutrients and minerals leached from the soil; storm runoff with most contaminants in the first major storm of the season; aerial fallout; vessel discharge; solid waste disposal; and natural erosion. Chemicals normally sampled in sediment samples for dredging of navigation projects are lead, zinc, mercury, cadmium, copper, and oil and grease. Distribution of these varies within dredged channels of the Bay.

Water quality can only be evaluated in terms of intended use of the water. Parameters used to test water quality are salinity, temperature, pH, dissolved oxygen, turbidity and suspended soils. Water quality varies within the Bay system.

B. Estuarine Ecosystem

Five major habitats comprising the Bay ecosystem are discussed in Section II and are briefly summarized below:

Tidal Flats. These are very productive with a unique population of photosynthetic organisms called benthic diatoms. Also, other tidal algae are found in the flats. These produce oxygen and are important food producers for tidal flat grazing animals. Tidal flat animals, also numerous, include over 100 species of aquatic invertebrates. Many birds and fish feed in the tidal flats even though they are not considered permanent residents.

Salt Marsh. Flora consist primarily of cordgrass and pickleweed, the two most common plants, as well as other plants tolerant of a salty environment. Salt marshes are feeding and nursery areas for many small fish, and serve as habitat for many resident and visiting birds. Life styles of rodents found here are closely connected to tidal fluctuations. Very little undisturbed marshland remains of the original resources in the Bay Area. Marshes are important for (1) producing nutrients to feed wildlife, (2) trapping, removing and recycling nutrients, and (3) giving protection for wildlife.

Diked Salt Ponds. Salt production creates special habitats that vary in salinity and degree of acidity or alkalinity (pH). Plants and animals in salt ponds must be hardy to endure the extreme environment. Algae and aquatic invertebrates are abundant, as are predator fish able to stand high salinity in the water. Shore birds are heaviest bird users of ponds. They feed on a variety of organisms that live in the water.

Subtidal Benthic Habitat. In terms of surface area, the bottom of the Bay below mean lower low water (MLLW), or the subtidal benthic habitat, is the largest of the five generalized estuarine habitats (the open-bay habitat is the largest habitat in volume). Studies have found several hundred macrobenthic invertebrate species in the Bay with 30 to 40 species being in the majority. Most of the species belong to genera found in most temperate estuaries of the world. Central San Francisco Bay has the greatest number of benthic species in the whole Bay Area. Molluscs (snails, clams, etc.) total 70%, annelids (segmented worms) total 25%, and arthropods (crustaceans, etc.) total 5% of the volume in the Bay.

Open-Bay. The Open-Bay habitat is divided into the weaker plankton and the stronger free-swimming neckton (fish and marine mammals) communities. Plankton are abundant plants and animals that live in the water column, or live a brief time in the water column and the rest of their lives on the bottom. About 131 types of fish not directly dependent on the bottom have been found in the Bay. They range from strictly marine to strictly freshwater species. Waterbirds also utilize the open bay but are not restricted to this one habitat. The Bay is an important part of the Pacific Flyway for resting, feeding and wintering of birds. Most commonly seen of the marine mammals in the Bay is the Harbor seal. Occasionally other marine mammals such as porpoises and California sea lions are seen.

C. Terrestrial

Wildlife habitat is good in the unimproved and agricultural lands, freshwater marshes, and riparian systems. Nearly all but highly industrialized and urbanized areas have wildlife value. Mammals in the direct Bay Area are usually rodents living in grassy uplands or marsh and tidal meanders of the Bay. Limiting factor for habitat is reclaiming or other land use that diminishes natural vegetation or alters habitat. There are areas especially set aside for wildlife protection and use. There are also private salt ponds, refuges, preserves, parks, and other miscellaneous areas. Potential land disposal sites for dredged materiall will be surveyed for their vegetation and wildlife value.

D. Endangered and Rare Species

Twelve endangered and rare species have been sited or are known to breed in the Bay Area or off the coast of Central California (see Plate II-45). These species are briefly described in the Composite Statement under "Endangered and Rare Species" and "Marine Biological Characteristics off the Central California Coast." Species include the: California Clapper Rail, California Brown Pelican, California Least Tern, Peregrine Falcon, Southern Bald Eagle, California Black Rail, California Yellow Billed Cuckoo, Salt Marsh Harvest Mouse, Red Bellied Harvest Mouse, Alameda Striped Racer, San Francisco Garter Snake and the California Gray Whale.

E. San Francisco Bay and Vicinity

There is a crescent-shaped sand bar, six fathoms or less, that surrounds the entrance to the Golden Gate. Three natural channels, six to ten fathoms deep, tri-sect the sand bar. These are the Bonita Channel, Southern Channel, and San Francisco Bar Channel (Main Ship Channel). Only the Main Ship Channel depth is augmented by dredging.

The sand bar is the result of sediments deposited from eroding coastal beaches and cliffs and outwash from streams, mostly from the north. This deposition is balanced by currents around the bar which transport finer material away, but are slow enough to allow sand accretion. Interaction of coastal and tidal currents with sea-state have given four distinct sand layers at the bar. There is a relatively clear upper water layer extending 25 to 35 feet below the sea surface and a deeper turbid layer extending 3 to 15 feet off the sandy bottom. A third, fluid layer 3 to 6 inches deep exists on the bottom over the fourth, underlying compacted sand layer. As sea-state and currents become more turbulent, the turbid and fluid layers would grow in depth and their sediment load would increase. This dynamic movement of the layers at the bar does not allow long-term accumulation of surface build-up of any material deposited on the bar, whether it is material washed out from the Bay or disposed dredged material.

The three oceanographic seasons (Upwelling Period, Oceanic Period and Davidson Period) play and important part in affecting plankton species at the bar. Zooplankton found in Central San Francisco Bay are also found at the Gulf of the Farallones. Ocean shrimp, important commercially, are not havested in the Gulf of the Farallones. Approximately 172 fish species have been listed as frequenting the central California coast. Many are commercially and recreationally important.

Bottom-dwelling organisms at the bar must be well adapted to shifting sand and burial to survive since the area has a moderately high energy level. Although the bar has diverse bottom fauna, it is less numerous than deeper areas with weaker tides, and the shallow, rocky shore communities. Benthos at the 100-fathom EPA designated disposal site have not been studied.

Like pelagic fishes, marine mammals in the area off Central California are active migrants, ranging over a wide geographical area. Some endangered species of whales can be seen near the Farallones during whale migrations.

F. <u>Regional Economy</u>

The various Bay Area counties are described in the Composite Statement, giving a short history and available statistics on income, population, employment, etc. The active port system of the Bay Area is described, giving statistics available on waterborne commerce for all ports. Military and government facilities are also listed and waterborne commerce activities noted.

G. <u>Social Characteristics</u>

Man-made resources which cannot be assigned cash value, but contribute to the value of life for residents, are listed and those directly related to maintenance dredging in the Bay are discussed.

<u>Archaeology, Ethnography and Early History</u>. The Bay Area was originally inhabited by Costanoan Indians. Indian sites and shell mounds have been found all over the Bay Area. Spanish influence and the migration of Americans to the area have all had an impact on historical resources, as well as the demise of the Indians. Originally, some of the 20 projects in the Composite may have had adverse impacts on archaeological resources, but now these resources are not affected by maintenance dredging and aquatic disposal.

Demography. The Composite Statement also lists inhabitants, population composition and distribution, population trends and social status of the present Bay Area.

Government/Civic Activity. Various Federal, State, regional, sub-regional, county and city agencies are discussed in the Composite.

Transportation. Transportation systems in the Bay Area are discussed, noting heavy reliance on the private automobile and other aspects such as mass transit, freight systems, corridors and priorities.

Land Use. Land use from the first discoverers to present day is included in the Composite, stressing San Francisco's natural location as a central transfer point and importance of the Bay as a water transportation system. Factors that have always affected land use and development are discussed, including physical constraints of the area, modes of transportation, local economy, government policies, and national trends. Major development issues are reviewed for the four main parts of the Bay Area region: San Francisco Peninsula, South Bay, East Bay, and North Bay.

Recreation and Culture in the Bay Area. Recreation and culture in the Bay Area are varied and abundant. The Composite Statement centers on water-oriented recreation facilities, especially boating and marinas.

IV. IMPACTS

Environmental impacts attributed to dredging and disposal operations in the Bay Area are summarized below and are divided into three major headings: Impacts on the Natural Environment, Impacts on the Regional Economy, and Impacts on Social Characteristics.

A. Impacts on the Natural Environment

All 20 dredging projects are existing projects of which most have been periodically dredged for many years. The five aquatic disposal sites have also been routinely used, and therefore impacted upon for a long time. Only land disposal sites are areas for potentially new impacts. The 100-Fathom Ocean Disposal Site could also be considered "new" since its distance from the Bay causes infrequent use of the area. Six general areas of impact on the natural environment summarized below are: Bay Estuary, Terrestrial Environment (for land disposal), San Francisco Bar, 100-Fathom Disposal Site, Endangered and Rare Species, and Air Quality.

1. Bay Estuary

Generally, three kinds of dredges are used in the Bay Area: hydraulic cutterhead with pipeline, trailing suction-head hopper, and clamshell. Each type of equipment disturbs the sediment differently, but they all cause turbidity during operations. The type and size of equipment used and site conditions affect the degree of disturbance at dredging and disposal sites.

Studies on dredging have shown that turbidity lasts usually less than 15 minutes and highest turbidity values were adjacent to the dredge, reaching background levels a few hundred yards downcurrent of the dredge. During periods of low salinity, turbidity levels above background will last longer. In addition to the turbidity in the water column, the dredging disturbance generates an ill-defined sediment-water interface or fluff zone. The fluff zone is confined to the channel and eventually consolidates within a few weeks after dredging. Many benthic organisms in the dredging areas are either destroyed or transported from the area to the disposal site. Repopulation is evident, however, even after many years of recurrent dredging.

Corps studies have shown that sediments released at open water disposal sites reach the bottom relatively intact. Less than 5% is dispersed in the upper water as the material descends. The sediments are transported from the site within a few feet of the bottom, subsequently diluted and follow the circulation pattern of natural sediment distribution in the Bay. Within two months, material disposed at the Carquinez Strait Disposal Site is widely distributed over a 100 square mile area in a very low order of concentration.

Physical impacts attributed to dredging and disposal, such as decreased plankton production, impaired predator visual activity, impairment of filter feeding organisms, blocked anadromous fish runs, clogged gills, etc., may occur where dredging and disposal are in confined or enclosed systems with high, prolonged sediment loading in the water column and decreased oxygen. Dredging and disposal in the Bay, however, are not in an enclosed system and the area immediately affected is small compared to the whole Bay. The area of direct impact is affected temporarily and there is repopulation of organisms in dredged and disposed areas. Benthic organisms experience various amounts of impact upon dredging, depending on the surface area disturbed, the number and species present, depth of the cut, and frequency of maintenance. In San Francisco

Bay, studies indicate that sediment from disposal operations will not cause extensive smothering of benthic organisms. Estuarine fish are generally tolerant of relatively high turbidity and can avoid or move away from immediate areas of impact.

There is no doubt that dredging and disposal operations have adverse impacts on bottom-dwelling organisms in the immediate work area. Although no extensive studies have been done on recolonization of post-dredge or disposal in the Bay, samples taken at some Corps projects and disposal sites indicate a diversity of life. However, other studies have also shown that areas outside the channel or disposal site tend to have greater abundance of life.

Potential mobility of chemicals bonded to sediment particles and the transfer to marine organisms are also considered. To date, there is no evidence to show that dredging and disposal operations directly influence uptake of toxic constituents, although there is evidence of minute releases of some chemicals during sediment agitation.

In addition to the direct effects of maintaining the Bay's navigation channels, there are secondary or indirectly-related impacts resulting from port, marina, military and commercial operations that are dependent on maintenance dredging. These impacts on the Bay estuary stem from, among other things, inadvertent oil spills, runoff, waste discharges, and ship and auto pollutant emissions.

2. Terrestrial Environment

The second area of direct impact is land disposal. Five projects are being considered for a possible land disposal alternative. These are Redwood City Harbor, San Rafael Creek, San Leandro Marina, Suisun (Slough) Channel and New York Slough. Except for Redwood City Harbor, potential land sites have not been investigated for dredge material disposal. Redwood City Harbor has four land areas that are being considered, of which one will probably be selected. Site No. 1 is the Port of Redwood City's preferred site but various agencies have raised objections to using this site. All sites will be investigated for impacts on geologic and hydrographic conditions (subsidence, settlement and seismic hazards), aesthetics, vegetation and wildlife, and anticipated long-range use of the filled site. All existing projects from which dredged material will be placed on land (except for Redwood City Harbor if the material is disposed on Site No. 1) will require a supplemental environmental statement that will address the impacts of land disposal. If a land site cannot be agreed upon, then open-water disposal sites will be considered for those projects.

3. San Francisco Bar

Five miles west of the Golden Gate, the Bar receives dredge material from annual dredging of the Main Ship Channel. The disposal site is 6,000 feet south of the channel and is characterized by strong tidal currents, rigorous wave climate and a shifting sand bottom. The disposal site receives the fine-grain, unpolluted sand taken from the Main Ship Channel.

A Corps study of the Bar concludes that very little turbidity is created during disposal, and that constant motion in the area disperses the sand back into the littoral system. Since the bottom sand is constantly shifting, only animals adapted to an unstable or shifting substrate survive in the area. The study suggests that dynamic conditions of the Bar have a far greater effect on the kinds and numbers of bottom animals living in the channel and disposal site than dredge or disposal operations. Because dredging is done annually, however, the average number of organisms in the channel is probably less than some other areas on the Bar even though kinds of animals in each area are probably the same. Species collected at the area are very mobile and are adapted to changing conditions.

4. 100-Fathom Disposal Site

The designated 100-Fathom Ocean Disposal Site 30 nautical miles southwest of the Golden Gate is used infrequently and predominantly for the most polluted Bay-dredged sediment. Bay sediments are different from the 100-Fathom sediments. The Bay has more silt, clay and heavy metals and is a non-compatible substrate when compared to the sediments at the ocean site. Sediments reach the bottom essentially intact in clumps. If this is used routinely, the Bay sediments could inhibit or reduce recolonization by indigenous species and could affect any possible spawning, nursing, or feeding in this area. Areas affected beyond the dump site would depend on the extent of dispersion and dilution.

5. Endangered and Rare Species

The most potentially affected endangered and rare species are those living close to proposed land disposal sites. The existence of endangered or rare species would, of course, be included in the investigation of potential land disposal sites and a supplemental environmental statement would be prepared before any action is taken. Threatened species would not be directly affected by dredging and aquatic disposal operations.

Since maintaining the navigation channels helps sustain port, marina, military and commercial activities, there can be an indirect impact on endangered and rare species from inadvertent oil spillage, runoff and waste discharge from these various facilities. These impacts are probably limited, however, because these facilities are highly industrialized or have high human activity, and inhabitation or usage of these areas by endangered and rare species are probably very limited.

6. Air Quality

Compared to total shipping activities in the Bay, Corps dredging activities are very minor. Although total shipping contributes relatively significantly to concentrations of sulfur dioxide, nitrogen oxide and particulate matter, the Corps small percentage accounts for only minor amounts of the total air pollutants found in the Bay Area. Since maintaining these projects allow safe navigation, dredging indirectly contributes to air pollution from other sources; such as from ships and from autos that transport people to and from the maritime ports, marinas, etc.

B. Impact on Regional Economy

Economic impacts considered in the Composite Environmental Statement focus on the impacts of deepwater navigation on Bay Area economy. This navigation is of course dependent on maintenance dredging of channels. The channels serve commercial ports, private wharves, oil piers, and military installations that are dependent on Bay access. Approximately 20,400 jobs in 1973 in the San Francisco Bay-Delta area were directly related to waterborne transportation and had a total payroll of $309 million. Approximately 7,800 jobs were related to exports in the Bay Area. Numerous other jobs are indirectly related to waterborne transportation also. Total military and civil port investment in the Bay-Delta area was nearly $2 billion in 1973. Over 4,500 vessel trips with ships greater than 25-foot draft, requiring dredged channels for navigation, passed through San Francisco Bay and over 56 million tons of cargo were handled in Bay-Delta ports in 1973.

Unlike some of the negative impacts on the natural environment, maintaining navigation projects has positive impacts on the Bay-Delta regional economy. Dredging has beneficial long-term impacts for maintaining port facilities and navigation commerce, helping to maintain land values and public revenues, and maintaining the need for community services.

C. Impacts on Social Characteristics

1. Historical and Archaeological Sites

All 20 projects include dredging areas previously dredged. Five projects are anticipating land disposal, and only the Port of Redwood City has tentatively chosen a land disposal site. Of the four sites available to the Port of Redwood City for land disposal, the preferred one (site #1) has been investigated by an archaeologist, according to current regulations. It has been determined that no archaeological resources exist; nor will historical sites in Redwood City be affected, according to the State Historical Preservation Office. Any potential sites for Port of Redwood City land disposal (other than Site #1) or that of other projects would be surveyed by a professional archaeologist and a supplement to the Composite would be issued to cover this and other considerations.

2. Demography and Land Use

Most of the 20,400 port-related jobs are in core urban areas and help sustain the economic health of these areas. Maintenance dredging is essential to port operations; thus, it strengthens the inner-city economy and to some extent retards the exodus from cities to suburbs.

3. Government

Ports are important enough to city governments to have those governments plan continued port activity as part of the socio-economic structure of land use plans.

4. Transportation

Trucking and rail lines interface with waterborne commerce in the Bay Area to link water and land freight transfer. This freight transfer is efficient and economical, and maintenance dredging serves to continue this land-water freight system.

5. Community Cohesion, Recreation and Culture

Maintenance dredging benefits some recreation boaters in areas like San Rafael Creek and San Leandro Marina. Ceased maintenance dredging would have negative impacts on many community economies, structures and cultures.

6. Scenic Resources

Land disposal would have the most impact on aesthetics. Each potential site must be evaluated for habitat value, scenic beauty, and recreation possibilities. A supplement to the Composite Environmental Statement prepared for a chosen land disposal site for specific navigation projects would include these considerations.

V. ALTERNATIVES

Section VI of the Composite EIS, Alternatives, first discusses the alternative involving no maintenance dredging. In order to provide open navigation channels for commercial shipping and for purposes in the national interest, dredging in the Bay Area has become a continual operation and it is doubtful that maintenance dredging would be permanently halted. However, to compare potential impacts resulting from no dredging with those of maintenance dredging, the conditions anticipated from a halt in O&M dredging activities are presented. Two programs of decreasing maintenance dredging activities are described in discussions of complete and partial moratoriums. In general, both moratoriums on maintenance dredging would be extreme measures having both positive and negative environmental effects, but with severe socio-economic impacts of widespread influence in the Bay region and nation as a whole.

To develop a better understanding of dredging operations and the effects derived from them, a number of methods of dredging has been described in Appendix A. The three methods presently in use in San Francisco Bay are the hydraulic cutterhead pipeline, the hopper dredge and the clamshell dredge. Studies now being conducted at the Corps Waterways Experimental Station in Mississippi are mentioned briefly to indicate that work is being done to develop methods which may reduce impacts on the aquatic environment without decreasing dredging efficiency.

After describing the various aspects of the dredging operations, alternative proposals for disposal are examined. Three alternative means of disposing dredged material are elaborated, including ocean disposal, land disposal, and salt marsh development.

A study was conducted by the San Francisco District and the U.S. Navy in September 1974 to assess the impact of ocean disposal in 100-fathoms of water. The Ocean Disposal Study is described in this report.

The means of transporting the dredged material to the disposal site have been cursorily investigated. A conceptual plan of permanent, self-contained pipeline system to the ocean disposal site is presented. The discussion includes general descriptions of accessory facilities such as transfer points on land near Petaluma and Sherman Island, and in San Pablo Bay. Any particular ocean disposal plan would require a detailed feasibility study in which alternative ocean disposal plans would be assessed if implementation is to be eventually approved.

Appendix J of the Dredge Disposal Study discusses the overall feasibility of land disposal. Information related to land disposal in this section has been extracted from Appendix J. Limiting criteria and the site selection process are briefly described. Three land sites suitable for maintenance dredging activities have been selected from the Land Disposal Study and are discussed further: Petaluma River Area, Montezuma Area, and Sherman Island Area. Land disposal is considered as an alternative to open water disposal, since land disposal is a short-term alternative.

Use of dredged material for construction purposes - as conditioned sediments for engineered fill and developing wildlife habitat, and a mixture with urban waste for Delta Island reclamation - are discussed as future planning alternatives to be considered. Prior to implementation of these future programs additional studies would be required for environmental and socio-economic evaluations.

The concept of using "waste" material for beneficial purposes is especially related to development of salt marsh habitat. Several factors have continued to the beneficial nature of this method of dredge disposal. The marsh habitat provides food, spawning and nursery areas for most forms of life in the estuary, as well as contributes significantly to water quality by removing pollutants. There also has been a long history of marsh destruction in the Bay Area due to filling to elevations above tidal influence and diking. Reclamation of marsh habitat has been recognized as a means to help restore the biological productivity of the Bay system.

In related studies of marsh development, as early as 1969, the Coastal Engineering Research Center (CERC) began to study marsh propagation at North Carolina State University. This study showed that cordgrass, a common marsh plant, can be successfully established on dredged material and eroding shorelines.

In 1973, the Waterways Experiment Station in Vicksburg, Mississippi, began a long-range, $30 million, comprehensive study known as the Dredge Material Research Program (DMRP). This program has been designed to develop information on all aspects of dredge-disposal on a nationwide scale. Separate research projects deal directly with artificial marshland island creation and habitat development.

In April 1972, the San Francisco District initiated an investigation of impacts of dredging and dredged material disposal operations in the San Francisco Bay and estuarine environment. The Marshland Development Study (MDS) is one of three studies which addresses specific alternatives to the present system of aquatic disposal in San Francisco Bay. As a result of the MDS, other governmental and private agencies have become convinced of the feasibility of marsh creation and some of these agencies are considering this method for disposing dredge material from their projects.

Comparing the cost efficiency of alternative dredging and disposal systems was found to be a complex undertaking due to the variations of options available. Even considering only the basic options, 1,200 potential dredging/disposal systems could be developed. A computer model was developed to assist in the economic analysis. The following considerations were made to simplify the evaluation:

1. All dredging projects (maintenance and new construction) were arbitrarily assigned to 12 dredging areas in San Francisco Bay and the annual volume of dredged material (1975-1994) associated with each area was totaled.

2. Five major disposal alternatives were considered:

a. Bay disposal

b. Ocean disposal

c. Land disposal

d. Delta Island Reclamation

e. Marshland development

From the considerations, six dredging/disposal schemes were derived as follows:

1. Closest aquatic disposal (no constraints on disposal)

2. Closest aquatic disposal seaward (no constraints, but use closest disposal site seaward from dredging site)

3. Ocean disposal (100-Fathom contour)

4. Land disposal (Petaluma River Area)

5. Delta Island Reclamation (Sherman Island)

6. Marshland Development (Petaluma River Area)

All costs described in Tables VI-9 to VI-15, for each scheme, do not include profit, overhead, supervision, or additional costs which might be incurred for the engineering and design of new equipment. Four equipment categories were selected and evaluated for each of the six schemes:

1. Least cost

2. Hopper only

3. Clamshell only

4. Hydraulic only

Based on the limits of assumptions made for the cost comparison, the following ranking was derived from the least expensive to the most expensive (weighted averages for the least cost solutions of the six schemes):

1. Closest aquatic

2. Closest aquatic seaward

3. Ocean disposal

4. Land disposal

5. Delta Island Reclamation

6. Marshland Development

The San Francisco District has conducted studies on reducing shoaling and maintenance dredging in the Bay utilizing the San Francisco Bay hydraulic model. Tests conducted involved structural plans to either prevent shoaling in the navigation channels or to increase flushing of the channels, and selection of alternative aquatic disposal sites to reduce the amount of sediments returning to the channels.

In ending Section VI, development in dredging equipment and techniques are discussed. Important factors being considered involve improving the efficiency of dredging techniques, thereby reducing turbidity by altering design of existing equipment, acquiring new equipment, applying chemical additives, and adjusting the timing, scheduling, and methodology of dredging operations. An assortment of disposal equipment is also described. For the most part, costs would increase substantially with the minimization of environmental effects.