LTMS FRAMEWORK PLAN
San Francisco Bay

PHASE I. NEEDS ASSESSMENT

PHASE II. DEVELOP CRITERIA

PHASE III. DISPOSAL ALTERNATIVES EVALUATION

- Ocean
- In-Bay
- Upland

SITE SELECTION

PHASE IV. PROGRAM MANAGEMENT

LTMS FRAMEWORK PLAN
San Francisco Bay

PHASE 1: NEEDS ASSESSMENT

IB-6 <u>DREDGING NEEDS:</u>
- Quantities - maintenance & new work
- Existing disposal methods
- Benefits from dredging & disposal

IB-2 <u>SED.RESEARCH:</u>
- Assess SF Bay sediment dynamics
- Project dredging needs
- Provide data base for IB-3

IB-1 <u>SED. CHARACT:</u>
- Compile existing database on sediment physical and chemical characteristics
- *Identify data gaps*
- *Obtain required data*

DRAFT

LTMS PHASE 1: NEEDS ASSESSMENT

Phase Objective: Why are disposal sites needed?

- Quantities to be dredged.
- Benefits of dredging.
- Projects to be included, i.e. deep draft, shallow draft
- Existing disposal site capacity.
- Sediment characteristics: physical & chemical. What is character of material requiring disposal?

(IB-6) DREDGING NEEDS

OBJECTIVES OF THE WORK ELEMENT: The objective of the Dredging Needs work element is to identify the dredging and disposal needs of San Francisco Bay for the 25 year period covered by the Long Term Management Strategy. The needs assessment includes identification of new work, operation and maintenance, and permitted project dredged material quantities for the LTMS period. Two primary reasons for this information are to identify additional required disposal site capacity for ocean, in-bay and upland tasks and to identify benefits resulting from dredging and disposal in San Francisco Bay. Other reasons include identification of dredging areas so sediment sampling can be conducted, geographical study limits can be set and other methods for reducing disposal requirements can be identified and employed if suitable.

AREAS WHERE SIMILAR WORK TASKS HAVE BEEN PERFORMED: The definition of annual dredging needs is being carried out in many locales as part of long term dredging and disposal planning. The Puget Sound Dredged Disposal Analysis in Washington State identified quantities dredged in the previous fifteen year period and disposal methods for that material. Historic records, interviews with port authorities and marina operators, Corps of Engineers permit records and other methods were used to forecast dredging volumes over a 15 year planning horizon. For the Lower Columbia River LTMS, maintenance dredging records were compiled, existing disposal site capacity inventoried and new work dredging quantities considered during the initial needs assessment. For the Lower Columbia LTMS, emphasis was placed on structural and non-structural solutions to reducing dredging quantities. In most areas the Corps of Engineers annual dredging work load has been defined but dredging performed under permit is not as quantifiable.

Portions of this work element (IB-6) have been undertaken for San Francisco Bay. The San Francisco District, Corps of Engineers, has completed studies estimating annual dredging quantities from Corps authorized projects and from permit records. Related benefits accruing to the region from dredging have been identified have also been identified by Bay segment, including those accruing to Stockton and Sacramento Ship Channels. Sedimentation patterns have been assessed and measures to reduce the federal maintenance dredging quantities have been identified. These studies provide a data base for further investigation during IB-6. Analysis of long term trends will be assisted by element IB 2; additional work must be done on the subject of reducing annual dredging quantities.

CURRENT TECHNOLOGY AND ACCEPTANCE: Dredging in San Francisco Bay can be divided into three components. The first is the dredging taking place on federally authorized navigation projects. The work is administered by the Corps of Engineers and is carried out by a combination of contractor and Corps dredging plant. Most of the dredged material is disposed to in-water areas. This constitutes the greatest share of dredging in the Bay and quantities are well documented.

The second type of dredging is carried out by facility owners to maintain access to, and suitable depths at, deep draft marine facilities. The work is administered by the facility owner (e.g. port authority, U. S. Navy, private company) and is performed within the framework of federal, state and local regulations. This work is covered by permit and is not well documented as to actual quantities.

The third type of dredging is carried out by boat harbors and marinas to maintain access and suitable depths for shallow draft water craft. This work is primarily maintenance dredging and may occur in fairly small quantities at irregular time intervals depending on area siltation rates. The work is administered by the facility owner and carried out by private contractors with the regulatory framework mentioned above. Quantities and activity are not well documented.

Quantifying the details of the existing dredging workload can be done to acceptable levels of accuracy. Defining long term trends and methods to reduce dredging will be somewhat speculative and will provide qualitative rather than quantitative answers. The definition of dredging benefits is complex and results in the statement of benefits in simple economic standards such as jobs, dollars of turnover and effect on product cost.

DETAILED SCOPE OF WORK:

I. TASK 1. DREDGING NEEDS. Existing and ten year forecast of dredging in San Francisco Bay.

A. Channel dredging. Review existing literature. Utilize Corps of Engineers historical data on maintenance dredging. Evaluate new work dredging plans and studies and project annual work load for ten years.

B. Facility dredging. Review existing literature. Solicit information from U.S. Navy and port authorities on dredging quantities and future plans. Review existing Section 10 permit files and compile quantities and sources of dredged material. Evaluate new work dredging requirements.

C. Marina dredging. Review existing literature. Review existing Section 10 permit files and compile quantities and sources of dredged material . Interviews as appropriate with selected marina owners and dredging contractors.

PRODUCT. A report documenting annual dredging quantities, by category, by area and by disposal method and location for the 1990-2000 year period.

II. TASK 2. REDUCTION OF DREDGING. Studies and methods available to reduce dredging load.

A. Review existing literature. Identify further studies or design work likely to make significant reductions in maintenance dredging work.

B. Provide brief outline for the scope of this additional work, its cost and its likely benefits in terms of reduction of annual dredging.

C. Review using traffic in terms of vessel size and frequency and compare to channel design parameters. Discuss existing channel situation with responsible Corps of Engineers, Coast Guard, port authority and pilot representatives. Identify specific channel reaches where dredging practices could be modified with minor or no effect on using traffic or existing benefits.

D. Provide brief outline for the approach and cost to evaluate channel design modifications identified and the likely benefits in terms of reduction of annual dredging.

E. Provide brief outline for the approach and cost to provide guidance in siting shallow draft marine facilities to minimize sedimentation and reduce maintenance dredging.

PRODUCT. A report containing the findings for the work element and estimating the amount of dredging reduction which could be accomplished.

III. LOSS OF BENEFITS. Identify and quantify benefits lost or costs increased through reduction or changes in the dredging program.

A. Review existing literature. Document and update existing data sources on studies to 1990-2000 time frame. Provide an estimate of loss of economic activity by cessation of dredging for various sections of the Bay.

PRODUCT. A report containing the results of the benefits lost calculations.

IV. POLICIES AND RECOMMENDATIONS. Formulation of policy statements and recommendations regarding dredging and disposal.

A. Based on the results of the preceding work, formulate a draft policy statement regarding dredging and disposal for each of the three categories; channels, deep draft and shallow draft facilities. The policy statement will, at a minimum, cover the necessity of dredging, the preferred methods of disposal, acceptable levels of economic and financial penalties and benefit losses to users as well as overall guidance to federal, state and local decision makers and regulators. This policy statement should also recognize, and explain, the existing regulatory framework for authorizing, funding and carrying out dredging work in the Bay. The policy statement will be in draft form subject to the outcome of additional work elements.

PRODUCT. A report containing the policy statement and the rationale for it, with an appendix explaining the existing regulatory framework.

(IB-2) SEDIMENT RESEARCH

OBJECTIVES OF THE WORK ELEMENT: Research on the sediment inputs/source, sediment circulation and sediment losses of the San Francisco Bay system is needed for design and siting of works and operations that will minimize sediment accumulation in navigation facilities, management of maintenance dredging and dredged material disposal, and for sediment related water quality management. Research is also needed to found sediment transport models on physically sound processes and accurate sediment characterization and for verification of transport models. The objectives of this work element include determination of sediment input/source, distribution of sediment accumulation, and losses from the system on an annual and longer time scale to provide relevance to dredging and disposal time scales, and on shorter time scales to provide information on the transport that is appropriate to modeling and design of navigation works and management of water quality.

AREAS WHERE SIMILAR TASKS HAVE BEEN PERFORMED: Pioneering work in the San Francisco Bay system sediment budgets includes that of Gilbert (1917), Porterfield, Schultz and Smith (1966), and Krone (1979). Studies of cohesive sediment transport processes include field and laboratory studies of Krone (1959, 1962, 1963), laboratory erosion and deposition studies by Partheniades, Mehta and others, and a tracer study of sediment transport in the upper bays by the Lawrence Livermore National Laboratory (LLNL) for the San Francisco District (1979). [illegible] been a [illegible] sediment transport [illegible]

CURRENT TECHNOLOGY: The studies described above have provided descriptions of sediment input, circulation and loss from the system as of 1956, when the last system-side hydrographic surveys were completed. Projections of the previous studies are of limited use because the sediment inputs have been reduced by upstream water diversions and dredging activity and dredged material disposal sites and site loading have been changed. A system-wide hydrographic survey by the National Ocean Survey is nearly complete, making this an opportune time for conducting a sediment balance study.

Descriptions of sediment transport processes are now included in sediment transport models. These descriptions include parameters that require measurement of sediment properties. Settling velocities of aggregates, critical bed shear stresses for deposition and erosion, and bed density and bulk shear strength from the surface downward, for example. Such data are available for few sites in the San Francisco Bay system. Improvements have been made in field determination of settling velocities, but little improvement has been made in determining shear strengths. Measurements of suspended solids concentrations require sampling and laboratory determination, at least for frequency calibration of optical devices.

Hydrographic survey equipment is now available for making detailed, accurate surveys of water depths. As noted above, the NOS surveys of the Bay system are nearly complete. Hydrographic surveys of problem areas, such as areas of rapid shoaling and disposal areas, can be made at appropriate interval to evaluate the processes that lead to their problems.

DETAILED SCOPE OF WORK:

I. TASK 1. Conduct an annual (water year) sediment budget for the period 1956 to 1990 and project to years 1990 and 2030.

   A. Obtain water year delta outflows from the Bureau of Reclamation for the years 1955 through 1990 and the projected outflows for storage and diversion conditions existing in 1990 and 2030. These outflows should include application of the appropriate operations to all the river flow years of record. Related annual flow to sediment production and determine annual sediment production for the years 1955 through 1990, and for the projections using all years of records.

   B. Determine the NOS hydrographic surveys of mid-1950's and late 1980's the changes in water depths averaged over one-minute quadrangles and adjust for sea level rise to obtain changes in elevation.

   C. Determine amount of dredged sediment disposed on land from the Navy, the Corps, and private port and marina operators.

D. Calculate the distribution of in-Bay deposits by bays and the loss to the ocean by difference between input and total accumulation. (Measurement of the annual loss to the ocean would require continuous monitoring of the complex three-dimensional, high velocity flows through the Golden Gate over a long enough time to provide statistically significant annual losses. Short duration efforts, described below, can be combined with modeling to estimate losses for particular hydrologic conditions.)

E. Obtain annual maintenance dredging volumes to relate annual sediment supply to maintenance requirements.

PRODUCT: A report documenting the study and showing effects of changing sediment input and an estimate of the effect of changes in disposal operations on loss to the ocean. The report will also show relations between sediment supply to the system and maintenance dredging volumes, if such relations exist, and project future sediment inputs and their variability and trends in in-bay accumulation (assuming the same fractional loss to the ocean). A bathymetric atlas, with graphic depiction of historic accretion and erosion areas.

II. TASK 2. FIELD AND LABORATORY STUDIES

A. Characterization of suspended and deposited sediment. Field measurements of the settling velocities of suspended aggregates in five shoaling areas, including three navigation facilities and a shallow area in San Pablo Bay and a shallow area in San Francisco Bay, at various suspended sediment concentrations are needed for modeling.

Measurements of bed properties are needed in the shallow areas of San Pablo, San Francisco, and South San Francisco Bays on a monthly schedule from October 1 to May 1 to determine the amount and duration of transient deposits in these areas for use in verifying models. The thickness and density of the transient deposits are needed in representative locations with regard to wind patterns and water depths. Particle size distributions of composites of multiple samples in each location are also needed.

Densities and particle size distributions of material deposited in navigation facilities have been obtained. These data should be reviewed, and if inadequate, core samples should be taken for determination of sediment density with depth from the bed surface.

A synoptic measurement of currents, winds, and suspended sediment concentrations should be made over a tidal cycle for verification of models. He locations of the measurements in the system should be selected after evaluation of the availability of current meters and sampling equipment and in consultation with the modelers so that the objectives of the model studies are assured.,

Detailed hydrographic surveys of navigation and disposal areas of interest should be taken in the fall one year apart for verification of sediment transport models.

PRODUCT: A documented data set that will provide sediment parameters for transport models and suspended solids and sediment accumulation data for their verification.

III. TASK 3. SUSPENDED SEDIMENT FLUX THROUGH THE GOLDEN GATE

A. In view of the importance of suspended sediment losses through the Golden Gaste, it would be desirable to measure sediment afflux and influx there over several tidal cycles. Such measurements would be useful for verifying models that then can be used to simulate sediment losses for particular disposal operations or other system modifications. Flows in this region are complex, and useful measurements would be obtained only with a dense array of meters and suspended solids measuring devices. Measurements in the high energy environment of the Golden Gate will be hazardous and expensive, and the desirability of undertaking this task should be evaluated in terms of the funds available and the need for model verification.

PRODUCT: A documented and evaluated data set giving the flux out of and into the Golden Gate for the tidal conditions and the ambient suspended sediment regime at the time. This data set would be useful for modeling the loss of sediment disposed in the region, and for verifying a system-wide model if the measurements were made as part of the synoptic current and suspended solids data collection described Task (IB-2).

(IB-1))SEDIMENT CHARACTERIZATION- REVIEW EXISTING DATA

OBJECTIVES OF THE WORK ELEMENT:

1. Construct a sediment quality database using sediment physical and chemical and toxicity data compiled by the RWQCB for approximately fifty (50) proposed dredging projects since 1987.

2. Use the database as the foundation of a sediment chemical and toxicological analysis program designed to establish sediment quality objectives for San Francisco Bay.

The review of existing sediment chemical and toxicity data will provide information to both the Needs Assessment and Criteria Development Phases of the LTMS program. While this work element has been placed within the In-Bay Studies Task of the program, the information that would be produced by this work is relevant to the Ocean and Upland Studies Tasks as well. This is because to some extent at least, the characteristics of Bay sediments along with other program considerations will influence decisions about the suitability of dredged Bay sediments for unconfined in-Bay disposal, ocean disposal or confined aquatic, nearshore or upland disposal. Disposal option decisions will ideally be affected by sediment quality information through comparisons between the characteristics of material to be dredged, and technically-founded sediment quality standards, or more flexible guidelines designed to predict sediment toxicity in different physical-chemical environments. The sediment quality database would be designed and constructed under this work element and would support the development of these regional sediment quality standards or guidelines. This work element will not produce sediment quality standards or guidelines. These will be the product of Work Element No. 9 of the In-Bay Studies Task entitled, Development of Sediment Quality Objectives.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED: The New England and Northwestern Regions of the coastal U.S. have been the two areas of the country where attention to sediment classification and sediment quality development have been most intense.

In 1980, the New England River Basins Commission published an Interim Plan for the Disposal of Dredged Material from Long Island Sound. The Interim Plan was developed in response to public health concerns of several state, interstate and Federal agencies regarding open water disposal. The plan represented a cooperative effort to define a consistent disposal management program and set forth the State policies of Connecticut and New York on open water disposal in Long Island Sound. The plan applies only to open water disposal within Long Island Sound and does not recommend alternative disposal strategies to open water dumping. The plan contains a classification scheme for dredged sediments that is used to determine if biological testing of sediments will be required in the review of a disposal action or what conditions will be placed on the disposal of dredged material. The classification scheme is based upon the statistical analysis of sediments from numerous ports and harbors in the vicinity of open water disposal sites.

The Puget Sound Dredged Disposal Analysis (PSDDA) Program in Washington State has as its goal the development of publicly acceptable guidelines governing environmentally safe unconfined open water disposal of dredged material and an improvement in the consistency and predictability of the decision making process. The PSDDA Program's objectives are to: (1) identify acceptable public multiuser unconfined open water disposal sites; (2) define consistent and objective evaluation procedures for dredged material to be placed at those sites; and (3) formulate site use management plans that will ensure adequate site use controls and program accountability. Sediments meeting the open water disposal criteria established during the PSDDA process may be disposed at an approved and permitted open water sites. The State of Washington is currently developing criteria, including sediment standards, for confined disposal of dredged material. Confined disposal options include aquatic, nearshore and upland disposal sites.

Both the New England and Puget Sound Programs are in effect at this time. Active open water disposal sites for dredged material exist in both regions; these sites are being managed according to programs that began in the same way and for the same reasons as those which have influenced the need for the LTMS Program in San Francisco.

CURRENT TECHNOLOGIES AND ACCEPTANCE:

Database Management Hardware and Software: The probable success of the database construction and analysis aspects of this work element are improved by the existence of powerful, relatively economical PC-compatible micro-computers and off-the-shelf database management program software. The database management scheme should permit the flexibility that will be required by a new program that will evolve with new ideas about how the data should be analyzed. And the database should be accessible to the multiple potential user groups that are represented within the LTMS program. Specifications for PC-compatible hardware and commercially available off-the-shelf database management software are intended to optimize accessibility with the understanding that proficiency in database programming will be required during database design and during any modifications to the design. But there is no question about the adequacy and technical acceptability of current technology to do the job.

Data Accessibility, Comparability and Quality: Existing data will need to be entered into the database according to a uniform format. If data exists only as hard copy in project files, data will be less accessible and the data entry task will be more arduous than would be the case if data existed in computer files. Manual data entry would also require attention to quality assurance to detect and correct data entry errors. Data comparability and quality will be influenced by understanding the affects of sediment sample collection, sample handling and sample analysis procedures upon the information available for database entry. It will be important to understand the probable contribution of sampling, handling and analysis procedures upon sampling error and analytical error. It will be important to ask the following questions of the data. (1) How well did the sampling represent horizontal and vertical variability in the data describing a particular area? (2) Did sample handling procedures which occurred between sample collection and sample analysis affect sample quality? For example, how long were samples held before analysis and what were the holding conditions? (3) Were comparable analytical and biological testing procedures employed by the chemical and biological testing laboratories? Identical procedures are not necessarily required; however, there should be a basis for determining compliance with performance standards expressed in terms of chemical analytical sample detection limits, or mortality of controls during bioassay tests. Without incorporating these considerations into the database screening process, the quality of the database will always be suspect and the technical defensibility of all conclusions derived from the analysis of the database will be questionable.

DETAILED SCOPE OF WORK

I. TASK 1: DATA INVENTORY. This phase will support efforts to determine what data and how much data are available and the format of the data. This phase would conclude with a decision about what data will be used and would allow the investigators to better estimate the effort required for the next phase.

II. TASK 2: COMPILE THE DATA. If the data is already all in one place, this would be a very small effort. If the data is dispersed, the effort would obviously be larger.

III. TASK 3: SCREEN THE DATA. This would be done in steps;

Step 1 Identify screening criteria for data sorting that could be used and data of questionable quality that should not be used. A reason to question data quality would be the absence of any QA/QC data to support the sediment chemistry results,

Step 2 Apply the screening criteria to the available data.

IV. TASK 4: DATABASE DESIGN. This would ideally be carried out in collaboration with the investigators responsible for the development of sediment quality objectives in LTMS Phase 2. This is because the database should be designed to permit specific questions to be asked and analyses to be performed. Those responsible for sediment quality objectives will choose the approach that will be taken for defining these objectives and the approach chosen will dictate the questions to be asked.

PRODUCTS: A variety of products is possible and it is likely that iteration between the database builders/managers will lead to some changes in direction but the following are suggested for further discussion:

First generation - A PC-compatible database integrated with PC based descriptive and analytical statistical software and graphics software. The first version would be relatively less user friendly than subsequent versions.

Second generation - A more friendly, easier to use, menu-driven database accompanied by a users guide containing hardware and software requirement specifications.

Third generation - A database capable of accepting new sediment characterization data and coupled with an integrated QA/QC screening program to assess input data acceptability and summary output programs describing the results of comparisons between the project data and sediment quality objectives or criteria for various disposal options.

PHASE 2: DEVELOP CRITERIA

A IDENTIFY RESOURCES TO BE PROTECTED:

- *Biological, ecological resources of concern*
- *Identify data gaps*
- *Obtain required data*
- *Based on existing plans (BCDC, RWQCB)*

IB-5 <u>BIOACCUMULATION:</u>

- Assess health of resources of concern (Element A)
- Impacts of disposal on resources

IB-9 <u>SEDIMENT QUALITY CRITERIA:</u>

- Criteria to aid in identification of appropriate disposal option for a particular dredged material

DRAFT

DRAFT

LTMS PHASE 2: DEVELOP CRITERIA

PHASE OBJECTIVE: Which resources do we want to protect and what criteria will protect them?

- Characteristics of resource: biological, ecological.
- Affect on resource(s) by sediments identified in Needs Assessment (above).
- What is existing resource(s) health.
- Agree on sediment criteria objectives; which sediments are suitable to remain uncontained, which need containment.

ELEMENT A. IDENTIFY RESOURCES TO BE PROTECTED

OBJECTIVES OF THE WORK ELEMENT: The goal of this element is to identify those San Francisco Bay region resources that are affected by dredging and disposal and which are to be protected. Legislation and public policy exist that have established resources of concern. Representative documents that reflect such policy include BCDC's San Francisco Bay Plan and the RWQCB Basin Plan.

Note: Need consensus on appropriateness of element prior to completing work scope. Topic for discussion.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED:
CURRENT TECHNOLOGIES AND ACCEPTANCE:
DETAILED SCOPE OF WORK:

(IB-5) BIOACCUMULATION

OBJECTIVES OF THE WORK ELEMENT: The objective of bioaccumulation studies during LTMS Phase 2 is to assess and document the baseline condition of applicable biological resources identified in *A. Resource Identification*, above. These objectives include:

1. Establish baseline body burden concentrations of contaminants in one or more than one macrobenthic infauna species inhabiting potential dredged material disposal sites within San Francisco Bay.

2. Assess the bioavailability of contaminants associated with suspended sediments and water at candidate or designated disposal sites.

The biological effects of dredged material disposal in the aquatic environment are among the more prominent concerns of the public and regulatory agencies, particularly as they relate to resource species. These concerns are focused in two areas: contaminant bioaccumulation and food chain transfer, and toxicological impacts which may cause cumulative chronic impacts. Investigations that address these two areas must consider the appropriate exposure route, the biological endpoint and the species used. In addition, stations where field bioaccumulation studies are performed must be located in such a way that the effects of disposal operations can be differentiated from other regional water and sediment quality effects.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED: There is a very large volume of technical literature describing the transf[illegible] chemical substances from water or from sediment to animals or from animals when eate[illegible] other animals. Most of this literature describes investigations whose objectives are to d[illegible]t levels of faunal contamination related to levels of contamination within the environments inhabited by these fauna. The bioaccumulation analysis investigation element associated with the In-Bay LTMS Studies Task share this objective but will be designed to establish baseline levels of contaminant concentrations in the tissues of selected marine organisms, and to discern any change in concentrations of contaminants that are related to the disposal of dredged material in San Francisco Bay.

Studies of contaminant levels in benthic infauna and mussels have been performed in San Francisco Bay. These studies have led to conclusions that there is a relationship between sediment contamination and the contamination levels in animals associated with those sediments. These studies have also identified the existence of seasonal variability in contaminant body burdens within the sa[illegible] population.

There are two nationally recognized dredged material management programs that include bioaccumulation considerations in their dredged material management decisions. These are the Disposal Area Monitoring Systems (DAMOS) Program in New England and the Puget Sound Dredged Disposal Analysis (PSDDA) Program. Both of these programs incorporate information obtained from the analyses of organisms collected on-site and off-site to determine if contaminants associated with the dredged material are being transferred to animals inhabiting the disposal site and more importantly according to Federal regulatory standards, to animals located outside the designated disposal site boundaries.

CURRENT TECHNOLOGIES AND ACCEPTANCE: The presence of elevated concentrations of contaminants in animals inhabiting contaminated aquatic or terrestrial environments has been established and is generally well accepted. As is the case with many scientific inquiries, the trend has moved from studies to document the occurrence of a relationship between environmental and faunal contamination to studies intended to quantify the nature of that relationship and studies to understand the chronic sublethal impacts of contaminants on affected organisms.

A Corps of Engineers, Waterways Experiments Station, Environmental Effects of Dredging Information Exchange Bulletin dated October 1983 states that with regard to both metals and PCBs:

1. Concentrations of chemicals in organisms generally approach the concentrations in sediments within an order of magnitude under severe exposure conditions.

2. The approach to steady state is describable in kinetic terms.

3. Suspended particulate concentrations influence uptake of chemicals.

4. Ingestion of contaminated food may also be an important route of introduction of contaminants into the tissues of an organism.

The DAMOS Program has taken two approaches to determine bioaccumulation potential that may result from dredged material disposal: the deployment of caged mussels and collection of indigenous benthic deposit feeders. These organisms are analyzed for uptake of contaminants associated with dredged material to indicate dredged material transport and exposure.

The PSDDA Program included the analysis of contaminants in tissues of an indigenous infaunal species, a seacucumber, during baseline studies of its non-dispersive Puget Sound disposal sites. This analysis is also included in the annual monitoring program for disposal sites used during the preceding dredging season.

There are numerous subtle but very important considerations that must be a part of a bioaccumulation investigation if the investigation is to produce useful results. The occurrence of seasonal contaminant body burden changes has already been mentioned. There are obviously species-specific differences that make it necessary to collect and analyze a single species. Size within a species is important. When an infaunal species is being selected, a species which feeds on sediment particles is preferable to one that feeds by filtering water circulating through its burrow. All in all the techniques are pretty well established and accepted. As is true in all studies involving the collection and processing of environmental samples for trace contaminant analyses, scrupulous attention to QA/QC procedures are absolutely necessary.

DETAILED SCOPE OF WORK:

I. TASK 1. LITERATURE REVIEW. Compile and review literature describing contaminant body burdens in Bay infauna. Include both laboratory and field investigations in the review but discuss results separately. Also include in this review any studies describing the accumulation of contaminants by organisms exposed to suspended natural Bay sediments. Results of the National Mussel Watch Program and the National Status and Trends Program should be incorporated into the review. Time to complete: 3-4 months.

PRODUCT: A concise report emphasizing the use of summary tables and graphics and containing a narrative introduction, methods, results and discussion. This should not be an annotated bibliography. Complete citations along with information on the location of all cited references should be provided by the investigator.

II. TASK 2. STUDY PLAN. The Literature Review will identify candidate organisms, historical trends [illegible] and the apparent importance of deposited and suspended sediment sources of contamination of Bay organisms. This information will be used to prepare a detailed field study plan that will include methods for sample collection, handling (including gut purging if necessary), storage, transport and analysis. The analytical plan will recommend a list of contaminants, and will contain guidelines for dealing with level of detection difficulties affected by complex tissue matrices or other likely analytical problems. The collection of ancillary field data or the analysis of non-contaminant tissue characteristics such as total lipids should be specified by the plan.

Procedures for deposited sediment bioaccumulation studies using infauna and for suspended sediment bioaccumulation studies using mussels (or other organisms) should be specified as appropriate. If special exposure devices are required, as would be the case in a caged mussel study, then detailed plans for the fabrications of these devices need to be included in the Plan. Time to complete: 1-2 months.

PRODUCT: A detailed Bioaccumulation Study Plan.

Site specific bioaccumulation analyses will be made during LTMS Phase 3: Disposal Alternatives Evaluation (see Phase 3, IB-5- Bioaccumulation).

(IB-9) DEVELOPMENT OF SEDIMENT QUALITY CRITERIA

OBJECTIVES OF THE WORK ELEMENT: The work element will produce numerical chemical-specific sediment quality values and quantitative toxicity sediment quality values. These values will be used as part of an initial screening process to help identify sediments best suited for in-Bay or other disposal options.

AREAS WHERE SIMILAR TASKS HAVE BEEN PERFORMED: Numerical chemical and/or toxicity values are being used in several areas. EPA Region V has used numerical chemical-specific values since the 1970s. However, in recent years they have placed increasing emphasis on the results of case-by-case biological testing due to the difficulty in relating their chemical values to potential for unacceptable adverse impact. EPA Region II and the New York District of the Corps of Engineers chose not to develop chemical values, but since the late 1970s have used quantitative toxicity and bioaccumulation objectives to evaluate case-by-case biological tests of dredged material.

The Puget Sound Dredge Disposal Analysis (PSDDA) Program has developed chemical-specific numerical sediment quality values that the State of Washington has used as a basis for sediment quality standards. The PSDDA values were approved through a public participation process, and are used to determine acceptability for unconfined aquatic disposal. A dredging proponent whose operation is judged unacceptable can conduct case-specific biological tests to demonstrate that the operation is acceptable even though it exceeds the values.

Most of the rest of the country does not have formally adopted numerical chemical or toxicity values for assessment of dredged material. Case-by-case testing and evaluation in comparison to reference data and project objectives are used to select disposal options.

Numerical chemical-specific values are being developed by the U.S. EPA Criteria and Standard Division. Tentative values have been developed for a few chemicals, but the agency has yet to issue a description of the intended use or an implementation plan for applying the values when they are developed.

CURRENT TECHNOLOGY AND ACCEPTANCE: As indicated above, dredging is being regulated and conducted in many areas of the country without the use of numerical chemical or toxicity values. Some areas have found such values useful and have ongoing regulatory programs in which the values play a prominent role.

Numerical toxicity values are developed by a consensus of interested parties concerning the appropriate tests, species and levels of response. Chemical values are usually derived through a procedure intended to allow inference of biological effects from sediment chemistry. The two procedures for driving numerical chemical specific values receiving the most attention at present are the Apparent Effects Threshold (AET) and Equilibrium Partitioning (EP) procedures. The AET approach is used in the PSDDA program. It is based on correlations between sediment chemistry and biological parameters in a data set from the area in which the values are to be applied. The EP approach is being developed by the U.S. EPA. It is based on the present understanding of the mechanisms controlling the availability of sediment-associated contaminants to biota. Both procedures for deriving numerical chemical-specific values have been reviewed by the U.S. EPA Science Advisory Board, which expressed reservations about the scientific adequacy of either procedure to form the basis of a regulatory program, given the present level of knowledge.

The objectives for developing sediment quality values in this work element include screening to help identify appropriate disposal options for a given sediment. This requires an awareness of the basic factors controlli[illegible] [illegible]nvironmental impacts of each disposal option. The basis physicochemistry that contro[illegible] [illegible]tential impact is very different in aquatic (in-Bay or ocean) and upland (or emergent island) sites. Sediment in aquatic sites is reduced, anoxic and near neutral in pH. A large proportion of the metals in the sedime[illegible] [illegible] present as sulfides and many of the benthic and water column estuarine (or marine) organisms in the Bay or ocean. If dredged and organic contaminants tent to associate with organic carbon. The resources potentially at risk are placed in an upland site, a sediment will dry and oxidize. The oxidation of any sulfides present lowers the pH, which is exacerbated by acid rain, and can increase the mobility and availability of metals. Oxidation of organic carbon over time can also increase the mobility and availability of organic contaminants. In addition to chemicals in upland sites, the potential impacts of salt on surface and groundwater must be considered. The resources potentially at risk include groundwater, terrestrial plants, soul invertebrates and their predators, etc.

Because of the different physicochemical conditions and resources at risk in aquatic and upland disposal, there is not a simple relationship between degree of contamination and preferable disposal option. Some sediments (i.e. saline sediments high in metals and sulfides) may have a greater potential for adverse impact in an upland site than in an aquatic site. The fact that a sediment has a potential for impact in an aquatic site does not mean it has less potential for impact in an upland site. It is not technically sound to say that any sediment that exceeds a certain chemical value is unacceptable for aquatic disposal and therefore should go to an upland site.

All present numerical chemical-specific or toxicity values are for sediments in the aquatic environment. Therefore, their technical acceptance as screening tools depends on carefully establishing proper bounds on their use. Exceedance of values developed for the aquatic environment might be used to indicate the potential for impacts of a sediment at aquatic sites. However, exceedance of these values does not mean that upland disposal poses less environmental risk. Toxicity to aquatic organisms under aquatic conditions tells almost nothing about effects on terrestrial resources under upland conditions. Therefore, numerical chemical or toxicity values might be used to screen for suitability for aquatic disposal, but the same values would not be technically acceptable for deciding that upland disposal was environmentally preferable.

DETAILED SCOPE OF WORK:

Sediment quality values will be useful in both the LTMS program and the broader Bay Protection and Toxic Cleanup Program of the Regional Water Quality Control Board. The development of technically sound, comprehensively useful sediment quality values is a relatively time consuming and complex exercise. Therefore, it should be undertaken with the maximum utility for all programs in mind. One of the overall goals of the LTMS approach is to establish a procedure for selecting the most suitable disposal sites for material dredged in the San Francisco area.

Sediment quality values developed under the program must be helpful in achieving that objective. The sediment quality values and the guidelines for their implementation (described in Task 4 below) must by fully compatible with the provisions of the various federal (NEPA, CWA, MPRSA, etc.) and State laws under which LTMS will be implemented.

I. TASK 1: DETERMINE PURPOSE OF LTMS SEDIMENT QUALITY VALUES. This must be done with the objective of helping to select the appropriate disposal option clearly in mind. The proceeding discussions concerning the physicochemistry of the disposal options must be kept in mind when determining the ways in which sediment quality values could best be applied to achieve the objectives of LTMS. Task 1 should be given serious attention because it is the most critical part of the entire process. However, it might be rather quickly accomplished and the results may require only a few pages of text to state.

II. TASK 2: REVIEW VARIOUS APPROACHES TO DEVELOPING SEDIMENT QUALITY VALUES, CRITICALLY IDENTIFYING THE STRENGTH AND LIMITATIONS OF THE VARIOUS APPROACHES AND METHODS.

A. The utility of numerical chemical-specific values versus a toxicological approach should be considered identifying the strengths and limitations of each general basis for setting sediment quality values.

B. Specific chemical and toxicological methods for deriving sediment quality values should be evaluated, critically identifying the strengths and limitations of each method.

C. Based on objectives of Task 1 and characteristics of methods identified in Task 2, identify most applicable approach for LTMS interim and long-term needs. For example, Task 2 might indicate that the easiest and least expensive approach to implement as an interim measure would be sediment quality values consisting of a narrative statement such as "The screening values is x percent response in the specified sediment toxicity test using the designated species." This type of sediment quality value could be applied in both aquatic and upland disposal options by designation of appropriate tests, end points and species. The Task 2 information may indicate that an appropriate approach for long term development of sediment values might be the use of a suite of biological tests, each of which would address differing concerns such as chronic toxicity, bioaccumulation, etc. Some of the tests that might be desired for inclusion in the longer term sediment quality statements may need to undergo refinement before they are ready for routine regulatory application. Alternatively the Task 2 exercise might indicate that one of the approaches for developing chemical-specific values better suits LTMS needs and might be amenable to interim implementation.

III. TASK 3. DEVELOP SEDIMENT QUALITY VALUES, IDENTIFY APPROPRIATE EXISTING DATA AND IDENTIFY AND FILL DATA GAPS. Develop values for both interim and long term implementation. Depending on findings of Task 2, Task 3 may develop chemical-specific values by one of the available procedures. Alternatively, if a biological approach were identified as preferable, Task 3 may refine biological procedures identified as necessary for more complete implementation of the preferred biological approach.

IV. TASK 4. DEVELOP IMPLEMENTATION CONCEPT AND PLAN FOR UTILIZING SEDIMENT QUALITY VALUES. Identify interim and long term application. Identify appropriate and inappropriate purposes for sediment quality values and describe how values are to be used in achieving those purposes. Provide the framework for regulatory implementation of sediment quality values.

V. TASK 5. APPLICATION OF SEDIMENT QUALITY VALUES TO S.F. BAY DREDGED MATERIAL. Depending on the timing of implementation, characterization might be based on the short term procedures, or if longer term procedures had been developed, they would be used to characterize the Bay.

PRODUCT: Task 1 would produce a written policy statement. Tasks 2,3 and 5 would produce scientific reports and manuscripts for publication in peer-reviewed scientific journals to provide independent review and credibility for the work. Task 4 would produce a policy statement for implementation of sediment quality values.

LTMS FRAMEWORK PLAN
San Francisco Bay

PHASE 3: DISPOSAL ALTERNATIVES EVALUATION

	PHYSICAL	BIOLOGICAL	RESOURCE	ECONOMICS/COST	INSTITUTIONAL
IN-BAY •Dispersive •Non-Disp.	IB-4: Suspended Sed. Effects IB-7: Surveys IB-3: Disposal Monitoring	IB-4: Suspended Sed. Effects IB-7: Benthic Analysis	IB-7: Fisheries Usage	*B. Operational Cost Estimates*	
UPLAND •Beneficial •Contained, Single Purpose	U-1,2,: Physical Site Con-straints for Designated Use	U-1,2,3: Wetland/upland habitats	U-1,2,3: Resource impacts/ enhancement	*B. Operational Cost Estimates* U-1,2,: Market, demand for material	U-3 Standards
OCEAN	O-1: Prel. ZSF O-2: Prel. Survey O-3: Physical Oceanography O-4: Geological Oceanography	O-5: Benthic Epifauna/ Infauna	O-6: Fisheries O-7: Marine Birds/Mammals	O-8: Economic Valuation *B. Operational Cost Estimates*	O-9:Site Desig. Process

DRAFT

LTMS PHASE 3: DISPOSAL ALTERNATIVES EVALUATION

Phase Objective: What disposal sites are available and suitable to meet the criteria and need established above?

Three "places to look" have been identified: ocean, in-Bay and upland. For each of these locales, similar investigations are required. Investigations are required of:

1. **PHYSICAL**-potential sites' physical characteristics,
2. **BIOLOGICAL**-their biological communities and values,
3. **RESOURCE**-their resource contribution and its value
4. **ECONOMIC**-economic considerations and impact of an option and/or specific site
5. **INSTITUTIONAL**-the institutional factors and framework affecting use, permitting, funding

IN-BAY DISPOSAL ALTERNATIVE ASSESSMENTS

(IB-4) SUSPENDED SEDIMENT EFFECTS - PHYSICAL and BIOLOGICAL

OBJECTIVES OF THE WORK ELEMENT: There is concern that the resuspension of sediments can influence biota in two primary ways. One has to do with the effect of resuspension on the release of contaminants from the sediments and the availability of those contaminants to organisms. The other is the direct physical effect of suspended solids on organisms. A third area of concern is not biological, but concerns the aesthetics of suspended sediments associated with dredged material disposal. All these concerns will be addressed by tasks in this work element which objectives are:

1. Determination of the effect of suspensions of sediment on the biological availability of contaminants from those sediments.
2. Determination of the effects of suspended sediments on survival of sensitive life stages of fish and other Bay organisms.
3. Determination of the potential aesthetic impacts of suspended sediments associated with dredged material disposal.

AREAS WHERE SIMILAR TASKS HAVE BEEN PERFORMED: The partitioning of contaminants from sediments in suspension has been investigated by a number of scientists from a theoretical physical chemistry perspective. These studies have determined that the resuspension of the sediment influences the rate and extent to which contaminants associated with the sediments become more readily available to biota. This phenomenon has been investigated from a biological perspective to a lesser extent. MacFarland has studied the influence of various concentrations of suspended sediment on biological availability of contaminants on freshwater systems and has shown that availability increased with increasing concentrations of sediment in suspension. Investigations by the U.S. EPA laboratory at Narragansett, Rhode Island have touched on this phenomenon to a lesser extent and have confirmed the general pattern seen by MacFarland and expected from the physical chemistry studies. Most such study is either from a chemical perspective or involving freshwater or east coast species. Little such work has been conducted using San Francisco organisms or sediments from San Francisco Bay. While the general phenomenon should not be any different in San Francisco Bay sediments or organisms, the details of the rate and magnitude of occurrence need to be determined in the Bay area for application here.

The direct influence of suspended sediments on aquatic organisms was studied by several investigators in the 1960s and 1970s. These studies include Appendix G to the 1975 San Francisco Dredged Disposal study. This study looked at the influence of salinity, temperature, dissolved oxygen, and suspended sediment concentrations on survival of juvenile and adult organisms from the San Francisco Bay area. Field studies in the Chesapeake Bay in the late 1960s touched on the issue of suspended sediment effects on planktonic organisms, and Davis and Hidu studied the effect of suspended sediments on bivalve larvae. Few other studies have addressed the issue of effects of suspended solids on sensitive life stages and very little work on this topic has been done using San Francisco Bay area organisms.

The aesthetic impacts of suspended sediments associated with dredged material disposal depend on a host of site-specific conditions, and have been little studied in San Francisco Bay.

CURRENT TECHNOLOGY AND ACCEPTANCE: Proper conduct of contaminant bioavailability studies of suspended sediments depends upon the maintenance of constant suspended solids concentrations in the test aquaria over long time periods. This is not a trivial task, but can be done successfully using several different approaches. All require frequent monitoring of suspended solids concentrations in the aquaria, continuous dosing of suspended solids, and a feedback mechanism to control the dosage in response to the concentration measured in the aquaria. Maintenance of suspended sediments in vessels adequate for investigating sensitive life stages is a simpler matter, since these tests can be conducted in smaller containers and do not require frequent changing or replacing of water. Studies of aesthetic impacts are based on field measurements and observations, and perhaps model results. If the studies are properly designed to test appropriate hypotheses, the relevance of the data is apparent. The acceptance of the data depends on the selection of appropriate hypotheses, species and end points to address the local concerns in the Bay area about potential effects of suspended solids.

DETAILED SCOPE OF WORK:

I. TASK 1: BIOLOGICAL AVAILABILITY OF CONTAMINANTS FROM SUSPENDED SOLIDS.

A. Tests should consider several modes of feedings and several biologically different organisms. Suggested species include Macoma - a deposit feeding bivalve, Mytilus- a filter feeding bivalve, and Cymatogaster - a surf perch.

B. Expose test species to deposited sediments and several different concentrations of suspensions of the same sediments. The suspended sediment range chose would be carefully selected in conjunction with the results of work element IB-3 DREDGING NEEDS to represent concentrations of suspended solids likely to be found in the Bay in association with dredging operations. It may be necessary to test concentrations different than those expected in association with dredging in order to adequately measure a biological response. In any case, it is critical that work elements IB-4 and IB-3 be closely coordinated so that the suspended sediment concentrations shown to have biological effects can be evaluated in light of the concentration shown in Element IB-3 to occur in the Bay in association with dredged material disposal. The sediments used in the bioavailability study should include a range of contamination, including a highly contaminated sediment from with the Bay area, a sediment representative of typical navigation dredging in the Bay, and a sediment representing conditions typical of the present "undisturbed" state of San Francisco Bay. The end points measured in the test will be body burden of a broad range of contaminants; the body burdens will be used as a measure of the bioavailability of the contaminants. Samples of organisms will be taken at several time intervals from the various exposure regimes and analyzed for concentrations of contaminants in the tissues of each of the species. These data will be used to determine the steady state concentration of the various contaminants in each species in each exposure regime. The primary evaluation will be comparison of the steady state body burden in deposits and suspensions of the same sediment.

II. TASK 2: SUSPENDED SEDIMENT EFFECTS ON SENSITIVE LIFE STAGES

A. Test design will consist of exposure of the sensitive life stages to several concentrations of suspended sediment and a container of in situ Bay water, as well as a control. Tests will be conducted with pelagic eggs of fish species that spawn in San Francisco Bay. Eggs/embryos/larvae of other species that spawn in San Francisco Bay might also be considered. Emphasis will be on physical effects of the presence of suspended sediments. The test sediments will represent typical navigation dredging and present "undisturbed" conditions in the Bay. If warranted by the results of these tests, Task 1 and Element IB-3, the study could be repeated using more highly contaminated sediments. Again, it will be important to coordinate the suspended solids concentrations used with work element IB-3 in order to maximize utility of the results. The end points measured will be hatching and developmental success under the various treatment conditions. The primary data evaluation will be comparison of each treatment result to the controls and to the Bay water.

III. TASK 3. AESTHETIC IMPACTS OF SUSPENDED DREDGED SEDIMENT

A. This task will quantify the turbidity (the visual property) associated with suspended dredged material. It will monitor disposal operations and background conditions, and use the output of modeling exercises in element IB-2. Turbidity associated with dredged material disposal and resuspension will be compared to variations in natural turbidity in the Bay. The comparison will consider magnitude, spatial extent and duration of natural and dredged material-associated turbidity. Seasonality will also be considered in relation to dredging activity and annual cycles of natural turbidity.

PRODUCT: Products of each task will be reports and input to other aspects of LTMS. The results of these studies will be used to provide input to the selection of the biological parameters to be used in development of sediment quality values in Tasks IB-9. The results from Tasks 1, 2 and 3 will provide useful input to the overall decision making approach within LTMS, indicating the importance of suspended sediments in the evaluation of dredged material disposal.

It is also important that these scientific studies be reviewed by the scientific community. A scientific report will be prepared on each task. Therefore, one of the products for these studies will include the submission of a manuscript describing the work for publication in a peer reviewed scientific journal. The results of peer review can be applied during LTMS Phase 4 to program management, monitoring and updating.

(IB-7) SITE SELECTION STUDIES - PHYSICAL, BIOLOGICAL, RESOURCE

OBJECTIVES: The goal of this work element is to focus on specific in-Bay locations which, based on initial assessment and a determination of their general acceptability to regulatory agencies and the public, appear worthy of further consideration and investigation.

Specific studies performed under this work element encompass both physical and biological assessments, as summarized below.

PHYSICAL:

1. Document site bathymetric and geologic conditions to permit estimates of the site's capacity to contain dredged material and its foundational stability.

2. Document the physical and chemical characteristics of the ambient sediments to establish a baseline for describing the effects of potential disposal operations on sediment quality.

3. Document the hydrodynamic climate considering high frequency patterns due to tides and seasonally prevailing currents and waves and the potential for more severe low frequency storm events. The physical oceanographic investigation should focus upon the influence of hydrodynamics on sediment transport and deposition at the site. The investigation will discuss the probability of dredged material accumulation or transport from the site, if it is selected as a disposal site and keep in mind the Alcatraz experience. The probable fate of dredged material transported from the site, if it is selected as a disposal site, would also need to be assessed.

BIOLOGICAL/RESOURCE

4. Document the structural and functional characteristics of the location's benthic faunal community, discuss the probable response of the community to dredged material disposal operations, and the pre- and probable post-disposal value of the community to the demersal fish community inhabiting the area.

5. Document the structure of the fish community within and adjacent to the site and describe the pre- and potential post-disposal habitat value of the site to the populations comprising that community.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED: Studies designed to achieve each of the above five (5) objectives have been performed at potential aquatic disposal sites for dredged material throughout the coastal U.S.

CURRENT TECHNOLOGIES AND ACCEPTANCE: The issue which is most often the topic of discussion regarding these proposed investigations is not the need to address each of these objectives; it is the level of effort (LOE) that may be expended to address each of these objectives. Levels of effort range from lowest to highest along the following course:

	Level of Effort (LOE)	Description
(Lowest)	#1	Review of available regional information coupled with the best professional judgment of regional experts.
	#2	LOE No. 1 supplemented with the results of investigations performed in other similar ecological systems, and the best professional judgment of nationally recognized experts.
	#3	LOE No. 1 or No. 2 supplemented by a minimum field investigation designed according to a sound logic which recognizes that (a) some site conditions such as sediment geochemistry do not vary with time in a seasonal way, (b) others, such as site hydrodynamics, do vary seasonally but it is the average condition or conversely, it is the extreme condition that is most important and (c), resource populations may use the site or inhabit areas near the site in particularly important ways during certain times.
	#4	LOE No. 1 or No. 2 supplemented by an intensive, comprehensive multi-season investigation.
(Highest):	#5	LOE No. 4 with multi-year field investigations.

Technologies applicable to each of the five site selection information objectives are addressed by the following discussion. Information is arranged by objective Site Bathymetry and Geology. The ability of a potential disposal site to contain dredged material (physical capacity) will be determined by the depth of the site and its bottom topography. Precision bathymetry surveys, often referred to as hydrographic surveys, are used to define depth and topographic conditions. The best techniques, those routinely used for nearly all contemporary survey work, involve the integration of precision fathometers with electronic navigation and position control capabiities to achieve instrumentation accuracies of +/- 0.01 percent of measured depth and +/- 2-3 meters in horizontal position. The incorporation of corrections for tide, speed of sound related to water density, and barometric pressure, and factors related to the vertical motion of the survey vessel, are critical to high quality surveys. The technology is proven, rapidly advancing and well accepted. In addition, precision bathymetric surveys repeated over time produce useful data for determining if dredged material has been lost from a disposal site. For work inside San Francisco Bay, foundational stability will be affected most by topography such that the occurrence of a sloping bottom at a proposed site may lead to the downslope movement of material. Under these circumstances, if a high capacity non-dispersive site was desirable, site selection criteria would favor deep, level bottom locations within the Bay.

Hydrographic surveys of potential disposal sites would need to be coordinated with those undertaken in the ongoing NOS Bay-wide survey effort to ensure consistency in formatting and avoid duplication of effort. (See LTMS Phase 1 - (IB-2)-Sediment Research.)

Sediment Physical and Chemical Characteristics. Side scan sonar, sediment profile camera imagery and core or grab sampling represent three different techniques for acquiring information about sediment physical characteristics. Side scan acoustic reflectance patterns permit a qualified analyst to distinguish bottom types which have different reflectance characteristics. These characteristics are often related to sediment type. Side scan is most useful for performing reconnaissance surveys of large areas. Sediment Profile Camera (SPC) imagery employs a sediment profiling camera which images the upper 15-20 cm of deposited sediment. The SPC technology is not impeded by the ambient turbidity levels and yields detailed quantitative data about sediment particle sizes and small scale sediment-water interface boundary relief.

SPC technolgy has been applied throughout the continental U.S. and Europe. It is rapidly becoming well accepted as a primary data collection technique and as a technique that can be used in a reconnaissance mode to discern different sedimentary facies for more detailed physical, chemical, or biological sediment characterization programs. The tried and proven techniques that involve the use of grab or core samplers ot obtain near-surface samples for detailed sediment characterization are the only techniques capable of yielding samples for detailed chemical and biological studies. These techniques are traditional and well accepted. As reconnaissance tools they are very inefficient. However, they can be and have often been used following site reconnaissance surveys to permit a more detailed site surveys.

Hydrodynamics. Information about current velocities and directions which is acquired using traditional electromagnetic or more contemporary acoustic dopler current profiling technologies is important for describing site hydrodynamics and a site's potential dispersive character. The specific design features of a hydrodynamic investigation will dictate the number of metering locations, the depths of observations and the duration of observations. Hydrodynamic investigations involve requirements for sophisticated hardware, for hardware maintenance and involve a large volume of data generated by arrays of current metering instruments programmed for nearly continuous observation. Directly acquired information about urrents and complementary information on wave dynamics, which will be most important at relatively shallow sites, represent the best types of data in circumstances where the need for this kind of information is identified. Descriptions of a site's physical energy region based upon general knowledge about regional water movements and wave conditions represent a less well accepted option. Conclusions concerning the stability of the bottom sediment re- and post-disposal under the objserved hydrdynamic conditions should be based upon an understanding of shear velocities, a recognition of the important effects of dredging equipment and bioturbation on sediment cohesiveness and ancillary data offering cues about sediment stability. SPC imagery is one source of ancillary data.

<u>Benthic Fauna.</u> Site biological characterization programs requently focus on benthic macroinvertebrate infauna and epifauna, i.e., relatively large bottom dwelling invertebrates that live at or below the sediment surface. The sensitivity of the benthos to sedimentary conditions and linkages between the benthos and many fishes are some of the reasons for the importance of benthic community data. The techniques most commonly used during investigations of few in number. Most investigations have involved the infaunal benthos sampled using the same kines of cores and grabls employed for collewcting sediment samples to be physically or chemically analyzed. Epifaunal benthos rely upon sled or trawl sampling

or video/photographic survey methods. These methods represent the traditional and best accepted tools available for characterizing community structure. Sediment Profiling Camera (SPC) imagery, which was discussed above, represents a relatively recent but increasingly accepted technology for describing benthic community structure and function. SPC data cannot replace a grab or core-based sampling and community study. But it is capable of generating information about the character and apparent health of the benthic community in a large area at much lower cost and much more rapidly than is possible using traditional techniques. SPC survey information has also been used as reconnaissance data to direct the more efficient allocation of traditional sampling techniques. Equally impoertant to the quality of the field data will be the ability of the benthic investigator to interpret that data in a way that will allow some understanding about the probable response of the benthos to disturbance caused by disposal and sediment alteration. There are significant and well regarded theories concerning community responses to disturbance and successional paradigms which apply to this objective.

A procedure called the Benthic Resources Assessment Technique (BRAT) has been used on the Atlantic and Gulf Coasts and in Puget Sound to describe the potential value of a site's benthic community, and to describe changes in the value of a site for fishes which feed upon the benthos. The procedure is founded upon generally well accepted theory concerning fish feeding ecology. The BRAT uses information from box core collections of benthos and from the analysis of fish diets in special ways that are designed to cope with the large variability in both benthic community characteristics and fish feeding behavior. The BRAT yields information describing the quantity of fish food occurring at different locations for different groupings of fishes. It is a labor intensive and consequently costly procedure unless coupled with a reconniassance procedure, like SPC imagery, that can be used to minimize sampling intensity requirements. But there is not another procedure capable of yielding the same kind of information at the same cost or at lower cost.

Fish. Fish community structure information is obtained most often using active sampling techniques such as trawling, or by gathering information about the fish community of a site from fishing interest groups within the region. It is generally accepted that dredged material disposal operations and substrate changes affected by those operations are more likely to impact bottom-dwelling (demersal) fishes than fishes that are not associated with the bottom. While deposited dredged material may be transported from a disposal site and affect an increase in the concentration of sediments suspended in Bay waters downcurrent of a site, it is very difficult to measure the effect of this condition upon fishes, to separate the effect from other sources of suspended sediments, or to achieve conclusions from a rigorous scientific analysis that the effects of these potential water column alterations on fishes are significant ones. For this reason, fishery field studies should probably be focused upon demersal fishes and assessments of potential water quality alterations upon non-demersal fish species should be based upon controlled laboratory investigatory employing natural weathered San Francisco Bay sediments and realistic concentrations of suspended material. The Benthic Resources Assessment Technique discussed in the Benthic Fauna section above represents one type of demersal fish habitat valuation procedure.

DETAILED SCOPE OF WORK: In-Bay site specific studies may be comprised, at least in part, of addressing the five objectives discussed above, and the work element objective associated with IB-5, Bioaccumulation Analysis.

The LOE acquired to achieve in-Bay site analysis, the specific technolgies selected for field investigation and the important details concerning field sampling and statistical data analytical design will be directed by the results of LTMS Phase 2 - Element A-Resources to be Protected, a study proposed in this Framework Plan. In any event, the questions that need to be addressed to influence the final design of site specific studies in Element IB-7 are:

1. What are the specific valued ecosystem components (VECs)?
2. Can we describe a relational or box model presenting the relationship between each VEC and the perceived direct or indirect impact of disposal on these VECs?
3. Can we resolve some or all of these impact issues with LOEs No. 1 or No. 2?
4. Can we define testable hypotheses concerning impact issues we cannot resolve using LOE No. 1 or No. 2?
5. Is it technically possible and economically feasible to perform field investigations to test these hypotheses?

Until those questions are addressed and concensus on pursuing them is reached, detailed scopes of work for specific studies cannot be deveped. The following scope of work suggests one process to achieve concensus:

> Phase 1, Address questions 1 and 2 during a two day intense workshop facilitated by a professional facilitator and attended by technical representatives of all agencies with concerns about in-Bay impacts due to disposal operations at the pre-selected candidate sites. Consider inviting representative of recreational fishing interest groups and non-technical representatives of environmental interest

groups but establish ground rules that clearly define the technical focus of the discussions. Time to complete: 1 month.

PRODUCT: Workshop proceedings document listing all VECs, presenting the impact relational model, and summarizing significant discussion and conclusions.

Phase 2, Resolve as many issues as possible using LOE No. 1 or No. 2. Assign individual impact questions/relations between disposal and VECs to regional or national experts. Task them to prepare a summary review and technical position paper. Bind and circulate these papers to all attendees of the Phase 1 workshop, allow a reasonable review period and schedule another two day workshop that would be attended by the same personnel. Use Day 1 to review and discuss the status of all VEC impacts.

Some will be resolved completely, others partially and some probably not at all. Use Day 2 to define testable hypotheses concerning VEC impacts partially resolved or totally unresolved in Day 1. Also discuss field investigation designs and level of effort (as described above). Time to complete: 3 months.

PRODUCT(S): A series of technical summary/position papers describing relevant literature and the judgments of Regional or National Technical experts.

The proceedings of Workshop #2 containing a description of VEC impact issues resolved, and summarizing the conclusions of discussions concerning partially resolved and unresolved VEC impact issues.

Phase 3, Design and Conduct In-Bay Field Investigations. Time to complete: Dependent on outcome of Phases 1 and 2.

(IB-5) BIOACCUMULATION (See also Phase 2, (IB-5) Bioaccumulation.)

I. TASK 3. FIELD INVESTIGATIONS AT CANDIDATE DISPOSAL SITES IN SAN FRANCISCO BAY Time to complete: Approximately 12 months.

PRODUCT: A current LTMS Baseline Bioaccumulation Survey with conclusions about the relative levels and absolute levels of faunal contamination related to deposited sediment conditions and, if appropriate, suspended sediment conditions.

ELEMENT B: COST ESTIMATES - ECONOMIC/COST

OBJECTIVES OF THE WORK ELEMENT: The objective of the Cost Estimate work element is to identify costs associated with the various disposal options in combination with the various dredging requirements. The work element will take the actual categories and typical locations of the dredging work defined in the (IB-3) Dredging Needs element and analyze the methods and costs of disposing of this material to different areas (e.g. in-Bay, upland and ocean) by different dredging methods (e.g. hopper dredge and bucket dredge). It will develop a series of cost scenarios which can be used to compare disposal alternatives. It will also develop a cost estimating methodology which can be applied in future studies and to evaluate new alternatives.

AREAS WHERE SIMILAR WORK TASKS HAVE BEEN PERFORMED: This work has been done recently for several alternative San Francisco Bay disposal techniques including upland disposal in the Central Bay and in the Sacramento Delta. (Ogden Beeman and Associates, Inc. 1989,1990). Similar work has been done as part of the PSSDA Program, Parametrix, 1989; Tetra Tech, 1988). Numerous site specific project cost estimates have been made by the Corps of Engineers, lgeocal port agencies and others for dredging projects in the San Francisco Bay area.

CURRENT TECHNOLOGY AND ACCEPTANCE: The cost estimating techniques for conventional dredging techniques for non-contaminated sediments are straightforward and well accepted. The cost estimates resulting for this work will be particularly appropriate for comparison of costs for various alternative disposal plans since many of the assumptions on equipment and labor costs and cost escalation will apply to all of the alternatives under consideration. That is, although the estimates may not exactly reflect contractor bidding on a particular job, the relative costs between alternatives will be correct.

The cost estimating for contaminated materials is much more complex and depends on the assumptions made regarding final permitting and choice of construction techniques and environmental protection measures. Nevertheless, so long as the assumptions are well documented, the comparative cost estimates between alternatives should be helpful in the site selection process.

AREAS WHERE SIMILAR WORK TASKS HAVE BEEN PERFORMED: This work has been done recently for several alternative San Francisco Bay disposal techniques including upland disposal in the Central Bay and in the Sacramento Delta. (Ogden Beeman and Associates, Inc. 1989,1990). Similar work has been done as part of the PSSDA Program, Parametrix, 1989; Tetra Tech, 1988). Numerous site specific project cost estimates have been made by the Corps of Engineers, lgeocal port agencies and others for dredging projects in the San Francisco Bay area.

CURRENT TECHNOLOGY AND ACCEPTANCE: The cost estimating techniques for conventional dredging techniques for non-contaminated sediments are straightforward and well accepted. The cost estimates resulting for this work will be particularly appropriate for comparison of costs for various alternative disposal plans since many of the assumptions on equipment and labor costs and cost escalation will apply to all of the alternatives under consideration. That is, although the estimates may not exactly reflect contractor bidding on a particular job, the relative costs between alternatives will be correct.

The cost estimating for contaminated materials is much more complex and depends on the assumptions made regarding final permitting and choice of construction techniques and environmental protection measures. Nevertheless, so long as the assumptions are well documented, the comparative cost estimates between alternatives should be helpful in the site selection process.

DETAILED SCOPE OF WORK:

I. TASK 1. SELECTION OF DREDGING AREAS AND DISPOSAL ALTERNATIVES FOR CONSIDERATION. From the needs study, and the knowledge of existing and proposed disposal areas, prepare a list of specific dredging projects to be analyzed. All annually occurring navigation projects and regularly occurring dock front dredging projects will be included. For marina dredging and contaminated material disposal, typical projects will be chosen to produce representative costs which can be applied to other projects.

Proposed disposal areas will include in-Bay, ocean (with several alternatives), upland bay and upland delta sites. The entire list of dredging and disposal areas will be coordinated with appropriate agencies or technical committee prior to finalization.

PRODUCT: A list of dredging areas and disposal sites to be considered.

II. TASK 2. COST ESTIMATES. Cost estimates will be prepared to preliminary level (plus or minus 25%) for the dredging/disposal combinations under consideration. Cost estimates will include separate items for mobilization of equipment, excavation and disposal and environmental controls or monitoring required to facilitate the 3 - applicability of the estimates to numerous projects.

PRODUCT: A report including the cost estimates for the dredging and disposal options considered.

III. TASK 3. COST ESTIMATING MODEL. A cost estimating model will be developed covering the mobilization, excavation, hauling, disposal and monitoring costs for the main dredging/disposal techniques under consideration. This model shall be PC based, written in a common language, and be menu driven for simplicity of operation. The purpose of the model will be for comparison of dredging alternatives, rather than cost estimating or budgeting of dredging projects.

PRODUCT: A cost estimating model, with operating instructions, for use in comparison of dredging alternatives.

(IB-3) SEDIMENT TRANSPORT MODEL - PHYSICAL

OBJECTIVES OF THE WORK ELEMENT: To prepare and validate a sediment transport modeling capability for the San Francisco Bay system that can be used for evaluation of alternate disposal options in terms of environmental impact and operational costs, for design of navigation facilities that will lead to minimum maintenance costs, and for prediction of future maintenance requirements under changing sediment inflows to the system.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED: Sediment 3 - transport models, including the associated hydraulic modeling, have been used widely during the last decade, and a number exist. The Corps of Engineers have applied the TABS II system of models and associated utilities to estuaries widely in the United States, and other two-dimensional models are used in Europe and Asia. Three-dimensional hydraulic models are emerging: the Waterways Experiment Station has recently completed a 3-D boundary fitted coordinate finite-difference model to the entire Chesapeake Bay system and have simulated 60 continuous days.

CURRENT TECHNOLOGY: Two-dimensional laterally and vertically averaged sediment transport models, used in a hybrid mode with physical (3-D) hydraulic model are an available technology. This technology is especially appropriate to the San Francisco Bay because of the availability of the Bay/Delta model. Parts of the San Francisco Bay system have been modeled by Resource Management Associates using a 3-D finite element model, and the U.S. Geological Survey is developing a 3-D capability. Numerical models are continuously evolving, and such evolution should be planned for the San Francisco Bay. Economy of operation will lead to models that contain one-, two- and three-dimensional components.

The cost of running existing models has precluded the simulation of entire years or longer. Calculation of long term effects of changes in the simulated system have been made by simulating conditions typical of different seasons, inputs, etc., and projecting the simulations to the period of interest. Progress in hardware and software during the past decade foretell a coming capability to simulate long periods, however.

DETAILED SCOPE OF WORK:

I. TASK 1. ADAPT EXISTING SEDIMENT TRANSPORT MODELS TO THE SAN FRANCISCO BAY SYSTEM.

   A. Considerable effort to adapt the USACE TABS II models to the San Francisco Bay system has already been made, and extension of these models to include the effects of wave action in shallow areas can provide useful simulations of general sediment circulation, deposition in navigation facilities, and suspended sediment concentrations. Implementation of these models would provide modeling capability soonest and at least cost.

Two-dimensional models will not accurately simulate sediment transport in flows that cannot be represented by averaging or parameterizing the third dimension. Accurate simulation of disposal in the region of the Golden Gate, for example, requires modeling in three dimensions. In view of the emerging 3-D modeling capability, the developer should have the opportunity to propose such models, or the incorporation of 3-D portions into existing models, describing in the proposal the time required to prepare them and the associated cost.

B. Incorporate the sediment properties obtained in IB-2 in the model.

C. Verify the models using the currents and suspended solids concentrations obtained by IB-2 for intra-tidal cycle verification, and the changes of shallow area deposits and deposition in navigation works for long term verification. Verification of the hydraulic model without wind effects can be accomplished using currents and tides from the physical model.

D. Train responsible agency personnel in the use of the models or, if mutually beneficial, establish an interagency modeling service for LTMS implementation. Continuing support of modeling personnel will be needed.

PRODUCT: A documented, verified, time dependent, operating model of sediment transport, capable of providing suspended solids concentrations and deposition rates throughout the San Francisco Bay - Delta system.

UPLAND DISPOSAL ALTERNATIVES

U-1,2 (Combine): NON-AQUATIC BENEFICIAL USE - PHYSICAL, BIOLOGICAL, RESOURCE, ECONOMICS/COST

OBJECTIVES OF THE WORK ELEMENT: The objective of the work element is to identify potential beneficial uses of dredged material in the San Francisco Bay region, including the Delta, analyze the feasibility of the most appropriate beneficial uses and develop implementation plans for the most feasible options.

AREAS WHERE SIMILAR WORK TASKS HAVE BEEN PERFORMED: Investigation of beneficial uses of dredged material have been encompassed by other Long Term Management Strategy programs.

The Port of Baltimore Master Plan is a LTMS which defines a range of alternatives to meet dredging needs of the port from 1990 through 2010. The ongoing Lower Columbia River LTMS has a planning timeframe of 50 years. Both of these plans include identification and investigation of beneficial uses from dredged material disposal.

The U.S. Army Engineers Waterways Experiment Station actively assists and documents beneficial uses of dredged material either associated with a LTMS or pursued for other purposes. As part of this documentation, over 1,300 dredged material beneficial use sites, developed by federal, state and provincial, and local agencies in the U.S. and Canada, have been identified.[1]

---

1 Landin, Mary C., T.R. Patin, H.H. Allen, (U.S. Army Engineers Waterways Experiment Station), "Dredged Material Beneficial Uses in North America," Proceedings of WODCON XII, May, 1989

CURRENT TECHNOLOGY AND ACCEPTANCE: The U.S. Army Corps of Engineers recognizes beneficial uses of dredged material as a valuable disposal option. In 1987 it published Engineer Manual 1110-2-5036, "Beneficial Uses of Dredged Material" which provides guidance for the design, implementation and operation of disposal sites providing beneficial uses in the following areas:

1.) Habitats, including wetland, upland, island and aquatic
2.) Aquaculture
3.) Beaches and beach nourishment
4.) Parks and recreation
5.) Agricultural, horticulture and forestry
6.) Mine reclamation and sanitary landfill cover
7.) Multipurpose, construction and industrial/commercial uses

Constructed beneficial use projects and their subsequent monitoring programs provide an increasing body of knowledge on the opportunities and constraints associated with a variety of beneficial use project types. For instance, in the San Francisco Bay region, the monitoring program undertaken by the Sacramento District, Corps of Engineers, of the habitat development projects at Donlon Island and Venice Cut has provided valuable information on establishing vegetation for wetland habitats.

DETAILED SCOPE OF WORK: This work element has been developed assuming that existing San Francisco Bay region studies will form the basis for more detailed analysis of alternatives.

CURRENT TECHNOLOGY AND ACCEPTANCE: The U.S. Army Corps of Engineers recognizes beneficial uses of dredged material as a valuable disposal option. In 1987 it published Engineer Manual 1110-2-5026, "Beneficial Uses of Dredged Material" which provides guidance for the design, implementation and operation of disposal sites providing beneficial uses in the following areas:

1.) Habitats, including wetland, upland, island and aquatic
2.) Aquaculture
3.) Beaches and beach nourishment
4.) Parks and recreation
5.) Agricultural, horticulture and forestry
6.) Mine reclamation and sanitary landfill cover
7.) Multipurpose, construction and industrial/commercial uses

Constructed beneficial use projects and their subsequent monitoring programs provide an increasing body of knowledge on the opportunities and constraints associated with a variety of beneficial use project types. For instance, in the San Francisco Bay region, the monitoring program undertaken by the Sacramento District, Corps of Engineers, of the habitat development projects at Donlon Island and Venice Cut has provided valuable information on establishing vegetation for wetland habitats.

DETAILED SCOPE OF WORK: This work element has been developed assuming that existing San Francisco Bay region studies will form the basis for more detailed analysis of alternatives.

I. TASK 1. IDENTIFY POTENTIAL BENEFICIAL USES

A. Review existing literature on beneficial uses of dredged material, including EM 1110-2-5026 "Beneficial Uses of Dredged Material," proceedings of the First Interagency Workshop "Beneficial Uses of Dredged Material" (1986) and other documents.

B. Review completed studies on the beneficial uses of dredged material in the San Francisco Bay region, including the Dredge Disposal Alternatives Study (1986), Detailed Feasiblity Study of Land Disposal Options (1988) and Investigation of Options for Disposal in the Delta (1990). Review BCDC Bay Plan, Basin Plan and other applicable documents identified by resource agencies.

C. Review sediment chemical and physical characteristics defined in Phase 1 to determine sediment suitability for specific beneficial uses. Categorize sediment suitability for specific beneficial uses by dredging reach.

D. Discuss potential beneficial uses with program representatives from WES Environmental Effects Laboratory, Vicksburg, MS. Review findings with EPA, CoE, RWQCB, BCDC and other agency representatives. Summarize study findings and prioritize beneficial uses for site specific analysis in San Francisco Bay. Most applicable beneficial uses are expected to include habitat development and reclamation/reprocessing facility for construction end-use, including levee rehabilitation and landfill lining and cover material.

PRODUCT: Narrative summary of beneficial uses of dredged material being applied throughout the United States and those most applicable to San Franciso Bay region. Priority listing of beneficial uses most applicable to San Francisco Bay region for decision making on pursuing by BCDC.

II. TASK 2. ASSESS DEMAND /SITE IDENTIFICATION. For highest ranking beneficial use options, establish demand, identify sites and estimate quantities required.

A. <u>Levee Maintenance:</u> Identify material requirement and quantities for specific levee rehabilitation location(s). Document demand through discussions with Department of Water Resources, Regional Water Quality Control Board, other agencies and interested parties. Establish site ownership/sponsorship and willingness to participate.

B. <u>Habitat/Wetland Creation:</u>Identify material characteristics and volumes for habitat creation. Establish site ownership/sponsorship and willingness to participate.

C. <u>Waste Disposal Site Liners/Cover:</u> Evaluate appropriateness of dredged material for liner and/or cover material; identify treatment options to increase material suitability. Identify landfill(s) for closure requiring cover material. Identify timeline, quantities required, suitable sediment characteristics and landfill ownership.

PRODUCT: Demand/market assessment, including specific sites and project sponsors.

III. TASK 3: IMPLEMENTATION REQUIREMENTS. Assess regulatory and institutional framework affecting option development, including federal, state and local resource and commenting agencies. Identify requirements, criteria and constraints for option permitting including mitigation requirements

Research dredged material treatment options including desalinization of material for use in fresh water environments, neutralization of chemicals of concern, if applicable, and updated dewatering methodologies. Representative information sources include Waterways Experiment Station, Vicksburg, MS for dewatering data and agricultural engineering programs at various universities and other institutions for desalinization.

IV. TASK 4. ENGINEERING ELEMENTS. For specific uses and sites prepare concept level design, including transport and placement methods, equipment requirements, liner requirements, effluent system, sediment treatment methods. and cost estimate. Cost estimates should be developed consistent with the format of Element B. Cost Estimates. For all options and sites, identify required quantities and timelines for construction, considering dewatering and other treatment requirement.

Engineering design must consider permit requirements and guidance established during Task 3 above.

A. Levee Maintenance: Based on implementation requirements (Task III) and characteristics of dredged material (established during LTMS Phase 1 - Sediment Research), two options may be evaluated for levee maintenance.

   1. Option 1 - Reprocessing Site Development. Concept level design for reprocessing site for dredged material dewatering, desalinization, storage and eventual transport to end use levee maintenance site. Include loading/unloading (pumpout) facility, equipment identification, groundwater and water quality protection measures, berm requirements, etc.

   2. Option 2 - Direct Placement to Levee. Concept level design for transport and placement of material at levee maintenance site without reprocessing at facility. Include dewatering, desalinization and other treatment at site.

B. Habitat Development. Design features may include berm or containment measures, material placement, site stabilization, dewatering, effluent controls, groundwater protection, elevations, planting plans.

Design elements must be specific to specific habitat identified in demand analysis, Task 1.

C. Landfill Liners/Cover. Design features may be similar to those for levee maintenance, including development of a reprocessing site for material treatment prior to transport to identified end use. Single reprocessing sites to serve two or more end-uses may be considered.

Actual design and placement of material as liner or covermust be in accordance with WMU specifications.

V. TASK 5 ENVIRONMENTAL - Beneficial use sites provide good opportunities for win-win situations. For instance, requirements for flood control in the Delta are well documented, and serve environmental as well as economic objectives. Use of dredged material for flood control works, including levee maintenance, must be considered in context of the overall regulatory framework and address environmental concerns. Site specific mitigation requirements will be identified during the permitting process and should be addressed early in design. This scope of work recommends early and continuance coordination with key resource agencies.

PRODUCTS (Tasks 4 & 5): Site specific development and implementation plans for beneficial use projects.

(U-3) LAND DISPOSAL GUIDANCE

OBJECTIVES OF THE WORK ELEMENT: The objective of U-3 is to develop evaluation procedures and design criteria for the placement of dredged material on land. More information is required about San Francisco Bay's dredged material physical, chemical and toxic characteristics. Specific design requirements need to be developed which address those characteristics so the RWCQB can provide consistent guidance for protecting groundwater and other aquatic resources and meet its responsibility as authorized under CCR Title 23.

AREAS WHERE SIMILAR TASKS HAVE BEEN PERFORMED: The Puget Sound Water Quality Authority and State of Washington Department of Ecology are developing siting guidelines and design criteria for the construction of contained disposal areas, including aquatic, nearshore and upland mono- and multi-user landfills. This work effort has resulted from PSDDA in which open water, unconfined disposal sites were established. Guidelines and criteria for material unsuitable for open water disposal were required.

CURRENT TECHNOLOGIES AND ACCEPTANCE: Extensive design and siting guidance exists for disposal of dredged material on land, whether in a dedicated, single purpose disposal site or for a beneficial use. The Corps of Engineers provides disposal site guidance in its Engineering Manuals for Dredging and Disposal, Disposal Site Design, and Beneficial Uses. The COE's ongoing dredged material research program publishes results of research and monitoring on a monthly basis.

DETAILED SCOPE OF WORK:

I. TASK 1: REVIEW EXISTING LITERATURE, AVAILABLE DATA AND REGULATORY FRAMEWORK.

A. Review and summarize existing research and guidance on siting and design of contained disposal sites. Apply beneficial use design factors from Element U-1,2. Summarize guidance into four areas: environmental, engineering, economic and regulatory/institutional.

B. From sediment research and characterization performed in previous tasks, summarize dredged material characteristics in the Bay which may be proposed for upland disposal. This effort is affected by the Sediment Quality Criteria developed during LTMS Phase 2.

C. Identify existing regulatory framework and programs affecting upland disposal. The existing regulatory framework may be changing, due to developing policies such as the Bay Protection and Cleanup Plan and the developing LTMS. Guidance and criteria for upland disposal site development should coordinate efforts with changing regulatory and institutional policy.

II. TASK 2. DEVELOP CRITERIA FOR EVALUATING SEDIMENTS PROPOSED FOR UPLAND DISPOSAL. Based on identified resources of concern (as stated in previous policy documents and legislation) and the sediment criteria established during LTMS Phase 2, develop criteria for classifying dredged material. This task is described in detail in LTMS Phase 2 (IB-9) SEDIMENT QUALITY CRITERIA. Emphasis must be placed on particular sediment chemical constituency behavior when changed from a wetted environment.

III. TASK 3. SITE DESIGN GUIDANCE. Based on the resources to be protected and the sediment type to be disposed, develop siting and engineering guidance for placement of dredged material to land. Guidance may be categorized into two areas: nearshore and upland. Engineering elements include:

A. Siting guidance considering foundation quality, sediment type, end use, treatment facility requirements.

B. Design features, including groundwater protection, containment structures, effluent treatment, land requirements related to volumes (considering dewatering requirements).

C. Operation, including site management, dewatering, timing.

PRODUCT: Draft engineering guidelines for incorporation into CCR Title 23.

O-1. Preliminary Zone of Siting Feasibility. According to Corps of Engineers and EPA guidance contained in "Ocean Dumping Site Designation Delegation Handbook for Dredged Material, 1986", a Zone of Siting Feasibility (ZSF) selection involves consideration of:

a. Environmental acceptability
b. Distance to the edge of the continental shelf
c. Political boundaries
d. Economic feasibility
e. Safety
f. Operational feasibility

In order to begin studying potential ocean disposal sites, EPA has considered the first three components and comments heard at the 102 Ocean Disposal Site Public Scoping Meeting, held April 1989, and proposes a preliminary Zone of Siting Feasibility which includes the following areas:

a. Channel Bar site or other nearshore site
b. Shelf area (30-100 fathoms)
c. 100-300 fathom area
d. 300-1000 fathom area
e. Two areas between 1000-1300 fathoms (One may be one of the chemical/munitions dump sites; these sites would require preliminary reconnaissance to determine present site conditions; the USCG is concerned about rupturing drums.)

EPA will request the Corps of Engineers to assist EPA in determining the economic, safety and operational feasibility of dredged material disposal in these study areas in order to complete a final ZSF. EPA will hold another Public Scoping Meeting in Spring 1990 to facilitate public involvement in the selection of study areas.

O-2. Preliminary Survey. A preliminary survey of the areas within the ZSF will be conducted to identify rock outcropping, unstable sediment masses, canyons, undersea slide zones, and other areas of geologic significance as well as shipwrecks or other artifacts of historic interest. A second objective will be to determine surface sediment distribution. Specifically, the following study tasks are proposed:

a. Seven day cruise using SeaMarc side-scan sonar to produce a shipboard mosaic of geologic data of all six study areas;

b. Followed by seven days of sediment sampling to verify side-scan data and map surface sediment distribution;

c. Cruise will sample transits spaced at 4 km intervals using Sidescan sonar with a 5 km beam; and

d. Final data should be available within a month of the cruise and will be used to site current meters and select smaller areas for further study within the six initial areas.

Cost will depend on who does the study and vessel availability. EPA has spoken with USGS and are currently comparing their proposal to other options.

O-3. Physical Oceanography. The following specific tasks are proposed under this work element:

a. Evaluate existing models for use in predicting sediment transport in the study areas (e.g., DIFID, Tetra Tech modification of DIFID model, Coe-Chang model, USGS model and others); choose appropriate model and design data collection to fit model.

b. Siting of current meters will be based on results of the pre-survey (e.g., in stable areas, away from canyons and seamounts)

c. Current meter arrays will be stationed according to the following specifications: (1) one array at each of the 6 study sites (subsurface, at permanent thermocline(if present), and 5-10 meters off bottom); (2) arrays will be left in place for one year, with an option for another year; (3) retrieve data every 2-4 months (preferably every 3 months); and (4) data recorded: current velocity & direction, transmissivity, conductivity, temperature.

d. Existing wave gauge data and possibly nearshore wave gauge data will be assessed for influence on the bed movement and on sediment resuspension.

e. Available high altitude aerial photography (remote sensing data) may provide information to assess surface temperature, chlorophyll a, and surface currents. Existing environmental data may be useful as ground truth references.

f. Modelling will begin as soon as the first data set is available and will run concurrently with latter part of data gathering.

EPA is presently developing options for equipment type, acquisition and contractors/IAG (each will influence cost).

O-4. Geological Oceanography. The following study elements are proposed for assessment of potential ocean disposal sites.

a. Smaller scale (several square mile) study sites will be chosen based on the pre-survey and existing hydrodynamic and living resource literature and data sets.

b. Take 25-40 samples per study area during late summer or fall.

c. Analyze the top 2-5 cm for: grain size, water content, total organic carbon and individual heavy metals and organics (optional).

d. Integrate existing literature and data into field surveys and analyses.

O-5. Benthic Epifauna and Infauna. The same sampling stations as used for the geological investigations will be used for benthic fauna sampling. The following tasks are proposed for examining benthic organisms:

a. Three sampling seasons at sites less than 1200 fathoms and 1 sampling season (probably late summer or fall) for sites greater than 1200 fathoms.

b. Infauna will be sampled with box corer at 25-40 stations per site.

c. Infaunal samples will be sieved to 1 mm and identified to lowest possible taxon as necessary to determine community structure (samples may also be sieved to 0.5 mm and archived).

d. The epifauna will be sampled with 20 minute bottom research trawls or ROV (for sites deeper than 1200 fm).

e. Results will be applied to BRAT technique to assess value as fish foraging resource (sites will be compared to each other).

O-6. <u>Commercial and Recreational Fisheries and Mid-Water Analyses</u>
The following tasks are proposed for assessing commercial and recreational species in the potential disposal locations.

a. Analyze existing CDFG bottom trawler (commercial) fisheries database for study areas.

b. Analyze existing recreational fisheries databases for conflicts at study areas including, but not limited to, CDFG recreational landings database and CDFG partyboat surveys.

c. Obtain MMS, NMFS questionnaires and surveys of offshore fishing areas; if possible, conduct interviews or surveys of fishermen's groups to obtain input on site selection and consider fisheries not covered by existing databases.

d. Use existing data from NMFS, California Dept. of Fish and Game and other sources to assess mid-water impacts of dredged material disposal.

e. Integrate all information and use to evaluate potential disposal sites.

O-7. <u>Marine Birds and Mammals.</u> The following tasks will be used to assess species usage of the potential dredged material ocean disposal site(s). In addition, the work will identify any endangered species.

a. Literature search of published and unpublished studies.

b. Access available databases, including, but not limited, to Point Reyes Bird Observatory, National Marine Fisheries Service, Gulf of the Farallones National Marine Sanctuary, and California Marine Mammal Center.

c. Coordinate existing data with possible collection of new data by airplane transits or shipboard observations in the study area.

d. Integrate all information and use to identify potential disposal sites.

O-9. Site Designation Process A draft EIS will be prepared according to the NEPA process, the Marine Protection, Research and Sanctuaries Act, the Ocean Dumping regulation's 5 general and 11 specific criteria and the following decision criteria:

a. Stability of site (answered by sediment studies and seismic and morphological information from preliminary survey);

b. Movement of dredged material (answered by current meter data and subsequent modelling, and sediment resuspension from preliminary and geologic studies);

c. Size of footprint (answered by current meter data and subsequent modelling, and sediment resuspension from preliminary and geologic studies);

d. Impact to fisheries and other sensitive groups (answered by fisheries, birds and mammals studies);

e. Importance of prey species at the site (answered by box core and trawl/ROV aspects of benthic studies);

f. Feasibility of monitoring (answered by sediment chemistry and stability results of the geologic studies and physical oceanography data and modelling); and

g. Feasibility of using the site (answered by ZSF finalization including results of economic and operational studies).

Following the preparation of the draft, it will be released for public comment. Thereafter, the final EIS and the Proposed Rule will be prepared. These documents will also be released for public comment. After the close of the comment period, EPA will prepare the Final Rule which will also require a 30-day review period before the ocean site can be designated for disposal use.

LTMS FRAMEWORK PLAN
San Francisco Bay

PHASE 4: PROGRAM MANAGEMENT

IB-8: <u>REG'L MONITORING PROGRAM:</u>	•Monitor Site Capacities •Monitor Resource Impacts •Program Modifications/Updates
IB-3: <u>SEDIMENT TRANSPORT MODELING</u>	•Monitor Actual Disposed Sediment Behavior

LTMS PHASE 4: PROGRAM MANAGEMENT

Phase Objective: LTMS management and monitoring elements, including management and institutional framework, public involvement, site monitoring, program updates and status reports, funding.

(IB-8) REGIONAL MONITORING PROGRAM

The detailed scope of work for IB-8 is not available as of April 26, 1990. Further discussion with RWQBC pending review of the LTMS work elements as proposed in this document is required. However, many elements of LTMS Phase 3 help meet the objectives of the maintenance dredging demonstration program required for FY 1990, 1991 and 1992 and, in turn, will contribute to the baseline data base for a long term monitoring program.

The Regional Monitoring Program as described in the LTMS Study Plan is an appropriate element of both short and long term management and monitoring programs. Specific responsibilities and interface with the dredging and disposal program need to be further defined before developing a detailed scope of work. This effort is ongoing by the consultant team.

(IB-3) SEDIMENT TRANSPORT MODELING (Developed in Phase 3.)

OBJECTIVES OF THE WORK ELEMENT: To prepare and validate a sediment transport modeling capability for the San Francisco Bay system that can be used for evaluation of alternate disposal options in terms of environmental impact and operational costs, for design of navigation facilities that will lead to minimum maintenance costs, and for prediction of future maintenance requirements under changing sediment inflows to the system.

AREAS WHERE SIMILAR WORK HAS BEEN PERFORMED: Sediment transport models, including the associated hydraulic modeling, have been used widely during the last decade, and a number exist. The Corps of Engineers have applied the TABS II system of models and associated utilities to estuaries widely in the United States, and other two-dimensional models are used in Europe and Asia. Three-dimensional hydraulic models are emerging: the Waterways Experiment Station has recently completed a 3-D boundary fitted coordinate finite-difference model to the entire Chesapeake Bay system and have simulated 60 continuous days.

CURRENT TECHNOLOGY: Two-dimensional laterally and vertically averaged sediment transport models, used in a hybrid mode with physical (3-D) hydraulic model are available technology. This technology is especially appropriate to the San Francisco Bay because of the availability of the Bay/Delta model.

Parts of the San Francisco Bay system have been modeled by Resource Management Associates using a 3-D finite element model, and the U.S. Geological Survey is developing a 3-D capability. Numerical models are continuously evolving, and such evolution should be planned for the San Francisco Bay. Economy of operation will lead to models that contain one-, two- and three-dimensional components.

The cost of running existing models has precluded the simulation of entire years or longer. Calculation of long term effects of changes in the simulated system have been made by simulating conditions typical of different seasons, inputs, etc., and projecting the simulations to the period of interest. Progress in hardware and software during the past decade foretell a coming capability to simulate long periods, however.

DETAILED SCOPE OF WORK:

I. TASK 1. ADAPT EXISTING SEDIMENT TRANSPORT MODELS TO THE SAN FRANCISCO BAY SYSTEM.

A. Considerable effort to adapt the USACE TABS II models to the San Francisco Bay system has already been made, and extension of these models to include the effects of wave action in shallow areas can provide useful simulations of general sediment circulation, deposition in navigation facilities, and suspended sediment concentrations. Implementation of these models would provide modeling capability soonest and at least cost.

Two-dimensional models will not accurately simulate sediment transport in flows that cannot be represented by averaging or parameterizing the third dimension. Accurate simulation of disposal in the region of the Golden Gate, for example, requires modeling in three dimensions. In view of the emerging 3-D modeling capability, the contractor should have the opportunity to propose such models, or the incorporation of 3-D portions into existing models, describing in the proposal the time required to prepare them and the associated cost.

B. Incorporate the sediment properties obtained in IB-2 in the model.

C. Verify the models using the currents and suspended solids concentrations obtained by IB-2 for intra-tidal cycle verification, and the changes of shallow area deposits and deposition in navigation works for long term erification. Verification of the hydraulic model without wind effects can be accomplished using currents and tides from the physical model.

D. Train responsible personnel in the use of the models and, if mutually beneficial, establish an interagency modeling service. In any case, te- ontinuing support of modeling personnel will be needed.

PRODUCT: A documented, verified, time dependent, operating model of sediment transport, capable of providing suspended solids concentrations and deposition rates throughout the San Francisco Bay - Delta system **applied to evaluating site capacities, disposal behavior and other factors for program monitoring.**