DREDGED MATERIAL MANAGEMENT OFFICE

GUIDELINES FOR IMPLEMENTING THE INLAND TESTING MANUAL IN THE SAN FRANCISCO BAY REGION

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1. INTRODUCTION

1.1. The pilot Dredged Material Management Office (DMMO) agencies will apply these guidelines when determining the dredged material testing that will be required for dredging projects proposing disposal at designated sites in waters of the U.S. within San Francisco Bay, (Figure 1), until such time as these guidelines are upgraded or replaced (e.g., by a final Regional Implementation Manual (RIM)). Specifically, the disposal sites include SF-9 (Carquinez Strait), SF-10 (San Pablo Bay), and SF-11 (Alcatraz Island).

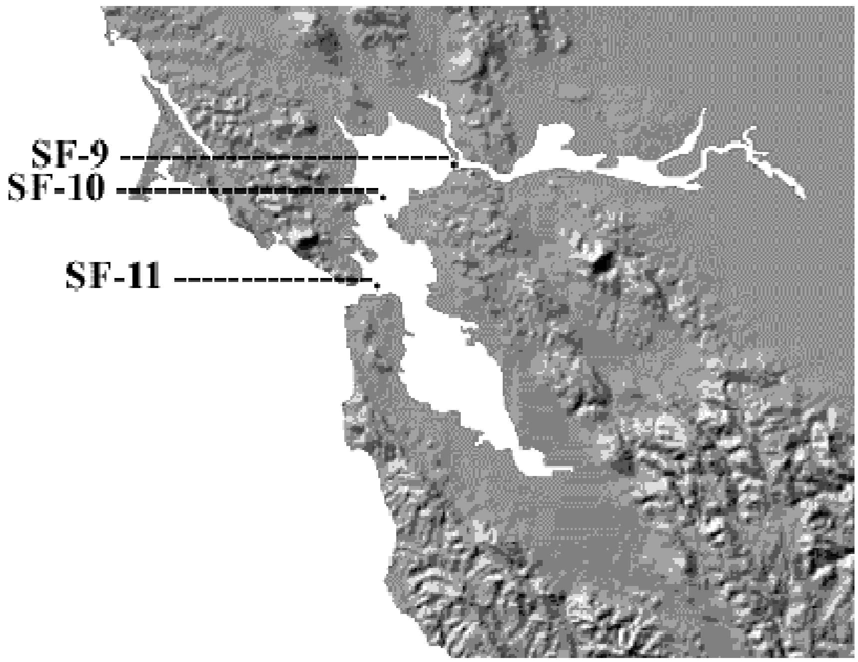

Figure 1. Multi-User Disposal Sites in the San Francisco Bay region

1.2. These local guidelines *supplement* the much more detailed information in the Inland Testing Manual (ITM), and are not intended to be used on their own. These guidelines do not repeat the detailed descriptions of each of the four tiers that make up the ITM's approach to dredged material evaluation (Chapter 3 of the ITM should be consulted for an overview of the tiered testing and evaluation framework). These guidelines also do not provide technical details about laboratory testing protocols. The ITM, its referenced literature, and any other agency guidance (such as any RIM published in the future) should be consulted for the most up-to-date technical information. Questions about any perceived inconsistencies between the ITM and these local guidelines should be directed to DMMO.

1.3. Proposals to use results of testing methodologies that differ from those described in the ITM and these guidelines will be considered by the DMMO, on a case-by-case basis, and should be approved in advance. All applicable Quality Control (QC) procedures should be reported. The ITM discusses these issues in some detail. The DMMO will issue Sampling and Analysis Plan (SAP)[1] guidelines that provide additional sampling, testing, and reporting recommendations to

[1] A SAP is also known as a Quality Assurance Project Plan (QAPP).

further supplement the ITM and these guidelines. Contact the DMMO about availability of the final SAP guidelines.

2. EXEMPTIONS FROM TESTING AND TIER I DETERMINATIONS (see ITM, Chapter 4)

2.1. The ITM, and the federal regulation on which it is based, provide for the possibility of an exclusion from the need to conduct testing on proposed dredged material in certain specific circumstances. The regulatory agencies will determine whether the following potential exclusions may apply in individual cases.

2.2. First, material may be excluded from testing "…where it is composed primarily of sand, gravel, or other naturally occurring inert material…in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels." [40 CFR §230.60(a)] Such material is unlikely to be a "carrier of contamination," especially when it is isolated from sources of pollution. Examples include material from the San Francisco Channel Bar and pre-industrial deposits of Merritt Sand in San Francisco Bay that have not been exposed by previous dredging projects. Unfortunately, much of the area's dredged material is composed of very fine particles and does not qualify for this exclusion.

2.3. Second, even if the material does not meet the regulatory exclusion noted above, additional testing may not be needed. This can be true if adequate data from previous testing in the area are available to establish that discharge of the material is unlikely to result in an unacceptable adverse impact on the aquatic ecosystem. For example, where several years of past data show that the material has consistently met current suitability guidelines, the agencies may determine that additional testing is not needed. Consistent with the tiered testing approach, on which the ITM is based, the agencies may require limited confirmatory testing before making such a determination. Confirmatory testing may include any one or combination of physical, chemical, or biological testing, depending on the nature of historic sediment quality data for the site and the length of time since sediment from the area was last tested.

2.4. If the agencies determine that Tier I determination can not be made, project-specific evaluations including both chemical and biological testing should be conducted in accordance with the ITM and the following sampling and testing guidelines.

3. SAMPLING GUIDELINES (see ITM, Chapter 8)

3.1. Chapter 8 of the ITM should be consulted for a detailed discussion of sediment sampling considerations. Additional agency recommendations that are specific to implementation of the ITM in San Francisco Bay are provided below.

3.2. ***Minimum Sediment Sampling***

Table 1 outlines the *minimum* number of sediment samples that should be collected, and composites that should be analyzed. Generally, a minimum of four samples is needed for one composite. However, because every dredging project is unique, this minimum sampling guidance may not be accepted by the agencies as adequate in all circumstances. Additional samples or analyses may be needed based on the results of past testing or the presence of known or suspected pollution sources. Proposed SAPs should be coordinated with the agencies before any sampling or testing begins. The test results from non-approved SAPs may not provide sufficient information for the agencies to make a determination and may require re-testing that would cause project delays. It is the project proponent's responsibility to obtain approval of proposed sediment testing in advance of sampling.

TABLE 1. Minimum Sediment Sampling Guidelines

DREDGE VOLUME* (*in situ* cubic yards)	MINIMUM # OF SAMPLE STATIONS	# OF COMPOSITES ANALYZED **
5,000 – 20,000	4	1
20,000 – 100,000	8	2
100,000 – 200,000	12	3
200,000 – 300,000	16	4
300,000 – 400,000	20	5
400,000 – 500,000	24	6

* Contact DMMO for guidance on projects smaller than 5,000cy or larger than 500,000cy.
** Numbers do not reflect reference and control sediment, or other QC samples.

3.3. *Core Sample Location and Depth*

3.3.1. Core samples should be taken to the full project depth, plus the permitted overdepth allowance (generally 2 feet below project depth). The full permitted overdepth allowance should be sampled, even if it differs from the "pay depth" identified in a dredging contract. Any sample material collected below the overdepth should be discarded.

3.3.2. Core sample locations must be appropriate. Samples must be representative of the sediment proposed to be dredged in terms of sediment type and possible pollutant sources throughout the dredging area. Proposed core sample locations should be identified in the proposed SAP and approved by the agencies in advance of sample collection.

3.3.3. SAPs should also describe reference and control sediment sampling locations and methods. Contact DMMO for information about reference sediment collection sites for SF-09 and SF-10. For SF-11, there are multiple reference sites, known as the Alcatraz Environs. The Alcatraz Environs Station locations are listed in Table 2. Reference site databases (e.g., the Alcatraz Environs database) may also be used.

TABLE 2. Alcatraz Environs Station Locations

Station*	Coordinates			
	NAD27		NAD83	
	Latitude, N	Longitude, W	Latitude, N	Longitude, W
R-AM-A	37º 49.75'	122º 25.88'	37º 49.75'	122º 25.94'
R-AM-C	37º 49.75'	122º 24.90'	37º 49.75'	122º 24.96'
R-AM-D	37º 49.27'	122º 25.88'	37º 49.27'	122º 25.94'
R-AM-G	37º 48.83'	122º 25.88'	37º 48.83'	122º 25.94'
R-AM-H	37º 48.83'	122º 25.57'	37º 48.83'	122º 25.63'
R-AM-I	37º 48.83'	122º 24.90'	37º 48.83'	122º 24.96'

* Station R-AM-B has been removed because of the physical danger associated with sampling at this location. Station R-AM-F has been removed because of its proximity to a previous dump site.

3.4. *Sediment Sample Compositing*

3.4.1. Compositing (combining several sediment cores into a single sample) is often allowed for testing purposes. Careful consideration must be given to the compositing scheme for any project. Sediment samples should only be composited together when:

- they are from contiguous portions of the project area,
- there is reason to believe that sediment throughout that portion of the project area is similar and is exposed to the same influences and pollutant sources, and
- the total volume represented by the composited samples is generally in accord with the minimum sampling guidelines in Table 1.

3.4.2. Proposed compositing schemes should be identified in the SAP and discussed in advance with the agencies. Compositing schemes should be reported and the rationale used fully described.

3.4.3. The amount of material from each core included in the composite sample shall be proportional to the length of the core (or cores if more than one core was necessary to secure adequate volume).

3.4.4. Sediment composites should comprise a sufficient volume for conducting all of the physical, chemical, and biological testing, including any QC analysis.

3.4.5. Table 8-1 in the ITM ("Type of Samples Which May Be Required Following Tier I to Conduct Dredged-Material Evaluations") summarizes the types of tests for which water, sediment, and tissue samples may need to be collected. Table 8-2 in the ITM ("Summary of Recommended Procedures for Sample Collection, Preservation, and Storage") lists appropriate collection methods, sample volumes, preservation and storage techniques, and holding times for the various analyses of sediment, water, and tissue samples. Any proposed modification or substitution of the listed methods must be described in detail in the proposed SAP and approved by the DMMO in advance of sample collection.

3.4.6. If it is suspected that contaminant levels vary with depth in the sediment or where multiple geologic strata are proposed to be dredged, the agencies may direct that core samples be subdivided for compositing and analysis of separate layers. When individual core samples are found to contain distinct layers that were not expected, the layers should be separated for individual testing (or at least sub-samples of each layer should be archived for possible later analysis).

4. SEDIMENT PHYSICAL AND CHEMICAL EVALUATIONS, "TIER II" (see ITM, Chapters 5 and 9)

4.1. Physical and chemical analyses are conducted on each composite sediment sample. In some cases, evaluation of individual core samples may also assist in decision making. When a composite "fails" some aspect of the testing, and individual core data are available, the agencies can sometimes determine that sub-areas are suitable for unconfined aquatic disposal (SUAD) without further sampling and evaluation.

4.2. Routine sediment physical and chemical analyses should be performed for the list of characteristics in Table 3. On a case-by-case-basis, the agencies may determine that additional characteristics of concern must be analyzed. The agencies may also approve the deletion of some of the characteristics listed in Table 3 for individual projects. Proposals to use reporting limits different from those listed in Table 3 should be approved by the DMMO in advance. The agencies may otherwise not have sufficient information to make a determination, which may then result in expensive re-sampling, re-analysis, or project delays.

- A WORD ABOUT LIMITS -

Laboratory reporting limits (RL) must be set to not less than the minimum level (ML) as defined in EPA's draft Guide to Method Flexibility and Approval of EPA Water Methods dated December 1996. The definition of ML is: "The lowest concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point for an analyte. It is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specific sample weights, volumes, and processing steps have been employed." Method detection limits (MDL) must be established as defined in 40 CFR Part 136, Appendix B. Values < MDL will be reported as not detected (ND) or < [value of MDL]. Values ≥ MDL and ≤ RL will be qualified with the "J" character as estimates. Values > RL will be reported without qualification unless required because of QC problems.

5. BIOLOGICAL EVALUATIONS, "TIER III" (see ITM, Chapters 11 and 12)

5.1. Three types of biological evaluations may be required for routine dredging projects in San Francisco Bay: water column toxicity tests, benthic toxicity tests, and benthic bioaccumulation tests. Issues specific to performing each of these evaluations for dredging projects are summarized in the following sections. The need to conduct any of the biological tests will vary from project to project based on factors such as the degree or type of known or suspected contamination. Proposed SAPs should therefore be coordinated in advance with the DMMO. The chemical analyses of tissues from bioaccumulation tests are conducted for the list of characteristics listed in Table 4.

5.2. Rigid adherence to the test conditions provided in Appendix E of the ITM is not required. Adaptations to improve the efficiency of testing are allowed. Laboratories need only demonstrate that equivalent results are obtained when modifying test conditions.

5.3. ***Water Column Toxicity Testing***

5.3.1. Water column toxicity testing is discussed in detail in Section 11.1 of the ITM. In these tests, an "elutriate" is prepared from dredged material and appropriate organisms are exposed to four elutriate concentrations.

5.3.2. The ITM recommends that three species representing different phyla be tested. This is one area where the agencies have determined that routine sediment testing for San Francisco Bay dredging projects proposing disposal at the existing sites, may appropriately differ from the nation-wide guidance presented in the ITM. Specifically, the agencies have determined that the water column is not a significant contaminant exposure pathway for typical dredging projects using the SF-09, SF-10, or SF-11 disposal sites. This determination is based on the hydrologic characteristics of the designated disposal sites, and on data from more than ten years of water column toxicity testing associated with area dredging projects during which acute water column toxicity has rarely been indicated after taking into account initial mixing. Tripling the number of water column toxicity tests required for routine dredging projects would provide little additional meaningful information for decision making, and would not be in keeping with the Long Term Management Strategy (LTMS) goals to conduct dredging and disposal in the Bay area in an economically and environmentally sound manner.

5.3.3. A single water column bioassay will generally be adequate for determining compliance with the State of California's narrative water quality standard. Results of the water column bioassay combined with the results of the benthic acute toxicity and bioaccumulation bioassays, provide for comprehensive characterization of sediment quality, and allows for consistent decision making (see "Interpreting Sediment Test Results," below).

5.3.4. In some circumstances, the water column may be determined to be an important exposure pathway of concern. For example, if the discharge is proposed in a location with limited water circulation. It could also be a pathway in the case of a relatively continuous, long-term discharge (e.g., where dredged material is being used for large-scale fill, such as for construction of a new shipping terminal). In such cases, the agencies may require additional species for water column testing, as described in the ITM.

5.3.5. A single water column bioassay must be conducted with one of the national "benchmark" species listed in Table 11-1 of the ITM. The species used should be appropriate to the salinity conditions under which the bioassay is run. For typical area projects, recommended test species include echinoderm or bivalve larvae, or *Mysid* shrimp. (Note: the echinoderm "sperm fertilization" bioassay is NOT recommended).

5.3.6. Water column toxicity tests are conducted using a minimum of four elutriate concentrations (100%, 50%, 10%, and 1%), in addition to laboratory control water (0% elutriate). Five replicates of each concentration should be tested. Endpoints in this bioassay are mortality and abnormal development (separate counts for each are to be reported). Both LC_{50} and EC_{50} values are to be calculated and reported. Data should be analyzed as recommended in paragraph 11.1.5 of the ITM (see Appendix D of the ITM). Normally, all test acceptance criteria specified in a test method must be met. However, for organisms tested using ASTM E-724, counts for abnormal larvae and calculated mortalities are to be added (i.e., it is assumed that abnormal larvae will not survive) when evaluating whether control survival is acceptable (>70 percent) and when calculating LC_{50} concentrations. The abnormality counts are to be used for calculating EC_{50} values. A reference toxicant bioassay must also be conducted at the same time and using the same population of test organisms. To be acceptable, the LC_{50} and EC_{50} values from the reference toxicant bioassay must be documented as being within two standard deviations of the laboratory mean response for that species using the Cusum control chart technique described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, Fourth Edition (EPA/600/4-90/02F, August 1993).

5.3.7. Results of water column toxicity tests are used to determine whether elutriate concentration outside the mixing zone would exceed 1% of the LC_{50}. If so, the State of California narrative water quality standard is not met, and the material represented by that sample is not SUAD at the proposed site (also see "Interpreting Sediment Test Results", below) without some sort of management action or contaminant control measures. The State and USACE are developing appropriate mixing zone boundaries. Project proponents will use the release zone method as documented in reference EPA/USACE 1977 until the State and USACE establish appropriate guidelines for using the STFATE model.

5.4. *Benthic Toxicity Testing*

5.4.1. Benthic toxicity testing, as described in ITM Section 11.2, involves exposing test organisms to the bulk (or whole) test sediment, as well as to the appropriate reference and control sediment for comparison. Table 11-2 of the ITM lists a number of appropriate species for use in benthic toxicity tests. As discussed in Section 11.2 of the ITM, benthic toxicity tests are to be conducted using a minimum of two species. Two species are adequate if, together, they represent the following three "life history stages:"

- Filter feeder
- Deposit feeder
- Burrower

5.4.2. For example, the amphipod crustaceans listed in ITM Table 11-2 are both burrowers and deposit feeders, while the *Mysid* shrimp listed are filter feeders. Therefore, the use of an amphipod and a *Mysid* shrimp could satisfy the benthic bioassay species requirements. Use of the amphipod *Ampelisca* (also a filter feeder) coupled with a polychaete worm such as *Neanthes* or *Nephtys* (which are both burrowers and deposit feeders) would also satisfy the benthic bioassay species requirements.

5.4.3. An amphipod must be one of the species tested in all cases. For typical San Francisco Bay area projects, the agencies specifically recommend that either *Rhepoxynius abronius*, *Ampelisca abdita*, or *Eohaustorius estuarius* be used, depending on the specific sediment conditions encountered (each species has different requirements and tolerances for salinity, grain size, etc.), along with a polychaete worm or *Mysid* shrimp. Proposals to use alternative amphipod species will be considered and must be approved by the DMMO in advance. Table 11-2 of the ITM lists only a single polychaete species (*Neanthes arenaceodentata*). The species *Nephtys caecoides* has also been used extensively in sediment bioassays throughout the West Coast, including San Francisco Bay. Either species may be proposed for use in dredged material benthic acute toxicity bioassays in this region.

5.4.4. When conducting benthic toxicity tests, special care must be taken to ensure that confounding factors (including anomalous ammonia and sulfide toxicity) do not influence the results. Direct measurement of *interstitial* concentrations of ammonia, salinity, and sulfides must be made prior to the initiation of the benthic bioassays and, if necessary, adjusted to below the species-specific thresholds given in the ITM on page 11-13. The agencies strongly recommend that interstitial total ammonia be no more than 15 mg/L at test initiation whenever possible. Methods for reducing ammonia or sulfide toxicity are provided in the ITM, page 11-13, or Jerretti 2000. Water in the laboratory aquaria above the sediment must also be monitored for the characteristics listed in Table 5.

5.4.5. The number of replicates for the species listed in Appendix E of the ITM should be tested for each composite sediment sample, and for reference and control sediments. The endpoint in benthic acute toxicity testing is mortality (in the case of amphipods, mortality and reburial). Results are compared to reference sediment results tested at the same time and using the same population of test organisms. Data should be analyzed as recommended in paragraph 11.2.4 of the ITM (see Appendix D of the ITM). When acute toxicity is indicated, the material represented by that sample is normally not SUAD at the proposed site. Generally, acute toxicity is indicated when mortality in the test sediment is both statistically significant and at least 10% absolute (20% absolute for amphipods) greater than that in the reference sediment (see “Interpreting Sediment Test Results,” below).

5.5. ***Benthic Bioaccumulation Testing***

5.5.1. Section 12.1 of the ITM describes bioaccumulation testing procedures. Routine bioaccumulation testing involves 28-day exposures of appropriate benthic organisms to the bulk (or whole) test sediment. The degree to which contaminants accumulate in the tissues of the test organisms is compared to similar results for exposure to reference and control sediments and other indicators of risk.

5.5.2. Bioaccumulation testing will be required by the agencies when concentrations of potentially bioaccumulative or biomagnifying compounds are known or suspected to be present in the sediment at concentrations of concern. Where there is sufficient existing information or confirmatory chemistry data to indicate that such compounds are unlikely to be present at concentrations of concern, the agencies may determine that bioaccumulation testing is not needed. One tool that the agencies use to determine if bioaccumulation testing is required is Theoretical Bioaccumulation Potential (TBP; see ITM Section 10.2). TBP provides an indication of the magnitude of bioaccumulation of potential contaminants that might result from exposure to the proposed dredged material. TBP is calculated using bulk sediment chemistry results and total organic carbon measurements and assumptions regarding organism lipid content and biota sediment accumulation factors. TBP usefulness is limited in that it can only be calculated for non-polar organics, such as chlorinated hydrocarbons, PCBs, and many PAHs. TBP cannot be estimated for metals, metal compounds, organic acids, salts, or organometallic complexes.

5.5.3. Not all contaminants that are routinely measured in dredged material samples (Table 3) are of concern for bioaccumulation. Fewer still have the potential to biomagnify. As discussed in the ITM, highly lipophilic organic compounds (defined as those having a log octanol-water partition coefficient [K_{OW}] > 3.5) may be of concern for bioaccumulation. When organic compounds with a K_{OW} of 3.5 or higher (e.g., see ITM Table 9-5) are present at elevated levels in dredged material samples, the agencies may require bioaccumulation testing. For inorganic compounds, the ITM recommends bioaccumulation evaluation when compounds have calculated bioconcentration factors (BCFs) greater than 3 are present at elevated levels (e.g., ITM Table 9.6). More information about contaminants of concern for bioaccumulation is contained in ITM Section 9.5.

5.5.4. Table 4 of these guidelines lists a number of bioaccumulative compounds that are often found in area sediment, and that the agencies would typically identify as contaminants of concern for bioaccumulation testing. The agencies may require analysis of additional compounds or only a subset of this list, based on project-specific factors such as proximity to past or present pollutant sources or previous testing data in the area.

5.5.5. When bioaccumulation testing is determined to be necessary, a minimum of two species will normally be required. Table 12-1 of the ITM lists appropriate species for benthic bioaccumulation tests conducted under various salinity conditions. For typical San Francisco Bay projects, the agencies recommend that either of the polychaetes *Neanthes (Nereis) arenaceodentata* or *Nereis (Neanthes) virens* be used, along with the deposit-feeding clam *Macoma nasuta*. *Nephtys* may also be used. Other species from ITM Table 12-1 may be proposed but must be approved by the agencies in advance. Appendix E of the ITM lists the number of replicates that should be tested for each composite sediment sample, and for reference and control sediments. Routine bioaccumulation tests use 28-day exposures; however, for some compounds the 28-day results are adjusted to estimate steady-state bioaccumulation levels.

5.5.6. Bioaccumulation testing is expensive and time consuming, and the agencies' intent is to require it only where elevated levels of bioaccumulative compounds are known or suspected. To reduce costs and increase predictability while remaining environmentally protective, the agencies hope to develop numeric "bioaccumulation trigger" values in the future, similar to those used in the Pacific Northwest, to identify when bioaccumulation testing must be conducted. Absent such numeric values for San Francisco Bay, bioaccumulation testing costs may still be minimized by careful design of the SAP and close coordination with the agencies and the testing laboratory.

5.5.7. Ideally, a separate confirmatory physical and chemical survey would be conducted throughout the dredging area first, to serve as the basis for up-front decisions both about the most efficient compositing scheme for the toxicity bioassays, and which composites need bioaccumulation testing. The area would then be re-sampled and only the necessary biological tests run. When a staged sampling program of this type is not feasible, it may be possible to expedite completion of the bulk sediment chemistry results and discuss them with the agencies prior to *initiating* the bioaccumulation bioassays. (For this to work, however, the chemical analyses must be completed and the results discussed with the agencies within the maximum 8-week sediment holding time for initiating the bioassays. Otherwise, the areas for which bioaccumulation testing is indicated would have to be re-sampled.)

5.5.8. When these approaches are not possible, the agencies recommend that the bioaccumulation tests be initiated at the same time as the other bioassays, using one of the approaches listed below. The choice of approach depends on the dredging project proponent's plans and priorities, and the laboratory's capability to expedite data availability. These approaches can still reduce testing costs, by avoiding analysis of tissues from bioaccumulation tests of sediment composites that do not have elevated levels of contaminants or that may have already "failed" other aspects of the testing program. The options are:

- Initiate the bioaccumulation tests on all composites concurrent with the other bioassays, and expedite completion of the bulk sediment chemistry results. Review the chemistry results with the agencies prior to completion of the bioaccumulation tests, completing the tests and analyzing tissues only for those composites indicated by the agencies.
- Initiate the bioaccumulation tests on all composites concurrent with the other bioassays, and complete the exposures but preserve (freeze) the tissues for possible later analysis at the direction of the agencies, after the results of the sediment chemistry and other bioassays have been reviewed.

5.5.9. Results of benthic bioaccumulation tests are reported as wet weight tissue concentrations of the contaminants of concern. Percent lipid content of the test organisms must also be measured. Bioaccumulation test results are compared with the results of the reference sediment bioaccumulation exposure, as well as with other indicators of human health or environmental risk (see "Interpreting Sediment Test Results," below).

6. CASE-SPECIFIC EVALUATIONS, "TIER IV" (see ITM, Chapters 7, 11 and 12)

6.1. For the majority of San Francisco Bay dredging projects, the routine physical, chemical, and biological evaluations described above that comprise Tiers I, II, and III of the ITM's testing framework will provide adequate information to evaluate the potential effects of a proposed discharge of dredged material. In unusual cases where routine testing does not generate sufficient information, more comprehensive case-specific evaluations may be required by the agencies. "Tier IV" evaluations may entail, for example:

- More intensive (higher resolution) sampling and analysis;
- Project-specific computer modeling;
- Steady-state bioaccumulation testing;
- Bioassays using additional species or endpoints (such as chronic endpoints);
- Field surveys of biological communities;
- Project-specific risk assessment; or
- Other case-specific assessments as directed by the agencies

6.2. Tier IV involves case-specific, state-of-the-art evaluations. In all cases where Tier IV assessment is required, the details of the proposed assessment (such as field and laboratory methodologies, sampling locations, and model inputs) must be approved in advance by the DMMO.

7. INTERPRETING SEDIMENT TEST RESULTS

7.1. The sediment testing program outlined above provides for a comprehensive, environmentally protective, yet cost effective evaluation of potential adverse effects that may be associated with the routine discharge of dredged material at established open water disposal sites within San Francisco Bay. Unlike the previous testing program under joint Public Notice 93-2, this ITM-based testing program is more comprehensive and allows for decision making to be somewhat more flexible. Specifically, this ITM-based program fully considers all relevant contaminant exposure pathways of concern by incorporating results from multiple benthic bioassays. The agencies can follow a "preponderance of the information" approach to data interpretation, as opposed to the rigid application of the benthic toxicity guideline necessitated by the single-species approach in PN 93-2. A higher degree of response is needed to indicate a "failure" in an individual benthic acute toxicity bioassay if all other test results are within acceptable ranges; lower degrees of response indicate "failure" when there are multiple indicators of potential adverse effect.

7.2. The following sections list the general interpretive criteria the agencies will follow when evaluating sediment test results for routine projects within San Francisco Bay. On a project-specific basis, the agencies may deviate from these general interpretation guidelines. This may occur based on project size (greater disposal volumes may translate into a greater risk of adverse impact), confidence in the test results, unrepresentative sampling, confidence in quality control procedures or results, or when results are not based on a pre-approved SAP.

7.3. *Sediment Chemistry, and Water Quality Standards Compliance*

7.3.1. Numeric water quality standards and criteria must be met in all cases. This requirement is not changed by the results of any of the other tests. Compliance with numeric water quality criteria is confirmed by modeling worst case concentrations (after initial mixing) assuming 100 percent solubility of chemical constituents in the bulk sediment. The RWQCB and USEPA will provide the DMMO with the most up-to-date information on specific water quality criteria at any time.

7.3.2. Material represented by any sediment sample that would cause a numeric water quality standard or criterion to be exceeded (after allowing for applicable initial mixing), is by definition not SUAD at the existing San Francisco Bay disposal sites. Any discharge permit for such material must include appropriate management restrictions that adequately address the particular contaminant(s) and exposure pathway(s) of concern.

7.4. *Water Column Toxicity Bioassay, and Water Quality Standards Compliance*

7.4.1. The state's narrative water quality standard (no discharges of "toxic materials in toxic amounts") must also be met in all cases. This need is not modified by the results of any of the other sediment tests. Compliance with the narrative water quality criterion is determined by evaluating whether the elutriate concentration, after initial mixing, would exceed 1% of the lowest of the LC_{50} or EC_{50} from the water column toxicity bioassay.

7.4.2. Material represented by any sediment sample that causes the narrative water quality standard to be exceeded (after allowing for initial mixing) is defined as not SUAD. Such material will not be found suitable for discharge at the existing San Francisco Bay disposal sites unless appropriate management restrictions that adequately address the particular contaminant(s) and exposure pathway(s) of concern are included in any permit.

7.5. *Benthic Toxicity*

7.5.1. Mean survival in benthic control sediment must be at least 90%. Mean survival of less than 90% may result in the agencies rejecting results and requiring re-testing. Mortality in a test sediment composite that is both statistically significant and at least 10% absolute (20% absolute for amphipods) greater than that in the reference sediment is considered to indicate acute toxicity. When acute toxicity is indicated, the material represented by that sample is defined to be not SUAD at the proposed site. When reference survival is less than 85%, project proponents should immediately consult with the agencies, which may require re-testing to confirm the reference results.

7.5.2. The acute toxicity threshold (10% or 20%) is modified somewhat when the agencies determine that none of the other sediment physical, chemical, or biological tests indicates a significant potential for adverse effect. This could occur when the sediment chemistry is not generally elevated with respect to reference or background conditions, the water column bioassay shows a relatively high LC_{50} or EC_{50}, there is no substantial bioaccumulation (if tested), and survival of the other benthic species is high. In such a circumstance, the sediment tested generally will be considered not SUAD when mortality in the one benthic toxicity test showing a positive response is statistically significant and at least 15% absolute (30% absolute for amphipods) greater than that in the reference sediment.

7.6. ***Benthic Bioaccumulation***

7.6.1. Results of benthic bioaccumulation tests are compared first with Food and Drug Administration (FDA) Action Levels, if available, for the contaminants of concern specified by the agencies for the individual project. Material represented by a tissue sample that exceeds any FDA action limit is defined as not SUAD. Where FDA Action Levels are not exceeded, or if the contaminants of concern include compounds for which no FDA Action Level has been established, bioaccumulation test results are compared with reference sediment bioaccumulation results, and with other indicators of human health or environmental risk. These indicators may include, but are not limited to, state fish advisories, cancer, and non-cancer risk models, literature concerning tissue residue effects, and local ambient fish data.

7.6.2. Other than FDA Action Levels, there are currently no nationally established numeric criteria for interpreting bioaccumulation test results. Decisions made based on bioaccumulation results are project specific and are based on best professional judgment of agency personnel. Risk assessment concepts may be applied, and in some cases a formal risk assessment may be required, depending on factors such as the particular contaminant of concern, project size, proposed disposal location and timing, and practicability of other alternatives such as ocean or upland disposal or beneficial reuse. Section 6.3 of the ITM discusses interpretation of bioaccumulation in more detail.

8. FURTHER INVESTIGATION OF SEDIMENTS THAT ARE NOT SUAD

8.1. When a sediment sample does not “pass” the relevant testing requirements outlined above, the dredged material that it represents is considered not SUAD. When the agencies identify dredged material not to be SUAD, the project proponent may choose one of the following courses of action:

- Dredge the unsuitable material and dispose of or reuse it at an appropriate permitted upland or confined location.
- Dredge only those portions of the project that are SUAD (note: in some circumstances, leaving unsuitable material in place may not be appropriate).
- Propose to conduct a more intensive evaluation of the area identified as including the unsuitable material in order to identify the maximum volume of SUAD that may be present.

8.2. More intensive investigation of an identified area of concern does not necessarily imply a Tier IV evaluation. Rather, it is common for project proponents to conduct higher resolution sampling and analysis in areas that "fail" based on the initial testing scheme. This approach is aimed at determining whether the area in question contains a "hot spot" that caused the original composite to fail, and at identifying any SUAD material in the area. Depending on project-specific circumstances, higher resolution sampling and analysis may entail:

- Analyzing sediment chemistry in individual cores archived from the original sampling event.
- Performing sediment chemical analyses based on high-resolution re-sampling near suspected pollutant sources (such as storm drains, other outfalls, or fuel docks) in addition to analyzing cores from original locations.
- Performing higher-resolution biological testing on multiple smaller composites divided (vertically or horizontally) from the original "failed" composite.

8.3. Higher-resolution testing can often be limited to the specific contaminants or bioassay organisms indicated as being of concern based on the original testing. Every project is unique, and what would be considered adequate further evaluation in one case may not be adequate in another. All proposals for higher-resolution testing should therefore be based on a new proposed SAP, and coordinated with the agencies in advance.

DEFINITIONS

"Appropriate," regarding a permitted upland disposal site, means a site located outside Waters of the State and the U.S. for which all necessary permits have been, or will be, secured.

"Fail," in the context used, means the opposite of "pass," above. For example, a sample meeting all quality control criteria that is at least 10% less than survival in the reference sediment (and statistically different from) fails the acute toxicity test.

"Higher resolution," in the context used means increased density (horizontal or vertical) of sampling or analysis with the intent of defining the areal extent of contamination more precisely than the original sample could.

"Hot spot," in the context used, is a localized area where either elevated levels of contaminants of concern in sediment or relatively elevated levels of toxicity occur.

"Pass," in the context used, means that the bioassay met quality control requirements, the difference between the reference testing and the sample sediments was less than 10%, or other value if appropriate, or if the difference was greater than 10% that the results were not statistically different from the reference. More simply, in the context used, "pass" means the material is SUAD.

REFERENCES

The following references shall be used in place of the similar outdated references in the ITM or as new reference material as appropriate. (See ITM, Chapter 13).

APHA, *Standard Methods* for *the Analysis of Water and Waste Water*, 19th edition.

ASTM D 2487-93, Standard *Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

ASTM E 724-98, *Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of Four Species of Saltwater Bivalve Molluscs*

ASTM E 729-96, *Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians*

ASTM E 1022-94, *Standard Guide for Conducting Bioconcentration Tests with Fishes and Saltwater Bivalve Mollusks*

ASTM E1367-99 *Standard Guide for Conducting 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods*

ASTM E 1391-94, *Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediment for Toxicological Testing*

ASTM E 1463-92, *Standard Guide for Conducting Static and Flow-Through Acute Toxicity Tests with Mysids from the West Coast of the United States*

ASTM E 1562-94, *Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids*

ASTM E 1563-98, *Standard Guide for Conducting Static Acute Toxicity Tests with Echinoid Embryos*

ASTM E 1611-99 *Standard Guide for Conducting Sediment Toxicity Tests with Marine and Estuarine Polychaetous Annelids*

ASTM E 1688-00, *Standard Guide for Determination of the Bioaccumulation of Sediment-Associated Contaminates by Benthic Invertebrates*

ASTM E 1850-97, *Standard Guide for Selection of Resident Species as Test Organisms for Aquatic and Sediment Toxicity Tests*

Jerretti, James A., Calesso, Diane F., and Hermon, Tonia R. (2000). Evaluation of Methods to Remove Ammonia Interference in Marine Sediment Toxicity Tests. *Environmental Toxicology and Chemistry* 19:1935-1941.

Gandesbery, Tom, and Hetzel, Fred (1988) "Ambient Concentrations of Toxic Chemicals in San Francisco Bay Sediments," Cal/EPA, Regional Water Quality Control Board, San Francisco Bay Region. http://www.swrcb.ca.gov/~rwqcb2/Downloadable_Files/sfbaysediment.pdf

Sims, J.G., and Moore, D.W. (1995). "Risk of pore water ammonia toxicity in dredged material bioassays," Miscellaneous Paper D-95-3, U.S. Army engineer Waterways Experiment Station, Vicksburg, MS

Sims, J.G., and Moore, D.W. (1995). "Risk of pore water hydrogen sulfide toxicity in dredged material bioassays," Miscellaneous Paper D-95-4, U.S. Army engineer Waterways Experiment Station, Vicksburg, MS

USEPA/USACE (1977). "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters" July 1977.

Ward, J.A., et. al. (1994). "Suggested Methods for Environmental Sampling and Analysis in San Francisco Bay," 3 volumes, Pacific Northwest Laboratory, Richland, Washington, December 1994.

TABLE 3. Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
Total Solids [TS](%)		0.1
Total Organic Carbon [TOC](%)		0.1
Grain Size (%)		0.1
Metals (mg/kg)		
Element (total)	**CAS No.**	
Arsenic	7440-38-2	2.0
Cadmium	7440-43-9	0.3
Chromium	7440-47-3	5.0
Copper	7440-50-8	5.0
Lead	7439-92-1	5.0
Mercury	7439-97-6	0.02
Nickel	7440-02-0	5.0
Selenium	7782-49-2	0.1
Silver	7440-22-4	0.2
Zinc	7440-66-6	1.0
Butyltins (µg/kg)		
Monobutyltin		10 each compound
Dibutyltin		
Tributyltin		
Tetrabutyltin		
Total Butyltins		

TABLE 3 (cont'd). Routine Sediment Physical and Chemical Evaluation

Characteristic	Reporting Limit*

PAHs (µg/kg)		
Compound	**CAS No.**	
Acenaphthene	83-32-9	20 each compound
Acenaphthylene	208-96-8	
Anthracene	120-12-7	
Benzo(a)anthracene	56-55-3	
Benzo(a)pyrene	50-32-8	
Benzo(b)fluoranthene	205-99-2	
Benzo(g,h,i)perylene	191-24-2	
Benzo(k)fluoranthene	207-08-9	
Chrysene	218-01-9	
Dibenzo(a,h)anthracene	53-70-3	
Fluoranthene	206-44-0	
Fluorene	86-73-7	
Indeno(1,2,3-cd)pyrene	193-39-5	
Naphthalene	91-20-3	
Phenanthrene	85-01-8	
Pyrene	129-00-0	
Total PAHs		

TABLE 3 (cont'd). Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
Pesticides (µg/kg)		
Compound	**CAS No.**	
Aldrin	309-00-2	2 each compound
α-BHC	319-84-6	
β-BHC	319-85-7	
δ-BHC	319-86-8	
γ-BHC (Lindane)	58-89-9	
Chlordane	57-74-9	20
2,4'-DDD	53-19-0	2 each compound
4,4'-DDD	72-54-8	
2,4'-DDE	3424-82-6	
4,4'-DDE	72-55-9	
2,4'-DDT	789-02-6	
4,4'-DDT	50-29-3	
Total DDT		
Dieldrin	67-57-1	2 each compound
Endosulfan I	959-98-8	
Endosulfan II	33213-65-9	
Endosulfan sulfate	1031-07-8	
Endrin	72-20-8	
Endrin aldehyde	7421-93-4	
Heptachlor	76-44-8	
Heptachlor epoxide	1024-57-3	
Toxaphene	8001-35-2	20

TABLE 3 (cont'd). Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
PCBs (µg/kg)		
Aroclor 1016	12674-11-2	20 each Aroclor
Aroclor 1221	11104-28-2	
Aroclor 1232	11141-16-5	
Aroclor 1242	53469-21-9	
Aroclor 1248	12672-29-6	
Aroclor 1254	11097-69-1	
Aroclor 1260	11096-82-5	
Total Aroclors	12767-79-2	

*Note: Sediment reporting limits are on a dry-weight basis. To achieve the recommended reporting limits for some compounds in sediment, it may be necessary to use a larger sample size than the method describes, a smaller extract volume for gas chromatography/mass spectrometry analyses, or recommended sample cleanup methods to reduce interference.

TABLE 4. Bioaccumulative Contaminants of Concern for Routine Tissue Evaluation

Characteristic	Reporting Limit[A]
Total Lipid (%)	0.1
Cadmium (mg/kg)	0.1
Copper (mg/kg)	1.0
Mercury (mg/kg)	0.02
Selenium (mg/kg)	0.5
PAHs[B] (µg/kg)	20
Pesticides[B] (µg/kg)	2
PCBs[C] (µg/kg)	20
Butyltins[B] (µg/kg)	10

A. Tissue reporting limits are on a wet-weight basis. To achieve the recommended reporting limits for some compounds in sediment, it may be necessary to use a larger sample size than the method describes, a smaller extract volume for gas chromatography/mass spectrometry analyses, or recommended sample cleanup methods to reduce interference.

B. Use same list of compounds as in Table 3

C. If bioaccumulation tests are necessary because of elevated levels of PCBs, the agencies expect to require PCB congener analysis rather than Aroclor analysis. The agencies are currently working on the specific list of congeners that will be required. A separate public notice will be issued listing the congeners of concern.

TABLE 5. Interstitial and Overlying Water Measurements

Characteristic	Reporting Limit
Salinity (ppt)	0.1
pH (pH units)	0.1
Ammonia (mg/kg)	0.2
Soluble Sulfides (mg/kg)	0.1
Dissolved Oxygen (mg/kg)	0.1
Temperature (°C)	0.1