U.S. EPA-REGION 5
GREAT LAKES
DREDGING HANDBOOK

FINAL DRAFT
OCTOBER 1989

U.S. EPA-REGION 5 GREAT LAKES

DREDGING HANDBOOK

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LIST OF ABBREVIATIONS

CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
EP	Extraction Procedure
EPA	Environmental Protection Agency
ERB	Environmental Review Branch
IDEM	Indiana Department of Environmental Management
IPPTF	In-Place Pollutant Task Force
MDNR	Michigan Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PDES	Pollutant Discharge Elimination System
PPM	Parts Per Million
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act of 1986
TSCA	Toxic Substances Control Act
WDNR	Wisconsin Department of Natural Resources
WES	Waterways Experiment Station

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SECTION 1.0

Introduction

1.0 INTRODUCTION

1.1 PURPOSE OF HANDBOOK

This handbook is intended to provide a comprehensive overview of the dredged material evaluation process conducted by the U.S. Environmental Protection Agency (EPA) Region 5 for to the U.S. Army Corps of Engineers (Corps) Federal projects in the Great Lakes region. The handbook is intended primarily for personnel in the U.S. Army Corps of Engineers and the state environmental agencies. It may also be distributed to various other Federal, state and local groups to provide them with information on the dredged material evaluation process conducted by Region 5.

EPA is concerned about the potential environmental effects of dredged material disposal because of widespread contamination of heavy metals, PCBs and pesticides in Great Lakes sediments that may require dredging. Initial efforts toward establishing standardized guidelines for evaluating Great Lakes sediments resulted in the "1977 Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments" (1977 U.S. EPA Guidelines, Appendix A). This document has provided interim guidance on classifying sediments based on specific physical and chemical parameters. However, the Guidelines have limited value in that they were not developed based on ecological effects. EPA recognizes the importance of utilizing analytical methods that go beyond identifying sediment contaminants because environmental effects are not necessarily directly associated with contaminant concentrations. The Region 5 dredged material evaluation practices have evolved considerably over the past decade. Recently, an effort has been underway to establish a standardized sampling, testing and evaluation protocol (Appendix B). The protocol focuses on evaluating potentially contaminated sediment to be dredged from Corps maintained navigational project areas.

There is a need to document the existing evaluation procedures that are acceptable to Region 5 and to explain the inter-office coordination process and management strategies that are currently being utilized. This manual provides this documentation and can act as a guide for future dredged material evaluations.

1.2 EPA'S DREDGED MATERIAL REGULATORY RESPONSIBILITY

The Environmental Protection Agency is a primary regulatory agency regarding disposal of dredged material in "waters of the United States". Under the purview of Section 404 of the Clean Water Act of 1972 (P.L. 92-500) and the National Environmental Policy Act of 1969 (P.L. 91-190), EPA is responsible for providing comments and recommendations to the Corps to insure that dredged material is disposed in an environmentally acceptable manner. Under the Toxic Substances Control Act (TSCA) (P.L. 94-469) and the Resource Conservation and Recovery Act (RCRA)(P.L. 94-580), EPA regulates the removal and disposal of material (including proposed dredged sediments) that is contaminated to an extent requiring special handling, disposal and monitoring applications. Other Federal and State agencies also have certain authorities relating to regulation of dredged material.

This handbook will focus on Region 5's management and decision making framework as it relates to evaluation of proposed Corps maintenance dredging projects within the context of EPA's regulatory authority.

1.3 OVERVIEW OF HANDBOOK COMPONENTS

This handbook is divided into several sections. Section 1.0 explains the purpose and its intended use. The handbook is primarily intended to provide personnel within the U.S. Army Corps of Engineers and the state environmental agencies with a comprehensive "hands on" reference document that explains the dredged material evaluation process conducted by Region 5. The document may also be distributed to various other Federal, state and local groups to provide them with information on EPA's evaluation process.

Section 2 0 provides an overview of historical dredging activities in the U.S. Great Lakes region. This includes a summary of the dredging methods, general degree of dredging activity for each of the Lakes and disposal alternatives commonly utilized

Section 3.0 explains various sediment characterization methods used by Region 5 to evaluate dredged material in the Great Lakes

Section 4 0 provides a summary of the Federal and state regulatory framework governing dredged material disposal activities in the Lakes region. This includes a state-by-state synopsis of pertinent regulations, evaluation methods, management policies, restrictions and coordination practices that have been identified during the development of this manual.

Section 5.0 provides details regarding the Region 5 Environmental Review Branch (ERB) and In-Place Pollutant Task Force (IPPTF) including their purpose, responsibility and organizational structure for evaluating proposed dredging projects. The ERB is the office responsible for reviewing dredging project information received from the Corps and coordinating their evaluation process within the Regional departments as well as responding to the Corps on dredged material suitability. The IPPTF is comprised of several individuals with dredged material management expertise and provides a means of in-house discussion and assessment of a variety of complex environmental issues that may arise during the review of Corps dredging projects. The coordination role and information transfer processes are reviewed in this section of the manual.

Section 6.0 details the case-by-case decision evaluation process utilized by Region 5 in providing comments and recommendations and in developing agency positions for the Corps regarding potential effects of dredged material disposal. A brief summary of the Corps' national dredged material management strategy is given. This section also provides selected examples of specific recommendations and rationales developed by Region 5 for various Corps dredging and disposal project proposals. This information provides further insight on the breadth of environmental considerations that may apply to specific disposal alternatives and sediment types. The entire EPA review process, including receipt of information from the Corps, in-house coordination, IPPTF involvement and evaluation of impacts relating to specific disposal options, is explained.

SECTION 2.0

Dredging and Disposal Practices in the U.S. Great Lakes Region

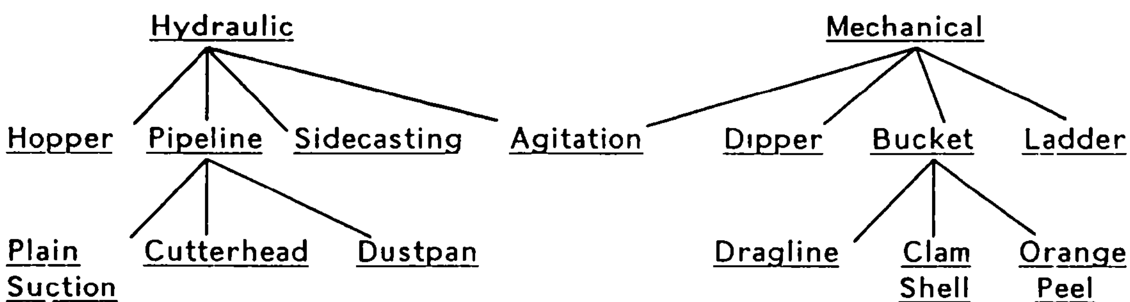
2.0 DREDGING AND DISPOSAL PRACTICES IN THE GREAT LAKES REGION

2.1 DREDGING ACTIVITIES

2.1.1 Methodologies

Historically, dredging activity in the Great Lakes Region has been quite intensive (Figure 2-1). Recent information indicates that the three Corps of Engineer Districts with jurisdiction on the Great Lakes dredged approximately 3.6 and 3.0 million cubic yards of material in the EPA Region 5 area for 1987 and 1988, respectively (Table 2-1). Also, information contained in the Dredging Register for the 1975-1979 period indicate dredged volumes ranged from 5.9 to 6.1 million cubic yards per year (IJC 1982) for all areas of the Great Lakes.

The dredging of sediments from the Great Lakes waterways as well as elsewhere is accomplished by one of two general techniques: hydraulic or mechanical. Each technique includes several different types of dredging technologies (Figure 2-2). Selection of the appropriate method is usually dependent upon sediment type, water depth, lake conditions, location and proximity to the disposal area and, to some extent, equipment availability and cost. However, the expected environmental impact from the proposed work is considered to be one of the most important factors when choosing a dredging method. Sediment characterization (i.e., physical properties and level of contamination) plays an important role in determining the best dredging method in relation to the environmental conditions at the dredge site (NRC 1985).



Source: NRC 1985

Figure 2-2 Dredging systems

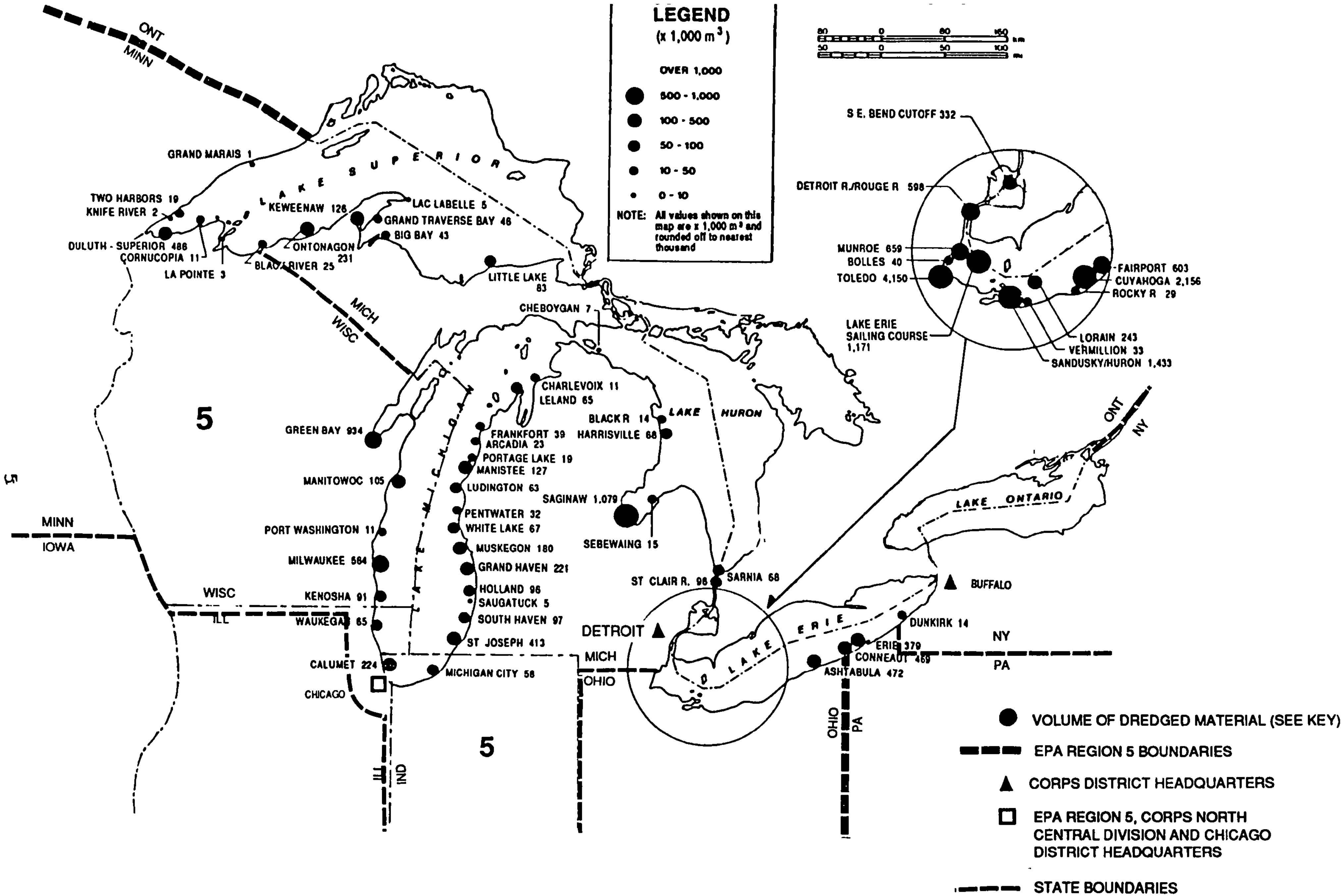


Figure 2-1. U.S. Great Lakes dredging activities in EPA-Region 5, 1975-1979.

Source: IJC 1982

TABLE 2-1. APPROXIMATE DREDGING VOLUMES (x 1000 yd^3) FOR GREAT LAKES PROJECTS IN CORPS OF ENGINEER DISTRICTS, 1987-1988.

SOURCE: N. CENTRAL DIVISION, CORPS OF ENGINEERS, 1989.

DISTRICT	1987	1988
Buffalo	1832.1	1565.0
Chicago	103.0	101.0
Detroit	1634.5	1347.3
Total	3569.6	3013.3

Hydraulic dredging technology utilizes a centrifugal pump to move a slurry of water and dredged material from the bottom through a pipeline to a disposal site. Generally, hydraulic dredges produce less turbidity at the dredge head since a suction pipe is used to remove the dredged material. However, disposal of material dredged in this manner may create turbid conditions since a diluted slurry of water and dredged material are delivered to the end of the pipeline. Usually, some filtration of the slurry is necessary to reduce this effect. Hydraulic dredges are productive methods for dredging large qualities of soft, fine to medium grained bottom materials (NAS 1985) but produce more water in need of treatment than mechanical dredging.

During hydraulic dredging, a practice known as overflow dredging has been used frequently. This practice allows pumping to continue after the barge holding bin is full, permitting excess water and lightweight sediment to overflow the sides of the dredge back into the water (GAO 1988). U.S. EPA does not support the practice of overflow dredging in instances where the sediment that overflows has been determined to be unsuitable for open lake disposal. Specifically EPA Region 5 does not allow the overflow dredging of sediments having PCB levels greater than 1 ppm (GAO 1988). During 1986 and 1987, 56 percent of sediment removed on the Great Lakes employed hydraulic dredging. The GAO report identified only one instance where overflow dredging was used in an area of highly contaminated sediment in the Saginaw River, near Bay City, Michigan.

Mechanical dredging techniques work well in areas where little agitation of contaminated sediments is tolerable and if cohesive fine-grained materials are present. In addition, no dilution water or pipelines are required. These dredges operate on land or water by physically picking up and lifting dredged materials using buckets or shovels.

2.1.2 Existing and Future Needs

The consensus of a panel that assessed dredging and other coastal port issues concluded that an efficient modern port system was important to the nation's economy (NRC 1985). Great Lakes port facilities are a part of that system and certainly have a vital regional economic role.

Data in Table 2-1 from the North Central Division of the Corps of Engineers in Chicago show that during a two-year fiscal period (1987-1988), approximately 6.5 million cubic yards of material were dredged from the Buffalo, Chicago and Detroit Districts. Maintenance dredging of port facilities and federal navigation projects is an ongoing feature of the Great Lakes system. Dredging operations and disposal areas need permitting and monitoring on a continual basis. However, only a limited amount of monitoring has been conducted at Great Lakes open water sites. A study in Lake Erie off Ashtabula, Ohio is one example (Tatem 1984).

2.2 DISPOSAL ALTERNATIVES FOR GREAT LAKES PROJECTS

2.2.1 Historical Disposal Site Usage

Historically, dredging projects within the U.S. Great Lakes boundary have utilized four disposal methods: confined disposal facilities (CDFs), open lake disposal, beach nourishment and upland disposal (IJC 1982). During that period, the most highly utilized disposal options were CDFs and open lake disposal; upland disposal and beach nourishment were used occasionally

2.2.2 Present Disposal Site Practice

Recent data from the Corps of Engineers indicate that disposal options for beach projects or confined disposal are utilized most frequently (Table 2-2). Open lake disposal is also utilized but less often as are combinations of disposal methods such as open lake/confined or beach use/confined. Section 4.0 of this handbook discusses in further detail regulations, evaluation methods and management policies regarding disposal option selection.

TABLE 2-2. FREQUENCY OF DISPOSAL OPTIONS USED IN U.S. GREAT LAKES, 1987-1988, BY THE CORPS OF ENGINEERS.*

DREDGING TYPE	DISPOSAL OPTION	1987	1988
Hopper	Open Lake	4	3
	Open/Confined	1	0
	Confined	2	3
Non-Hopper	Open Lake	2	5
	Open/Confined	0	1
	Beach	13	13
	Beach/Confined	1	1
	Beach/Upland	0	1
	Confined	10	7
	Upland	0	1

*Buffalo, Chicago and Detroit Districts

SECTION 3.0

Sediment Charaterization

3.0 SEDIMENT CHARACTERIZATION

3.1 SAMPLING AND ANALYSIS

Historically, sediment characterization in Region 5 is accomplished by utilizing data supplied by the Corps of Engineers for specific projects. Data are then compared to the 1977 U.S. EPA Guidelines and the 1982 IJC Guidelines to characterize the sediments.

3.1.1 Procedural Guidelines

The design and execution of sediment sampling and testing procedures associated with maintenance dredging projects are described by interim guidelines established by EPA-Region 5 (1989)(Appendix B). This document was written to provide a consistent procedure to guide project personnel to make management decisions concerning project specific removal and disposal options. It also promotes coordination among state and federal agencies involved in the dredged sediment assessment process.

Procedures described in the Region 5 document are 1) definition of the historical and background information required; 2) a rationale for levels of sediment testing; 3) establishment of the locations and number of sampling stations; 4) references for various procedures and protocols, and; 5) a general review of costs associated with sampling and testing. With established consistent procedures, Corps project personnel can design and implement sampling programs that are acceptable to Region 5.

Guidance for sediment sample collection and analysis is provided in Plumb (1981). This manual written as a result of Section 404(b) of the Clean Water Act describes in detail methods of sampling, preservation and analysis of dredge and fill material. These methods are designed to evaluate impacts of proposed dredge and fill operations in navigable waters of the United States.

Three major sections in Plumb illustrate the management of the assessment of dredging projects The first section describes in general terms a rationale for project managers to develop an appropriate sampling plan. In the second section, laboratory and field personnel are instructed in the implementation of the sampling plan. Sampling equipment and preliminary laboratory procedures are described. Analytical techniques are described in the third section for several parameters Other parameters may also be recommended for particular projects on a case-by-case basis.

While standardized methods and procedures create consistent review of dredging projects, each project is unique in some respects and, may require some degree of special considerations on a case-by-case basis.

3.2 SEDIMENT CHARACTERIZATION METHODS

3.2.1 Physical Characterization

Physical characterization generally refers to grain size analysis or particle size distribution. Grain size can be reported using various methods (Table 3-1)(Plumb 1981). Grain size is of interest for two reasons. It provides an indication of the energetics of the dredge and disposal sites. Sediments at the dredge and disposal sites should be of similar grain size so they will stay in place and less likely to change ecological conditions. Also, the finer the material (i.e., smaller the grain size) the greater is the potential for elevated contaminant levels. This is caused by the adsorption affinity of contaminants to the finer grained material, and thus, the potential to bind the contaminant load to the sediment. Silts are easily transported by currents and wave action and, thus, can carry pollutants from contaminated areas to nearby cleaner areas. Sand and gravel usually have low concentrations of contaminants and are less mobile. One must recognize, however, that this generalization can have exceptions.

Other physical-related sediment tests may be useful in evaluating certain disposal applications, particularly regarding confined disposal facilities (CDFs). Various settling tests are used to determine the concentration of suspended solids at various depths over time in confined disposal sites (USACOE 1987). These test methods are mainly applicable to hydraulic disposal operations when the settling rate of particulates is of concern relative to effluent standards and storage capacity.

3.2.2 Chemical Characterization

Bulk chemical testing provides information concerning the presence (or absence) of specified chemical constituents. The 1977 EPA Guidelines (Appendix A) list nineteen parameters including metals, nutrients, and polychlorinated biphenyls. This list is not exhaustive; recent testing methodologies have identified additional parameters that can cause environmental degradation as well Contaminants such as dioxins, polynuclear aromatic hydrocarbons (PAHs) and chlorinated pesticides are examples. Analysis of sediment should also include a determination of total

TABLE 3-1. METHODS FOR REPORTING SEDIMENT GRAIN SIZE DISTRIBUTION

CLASS NAME	MILLIMETERS	MICROMETERS	PHI VALUE
Boulders	>256		<-8
Cobbles	256-64		-8 to -6
Gravel	64-2		-6 to -1
Very coarse sand	2.0-1.0	2000-1000	-1 to 0
Coarse sand	1.0-0.50	1000-500	0 to +1
Medium sand	0.50-0.25	500-250	+1 to +2
Fine sand	0.25-0.125	250-125	+2 to +3
Very fine sand	0.125-0.062	125-62	+3 to +4
Coarse silt	0.062-0.031	62-31	+4 to +5
Medium silt	0.031-0.016	31-16	+5 to +6
Fine silt	0.016-0.008	16-8	+6 to +7
Very fine silt	0.008-0.004	8-4	+7 to +8
Coarse clay	0.004-0.0020	4-2	+8 to +9
Medium clay	0.0020-0.0010	2-1	+9 to +10
Fine clay	0.0010-0.0005	1-0.5	+10 to +11
Very fine clay	0.0005-0.00024	0.5-0.24	+11 to +12
Colloids	<0.00024	<0.24	>+12

Source: Plumb 1981

organic carbon which is an indicator of the sediment's binding affinity for non-polar organic compounds. Certain areas within the Great Lakes have been identified as areas of concern regarding chemical contamination (IJC 1987). Prospective dredging projects in these locations should be carefully evaluated for contaminants specific to those areas.

Elutriate testing was designed to mimic the hydraulic dredging and disposal process. In this test, sediment and dredging site water are mixed using a 4:1 (volume) ratio, allowed to settle, and filtered (Plumb 1981). The filtered water (the elutriate) is then analyzed for chemical constituents of interest based on project specific concerns.

A recent modification of the elutriate test eliminates the filtration of the supernatant prior to chemical analysis The entire resultant water from the mixing process is analyzed to determine "total" water column contaminants by including all suspended particualte matter in the analysis (Palermo 1986a).

Other methods of chemical characterization are still in developmental stages by the Corps and EPA. These relate to determining leachate concentrations and permeability rates through various dike construction materials, as well as investigating the establishment of sediment quality criteria using sediment equilibrium partitioning.

3.2.3 Biological Characterization

In addition to chemically characterizing sediment, biological characterization of a dredge or disposal area may also be required. Broadly grouped, there are generally three methods to characterize sediment biologically: benthic studies, bioassay and bioaccumulation studies.

Benthic surveys, depending on their objectives, may obtain general data about a specific area and be either quantitative or qualitative They may focus on species of special concern for instance, on a commercially important species. In addition, they may rely on literature searches for existing data

Benthic studies generally entail sampling a known area of the bottom to collect representative samples in and near the dredge and/or disposal site. Typically, organisms are screened from the sediment, counted and identified, and species abundances estimated by using several available statistical analyses; control or reference sites are used for comparison. While this effort can provide information regarding the impacts associated with dredging and disposal disturbance, it cannot provide information to assess the impact that chemical contaminants may have upon the biota.

A comparison of benthic community data to a reference site may not give a true picture since other parameters in addition to contaminants may result in site differences. However, benthic data compliment the chemical characterization of dredged sediment to provide an understanding of the general conditions at a particular site.

Bioassay testing, while not considered a definitive predictor of environmental effects, does determine the potential for community change due to sediment contamination. During bioassay testing, test organisms are exposed to field-collected sediments associated with certain contaminant concentrations. Mortality or sublethal effects are compared quantitatively to effects observed in reference sediments (Battelle 1988). Bioassays usually show mortality as the endpoint of the test. It may not be clear, however, what the relationship is between the mortality of a certain percentage of test animals and actual impacts on local populations of similar species in the vicinity of a dredge or disposal site.

Generally, the greatest impact from dredging occurs during the solid or whole sediment phase. During this phase, the sediments do not mix or disperse as rapidly as they do, for example, during a suspended phase. Consequently, bottom dwelling organisms within and on the disposed sediment are impacted the most. Solid phase testing measures the additive or synergistic effects that may be occurring of all the contaminants present in the sediment. To determine specific contaminant impacts, other testing methods may be required. Also, since bioassays are usually performed in the laboratory, a true measure of *in situ* biological effects may not be obtained (Battelle 1988).

Elutriate testing simulates the dredging and disposal process by mixing predetermined amounts of dredging site water and sediment to approximate a dredged material slurry (Plumb 1981). This test evaluates the dissolved fraction of chemical constituents that are immediately releasable from the dredged material as the material passes through the water column (IJC 1982). After the elutriate phase is accomplished, bioassays may be performed to evaluate the potential biological impact due to the particulate matter and biologically active contaminants present. Appropriate organisms as in the solid phase bioassay must be used for testing.

Bioaccumulation studies can be conducted to determine the potential uptake of contaminants by bottom dwelling organisms. However, due to the long term nature of bioaccumulation for most contaminants, an historical precedent should exist in the dredging project area under consideration before these studies are conducted (USACOE 1977). With this information, any substantial increase or persistent concentrations of contaminants due to exposure of the organisms to the sediment may be assessed. For bioaccumulation data to be useful in a permitting decision, it is necessary to predict whether there will be a cause-and-effect relationship between the organisms' presence in the dredged material and a significant elevation of the body burdens of contaminants in organisms higher in the food chain but not actually living in the dredged material (USACOE 1977).

Generally, the focus of bioaccumulation studies is on the solid phase since the concern is associated with gradual uptake over a long exposure time. Suspended phase bioaccumulation is rarely considered since only short exposure times occur due to rapid mixing of waterborne particulates and limited uptake of contaminants should occur under those conditions.

Bioaccumulation results are difficult to interpret because, generally, the ecological consequences of a given tissue concentration is not known. However, since the ultimate consumer of aquatic organisms such as fish is often people, statistically significant concentrations are viewed as a cause for concern.

3.3 SEDIMENT CLASSIFICATION

3.3.1 Primary Classification Methods

Several methods to classify sediments exist. A brief explanation of the primary ones follow.

In the apparent effects threshold (AET) approach, the sediment contamination level is identified above which statistically significant biological effects (e.g , mortality, benthic infauna population decreases, etc.) would always be expected (Beak 1987) The AET concentrations are empirically derived from paired field data for sediment chemistry and a range of biological effects indicators. This method requires collection of extensive field data for contaminant concentrations and at least one biological response indicator such as mortality or biological population decreases. Also, the possibility of effects by unmeasured, covarying contaminants is a source of uncertainty with this method (Beak 1987)

Equilibrium partitioning approaches are based on the assumption that the distribution of contaminants is controlled by a continuous exchange among sediment, organism, interstitial and overlying waters (Beak 1987). Using the sediment-biota equilibrium approach, contaminant-specific partition coefficients are determined and used to predict the distribution of the contaminant between sediment and benthic organism and/or interstitial water and benthic organism. With the sediment-water equilibrium partitioning approach, contaminant-specific partition coefficients are determined and used to predict the distribution of contaminant between sediment and interstitial water.

Assumptions using the equilibrium approach require extensive validation and study. Both partitioning processes need to be quantified. Rapidly metabolized compounds have poor correlations between partition coefficients and bioconcentration factors. Also, body burden-effect data are required to establish permissable limits. Although limits have been established for several contaminants in edible commercial fish species by organizations such as the U.S. Food and Drug Administration, their applicability to sediment characterization is vague because they are designed for human health evaluations only.

Sediments can also be classified according to the amount of contaminants present compared with a list of broadly defined pollutants. The 1977 EPA Guidelines (see Appendix A) established by Region 5 were based on bulk sediment analysis of samples from several harbor studies so that project personnel could make decisions regarding the disposal of dredged material. Using the Guidelines, a sediment is classified according to the highest individual parameter concentration category (i.e., non-polluted, moderately polluted, or highly polluted). Other project related factors such as sediment type, biological populations and other test results may also be considered in making the subjective determination for sediment classification. Considered interim when first proposed, these guidelines have been widely used by Federal and state agencies for dredging project management decisions.

The 1982 Dredging Register also contains sediment classification guidelines based on the relative quality of Great Lakes sediments. The data are based on the basinwide means for parameters of concern. Parameters are categorized based upon their relative potential as an environmental hazard Parameters were included if the potential existed for transformation to a toxic methylated form or if the sediments and organisms were enriched with the element (IJC 1982).

3.3.2 Site Specific Criteria

While standardized procedures attempt to streamline the evaluation process so that all concerned are proceeding in a similar manner, EPA Region 5 has several specific considerations regarding sediment sampling and testing strategies (U.S. EPA 1989)(Appendix B).

- Projects with volumes greater than 500,000 yd^3 of dredged material annually should establish independent sampling and testing strategy coordinated through the appropriate Corps of Engineer district.

- Projects with only slightly contaminated dredged materials and volumes less than 50,000 yd^3 may be excluded from testing if historical records of proper grain size composition and no elevated levels of contamination can be documented.

- Section 404 permitting for municipal bridge repair requires samples from each side of the structure be composited before analysis and testing based on the proposed method of material removal and disposal.

- Section 404 permitting for slip/dock dredging requires three samples with testing based on the proposed method of material removal and disposal and consideration of materials off-loaded or loaded at or around the site.

These specific site criteria illustrate that dredging projects while sharing similar details may in fact be different Standardized techniques may need modification or alteration so that adequate information may be gathered to make management decisions for dredging and disposal projects.

SECTION 4.0

Regulatory Framework

4.0 REGULATORY FRAMEWORK

4.1 FEDERAL REGULATIONS

Great Lakes dredging projects may fall under the jurisdiction of a number of federal regulations, depending on the level of contaminants and proposed use of dredged materials.

4.1.1 Clean Water Act (CWA)

Depending on the specific dredged material disposal activity being proposed, review and permitting may be required under Sections 401, 402 or 404 of the CWA.

Section 401 involves water quality certification which is the primary responsibility of the state in which the discharge would occur. Under this Section, EPA reviews proposed dredged material disposal projects and provides comments to the Corps and state to ensure water quality goals are met.

Under Section 402, EPA may recommend to the regulating state that a National Pollutant Discharge Elimination System (NPDES) permit be required for any CDF that is designed to channel and collect rainwater or accumulated seepage which may require removal from the CDF and discharging as a point source.

Section 404 involves the review and comment by EPA to the Corps for any project that involves the discharge of dredged (or fill) material into waters of the United States. Waters of the U.S include but are not limited to wetlands and open water areas Although the Corps is the permitting authority regarding the discharge of dredged material under 404, EPA is responsible for reviewing projects with respect to fulfillment of the requirements of EPA's 404(b)(1) guidelines (40 CFR Part 230).

The 404(b)(1) Guidelines form the basis for specification of disposal sites for dredged material and provide general evaluation procedures to protect the physical, chemical and biological integrity of the disposal area environment Specific considerations that must be evaluated under 404(b)(1) include:

- examination of practical disposal alternatives
- habitat loss or degradation
- water quality degradation

- effects on human health, aquatic life and wildlife resources
- impacts on special aquatic sites, threatened and endangered species.

EPA has veto authority over Corps decisions under Section 404. This can occur when EPA disagrees with the Corps regarding the proposed discharge of dredged (or fill) material when the expected water quality effects of the activity may produce overriding concern over public safety.

Proposed dredged material disposal actions regulated under Section 404 include open water disposal, beach nourishment, disposal in wetlands and, under specific instances, include operational use of CDFs. Usually the effluent or discharge from a CDF to "waters of the United States" via a weir or pipeline is what triggers the need to regulate under 404. Chemical contamination through leachate or weir discharge is the principal concern with CDF disposal.

4.1.2 Toxic Substances Control Act (TSCA)

The presence of polychlorinated biphenyls (PCBs) in proposed dredged sediments at concentrations equal to or greater than 50 ppm requires an EPA review under TSCA (40 CFR Part 761.60). PCB contamination is fairly widespread throughout the Great Lakes region and is of concern in a number of areas.

Under TSCA, only three disposal options are allowed for PCB contaminated dredged material:

- an approved incinerator
- chemical waste landfill
- a "third or other alternative" that has been specifically approved by EPA for this use.

The chemical landfill regulations (40 CFR Part 761.75) are utilized by the Region to the greatest practicable extent when evaluating disposal of TSCA dredged material The regulations for chemical landfills require the disposal sites to be as impermeable as possible and set forth the following minimum criteria:

1) In-place soil thickness of 4 feet or compacted soil liner thickness of 3 feet;
2) Permeability equal to or less than 1×10^{-7} cm/sec;
3) Percent soil passing No 200 sieve >30;

4) Liquid limit >30;
5) Plasticity index >15; and
6) Distance to historical high water table $\geq$50 feet and no surface water hydraulic connection.

It is important to understand that EPA's utilization of the chemical waste landfill requirements is flexible. Region 5 reviews each proposed TSCA action with respect to these requirements on a case-by-case basis. Certain specific features of a prospective disposal site or the surrounding environment may make it impossible to meet all landfill criteria. The EPA Regional Administrator may waive certain requirements when it is demonstrated that the proposed disposal site design will not present an unreasonable risk to human health or the environment. For example, in many land areas around the Great Lakes the groundwater level can be as near as 10-20 feet from the surface. In these areas proposed TSCA facilities may require the 50 foot rule be waived, provided the groundwater can be adequately protected.

Conversely, Region 5 may also institute stricter requirements than specified in Part 761.75. For example, groundwater monitoring may need to be more extensive than the regulation specifies. Also, testing for contaminants other than PCBs may be necessary.

EPA has also instituted a non-dilution TSCA provision. This relates to those situations where a proposed or historic dredging operation will expose sediments having PCB concentrations $\geq$50 ppm and there is a potential for movement or dilution of the PCBs. In those instances, under TSCA, EPA can direct removal and proper disposal of the entire volume of contaminated material, even though a portion of the material removed may not be specifically related to the original intent of the project. This requirement could pertain to Corps dredging projects where the original intent may be to remove sediment to a specified depth for maintaining a Federal channel. EPA may require the Corps to dredge deeper to remove (or shallower to retain) TSCA sediment that could be exposed to and diluted with the non TSCA environment.

It is recognized that there are budgetary problems associated with the non-dilution remediation process The Corps is specifically mandated and funded to conduct navigational dredging activities, not to clean up contaminated sediments. Additionally, EPA has no budget to finance the removal of TSCA material although the agency is tasked with regulating such activities

The concept of establishing TSCA CDFs for dredged material is not new, however, only one such site (Indiana Harbor) has been proposed to date (USACOE 1987b).

4.1.3 Resource Conservation and Recovery Act (RCRA)

RCRA was established in response to a growing need to responsibly dispose of hazardous wastes. The primary focus of RCRA is to prevent the contamination of groundwater (especially public drinking supplies) by toxic chemicals.

EPA is responsible for enforcing the RCRA regulations. RCRA applies to dredged material disposal in a broader sense than TSCA. Regulations promulgated under RCRA define the difference between solid and hazardous wastes. Because RCRA was designed to provide "cradle to grave" management of hazardous waste, it provides a basis for developing and managing disposal sites for such designated substances. The EP (Extraction Procedure) toxicity test subjects the sediment in question to an acidic digestion process and is used for determining whether dredged materials, in this application, contain toxic constituents that could be leached out in a landfill situation, potentially contaminating ground or surface water (Arbuckle *et al.* 1985, 40 CFR Part 264.92-264.94). Results of this test are used to establish physical requirements for disposal site construction to ensure adequate protection of water resources (e.g., physical barriers such as liners may be necessary).

Under RCRA, sediment may be regulated as a hazardous waste if it is found to exhibit the characteristic of EP toxicity under appropriate test procedures (40 CFR Appendix II). If, after following the extraction procedure, a sediment sample is found to contain concentrations of any constituent listed on Table 4-1 above the prescribed levels, that sediment may be regulated as a hazardous waste.

4.1.4 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/SARA - Superfund)

CERCLA provides for the clean-up of historically (pre-RCRA) contaminated sites and assignment of liability of responsible parties (40 CFR Part 300). This may involve the removal and disposal or treatment of highly contaminated sediments. While EPA is the primary Federal agency responsible for implementing CERCLA, the authority can be delegated to the states.

TABLE 4-1. MAXIMUM CONCENTRATION OF CONSTITUENTS FOR GROUNDWATER PROTECTION.

CONSTITUENT		MAXIMUM CONCENTRATION[1]
Arsenic		0.05
Barium		1.0
Cadmium		0.01
Chromium		0.05
Lead		0.05
Mercury		0.002
Selenium		0.01
Silver		0.05
Endrin	(1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,9a-octahydro-1, 4-endo, endo-5,6-dimethano naphthalene)	0.0002
Lindane	(1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.004
Methoxychlor	(1,1,1-Trichloro-2,2-bis (p-methoxyphenylethane)	0.1
Toxaphene	($C_{10}H_{10}CL_6$, Technical chlorinated camphene, 67-69 percent chlorine	0.005
2,4-D	(2,4-Dichlorophenoxyacetic acid	0.1
2,4,5-TP	Silvex (2,4,5-Trichlorophenoxypropionic acid)	0.01

[1]Milligrams per liter

Source: 40 CFR Part 264.94

CERCLA may be applicable to the removal of sediments in some areas of the Great Lakes that have been subjected to longterm industrialization. For example, certain areas in the Ashtabula River, Waukeegan and Sheboygan Harbors are being considered for dredging clean-up under this Act.

4.1.5 National Environmental Policy Act (NEPA) of 1969

NEPA directs all federal agencies to plan their policies and actions in light of the expected environmental consequences. This includes the need to conduct public scoping of issues and prepare an environmental impact statement (EIS) for any major federal action that may significantly affect the quality of the human environment (40 CFR Parts 1500-1508).

NEPA is applied by the Corps for proposed Federal dredging projects to determine whether any aspect of the project will significantly impact the environment. For each proposed project, the evaluation process initially involves the preparation of an environmental assessment by the Corps to be used to make a determination on expected impacts of various project alternatives. A finding of no significant impact (FONSI) would indicate that the preparation of an EIS is not necessary. A finding of significant impact establishes the basis under which an EIS would be prepared.

The initial step in developing an EIS includes interagency and public scoping to determine the substantive issues to be addressed in the EIS. EPA-Region 5 serves as a cooperating agency to the Corps in assisting with scoping the relevant dredging and disposal related issues under this process. The actual preparation of the EIS involves a draft document, a comment period, and a final EIS. Agencies, such as EPA, with certain regulatory authority or special expertise relating to the project are key in the review and comment process. A decision is made by the Corps after thorough consideration is given to comments and recommendations of others, including EPA-Region 5.

4.2 STATE REVIEW

States adjacent to the Great Lakes under EPA-Region 5 jurisdiction include Minnesota (Lake Superior), Wisconsin (Lakes Superior and Michigan), Michigan (Lakes Superior, Michigan and Huron), Illinois (Lake Michigan), Indiana (Lake Michigan) and Ohio (Lake Erie)(Figure 2-1). Each state's review process for dredging projects is summarized in this section.

4.2.1 Minnesota

Dredging activities in Minnesota are regulated through the Minnesota Pollution Control Agency (MPCA), Division of Water Quality.

In the past, Minnesota relied on the 1977 U.S. EPA Guidelines (see Appendix B) to evaluate contaminant levels in sediments. They now use a combination of EPA's Guidelines and inhouse guidelines. Potential dredgers are required to provide analyses for a suite of metals, PCBs and other contaminants of local interest, as determined by MPCA. The Division of Water Quality is responsible for issuing 401 Water Quality certifications for this type of activity.

Wetland and open water disposal of dredged material is generally not allowed unless the proponent can provide evidence that positive effects will outweigh the deleterious effects. Dredging projects are expected to utilize techniques such as silt curtains and upland or confined disposal to minimize water quality impacts. Where a new confined disposal facility is proposed, its capacity must be 4-5 times the volume needed for the project. Suitable sediments are usually approved for beach nourishment.

4.2.2 Wisconsin

The Wisconsin Department of Natural Resources (WDNR) is responsible for reviewing dredging projects. Chapter NR 347 of the Wisconsin Register of Administrative Code, revised as of March 1, 1989, discusses WDNR permit requirements WDNR is responsible for issuing Section 401 Water Quality Certification for dredging related activities. With the application, all dredging proposals for the Great Lakes are required to provide analysis of the dredged materials for the following parameters:

PCBs (total)	Barium
Total 2,3,7,8 TCDD	Cadmium
Total 2,3,7,8 TCDF	Chromium
Aldrin	Copper
Dieldrin	Cyanide
Chlordane	Iron
Endrin	Lead
Heptachlor	Manganese
Lindane	Mercury
Toxaphene	Nickel
DDT	Selenium
DDE	Zinc
Oil and Grease	Percent Solids
NO_2, NO_3, NH_3, -N, TKN	Total Organic Carbon
Total P	Moisture Content
	Settleability

The following polycyclic aromatic hydrocarbons may be required for analysis on a case-by-case basis.

Acenaphthene	Chrysene
Acenaphthylene	Dibenz(a,h)anthracene
Anthracene	Fluoranthene
Benz(a)anthracene	Fluorene
Benzo(b)fluoranthene	Indeno(1,2,3-cd)pyrene
Benzo(k)fluoranthene	Phenanthrene
Benzo(g,h,i)perylene	Pyrene
Benzo(a)pyrene	

If the proponent provides WDNR with adequate information on chemical constitutions from other sources, requirements for testing can be partially or fully waived. The WDNR may also require additional analyses. Although threshold values for contaminants were originally proposed, these were not included in the final version. Presently, the 1977 U.S. EPA Guidelines are used as a general guide in classifying contaminant levels in dredged material. Generally, dredged materials are regulated as solid waste.

Wisconsin currently allows no open water disposal of dredged material. This does not preclude disposal in confined disposal facilities (CDFs), subject to permitting under the Wisconsin pollutant discharge elimination system (PDES). Beach nourishment is allowed only for sediment deposited above the ordinary high water mark (The ordinary high water mark is defined by WDNR as the point on the bank or shore where the water has left a distinct mark by its presence) Additionally, for beach nourishment, the average percentage of silt and clay in the dredged material can not be more than 15% greater than that of the beach. Furthermore, there can be no significant difference in the color, and such use cannot violate the criteria of any general permit regulating wastewater discharges under the Wisconsin PDES.

If the beach disposal criteria cannot be met, other testing such as bioassays may be used by the proponent to demonstrate that environmental effects of dredging and disposal activities would be minimal. Material that is found to be contaminated based on bulk sediment analysis, if that is the sole test used, or on bioassay testing if conducted, must be placed in an upland disposal site. In this event, disposal is regulated by groundwater standards and/or land spreading criteria (Chapter NR 204) To evaluate compliance with groundwater standards the proposed dredged sediment may need to be subjected to elutriate testing to provide an estimate of contaminant mobility to groundwater. The results of elutriate analysis in the application are compared to the maximum concentration limits given in NR 140. An extraction procedure toxicity analysis may be required to determine solid waste disposal requirements if the elutriate testing groundwater quality criteria are found to be exceeded. Three sequential leaching tests are required using the ASTM D-3987-85 procedure for sediments that require the extraction procedure. The Department had developed proposed procedures under Chapter NR 522 to address specifically the disposal of dredged materials. However, the proposal has since been withdrawn from legislative review.

4.2.3 Illinois

State dredge and fill permits are issued by Regional Port Districts when the project falls within a particular district, and by the Illinois Department of Transportation for other navigable waters. Permit applications are subject to approval by Illinois EPA (IEPA), Department of Conservation and the Corps. IEPA is responsible for issuing Section 401 Water Quality Certification for dredging projects.

The Division of Water Pollution Control of the IEPA, has water quality standards that must be achieved for dredge and fill operations. Such activities in Lake Michigan generally require grain size analysis. When the silt-clay portion (i.e., that fraction passing through a No. 230 U.S. sieve [0.062 mm]) is $\geq$20%, resuspension testing (i.e., either elutriate or supernatant testing) is required (Ill. Reg 35 C 11.395). Supernatant testing for nonsettleable material is required for projects proposing hydraulic dredging or mechanical dredging with disposal within the waterway. Required parameters include total suspended solids, total volatile solids, ammonia-nitrogen as N, total lead and zinc for both the supernatant and receiving water. Where mechanical dredging with upland disposal is proposed, testing of the filtered elutriate is required. Analysis for ammonia-nitrogen as N, total lead and zinc is made in both the elutriate and receiving water. Indications of potential or known sources of other pollutants and information on disposal procedures may require that other analyses be performed specific to the identified concern. The results of elutriate and receiving water testing are compared to Lake Michigan and general use water quality standards listed in Table 4-2. Bulk sediment analysis may be required but this type of testing is rarely requested. When performed, the test results are compared to the 1977 U.S. EPA Guidelines.

4.2.4 Indiana

Indiana Natural Resources Commission reviews Great Lakes dredging projects. The Indiana Department of Environmental Management (IDEM) evaluates the impacts associated with dredging, utilizing the 1977 EPA Guidelines for assessing sediment quality and a compilation of background data. Background concentrations are listed in Tables 4-3 and 4-4. One individual within IDEM is designated as the Corps contact. IDEM is responsible for issuing 401 Water Quality Certification for dredging projects.

Open lake disposal and beach nourishment may be allowed for sediments that are coarse grained. If the sediments are designated as contaminated, the Office of Solid and Hazardous Waste Management determines whether sediments are hazardous. Disposal options for hazardous sediments are generally limited to confined disposal facilities.

4.2.5 Michigan

The Michigan Department of Natural Resources (MDNR) created a Corps Project Review Committee (CPRC) in 1978 to evaluate dredging projects. The Chief of the Water Management Division acts as chairman of the committee whose membership encompasses all interested divisions including Water Management-Engineering, Surface Water Quality, Hazardous Wastes, Fisheries, Groundwater, Wildlife, Land Resource Programs, Waterways and Environmental Services and the Michigan Department of Transportation. Representatives from the U S. Fish and Wildlife Service and EPA frequently attend the regular meetings. The CPRC convenes to discuss and resolve environmental issues Upon resolution, the represen-

TABLE 4-2. ILLINOIS LAKE MICHIGAN AND GENERAL USE WATER QUALITY STANDARDS.

PARAMETER	CONCENTRATION (mg/l)
Ammonia Nitrogen[a]	0.02
Chloride[a]	12.0
Sulfate[a]	24.0
Phosphorus (as P)[a]	0.007
Total Solids (Dissolved)[a]	180.0
Arsenic (total)	1.0
Barium (total)	5.0
Boron (total)	1.0
Cadmium (total)	0.05
Chromium (total hexavalent)	0.05
Chromium (total trivalent)	1.0
Copper (total)	0.02
Cyanide	0.025
Fluoride	1.4
Iron (total)	1.0
Lead (total)	0.1
Manganese (total)	1.0
Mercury (total)	0.0005
Nickel (total)	1.0
Phenols	0.1
Selenium (total)	1.0
Silver (total)	0.005
Zinc	1.0

[a]Lake Michigan water quality standards; all other parameters apply to general use standard.

Source Illinois Environmental Protection Agency, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, June 1989.

TABLE 4-3. BACKGROUND CONCENTRATIONS (mg/kg) OF INORGANIC CONSTITUENTS IN INDIANA STREAM AND LAKE SEDIMENTS.

	CONCENTRATION (mg/kg)				
PARAMETER	n	$\bar{x}$	S	MEDIAN	MAXIMUM
Aluminum	38	2,600	2,200	1,900	9,400
Antimony	18	0.16	0.14	0.16	0.49
Arsenic	64	2.8	4.8	1.0	29
Beryllium	19	0.7	-	0.7	0.7
Boron	29	2.2	2.0	2.0	8.0
Cadmium	63	0.78	-	<1	1.0
Chromium	64	13	10	10	50
Cobalt	33	10	3.3	10	20
Copper	66	10	5	10	20
Iron	42	9,900	10,000	6,400	57,000
Lead	64	17	19	10	150
Manganese	42	400	320	300	1,700
Mercury	61	0.051	0.088	0.016	0.44
Nickel	24	9.9	5.7	10	21
Nitrogen (Total Kjeldahl)	5	920	860	940	1,500
Phosphorus	31	250	170	240	610
Selenium	54	0.29	-	<0.1	0.55
Silver	25	<0.5	-	<0.5	ND
Strontium	7	49	25	92	110
Thallium	18	<3.8	-	<3.8	ND
Zinc	61	38	29	26	130

n = number sample
$\bar{x}$ = sample mean
S = standard deviation
ND = Not detected

TABLE 4-4. BACKGROUND CONCENTRATION (μg/kg) OF ORGANIC CONSTITUENTS IN INDIANA STREAM AND LAKE SEDIMENTS.

PARAMETER	CONCENTRATION (ug/kg)			
	n	$\bar{x}$	MAXIMUM	%>10 μg/kg
Phenol	9	<200	ND	-
Cyanide	19	<125	ND	-
PCBs (total)	33	9	22	21
Clordane[a]	32	18	29	12
Dieldrin	36	9	33	14
DDT[b]	31	5	20	3
BHC (total)[c]	23	7	14	9
Pentachlorophenol[d]	12	3	3	0
Heptachlor[e]	32	2	2	0
Aldrin	36	0.6	0.7	0
HCB[f]	6	<1	ND	0
Methoxychlor	23	<1	ND	0
Endrin	32	<1	ND	0

[a]Includes nonachlor and oxychlordane
[b]Includes DDE and DDD metabilites
[c]Benzene hexachloride
[d]Includes pentachloroanisole
[e]Includes heptachlor epoxide
[f]Hexachlorobenzene

tative from Water Management-Engineering Division drafts a 401 certification which is reviewed by the Surface Water Quality Division and approved by the Water Resources Commission Executive Secretary. The State's dredging permit regulatory authority is designated by Section 404(t) of the Clean Water Act (CWA) and Michigan's Act 246 of 1955 (Great Lakes Submerged Lands Act).

Michigan allows open lake disposal only if the dredged material would improve or is similar in character to sediments at the disposal site (MDNR 1978). The U.S. EPA 1977 Dredged Material Guidelines (Appendix B) and the International Joint Commission (1982) are used for the basis of this determination. Clean granular sediments may be used for beach nourishment.

Sediments not meeting conditions for unrestricted disposal are subject to further review under Michigan's Hazardous Waste Codes (Act 64 of 1979, Hazardous Waste Management Act, as amended) and 40 CFR 261 (1986). EP toxicity testing is required when any contaminant, found through bulk analysis, exceeds the EP toxicity limit by a factor of 20 but is not at a concentration that automatically places it in the hazardous waste category. Under these circumstances, or when concentrations are found in the "heavily contaminated" category (Appendix A), open lake disposal is prohibited. CDF disposal may be required depending on the outcome of an evaluation of upland disposal options under Michigan's Guidance for Land Application of Wastewater Sludge (Table 4-5) Hazardous materials, as defined by RCRA (P.L. 94-580), must be disposed in an approved hazardous waste landfill.

Rules of the Michigan Water Resources Commission also state that Water Quality standards apply to overflow dredging activities in certain areas containing contaminated sediments unless the Commission has determined that such activities would not result in unacceptable impacts on designated uses. The Commission reviewed the common practice of overflow dredging in December 1988. They determined that this practice, when carried out in areas with contaminated sediments, is likely to impose deleterious impacts on designated uses. For the purposes of this determination dredged sediments that are not suitable for open water disposal are considered contaminated The MDNR reviewed three Corps project areas in regard to this ruling They found that two reaches of the Saginaw River (vicinity of Crow Island and between the Middle Grounds and the CDF in Saginaw Bay) are contaminated and therefore not eligible for overflow dredging. However, the Corps was provided with the opportunity to demonstrate the absence of adverse impacts with overflow dredging MDNR found that neither the St. Clair River nor the Detroit River were contaminated based on a comparison of existing data to the 1977 U S. EPA Guidelines and thus have

TABLE 4-5. LAND APPLICATION OF SLUDGE RATE RESTRICTIONS BASED ON CHEMICAL QUALITY - MICHIGAN.

PARAMETER	CONCENTRATION CLASS 1 (mg/kg)	CLASS 2 (mg/kg)	CLASS 3 (mg/kg)
Cadmium	5	5 - 125	125
Chromium	50	50 - 5,000	5,000
Copper	250	250 - 2,000	2,000
Lead	250	250 - 2,000	2,000
Mercury	2	2 - 10	10
Nickel	25	25 - 1,000	1,000
Zinc	750	750 - 5,000	5,000
Selenium	10	10 - 80	80
Molybdenum	10	10 - 50	50
Arsenic	100	100 - 2,000	2,000
PCB	1	1 - 10	10
Other Organics*	NS	NS	NS

*Data not sufficient to establish land application standards.

Class 1 sediments may be acceptable for agricultural use with no restrictions.

Class 2 sediments may have some restrictions with use regarding application period and thickness.

Class 3 sediments may require further analysis (i.e., leachate testing) to determine acceptability for land disposal.

Source: Guidance for Land Application of Wastewater Sludge in Michigan, Michigan Department of Natural Resouces, March 1986 placed no restrictions on overflow dredging in these areas. They have reserved the opportunity to reevaluate this finding when additional data are available.

A final important aspect of Michigan's review of dredging projects is the seasonal component. On an area-by-area basis within each lake, the Fisheries Division has established a schedule of preferred dredging periods based on critical spawning, migration and recreational periods. A typical pattern is prohibition of dredging during April, May, September, October and November, as well as during holiday weekends, although exact dates and restrictions vary by area. The Fisheries Division reviews these restrictions regularly.

4.2.6 Ohio

The Ohio EPA, Division of Water Quality Monitoring and Assessment is responsible for issuing Section 401 certifications for dredging projects. They seek comments from the Department of Natural Resources regarding impacts although this department has no regulatory authority for permitting. Applicants must demonstrate that the dredging activity will comply with Ohio's water quality standards (i.e., no long-term violations, compliance with numerical standards, demonstration of absence of various contaminants).

Sediments are evaluated according to the U.S. EPA 1977 Guidelines. Elutriate testing is often required to supplement the bulk analysis. Occasionally, the Division requires bioassessment, but the Corps typically supplies this information unsolicited Sediments classified as moderately polluted or nonpolluted are eligible for open lake disposal. Sediments classified as heavily polluted may be disposed only in confined disposal facilities. Upland disposal, in regulated sites, is considered for hazardous sediments

SECTION 5.0

EPA-Region 5
General Evaluation Process

5.0 EPA-REGION 5 GENERAL EVALUATION PROCESS

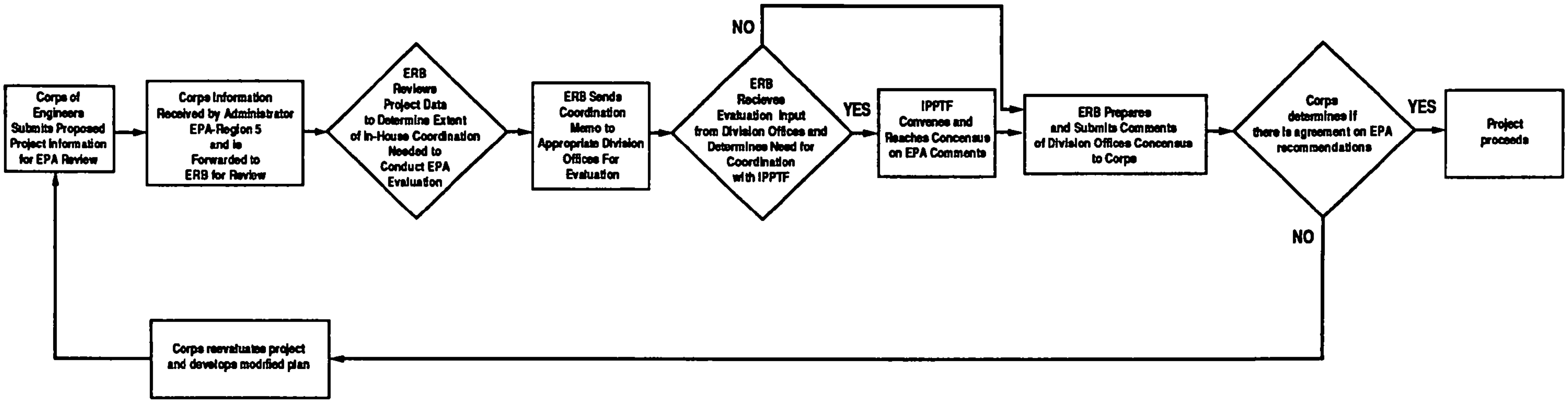
5.1 IN-HOUSE COORDINATION

EPA-Region 5 has designated the Environmental Review Branch (ERB) as their principle coordination office in response to a growing need to review Corps proposed dredging project information efficiently and provide them with comments relating to the potential effects of contaminated sediments in a cohesive manner.

The sequence of major decision steps that may be needed to complete Region 5's evaluation process is shown on Figure 5-1. The evaluation process begins upon ERB's receipt of Corps project information. ERB's Project Manager initiates the process by reviewing the submitted material to determine whether sufficient information is available and to complete the in-house review process. The type of project with respect to issues to be addressed are important to determine the specific offices within Region 5 that will be requested to review the Corps information. ERB's responsibility includes coordination of in-house office comments and formulating the Regional position to the Corps. ERB is also responsible for working out any differences of opinion that may be expressed within the Region regarding expected dredged material impacts.

The Region has also established an In-Place Pollutant Task Force (IPPTF) for addressing complex issues relating to dredged material assessment and management. The IPPTF consists of in-house experts from key groups within Region 5 The individuals within the IPPTF have varying responsibilities regarding regulation of the removal and placement of sediments in the Great Lakes region

EPA in-house coordination occurs mainly by inter-office memorandum in which the ERB contacts specific Division offices (Table 5-1) to provide an evaluation of impacts for a specific project. Individual member comments and evaluations are provided back to ERB in the same manner. The response time requested by ERB for inter-office comments varies, depending on project complexity and specific issues that need to be addressed. Requests for rapid (2-4 day) responses are infrequent, while requests for 10-14 day turn-arounds are more typical



Note: Figure 6-2 provides details regarding the Corps and EPA-Region 5 coordination process.

Figure 5-1. EPA-Region 5 Dredged Material Evaluation Process.

TABLE 5-1. EPA-REGION 5 IN-HOUSE COORDINATION OFFICES FOR REVIEW OF CORPS OF ENGINEERS GREAT LAKES DREDGING PROJECTS.

Water Division

- Office of Ground Water
- Water Quality Branch

Waste Management Division

- Office of Superfund
- Office of RCRA

Environmental Sciences Division

- Monitoring and Quality Assurance Branch
- Pesticides and Toxic Substances Branch

Great Lakes National Programs Office

Air and Radiation Division

Regional Counsel

5.1.1 IPPTF Purpose and Responsibility

The purpose of the IPPTF is to provide EPA-Region 5 with a team of experts available to discuss and resolve dredged material related matters. The IPPTF also formulates Regional positions on technical issues that relate to sediment characterization, evaluation and ecological impacts. The Task Force members review projects independently, each member focussing on his area of expertise while also taking a comprehensive look at the project or issue being addressed. These reviews are discussed in group meetings to resolve dredging or disposal issues that could not be adequately evaluated on an individual basis.

The IPPTF has varying levels of responsibility. Individual members provide technical evaluations pertaining to dredged material contaminant impacts as they relate to the particular responsibility of the individual's office within EPA (Table 5-1). For some members this responsibility is principally related to providing professional advice on the potential impacts of a particular dredging project on the aquatic environment. Representatives from certain offices have a more defined role by insuring that specific EPA regulatory requirements relating to the CWA, TSCA, and RCRA are satisfied for certain projects. The consensus developed by the Task Force is summarized by the ERB office which prepares the agency's "official" response to the Corps.

5.1.2 IPPTF Structure

The In-Place Pollutant Task Force is structured so that each member represents his respective office within Region 5. The chairperson convenes the group on an as needed basis. The broad technical expertise of the entire group can address most dredging or disposal issues that could conceivably arise.

In most instances, for Corps projects, IPPTF involvement would not occur until after ERB has coordinated the project review through normal Region 5 Division channels. There are basically two levels of interaction between IPPTF and ERB. For single-issue projects, for example, the ERB reviewer may contact one or several IPPTF members directly seeking specific expertise. More complex projects or broad based generic issues may require evaluation by all or most Task Force members. In these instances, ERB would initiate contact through the chairperson who sets the agenda and coordinates group discussion. There are many factors that could determine the specific Task Force offices that may be involved in reviewing any given issue or project. For example, the project size, dredging and disposal methods, possible contaminants (type and concentration levels), nearby sensitive resources (biological, groundwater, etc.) and proposed use of the sediment play an important role in determining what potential impacts need to be addressed. The experience and knowledge of each member is a major consideration in determining coordination needs

5.2 INTERAGENCY COORDINATION AND INFORMATION TRANSFER

The role of Region 5 regarding regulation of dredging projects is primarily as a commenting agency to the Corps pertaining to Section 404 of the CWA. However, to accomplish the necessary evaluations for the various dredging and disposal projects with respect to the site specific environmental impacts, EPA sometimes coordinates with other agencies. Although there is no formal interagency coordination process, EPA and various state and federal agencies rely on each other to provide certain technical information, expertise and assistance on testing methodologies for assessing potential impacts. For instance, Region 5 is considering the use of an ASTM freshwater bioassay testing method that is being developed under the supervision of the U.S. Fish and Wildlife Service. It is hoped that this testing protocol may be useful in standardizing bioassay testing for dredged material disposal in the Great Lakes.

Another means of information transfer is through the Corps of Engineers Waterways Experiment Station (WES), Vicksburg, MS. Since the early 1970's, WES has conducted extensive research programs on dredged material related technologies and evaluation methodologies. More recently, the Corps and EPA have collaborated in developing guidance documents on assessment protocol for ocean disposal.* While directed at a national level, much of the information developed can be applied regionally with certain adjustments to "localize" the particular evaluation methodology being applied. IPPTF members utilize information developed by WES and others in evaluating certain dredging projects. The type of information used by the members depends on the specific issue being addressed. Nevertheless, a substantial amount of technical expertise is available from the Corps to Region 5 by various means (i.e., technical reports, meetings with staff specialists, seminars, etc.) to assist in their dredged material analyses.

SECTION 6.0

EPA-Region 5
Dredged Material Evaluation Procedures

6.0 EPA-REGION 5 DREDGED MATERIAL EVALUATION PROCEDURES

Dredged material evaluations performed by EPA-Region 5 for Great Lakes projects involve assessment of a variety of project types in terms of dredging methods, sediment characteristics and disposal alternatives. The overall process by which each project is evaluated remains relatively constant but the specific project components dictate what evaluation tools are used in developing the agency's conclusion on potential impacts.

The Region 5 evaluation process is independent of the Corps evaluation national strategy and goes beyond this framework by instituting regional requirements. In effect, Region 5 has instituted regional testing recommendations (see Appendix B) and environmental evaluations to the specific dredging methods, environmental characteristics and available disposal options for the Great Lakes region.

The concept of developing a comprehensive decision making matrix for dredged material evaluations for Region 5 is not new. Over the recent years Region 5 has been developing procedures for evaluating dredged material. Section 6.3 explains the evaluation methodologies and rationale currently being utilized by Region 5 in reaching an agency position on Federal maintenance dredging proposals for the Great Lakes region.

6.1 <u>THE CORPS OF ENGINEERS NATIONAL DREDGED MATERIAL MANAGEMENT STRATEGY</u>

At the national level for the past 15 years, the Corps has studied a diverse array of dredging methods, sediment types and disposal methods with respect to assessment of expected ecological impacts. The Corps has developed a management strategy based on specific project design and sedimentological factors (Francinques *et al.* 1985). A flow chart of this strategy (Figure 6-1) provides the basis for selecting appropriate tests and disposal options for most dredged material. This strategy also incorporates the concept of improving the environment by using dredged material for beneficial uses whenever deemed appropriate and feasible. A primary decision-making determinant in the evaluation strategy is analysis of the prospective dredged material for contaminants and compatibility with the sediments at the prospective disposal site. That information is then used to identify potential disposal alternatives, testing requirements and implementation strategies, including monitoring and other mitigation measures. This national strategy protocol is followed by the various Corps Districts, including those within the purview of Region 5; however, Region 5 does not necessarily follow the strategy entirely.

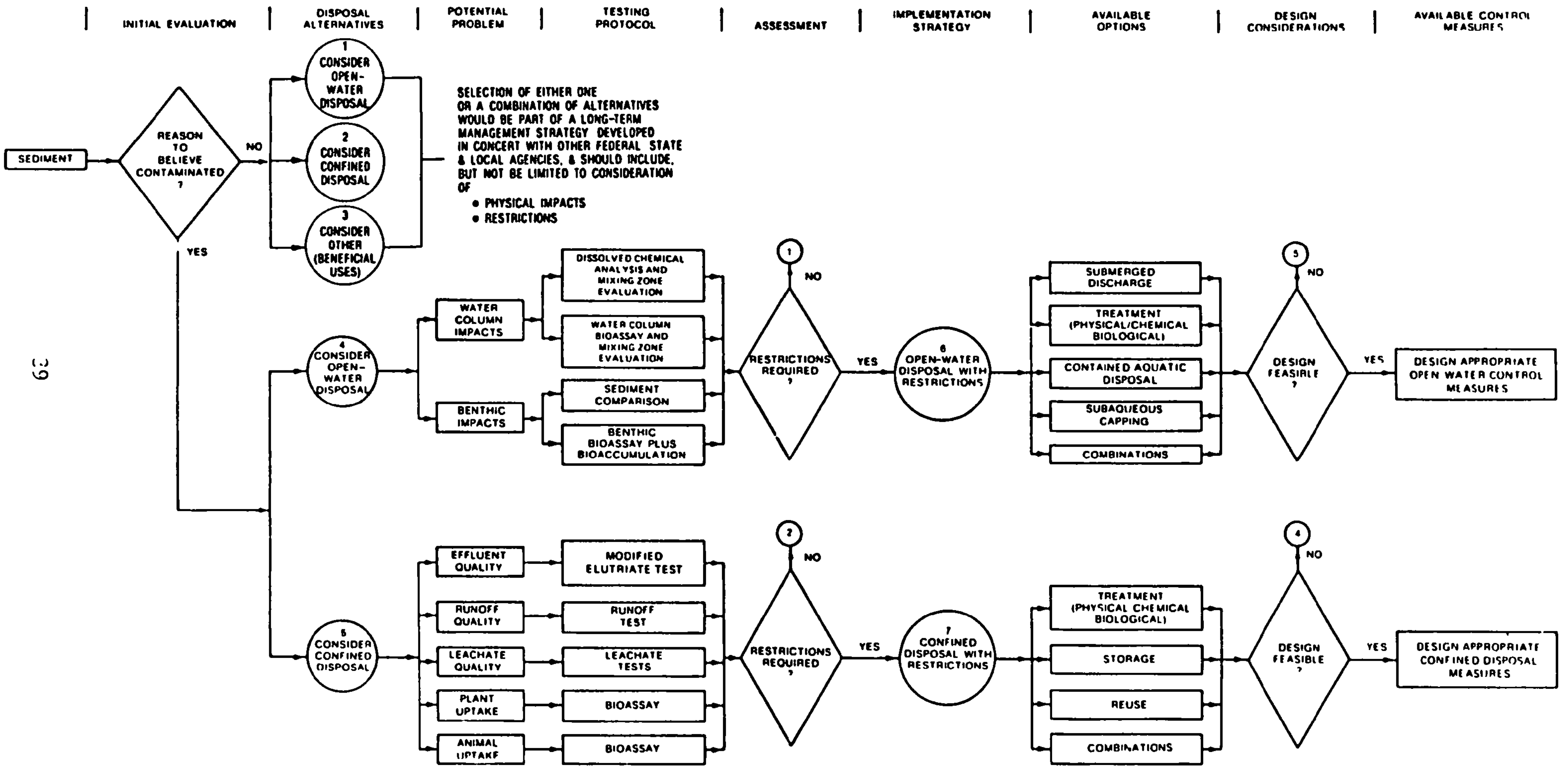


Figure 6-1. U.S. Army Corps of Engineers Dredged Material Management strategy flowchart (Francingues et al, 1985).

6.2 EPA REVIEW OF CORPS PROJECTS

6.2.1 Submittal of Proposed Project Information

The information submitted to Region 5 by the Corps for proposed dredging could be presented in several ways and at varying times during the Corps project planning process. In most instances the Corps will contact Region 5 after the Federal project plan has been developed. This will serve to notify EPA of the proposed action and to request identification of issues of potential concern and recommendations on assessment methodologies to evaluate project impacts (Figure 6-2).

Information submitted by the Corps could vary depending on the type and size of project and environmental information available when the coordination occurs. Region 5 and the three applicable Corps offices having jurisdiction in the Great Lakes (Chicago, Detroit and Buffalo Districts) have no unified coordination procedures for Great Lakes dredging projects. Information developed by the Corps for EPA (and others) to review could be as basic as dredging method, area to be affected, sediment type and the proposed disposal area. This could be presented as raw data and maps for projects that may have negligible impacts. Conversely, projects that may substantially affect the environment due to their magnitude and/or level of contaminants would require detailed planning and assessment studies which could involve complex Environmental Assessment or Environmental Impact Statement preparation.

A representative list of information the Corps may submit to EPA for review and evaluation is given in Table 6-1. Because of the highly variable nature of possible projects and environmental questions to be addressed this list is not intended to be all inclusive but to provide examples of information that could be necessary to conduct a project review.

Interim guidance, presented in Appendix B, has been prepared by the ERB (USEPA 1989) for developing sediment sampling and testing procedures for evaluating Corps maintenance dredging projects. The guide serves to establish consistency for sampling and testing of sediments from a Great Lakes-wide perspective. This guidance also provides an organized rationale and format from which EPA managers can make decisions and recommendations to the Corps

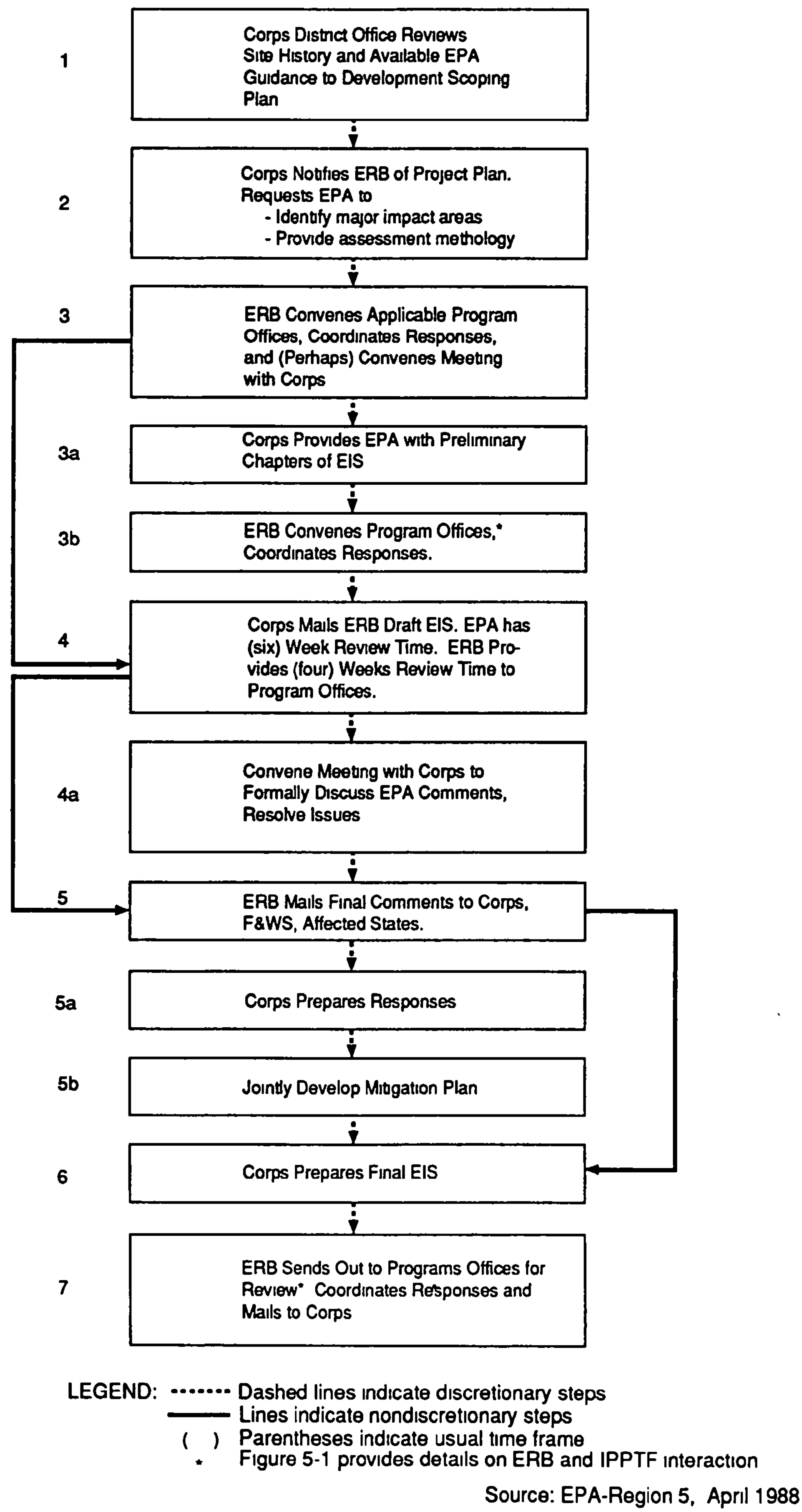


Figure 6-2. Process for EPA Review of Corps Maintenance Dredging Projects.

TABLE 6-1. REPRESENTATIVE LIST OF INFORMATION THAT MAY BE SUBMITTED BY THE CORPS TO EPA-REGION 5 FOR PROSPECTIVE DREDGING PROJECTS.

PROJECT INFORMATION	ASSESSMENT RELATED INFORMATION
Proposed Project Description	Physical
▪ area and depth to be dredged	▪ grain size
▪ quantity to be dredged	▪ volatile solids
▪ method of dredging and sediment handling	▪ Atterberg limits
▪ disposal alternatives considered	▪ organic content
▪ use of disposed material	▪ water content
	▪ settling tests
	▪ permeability tests
	▪ leachate test
Existing Conditions at Dredge Site	Chemical
▪ location	▪ point and non-point source discharges
▪ water depth	▪ outfall locations
▪ sediment type	▪ spills
▪ hydrological characteristics	▪ bulk chemical testing
▪ physical, chemical and biological environment	▪ elutriate testing
	▪ EP toxicity
Existing Conditions at Disposal Site	Biological
▪ location	▪ bioassay testing
▪ water depth or location in relation to nearest waterbody or groundwater	▪ bioaccumulation analysis
▪ soil conditions	▪ benthic community information
▪ wetlands	▪ fisheries
▪ other important resources	▪ aquatic vegetation.

6.2.2 Preliminary Review of Corps Information

Upon receipt of information regarding a prospective maintenance dredging project by the Corps, ERB reviews the information to determine whether it is adequate to evaluate the environmental impacts of the proposal. As mentioned earlier, the level of detail of the Corps information could vary widely among projects, ranging from a set of raw data on grain size to a comprehensive Environmental Impact Statement detailing complex testing (e.g., bioassays, elutriate, permeability analyses, etc.) and habitat issues. Depending on the outcome of the ERB review of submitted information, EPA may request additional information from the Corps or complete their evaluation of the proposed project. The evaluation is conducted on a case-by-case basis giving full consideration to the EPA 404(b)1 Guidelines for Specification of Disposal Sites for Dredged or Fill Material (CWA of 1977) and the National Environmental Policy Act to insure that adverse environmental impacts are minimized.

The initial evaluation involves a review of the sediment type in relation to the method of dredging and disposal options being considered. If the sediment to be removed is coarse grained (i.e., greater than 80% retention by a No. 200 U.S. sieve [0.074 mm]), it may not require chemical analysis. Determinations on exempting the need for sediment chemical analysis based on grain size are made on a site specific basis. Sediment of this type may be approved for a variety of disposal options. Beneficial uses such as beach nourishment, road sanding, habitat creation, dike construction or as capping material are preferred. Alternatively, the sediment may be disposed of in open water at authorized locations. Absence of contaminants does not exempt clean sediments from a review of the physical effects of disposal, such as habitat disruption due to burial, change in sediment characteristics, or turbidity These physical effects are factored into the selection of disposal options.

Fine grained sediments (i.e , those that show less than 80% retention by a No. 200 U.S sieve [0 074 mm]) have a greater chance of being associated with various contaminants and are therefore subjected to bulk chemical analysis to determine the chemical fingerprint of the material to be dredged. The parameters analyzed during the bulk chemical testing are fairly standardized for the Great Lakes region (Table 6-2). However, additional parameters may be requested to be analyzed depending on the outcome of review for potential contaminants at the dredge site

EPA-Region 5 and the Great Lakes States and Corps offices use the Sediment Classification Guidelines that were developed from data

TABLE 6-2. CLASSIFICATION OF SEDIMENTS FROM GREAT LAKES HARBORS BASED ON THE U.S. EPA 1977 GUIDELINES. ALL VALUES ARE IN MG/KG DRY WEIGHT EXCEPT FOR VOLATILE SOLIDS.

PARAMETER	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Volatile Solids (%)	<5	5 - 8	>8
COD	<40,000	40,000-80,000	>80,000
TKN	<1,000	1,000-2,000	>2,000
Oil and Grease - (Hexane Solubles)	<1,000	1,000-2,000	>2,000
Lead	<40	40-60	>60
Zinc	<90	90-200	>200
Ammonia	<75	75-200	>200
Cyanide	<0.10	0.10-0.25	>0.25
Phosphorus	<420	420-650	>650
Iron	<17,000	17,000-25,000	>25,000
Nickel	<20	20-50	>50
Manganese	<300	300-500	>500
Arsenic	<3	3-8	>8
Cadmium	*	*	>6
Chromium	<25	25-75	>75
Barium	<20	20-60	>60
Copper	<25	25-50	>50
Mercury	*	*	>1
Total PCBs	*	*	>10

*Lower limits not established.

Source· U.S EPA 1977

collected over several years from various Great Lakes harbors (U.S. EPA 1977). The Guidelines are presented in Appendix A. It is important to understand that the Guidelines are flexible and should be used only to compare relative contaminant concentrations. By comparing test results with the Guidelines and other known information such as the IJC Dredging Register, one can develop a sense of the relative importance that the subject contaminant concentrations may present to the environment. However, in many instances this information is insufficient to fully understand the ecological consequences of disposal of sediments containing those contaminants. Consequently, further analysis and consultation with individuals and (sometimes) other agencies may be necessary for Region 5 to complete their case-by-case evaluation and respond back to the Corps. The initial review process will involve the particular Region 5 offices that possess the evaluation responsibility and technical expertise relative to the specific dredging and disposal proposal being proposed. When further coordination or information becomes necessary to complete EPA's response to the Corps, ERB contacts the applicable program office(s) to convene the IPPTF.

6.2.3 IPPTF Coordination

As discussed in Section 5.1.1, the IPPTF is comprised of select technical experts within key Region 5 offices. These individuals are available for consultation on review of project information, evaluating the need for specific testing and environmental information on an as needed basis. The Task Force members represent a diverse range of expertise in areas relating to aquatic biology, benthic ecology, toxicology, water quality, geology, environmental engineering, dredged material and solid waste management. Initial evaluation of a particular dredging proposal by ERB and the pertinent Divisions will identify whether specific Task Force members need to be involved. The Task Force may become involved when the dredging or disposal issues are complex and interrelated, undefined or when an exchange of ideas and discussion from the entire group would assist in developing the EPA position to the Corps

Specific issues may relate to short or long-term impacts at either the dredging or disposal site In most instances, primary focus is directed towards disposal rather than dredging impacts. Emphasis is generally placed on determining the potential for environmental effects based on analysis of the prospective dredged material with respect to the ecological conditions at and near the anticipated disposal site There are a variety of testing procedures that may be required to evaluate the potential effects of depositing dredged material. As discussed in Appendix B, some of the procedures are relatively simple and inexpensive to conduct such as grain size and bulk chemical analyses. Other testing such as EP toxicity, elutriate and bioassay/bioaccumulation analyses are more complex. The type of testing Region 5 may request depends principally on the dredging and disposal methods to be used and whether the proposed dredged material contains any contaminant concentrations in levels of concern to the agency. If additional information is required, ERB formally requests the information by letter to the Corps.

6.2.4 Evaluation of Disposal Options

As described in Section 2.2, there are four general categories of disposal alternatives commonly employed in the Great Lakes region:-

- open water
- nearshore unconfined
- confined disposal facilities
- upland

EPA-Region 5 staff examine the disposal alternatives presented by the Corps for a particular project and determine whether there may be a potential impact on the environment and/or if additional information would be necessary to complete their assessment of potential impacts. For the most part, any of these options may be acceptable if the initial screening evaluation shows no concern regarding contaminants, physical compatibility or biological effects on nearby resources of interest (Figure 6-1). A bonafide concern regarding any potential impacts could result in the need for additional information. An overview of possible testing or ecological information needs for each disposal option is provided below.

6.2.4.1 Open Water (Lake) Disposal

The grain size and bulk chemical analyses described previously (Sec. 6.2.2) provide the primary basis for EPA's determination on whether additional testing is needed to evaluate open water disposal in the Great Lakes. If any parameters of concern are found in concentrations exceeding the 1977 U.S. EPA Guidelines threshold for moderately polluted sediment, additional testing may be required. Additionally, if PCB's are found in "heavily polluted" (10 ppm or greater) concentrations, open lake disposal will not be allowed. PCB concentrations below 10 ppm are evaluated on a case-by-case basis

As described in the Interim Sampling and Testing Guidance (Appendix B), once a sediment proposed for open water disposal is determined to contain contaminants at such a level to present uncertainty on environmental effects (e.g., by bulk analysis), more detailed testing may be necessary to complete the evaluation. Additional testing may include:

- elutriate analysis
- bioassays
- bioaccumulation analysis

Elutriate testing may be required primarily when a hydraulic dredging and/or disposal operation or overflow dredging is proposed and there is concern regarding the release of chemicals from the sediment to the water column during the agitation and disposal processes. The elutriate test simulates the mixing that occurs and is used to measure the potential short-term increase of contaminants to determine water quality impacts. The test results can be compared to the ambient water quality at the disposal site and to EPA's water quality criteria. Consideration is also given to the dilution zone at the discharge area when estimating potential water related contaminant loading.

Bioassay testing may be required when prospective dredged material intended for open water disposal is found to be "moderately or highly" contaminated and available management options regarding isolation of the contaminants are not feasible. The current practice for Region 5 is to evaluate the need for bioassay testing on a case-by-case basis. At present there is no standardized EPA/Corps bioassay testing protocol for the Great Lakes region.

In the past, Region 5 has relied on the particular Corps District Office to determine the specific bioassay testing method for any given project. More recently, EPA has identified ASTM methods that should be used for conducting toxicity and bioaccumulation assays for Great Lakes dredged material disposal projects (Appendix B) This testing requires the use of a cladoceran for lethal bioassays and either a midge or amphipod for sublethal bioassays. The fathead minnow is the recommended bioaccumulation species Details regarding these specific testing methods are given in the Interim Guidance (Appendix B) Analysis of the bioassay test results can provide the necessary additional information on potential biological effects for EPA to complete a suitability determination for open water disposal. However, Region 5 and the Corps have not yet established statistical evaluation standards for bioassays conducted on Great Lakes sediment.

Although each project is evaluated on a case-by-case basis, a recently proposed dredging project in the Waukeegan Harbor Federal navigation channel provides an example of the environmental review that is conducted by EPA-Region 5 for open water disposal. For this project, the Corps submitted a sediment evaluation report to EPA that showed concentrations of heavy metals and PCBs in the non-polluted category according to the 1977 U.S. EPA Guidelines. It was concluded that the sediment was acceptable for open water disposal. However, EPA requested information on the physical, chemical and biological conditions at the proposed disposal site before they could agree on its use. The initial step of reviewing sediment characterization data such as grain size and bulk chemical test results for the prospective area to be dredged provides a general assessment of acceptability for open water disposal. However, a comparison of the relative difference in sediment type and contaminant concentrations between the proposed dredged material and prospective open water disposal site can be used to determine whether the physical nature or contaminant concentrations in the disposal site would be expected to change, particularly toward higher concentrations. Those projects which would not result in a substantial increase and are within the "nonpolluted" category may be considered for unrestricted open water disposal. However, the evaluation regarding acceptability for open water disposal goes beyond this comparison. Additionally, the presence of primarily coarse grained sediments (sand) does not, in most cases, eliminate the need for comprehensive bulk chemical testing. Information on the physical, chemical and biological characteristics at each available alternative open water disposal site must be reviewed to determine which prospective location would result in the least impact on the aquatic environment. Each project is also reviewed in light of potential beneficial uses that may be derived from various disposal alternatives rather than merely disposing the dredged sediment in open water.

Further testing scrutiny is given to those projects intended for open water disposal which contain or have a potential to contain certain contaminants in the moderately or highly polluted category (1977 U.S. EPA Guidelines) For example, sediment analyses for improvement dredging by the Corps in the Toussaint River, Ohio, revealed elevated levels of arsenic, nickel, barium, copper, iron and lead as well as a concern regarding sediment contamination from a nearby Nuclear Power Station. For this project, additional sampling and bulk chemical analysis was requested to differentiate contaminated areas within the proposed dredging footprint from non-contaminated areas. The additional analyses allowed for a wider range of potential disposal options for the overall project sediments It also enabled a more accurate estimate of the contaminated portion of the sediment that would need special handling and disposal considerations For open water disposal the uncontaminated portion of the sediments may be allowed to be disposed without restriction. The contaminated portion would be subjected to further testing before a decision on open water disposal could be made.

For those situations where a concern exists regarding water column impacts upon disposal, elutriate testing and/or bioassay testing may be required. Elutriate test results would be used to evaluate water quality impacts; bioassay testing could be used to determine whether there would be a potential for acute toxicity or bioaccumulation of contaminants to water column or benthic organisms. Other disposal alternatives would also be considered for contaminated sediments (e.g., CDF or an appropriate upland location) in lieu of open water disposal, particularly if the sediment contains any contaminants that are of special concern regarding human contact and/or consumption.

Special handling techniques can also be considered for contaminated dredged material proposed for open water disposal. Such considerations could involve either soil separation, with specific placement and/or capping procedures. The soil separation process can be utilized when a mixture of contaminated fine and clean coarse grained sediment types are involved and the project is of a design that can accommodate the separation process, sediment handling and suitable disposal alternatives. This process has been considered for a Corps project in Duluth - Superior Harbor where sediments were proposed to be dredged from a restricted (contaminated) area. The resultant coarser grained sediments (i.e., sand and gravel components) from such a separation process are then chemically analyzed and if found to be uncontaminated, may be suitable for open water disposal at an acceptable location or used beneficially upland.

Capping contaminated sediments with cleaner "acceptable" sediment in open water is a management option that may be considered for the Great Lakes. When properly conducted, this process can result in minimal environmental impact and can allow for disposal of sediments that may otherwise be unacceptable for unconfined deposition.

Presently, there has been no open water disposal of contaminated sediments in the Great Lakes using the capping methodology. However, capping is being considered for sediment proposed to be dredged from St. Joseph Harbor, Michigan. The following information is needed to assist Region 5 in determining the suitability of any open water disposal capping project in the Great Lakes:

- Characterization (physical and chemical) of the sediment to be dredged

- Disposal site depth, currents, substrate type

- Biological community at disposal site

- Need for preparation of disposal site (e.g., pit or berm construction) prior to use

- Disposal management techniques to be used (i.e., buoys, ship riders, stopping of disposal vessel, electronic positioning, etc.)

- Monitoring of disposal site (before and after disposal)

- Remedial action plan should capping be found not to work.

Region 5 is interested in whether capping in the Great Lakes will be an effective dredged material management option for contaminated sediments. One way to determine the utility of this method could be to conduct a demonstration project using uncontaminated fine grained sediment with appropriate monitoring.

6.2.4.2 Nearshore Unconfined Disposal

This disposal option is generally divided into two categories: 1) beach nourishment and 2) nearshore shallow water disposal for a purpose other than beach nourishment. The analysis of sediment proposed for beach disposal is fairly straightforward, consisting of grain size determinations to evaluate compatibility and retention ability at the receiving beach and chemical analysis to evaluate the potential for contaminant impacts on water quality and biological uptake. The primary goal with beach replenishment is to utilize sediment that is physically similar to the recipient beach (e.g., sand on sand). The amount of fine grained material (silt and clay particles) and organic matter will play a significant role in determining the suitability of proposed dredged material for this use. A substantial difference in grain size could result in habitat changes, impacts on nearby habitats, increased erosional rates and introduction of contaminants to the project area Generally, the finer grained sediments increase the likelihood of these problems occurring. An evaluation of dredged material for compatibility to a receiving beach is usually a subjective comparison of grain size data. The extent of scrutiny given to this determination should be related to the environmental resources that could be impacted if non- compatible sediment were deposited. Engineering design and coastal protection manuals, such as those developed by the Corps (U.S. ACOE 1984), offer valuable information on evaluating coastal processes and potential retention ability of sediments intended for beach nourishment.

The chemical nature of dredged material proposed for beach nourishment must be considered to insure that undesirable impacts on water quality, aquatic plants and organisms do not occur. Consequently, sediment proposed for beach nourishment is usually tested to determine whether it contains undesirable levels of contaminants of concern. Contaminated sediment considered for this method of disposal may also need further scrutiny such as elutriate and bioassay testing. As with other disposal alternative evaluations, the specific testing requirements are determined on a case-by-case basis based on the project design and environmental concerns for the particular site.

Chemical testing may not be necessary to evaluate all proposed beach nourishment sediments. For example, when the proposed dredging area is far removed from historical and existing sources of contamination and is primarily coarse grained (sand and gravel), grain size analysis may be sufficient to determine suitability for beach disposal. For these instances, there should be project assessment documentation which leads to the conclusion of eliminating the need for chemical analysis.

Sediments intended for nearshore unconfined shallow water disposal are evaluated similarly to the open lake disposal alternative. However, since shallow depths promote disturbance of bottom sediments through wave action, consideration should be given to evaluating the greater potential for sediment migration, especially toward sensitive nearshore areas. Testing requirements for nearshore unconfined disposal are similar to those for open water (lake) disposal projects.

6.2.4.3 Confined Disposal Facilities

The specific evaluation procedure conducted by Region 5 in regulating dredged material disposal in CDFs depends on the contaminant type(s) and concentration of those contaminants in the prospective sediment to be deposited within the CDF. The contaminant and concentration level is used along with proposed operational procedures to determine under what regulations the material will be evaluated. This could involve Sections 402 and 404 of the CWA, TSCA, RCRA or CERCLA which are described in Section 4.1.

The evaluation of a particular proposed dredging project intended for CDF disposal involves an assessment of site specific environmental and engineering features. Consequently, each CDF disposal review is performed on a project-by-project basis.

One of the most important factors to consider when evaluating the suitability of disposing contaminated dredged material in any CDF is the extent to which fine grained soil particles and water borne contaminants will be retained in the structure. Additionally, if dewatering is necessary, appropriate monitoring of the effluent quality may be necessary to insure that the discharge will not produce undesirable impacts and can meet 401 certification requirements if needed. Since most contaminants are associated with silts and clays it is essential that the CDF under consideration be capable of retaining a high percentage of those particles. The retention of fine particles can be attained by proper design of the dike and use of appropriate construction material throughout the CDF. A report on Great Lakes CDFs, prepared by Region 5 provides an overview of Corps research, evaluation guidelines (404(b)(1)), design and use of CDFs in the region (U.S. EPA 1989a) This report includes information regarding location (Figure 6-3), design, capacity, environmental considerations and contaminant types that relate to each CDF used (historically and presently) in the region. This information is useful in determining the present condition of available CDFs and provides EPA and others a starting point for evaluating the feasibility of further use, testing, monitoring and management requirements for upcoming dredging projects.

Under current practices the Corps Districts and Region 5 generally utilize the bulk sediment test in conducting an initial evaluation of proposed CDF material. While this analysis shows what contaminants may be in the sediment, in many instances, it will not provide the information necessary to evaluate the potential effects of those contaminants should they migrate outside the containment facility. Aimed at improving available assessment capabilities, WES has conducted a considerable number of studies involving CDF design and evaluation methodologies Through this research, several testing methods have been developed to assist the Corps, EPA and other agencies in evaluating the need for containment and potential for contaminant migration out of confined facilities. Methods currently available include the modified elutriate test, runoff testing, leachate tests and bioassays which are specifically designed for evaluating this disposal alternative (Palermo 1986a, 1986b, 1988; Gunnison et al. 1987; Averett et al 1988, Palermo and Thackston 1988 and Hill 1988). Each of these tests

Figure 6-3. U.S. Great Lakes confined disposal facility (C D F) locations in EPA-Region 5 (IJC 1986).

is intended to evaluate specific potential impacts (Figure 6-1) and assist the managing authority in determining the need for restrictions or special treatment of the sediments in question.

Recent collaboration by Region 5, Great Lakes Corps Districts and Federal resource agencies such as the Fish and Wildlife Service have resulted in several CDF assessment efforts. There are several important components to this effort:

- Establishment of an interagency task force

- Development of modeling and improving the retention capabilities of CDFs

- Conducting various field studies relating to mass balance, biological effects, contaminant migration and risk assessment.

The results of ongoing studies may be used to modify current CDF design and management procedures.

6.3.4.4 Upland Disposal

The evaluation of upland (above ordinary high water) disposal of dredged material is often very similar to the considerations given toward CDFs. Some upland CDFs are located away from shore where potential impacts are related more to groundwater, and sometimes wetland areas. Additionally, many upland disposal projects serve a beneficial purpose such as for construction, road sanding or other uses.

Typically, sediments are subjected to bulk analysis to determine grain size and contaminant levels. Sediments that are found to be "clean" using the 1977 U.S. EPA Guidelines (Appendix A) can be used for most upland applications. Sediments found to be "moderately" to "highly" polluted must be evaluated with respect to the intended use of the material. Those sediments may be subjected to further testing employing methods developed for CDF and chemical landfill analyses on a case-by-case basis (U.S. ACOE 1987a, Gunnison *et al.* 1987, Hill *et al.* 1988).

The evaluation of dredged material for upland disposal should undergo close scrutiny as with any disposal option. For example, it is important to know the quantity of sediment to be disposed in relation to the location, size and features in and around the prospective disposal site. Site capacity and stability of disposed sediment should be satisfactory; the site should be accessible without affecting wetlands or other sensitive ecological areas, and the disposal activity itself should not substantially affect wetland areas.

Contaminated sediment may be considered for upland disposal under certain applications. However, groundwater and surfacewater contamination as well as public safety are important factors. Effects of contaminants on plants and wildlife in the vicinity of the prospective disposal site are also important considerations. Usually, it is recommended that contaminated dredged material placed upland be covered by a layer of noncontaminated dredged sediment or soil from an upland source to isolate the questionable material.

A proposed Federal dredging project in the Black River at Port Huron, Michigan illustrates the types of possible concerns related to unconfined upland disposal of dredged material. This project involved mechanical dredging of over two miles of river with placement of the dredged sediment on a large upland tract of land for drying for later use in building berms for a private recreation area. The dredged sediment was primarily uncontaminated; however, one section had concentrations of certain heavy metals (Pb, Cu, Zn and Ni) at a level of concern. The uncontaminated sediments from the dredged section of the river were suitable for unconfined disposal at the upland location from a general evaluation perspective. However, there was a need to address certain disposal site conditions, construction methods and post-construction features before the proposed disposal evaluation could be completed. The following factors were important in evaluating this project and would also pertain to most other upland disposal applications:

UPLAND DISPOSAL SITE CONSIDERATIONS

Dredging and Sediments

- Sediment contaminants (type and levels)
- Sediment physical characteristics
- Dredging and handling methods
- Quantity to be dredged
- Temporary dewatering needs

Disposal Site

- Site accessibility (for construction and use)
- Capacity (area and volume)
- Current and expected land use
- Wildlife habitat at and near disposal site
- Wetland impacts
- Proximity to surface and/or groundwater
- Underlying soils
- Human use/contact (during and after construction)
- Anti-erosion measures (hay bales, vegetation, sheet pile, etc.)

6.3 DREDGED MATERIAL EVALUATION GOALS

For the past several years EPA and the Corps of Engineers have made substantial progress in refining sediment evaluation methods and criteria to more closely predict dredged material disposal impacts. This effort has involved a significant expenditure of funds and research to develop many innovative and state-of-the-art evaluation techniques. One area of recent research involves the examination of contaminant-organism interactions related to equilibrium partitioning and maximum uptake potential.

Region 5 will follow the development of these methods with a goal to incorporate new methods that can improve dredged material evaluation procedures for Great Lakes projects. Consequently, it is expected that this manual will be revised occasionally to reflect those changes.

SECTION 7.0

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APPENDIX A

1977 Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments

Appendix A

GUIDELINES FOR THE POLLUTIONAL CLASSIFICATION OF GREAT LAKES HARBOR SEDIMENTS

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION V

CHICAGO, ILLINOIS

APRIL 1977

Guidelines for the evaluation of Great Lakes harbor sediments, based on bulk sediment analysis, have been developed by Region V of the U.S. Environmental Protection Agency. These guidelines, developed under the pressure of the need to make immediate decisions regarding the disposal of dredged material, have not been adequately related to the impact of the sediments on the lakes and are considered interim guidelines until more scientifically sound guidelines are developed.

The guidelines are based on the following facts and assumptions:

1. Sediments that have been severely altered by the activities of man are most likely to have adverse environmental impacts.

2. The variability of the sampling and analytical techniques is such that the assessment of any sample must be based on all factors and not on any single parameter with the exception of mercury and polychlorinated biphenyls (PCB's).

3. Due to the documented bioaccumulation of mercury and PCB's rigid limitations are used which override all other considerations.

Sediments are classified as heavily polluted, moderately polluted, or nonpolluted by evaluating each parameter measured against the scales shown below. The overall classification of the sample is based on the most predominant classification of the individual parameters. Additional factors such as elutriate test results, source of contamination, particle size distribution, benthic macroinvertebrate populations, color, and odor are also considered. These factors are interrelated in a complex manner and their interpretation is necessarily somewhat subjective.

The following ranges used to classify sediments from Great Lakes harbors are based on compilations of data from over 100 different harbors since 1967.

	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Volatile Solids (%)	<5	5 - 8	>8
COD (mg/kg dry weight)	<40,000	40,000-80,000	>80,000
TKN (mg/kg dry weight)	<1,000	1,000-2,000	>2,000
Oil and Grease (Hexane Solubles) (mg/kg dry weight)	<1,000	1,000-2,000	>2,000
Lead (mg/kg dry weight)	<40	40-60	>60
Zinc (mg/kg dry weight)	<90	90-200	>200

The following supplementary ranges used to classify sediments from Great Lakes harbors have been developed to the point where they are usable but are still subject to modification by the addition of new data. These ranges are based on 260 samples from 34 harbors sampled during 1974 and 1975.

	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Ammonia (mg/kg dry weight)	<75	75-200	>200
Cyanide (mg/kg dry weight)	<0.10	0.10-0.25	>0.25
Phosphorus (mg/kg dry weight)	<420	420-650	>650
Iron (mg/kg dry weight)	<17,000	17,000-25,000	>25,000
Nickel (mg/kg dry weight)	<20	20-50	>50
Manganese (mg/kg dry weight)	<300	300-500	>500
Arsenic (mg/kg dry weight)	<3	3-8	>8
Cadmium (mg/kg dry weight)	*	*	>6
Chromium (mg/kg dry weight)	<25	25-75	>75
Barium (mg/kg dry weight)	<20	20-60	>60
Copper (mg/kg dry weight)	<25	25-50	>50

*Lower limits not established

The guidelines stated below for mercury and PCB's are based upon the best available information and are subject to revision as new information becomes available.

Methylation of mercury at levels $\geq$ 1 mg/kg has been documented(1,2). Methyl mercury is directly available for bioaccumulation in the food chain.

Elevated PCB levels in large fish have been found in all of the Great Lakes. The accumulation pathways are not well understood. However, bioaccumulation of PCB's at levels $\geq$ 10 mg/kg in fathead minnows has been documented (3).

Because of the known bioaccumulation of these toxic compounds, a rigid limitation is used. If the guideline values are exceeded, the sediments are classified as polluted and unacceptable for open lake disposal no matter what the other data indicate.

	POLLUTED
Mercury	$\geq$ 1 mg/kg dry weight
Total PCB's	$\geq$ 10 mg/kg dry weight

The pollutional classification of sediments with total PCB concentrations between 1.0 mg/kg and 10.0 mg/kg dry weight will be determined on a case-by-case basis.

a. Elutriate test results.

The elutriate test was designed to simulate the dredging and disposal process. In the test, sediment and dredging site water are mixed in the ratio of 1:4 by volume. The mixture is shaken for 30 minutes, allowed to settle for 1 hour, centrifuged, and filtered through a 0.45μ filter. The filtered water (elutriate water) is then chemically analyzed.

A sample of the dredging site water used in the elutriate test is filtered through a 0.45μ filter and chemically analyzed.

A comparison of the elutriate water with the filtered dredging site water for like constituents indicates whether a constituent was or was not released in the test.

The value of elutriate test results are limited for overall pollutional classification because they reflect only immediate release to the water column under aerobic and near neutral pH conditions. However, elutriate test results can be used to confirm releases of toxic materials and to influence decisions where bulk sediment results are marginal between two classifications. If there is release or non-release, particularly of a more toxic constituent, the elutriate test results can shift the classification toward the more polluted or the less polluted range, respectively.

b. Source of sediment contamination.

In many cases the sources of sediment contamination are readily apparent. Sediments reflect the inputs of paper mills, steel mills, sewage discharges, and heavy industry very faithfully. Many sediments may have moderate or high concentrations of TKN, COD, and volatile solids yet exhibit no evidence of man-made pollution. This usually occurs when drainage from a swampy area reaches the channel or harbor, or when the project itself is located in a low lying wetland area. Pollution in these projects may be considered natural and some leeway may be given in the range values for TKN, COD, and volatile solids provided that toxic materials are not also present.

c. Field Observations.

Experience has shown that field observations are a most reliable indicator of sediment condition. Important factors are color, texture, odor, presence of detritus, and presence of oily material.

Çolor. A general guideline is the lighter the color the cleaner the sediment There are exceptions to this rule when natural deposits have a darker color These conditions are usually apparent to the sediment sampler during the survey

Texture. A general rule is the finer the material the more polluted it is. Sands and gravels usually have low concentrations of pollutants while silts usually have higher concentrations. Silts are frequently carried from polluted upstream areas, whereas, sand usually comes from laterial drift along the shore of the lake. Once again, this general rule can have exceptions and it must be applied with care.

Odor. This is the odor noted by the sampler when the sample is collected. These odors can vary widely with temperature and observer and must be used carefully. Lack of odor, a beach odor, or a fishy odor tends to denote cleaner samples.

Detritus. Detritus may cause higher values for the organic parameters COD, TKN, and volatile solids. It usually denotes pollution from natural sources. Note: The determination of the "naturalness" of a sediment depends upon the establishment of a natural organic source and a lack of man-made pollution sources with low values for metals and oil and grease. The presence of detritus is not decisive in itself.

Oily material. This almost always comes from industry or shipping activities. Samples showing visible oil are usually highly contaminated. If chemical results are marginal, a notation of oil is grounds for declaring the sediment to be polluted.

d. Benthos.

Classical biological evaluation of benthos is not applicable to harbor or channel sediments because these areas very seldom support a well balanced population. Very high concentrations of tolerant organisms indicate organic contamination but do not necessarily preclude open lake disposal of the sediments. A moderate concentration of oligochaetes or other tolerant organisms frequently characterizes an acceptable sample. The worse case exists when there is a complete lack or very limited number of organisms. This may indicate a toxic condition.

In addition, biological results must be interpreted in light of the habitat provided in the harbor or channel. Drifting sand can be a very harsh habitat which may support only a few organisms. Silty material, on the other hand, usually provides a good habitat for sludgeworms, leeches, fingernail clams, and perhaps, amphipods. Material that is frequently disturbed by ship's propellers provides a poor habitat.

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APPENDIX B

Interim Guidance for Sediment Sampling and Testing

Appendix B

Interim Guidance for the Design and Execution of Sediment Sampling and Testing Efforts Relating to Navigational Maintenance Dredging in Region V

Environmental Review Branch
Planning and Management Division
United States Environmental Protection Agency

October, 1989

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Appendix A: USACE Maintained Waterways of the Great Lakes

Appendix B: Comparison of Sample Size vs. Historical Data

Appendix C: Wastewater Characteristics of Selected Industrial Processes

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1.0 INTRODUCTION

It is the authority of the United States Army Corps of Engineers (USACE) to maintain all authorized navigation waterways. This includes many harbors, channels, and reaches of rivers in Region V of the United States Environmental Protection Agency (USEPA)*. Through erosional and hydrological processes, sediment deposits accumulate along these waterway areas, interfering with navigation and requiring maintenance sediment removal by the USACE, for maintenance of Federal navigational channels, as well as private dredging operations.

For over a century, many of these same waterway areas have served as centers of industrial activity, commercial expansion, and residential development, while upstream portions of the watersheds have been subject to agricultural activities. These waterways have received both point and non-point source discharges containing varied amounts of natural and man-made inputs. Many constituents of these discharges have a tendency to become physically or chemically associated with suspended particulates, which eventually may settle out and become incorporated into the bottom sediments of these waterways. In the past several years, these sediments have been clearly identified as potential sources of pollution and environmental degradation.

Improper removal or disposal of contaminated sediments can result in an unacceptable degree of environmental damage or degradation. In order to prevent adverse environmental impacts from maintenance dredging, materials from a proposed dredging project area must be accurately characterized physically, chemically, and toxicologically before maintenance dredging can occur. This requires the design and execution of a well-planned sediment collection and sediment testing scheme. The data resulting from these analyses are a basis for management decisions concerning project-specific removal and disposal options.

There is a need to establish a consistent method for the design and execution of sediment sampling and sediment testing efforts related to navigational maintenance dredging within USEPA Region V. This document was written to provide guidance and information concerning the following aspects of a navigational maintenance dredging sediment sampling and testing program:

1) Define the historical and background information necessary to design and assess a proposed sampling and testing scheme.
2) Provide a rationale for various levels of sediment testing, based on the projected suitability of materials for specific removal and disposal options.
3) Provide a method for the establishment of sampling station locations and the number of stations included in a project design.
4) Provide references of various procedures and protocols applicable to the execution of sediment sampling and testing.
5) Provide a general overview of the costs associated with various sampling and testing methods, along with a synopsis of contract options available to the USACE for the execution of sediment sampling and testing, to better inform Regulatory agencies involved in possible project design modification.

*see Appendix A

The goal of this work is to establish a consistent procedure for the sampling and testing of sediments contained within the boundaries of navigational maintenance dredging projects on the Great Lakes. It should also serve as a vehicle to promote coordination and cooperation among all State and Federal agencies involved in the dredged sediment assessment process by stating, in a clearly defined manner, what information is necessary and what procedures should be followed during the design, review, and execution of a sediment sampling and testing plan.

2.0 Overview of Design Stages

The design of a sediment sampling and testing plan is an iterative process. Figure 1 (next page) provides an overview of the stages involved in plan design, review, and execution. This document deals with sampling project design, review, execution, and reporting of data. The subsequent data interpretation (termed "characterization") is a basis for management decisions concerning removal options (i.e. hydraulic versus mechanical removal) and disposal options (i.e. open lake disposal versus confined disposal). This document deals with procedures up to, and including, the reporting of data resulting from the sampling and testing effort.

The first stage considered is termed "pre-design." This entails the acquisition of information concerning project-area water and land use practices, as well as historical information about previous sediment sampling efforts. This information is utilized to make initial assumptions concerning the projected suitability of project subareas for various removal and disposal options, a process termed "initial delineation." Initial delineation can be very useful in avoiding overrigorous sampling and testing of sediments where decisions concerning removal and disposal options may already be fairly straightforward, a valuable tool in optimizing the application of limited financial resources.

The second stage is termed "preliminary design." This involves the development of a preliminary sampling and testing plan by the USACE, based on factors identified through review of historical information.

The third stage is termed "final design", requiring the interaction of State and Federal regulatory agencies with the USACE. These agencies should be provided the opportunity to comment on the proposed USACE sampling and testing plan before it is executed. The final design of the sampling and testing plan needs to consider the objectives of that plan, in conjunction with what is economically achievable.

The next stage considered is the actual execution of the sampling and testing plan. Literature references and guidance procedures are provided for sediment collection, and handling, as well as analytical and toxicity testing protocols.

The final section of this guidance provides a format for the reporting of data to the regulatory agencies involved in the sediment characterization and classification process. A standard data reporting format facilitates a consistent and expedient review of sediment assessments.

The last two stages in Figure 1, characterization and management decisions, are to be the focus of a future guidance document addressing the rationale behind policy decisions concerning dredged materials management. Characterization is a term applied to the actual interpretation of data resulting from testing. Management decisions concerning removal and disposal options are based upon that characterization.

This guidance is divided into sections corresponding with the above identified stages. The first section deals with procedures encompassed during the Pre-design stage.

Figure 1. Stages of Sediment Sampling, Testing, and Characterization

STAGE	ACTION
	HISTORICAL PROJECT INFORMATION
Pre-Design	
	INITIAL DELINEATION
- - - - - - - - - - - - - -	
Preliminary Design	DESIGN CRITERIA Number of Stations Location of Stations Type of Samples Parameters of Testing and Analysis
- - - - - - - - - - - - - -	
	COORDINATION AND REVIEW
Final Design	
ECONOMIC FACTORS	
- - - - - - - - - - - - - -	
Execution	SAMPLING AND ANALYSIS
- - - - - - - - - - - - - -	
Characterization	INTERPRETATION OF DATA

3.0 Pre-Design Stage

The pre-design stage involves two separate phases. The first is the assimilation of historical project data relating to the waterway under consideration for dredging. The second phase is known as initial delineation, where the historical project data are utilized to make certain assumptions concerning the projected suitability of dredged sediments for specific removal and disposal options. As will be seen in subsequent sections, this projected suitability will effect the overall purpose and design of the sampling and testing plan.

3.1 Historical Project Information

Certain historical project information is necessary for USACE review before a preliminary project design can be initiated. This includes (but may not be limited to) the following:

a. project limits
b. project depth(s)
c. project area configuration and hydrologic patterns which influence sediment transport and depositional processes
d. most recent bathymetric data, with contours showing depositional areas to be removed, with mandated navigational depths indicated
e. volume determination of materials to be removed
f. location of previous sediment sampling locations, along with the data resultant from the testing and analysis of the sediments collected
g. location/identification of municipal, industrial, and combined sewer overflow outfalls within or above the project area
h. location/identification of loading docks, marinas, agricultural areas, surface drainage outfalls, and other possible non-point source influences
i. identification of changes in land and water use practices which may affect contaminant concentrations or distributions relative to previous sediment sampling and testing efforts

Items a-f are easily attainable from USACE records. Items g-i are attainable with little difficulty. Item g could be provided to the USACE by the USEPA or State environmental agencies.

The above information can be utilized to divide a project into discrete subareas, with each subarea requiring a different purpose for sampling and testing, based on reason to believe that sediments from the project area are clean or contaminated.

3.2 Initial Delineation

Sediments within a given project area can span a full spectrum, ranging anywhere from clean to heavily contaminated. Removal and disposal decisions concerning these endpoints of the spectrum (clean or heavily contaminated) can be relatively straightforward. Clean materials may be suitable for beneficial uses or open-water disposal, while heavily contaminated materials will require some type of confined disposal. If a project area has been subject to contamination (as identified in Sec. 3.1, historical project information), the ability to initially separate a project area into distinct subareas, based on projected disposal suitabilities, is a useful tool. Both effort and cost may be conserved through the design of a sampling and testing plan which is reflective of that projected suitability. The conserved effort and cost may be applied toward a more intensive acquisition of data from areas containing sediments which fall between these two endpoints, the gray areas where materials' suitability is not clearly demarcated.

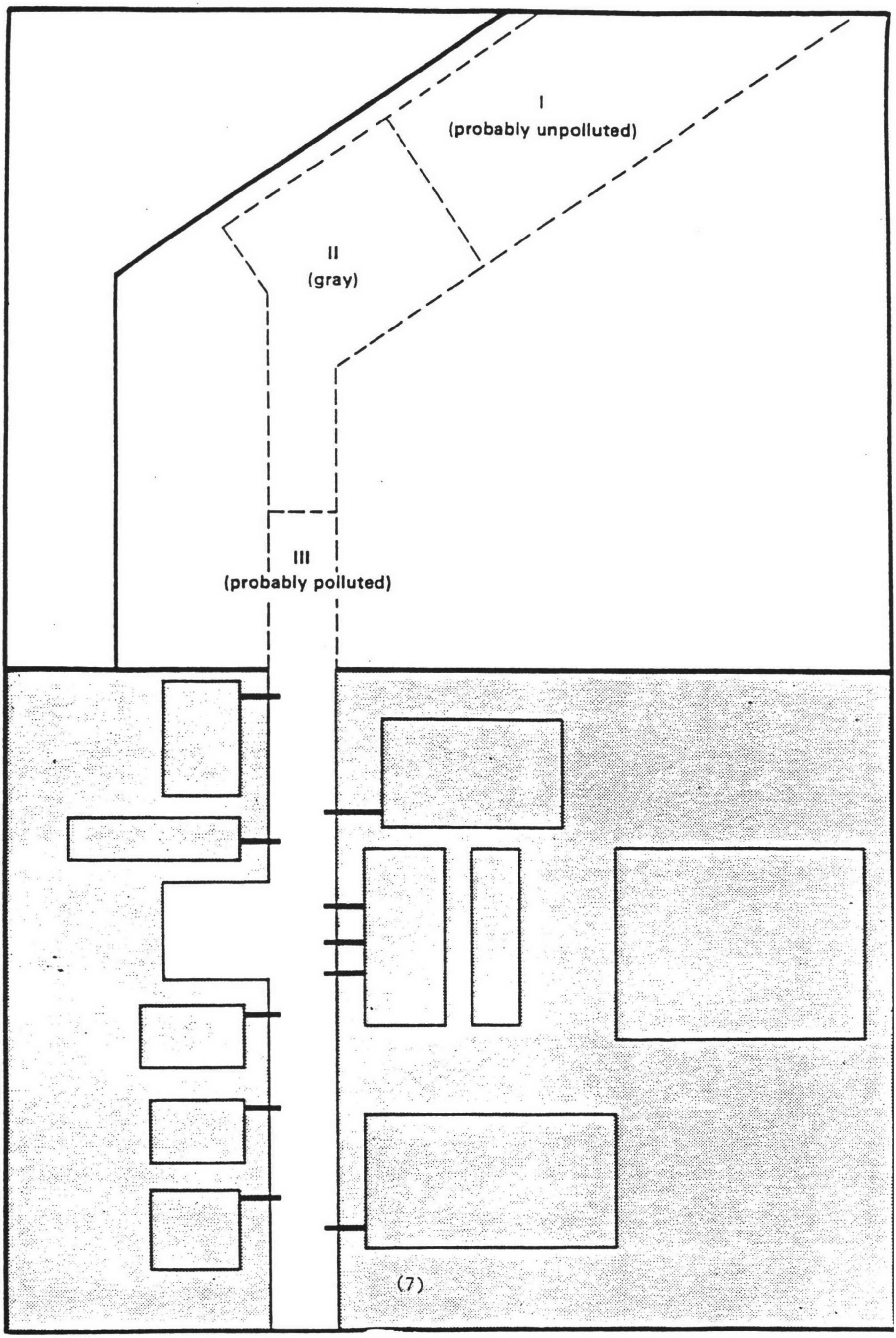
Consider the following example. Materials located at an outer harbor edge often result from littoral deposition of lake sands. These materials are usually non-contaminated, and their projected method of disposal would be either some beneficial use (i.e. beach nourishment) or possibly open-water disposal. Sampling and testing of this type of material should be geared toward this assumption.

Consider a second example. Based on historical sediment analysis and current land/water use practices, certain projects may contain sediments contaminated to levels which will obviously require some type of confined disposal. When this is the case, sampling and testing should be geared toward identifying sediment characteristics (i.e. settling, elutriate, etc.) which affect removal and disposal design.

These two examples illustrate cases where management decisions are fairly obvious. It is the materials which lie somewhere between these two extremes which are referred to as the gray area. Inadequate sampling and testing of these materials, whose projected suitability for removal and disposal is uncertain, can result in: 1) environmental damage from improper characterization and subsequent improper disposal of contaminated materials, 2) undue expense associated with confined disposal of non-contaminated materials, or 3) indecision and a need to repeat sampling and testing.

Three types of sediments are identified below as Type I, Type II, and Type III. Figure 2 shows the relative position of each Type in a hypothetical harbor. Project configurations and hydrologic patterns will vary from project to project, but this progression will be typical of many situations encountered. Definitions of each Type are based upon the origin of the material (littoral versus fluvial deposition) and project-specific historical data. The purpose for testing each sediment Type and the recommended level of testing to accomplish this follow each definition.

Figure 2
Relative Position of Sediment Types in a Typical Harbor



TYPE I Sediments

Composed primarily of sands (>80% retention by a #200 seive), Type I sediments are generally located at the outer harbor mouth or outer channel area. Type I sediments may also be present within some riverine dredging projects . Historically, these sediments have been considered non-polluted, as was defined by the 1977 Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments (1977 Guidelines), and past dredging exercises resulted in beneficial use or open-water disposal of the material.

Purpose for testing - The presumption is that Type I sediments are uncontaminated and suitable for some beneficial use or open-water disposal. (Open-water disposal of any material requires a comparison to materials at the proposed disposal site.) Sampling and testing are conducted for five reasons (applicable Federal regulations are also shown):

1) Confirm the sediment is non-contaminated (401/404/NEPA);

2) Delineate the extent (area) of the material (401/404);

3) Compare physical and chemical characteristics of materials from both the project area and proposed disposal site (404/NEPA);

4) Identify the benthic community being displaced by both the removal of the materials and disposal of the materials (NEPA);

5) Complete testing necessary for 401 certification.

Testing Necessary:

1) Grain size analysis of project sediments to confirm >80% retention by #200 seive; grain size analysis of proposed disposal area for comparison purposes;

2) Bulk chemical analysis of project sediments to confirm composition as non-contaminated ; bulk chemical analysis of proposed disposal site sediments for comparison;

3) Elutriate testing to determine the quality of discharge during the excavation and disposal;

4) Benthic invertebrate survey of both the project and disposal area to characterize the communities being displaced by the proposed activity.

In certain situations, valid reasons may exist for not carrying out one or more of the necessary testing steps given above. In such circumstances, full justification for the omission, along with the preliminary design of the sampling and testing plan, should be provided to the appropriate regulatory agencies for review before a final design is determined.

Type III Sediments

By definition, Type III sediments are known to be heavily contaminated based on historical sediment analysis, and are not to be considered for unconfined disposal. These materials are usually composed predominantly of silts and clays of fluvial origin, located in waterways receiving heavy industrial discharge, and possibly non-point source contamination as well. Cases will exist where coarse-grained materials are known to be contaminated and will qualify as a Type III material.

Purpose for testing - The presumption is that Type III sediments are contaminated and unsuitable for unconfined disposal. Sampling and testing are conducted for five reasons (applicable Federal regulations are also shown):

1) Confirm that the materials are contaminated;

2) Delineate the spatial distribution of the contaminated material to be dredged (401/404/NEPA);

3) Determine if the materials are regulated under the Toxic Substances Control Act (TSCA);

4) Determine if the materials are regulated under the Resource Conservation and Recovery Act (RCRA);

5) Define sediment characteristics necessary to assess potential impacts of removal (NEPA);

6) Define sediment characteristics necessary to determine disposal design options (404/401/NEPA).

Testing Necessary:

1) Grain-size analysis and other engineering analyses for assessing removal equipment and disposal options;

2) Bulk chemical analysis for inventory and monitoring purposes;

3) Chemical analysis for regulatory purposes; this may include TSCA and RCRA regulatory analyses as appropriate;

4) Elutriate testing;

5) Other physical and chemical testing (e.g. settling) considered necessary for assessing potential impacts of specific removal and disposal options.

In certain situations, valid reasons may exist for not carrying out one or more of the necessary steps given above. In such circumstances, full justification for the omission, along with the preliminary design of the sampling and testing plan, should be provided to the appropriate regulatory agencies for review before a final design is determined.

In cases where testing results indicate gross levels of contaminants, further testing may be warranted. The purpose of this additional testing would be to identify the source(s) of the contamination and attempt to have the source bear its share of the costs to dredge and dispose of the contaminated sediments.

There are several legal theories under which such recovery might be sought. TSCA provides authority to seek certain judicial relief against firms which disposed of TSCA materials. RCRA's imminent hazard and corrective action provisions, and its general liability structure, may also provide some legal recourse against persons generating such wastes. It is also possible that firms which are responsible for the contamination of sediments may have some liability under the Comprehensive Environmental Response, Compensation and Liability Act's imminent hazard and general liablility provisions.

Type II Sediments

Composed of silts, clays, and sands (<80% retention by a #200 seive), this material is typically located in the area of transition between Type I and Type III sediments. These materials may be of both fluvial and littoral origin. Historically these sediments may or may not have been suitable for open-water disposal based on the 1977 Guidelines. Type II sediments are considered the "gray area" often encountered in maintenance dredging.

Purpose for testing - Type II sediments are subjected to the most rigorous testing regime, owing to the nature of their variability from project to project and their uncertain suitability for any given removal or disposal option. Sampling and testing are conducted for the following reasons (applicable Federal regulations are also shown):

1) Quantify the % grain size distribution of the sediment (401/404);

2) Quantitate the concentration(s) of contaminants present (401/404/NEPA);

3) Determine the spatial distribution and the physical and chemical characteristics of the sediments (404/401);

4) Identify the benthic community being displaced by both the removal of the materials and disposal of the materials (NEPA);

5) Determine the potential sediment toxicity to the biological community (404);

6) Characterize the potential impact of various removal techniques (NEPA); and

7) Characterize the potential impact of various disposal options or for considerations necessary to design various disposal options (401/404/NEPA).

Testing Necessary:

1) Grain-size analysis for comparison to proposed disposal site or for removal and disposal design considerations

2) Bulk chemical analysis to assess the presence and concentration(s) of contaminant(s);

3) If appropriate, chemical analysis for regulatory purposes;

4) Elutriate testing;

5) Benthic invertebrate survey of both the project and disposal areas to characterize the communities being displaced by the proposed activity;

6) Bioassays to determine the potential effect of the contaminants identified above upon the indigenous biological community inhabiting the proposed disposal site, a necessary component for assessing the materials' suitability for open-water disposal;

7) Once bioassay testing is completed, it should provide the primary basis for decisions (together with all other factors). During this testing, it is mandatory under 404(b)(1) to compare the dredged material to material from the proposed disposal site.

In certain situations, valid reasons may exist for not carrying out one or more of the necessary testing steps given above. In such circumstances, full justification for the omission, along with the preliminary design of the sampling and testing plan, should be provided to the appropriate regulatory agencies for review, before a final design is determined.

In cases where testing results indicate gross levels of contaminants, further testing may be warranted. A discussion of this testing is provided on page 10, under the Initial Delineation of Type III materials.

In summary, Type I materials are predominantly sands, usually resulting from littoral deposition and usually non-contaminated. Type III sediments are materials located in areas subject to point and non-point source introduction of contaminants, and the materials by definition are not suitable for unconfined disposal. Type II materials are located in the region of transition between Type I and Type III sediments.

There will be projects where all three sediment Types are not present. Other case situations worth noting include (but are not limited to):

- small outer harbor projects that contain only Type I material
- projects with only two Types present (either Type I and Type II or Type II and Type III)
- the presence of Type I or Type II materials upstream from Type III material
- riverine or channel projects with only Type II materials present
- riverine or channel projects with only Type I materials present
- inner harbor projects with only Type II or Type III material present

Situations should seldom, if ever, arise where initial delineation is not possible. Virtually every waterway maintained by the USACE has past records of sediment sampling, dredging, and disposal.. Sediment location (i.e., outer harbor mouth versus in-channel) can give clues as to the origin of the materials and the suspected degree of influence that point and non-point sources may have had upon sediment contaminant levels. If there is uncertainty concerning regions of transition from one sediment Type to the next, simple preliminary grab samples can be taken prior to the design of the preliminary sampling scheme, and inspected visually noting grain size, color(s), odor(s), detrital material, the presence or absence of benthic invertebrates (see Section 4.5 for discussion of biosurvey utility in relation to navigational maintenance dredging), etc. This information can greatly aid in the initial delineation process.

This concludes the discussion on initial delineation, and also completes the section on the pre-design stage. The results of the pre-design stage will be utilized in the preliminary design of the sampling and testing plan, the next stage to be considered.

4.0 Preliminary Design Stage

This stage encompasses the designing of the sampling and testing strategy based on information and decisions derived from the pre-design stage, and includes decisions concerning the frequency of sampling, the number of sampling stations, the location of those sampling stations within the project area, the method for sampling, and the specific level of testing and analysis to be performed once the samples have been obtained. Each of these topics are dealt with separately in the following subsections. Decisions concerning these parameters revolve around many variable factors, making the formulation of a rigid and set plan impractical. This suggested guidance was designed to be flexible to variations in historical project data and situations encountered from project to project.

4.1 Frequency of Sampling

Sediment samples should have been collected and analyzed no more than 5 years prior to a proposed dredging project. If existing sediment data is greater than 5 years old, new samples should be taken. An exception to this time frame would occur when sediment samples were less than 5 years old, but evidence existed that the sediment quality had changed sufficiently since the last sampling effort to cause the sediment to be reclassified. In such instances, the sediment should be resampled immediately prior to the current dredging project to determine whether reclassification is merited.

4.2 Number of Sampling Sites

Possibly the most difficult question to address in the design of a sediment sampling scheme is that of sample number. What constitutes an adequate number of samples to characterize a large heterogeneous population of sediment? It was recognized that many factors can affect and influence sample number, including (but not limited to) volume of material to be removed, depth of deposition, surface area of deposition, projected degree of contamination, projected degree of homogeneity, and historical sampling data. No single parameter can dictate a required sample number for a given project.

The method for suggesting an initial sample number is derived from a combination of material volume, projected degree of contamination, projected degree of material homogeneity, historical records, and literature review. Appendix B compares these suggested sampling sizes to historical records. The overall objective of the suggested plan is to decrease the number of samples taken in Type I and Type III sediments where management decisions are fairly straightforward, and to increase the number of samples taken in the Type II sediments where the projected suitability of the material is unknown.

Projects should be subdivided (when possible) into subareas based on the projected sediment Type(s) (I,II, or III) and volume determinations made of the materials within each Type subarea. It should be noted that Type II materials break into two sub-types: 1) Type II materials which have always been judged as acceptable for open-water disposal or beneficial use and 2) Type II materials from areas where materials previously were not suitable for unconfined disposal. Table I (below) can be used to calculate the minimum number of samples to be placed within a given Type subarea of a specified volume. Additional sampling stations may be necessary for distinct depositional areas, known hot spots, or in cases judged not to conform to typical project design considerations. Special cases are considered on page 23.

Table I: Number of Sampling Locations as a Function of Volume and Type

	Type I	Type II		Type III
	80% retention by a #200 seive	History of unrestricted disposal	Past history of contamination	Not suitable for unrestricted disposal
VOLUME (yd^3)				
50,000	one station every 10,000yd^3; minimum of 3	one station every 10,000 yd^3 minimum of 4	one station every 8,000 yd^3 minimum of 5	one station every 10,000 yd^3 minimum of 4
0,000-00,000	one station every 15,000yd^3; minimum of 4	one station every 10,000 yd^3 minimum of 7	one station every 8,000 yd^3 minimum of 7	one station every 15,000 yd^3 minimum of 4
00,000-00,000	one station every 20,000 yd^3	one station every 15,000 yd^3	one station every 10,000 yd^3	one station every 15,000 yd^3

4.3 Sampling Site Locations

The positioning of sampling sites should reflect the purpose of testing, based upon the projected sediment Type found in that area. Specifics to consider (in conjunction with those listed below) include the locations of specific depositional areas and the locations of historical sampling sites.

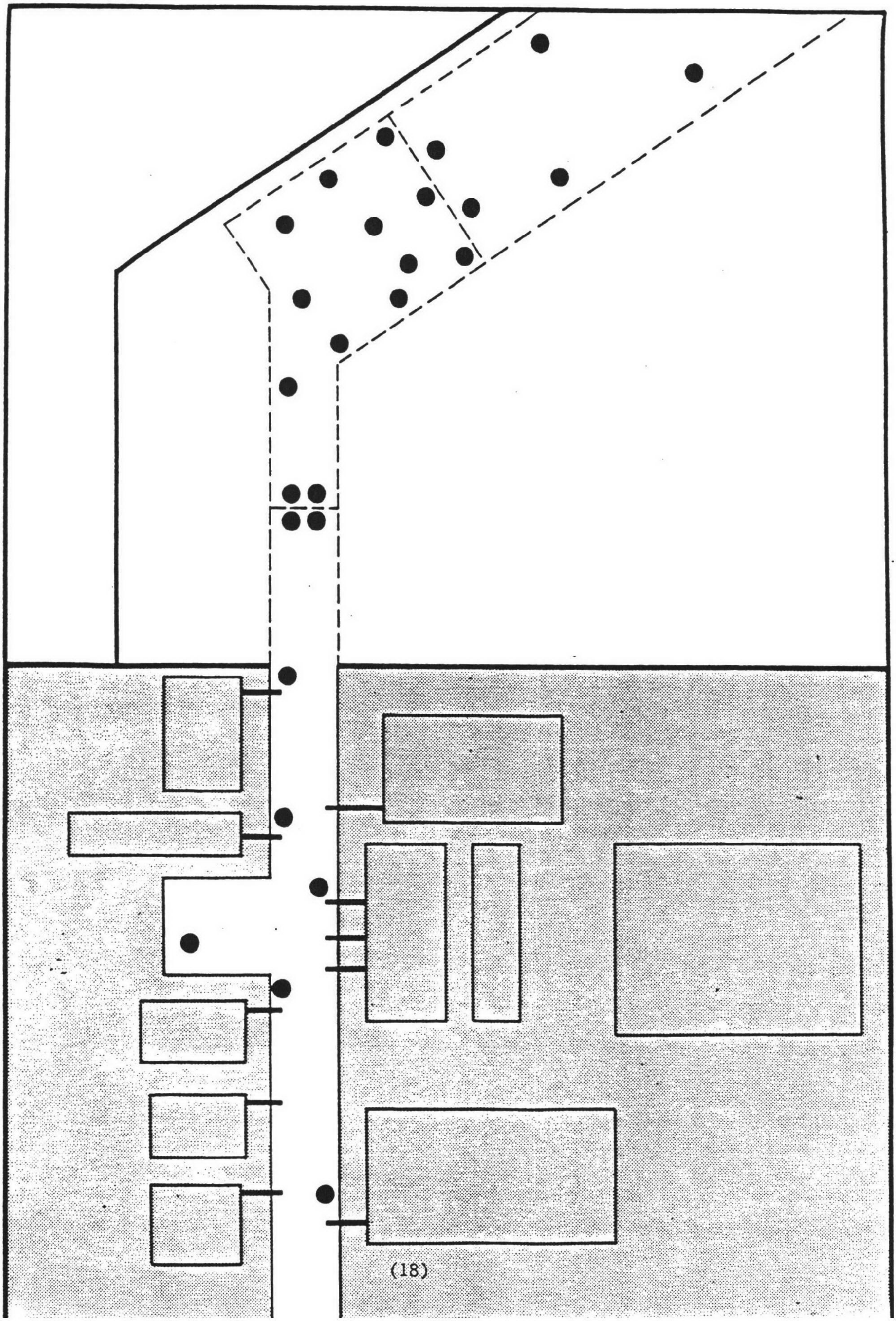
Type I sediments are sampled and tested to determine grain-size characteristics, confirm the chemical composition as uncontaminated, delineate the exact location of the material, and compare project materials to proposed disposal site materials. Samples should be collected in a random pattern to characterize the material to be dredged as a whole. Another line of samples should be taken along the projected Type I- Type II interface to delineate the boundary between these two Types.

Type II sediments are sampled and tested to determine physical characteristics of the material, to assess the degree (if any) the material is chemically contaminated, to assess the potential toxicological characteristics of the material, and to delineate the material from Type I and Type III sediments. Samples should be collected in a random pattern to characterize the material as a whole. A line of samples should be taken along the projected Type II- Type I interface and another along the projected Type II- Type III interface to delineate the boundaries between these Types.

Type III sediments are sampled to determine the physical characteristics of materials and the worst case concentrations of contaminants. This information is utilized to determine possible TSCA/RCRA regulation and to design removal and disposal controls. Sampling sites should be positioned below active or previously-active outfalls which at one time may have been discharging specific contaminants of concern. Sampling of historical "hot spots" is suggested. This should include areas of known chemical spills. Another line of samples should be concentrated along the projected Type III- Type II interface to delineate the boundary of these two Types.

Refer to Figure 3, showing the hypothetical harbor with subareas of Type I, II, and III sediments, along with the position of sampling sites within the various Types.

Figure 3
Positioning of Sampling Sites



4.4 Type of Sample

The following guidelines should be followed for deciding when and where core samples are more appropriate than grab samples.

Type I materials - require core sampling if last record of dredging is more than ten years prior to the proposed action.

Type II materials- require core sampling if last record of dredging is more than five years prior to the proposed action

Type III materials - require core sampling if last record of dredging is more than five years prior to the proposed action

All core samples should be taken with a piston-coring sampler. Core depth should be extend two feet below project depth to characterize material in the event of over-dredging and to characterize the material exposed by the dredging event.

Each core should be divided into three foot sections, from bottom to top, with each subsample undergoing the analysis and testing prescribed for the sediment Type at that sampling location.

When grab samples are judged proper, three replicates should be taken from an individual station. The three replicates should be composited and a subsequent subsample taken for testing and analysis.

4.5 Parameters of Testing

Once decisions are made concerning where and how samples are to be taken, the question of what form of testing and analysis is most appropriate must be addressed. Some combination of physical, chemical, and biological testing of sediments is necessary to provide data utilized during the process of characterization.

Physical testing, specifically grain-size analysis, provides information relating to the origin(s) of materials from a given area. Along with analysis of total organic carbon (TOC), it provides some indication of a sediment's potential capacity for binding contaminants. Physical information (e.g. settling) can also affect consideration of disposal site location or disposal design. All materials sampled should undergo grain-size analysis, while other physical analyses should be performed as needed for disposal control design.

Bulk chemical analysis provides information concerning the presence (or absence) of specific contaminants. Historically, chemical analysis has concentrated upon nineteen specified parameters outlined in the 1977 Guidelines for Pollutional Classification of Great Lake Harbor Sediments, which included metals, nutrients, and polychlorinated biphenyls (PCBs). Recent analytical and toxicological advances have identified many additional compounds which are capable of producing adverse environmental impacts, including (but not limited to) polynuclear aromatic hydrocarbons (PAHs), persistent chlorinated pesticides, dibenzofurans, and dioxins.

A standard set of chemical parameters should be tested for in all samples collected. Additional parameters should be added to the standard set in cases where evidence exists that other contaminants are present at the sampling site. As an aid to determining additional parameters, all potential sources of loading located within the watershed should be identified. Appendix C provides a general overview of wastewater parameters associated with selected industrial processes. More detailed information concerning characteristics of discharge for specific industrial processes may be obtained through examination of USEPA wastewater treatment feasibility studies for the specific process or industry under consideration. The proximity of agricultural lands to a project area's watershed should be taken into account when considering analysis for pesticides. Other factors which justify the inclusion of additional chemical contaminants for analysis include reported chemical spills, identification of processes discharging to municipal wastewater treatment facilities, or contaminants historically known to be present. The standard set of chemical parameters and the appropriate analytical methods for sediment chemistry are provided in Section 6.0 on Execution.

Along with bulk chemical analysis, an elutriate test should be conducted in instances where open-lake disposal is being contemplated. The elutriate test estimates the dissolved immediately-releasable fraction of the various chemical contaminants in the sediment as material is being dredged and disposed. Results of elutriate testing can be utilized when estimating whether applicable water quality standards will be violated during the disposal operation.

Other liquid phase (leaching) tests may be required if there is reason to believe that the material to be dredged is hazardous as defined under RCRA or CERCLA.

Benthic macroinvertebrate surveys may be utilized for two purposes in relation to assessment of navigational maintenance dredging projects. The first would be to characterize the communities being displaced both at the dredging and disposal sites. The second purpose would be to assess the in-situ toxicity (if any) of in-place sediments, aiding in distinguishing between Type I, II, and III sediments.

Bioassays are warranted for all materials showing any elevated level of contamination (above background) or for which there is reason to believe the materials may be contaminated and are still being considered for open-water disposal. This decision is based on the reports of many qualified experts who address the problem of assessing potential effects associated with contaminated aquatic sediments. The final summary of the Dredged Material Research Program (DMRP), a five year research program conducted by the USACE, states, "Different types of organisms will uptake different types of contaminants such as heavy metals depending on an apparent variety of environmental and biological factors. The complexity of this process and the low level of predictive capability have been controlling factors in the decisions that bioassays must be an integral part of the evaluative criteria used in implementing the Section 404 and 103 programs. It is fully realized that bioassay tests are expensive and time consuming, but the state-of-the-art allows no effective alternative for determining how organisms will be affected by contaminated dredged material." Many dredging projects encountered may contain an array of contaminants at various concentrations, whose potential availability and biological impact can vary depending upon the specific mixture of contaminants present and the physical characteristics of the specific sediment. Bulk chemical analysis alone provides no means for assessing site-specific availability, nor does it account for synergistic, antagonistic, or additive interactions among any specific mixture of compounds. Bioassays, at present, provide the optimal means of assessing potential biological impacts from site-specific contaminant mixtures.

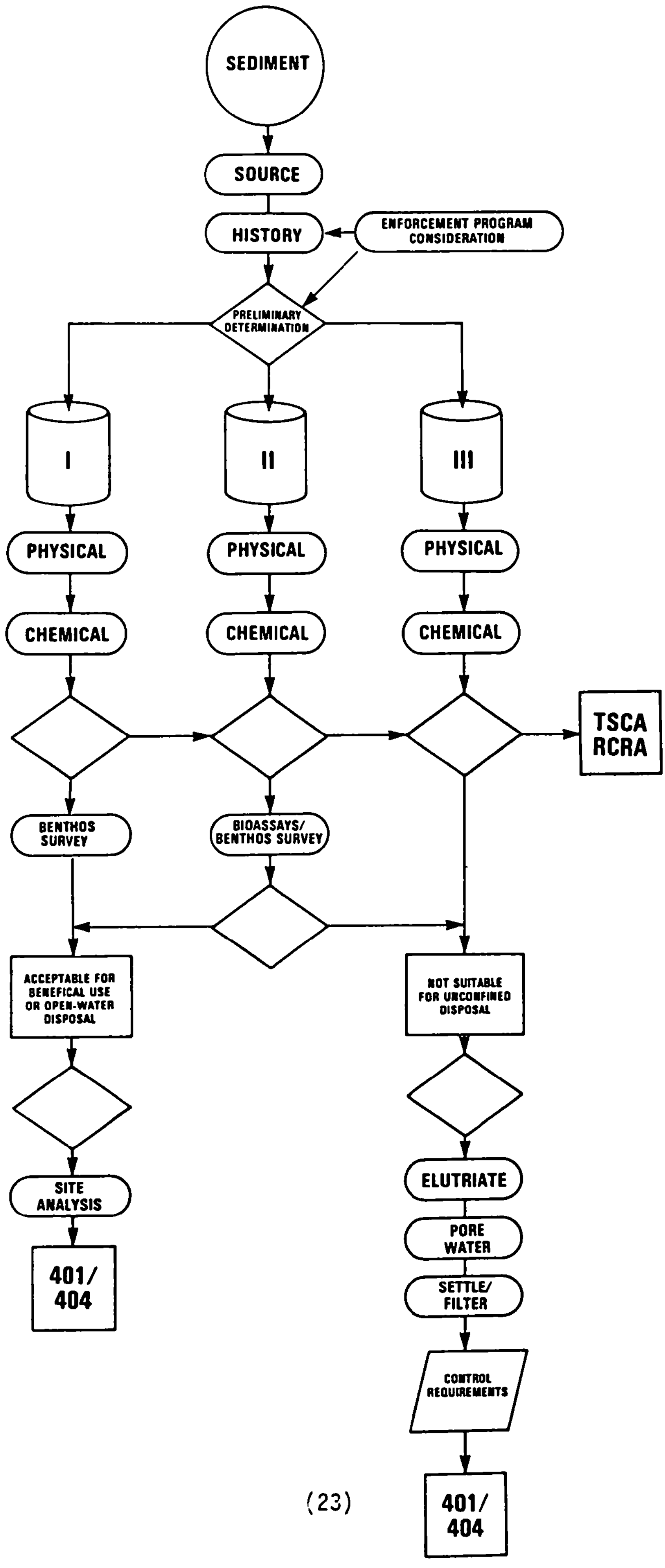
Bioassays should mimic, as closely as possible, both the route of contaminant exposure and the type(s) of organisms subjected to that exposure in the environment. Concern should be raised not only over the short-term impact open-water disposal has upon the water column, but also over the potential for impact from chronic exposure of benthic organisms to elevated levels of contaminants. Recommended testing should include a lethal elutriate-phase bioassay using a planktonic Cladoceran species, as well as a sublethal whole sediment bioassay using either the benthic midge Chironomus tentans, the burrowing amphipod Hyallela azteca, or the burrowing mayfly Hexagenia limbata. These recommended organisms are endemic to the Great Lakes and have been used sucessfully for sediment bioassays over the past few years. Bioaccumulation bioassays should be conducted if contaminants are present at levels of concern which merit this consideration (i.e. PCBs, mercury, DDT, etc.). This decision will be made on a case-by-case basis. Recommended testing protocols and a more detailed discussion of bioassay considerations are included in the section on Execution.

Figure 4. depicts the overall testing strategy for Type I, Type II, and Type III sediments.

This concludes the final subsection of considerations during the preliminary design stage. The preliminary design plan is next submitted to State and Federal regulatory agencies involved in the process of reviewing and commenting on navigational maintenance dredging.

Figure 4

Testing Strategy for Different Sediment Types



4.6 Special Cases

There are specific cases which qualify for special considerations relating to the design and applicability of a sediment sampling and testing strategy. These include the following situations.

1) Projects with volumes with more than 500,000 yd^3 of material removed annually should establish an independent sampling and testing strategy, coordinated through the specific USACE district responsible for the project, regulatory agencies within the specific State in which the project is located, the US EPA, and the U.S. Fish and Wildlife Service.

2) Projects consisting of only Type I materials and volumes less than 50,000 yd^3 may be excluded from testing if historical records of proper grain-size composition and no elevated levels of contamination can be supplied

3) 404 permitting for municipal bridge repair:
   a. should require a minimum of two samples, one from each side of the project, composited before analysis
   b. the required level of testing would be dependent upon the proposed method of material removal and disposal

4) 404 permitting for slip/dock dredging
   a. should require a minimum of three samples
   b. the required level of testing would be dependent upon the proposed method of material removal and disposal
   c. recommended analysis should take into consideration the type(s) of material(s) loaded or off-loaded at or around the project site

5.0 Final Design Stage

The final design stage involves the regulatory review and possible revision of the USACE preliminary sampling and testing design. A preliminary sediment sampling and testing plan, along with the appropriate historical project information, should be submitted to the appropriate regulatory agencies involved in the review of navigational maintenance dredging projects. Review and comment by these agencies provides for a more informed coordination, and allows regulatory agencies to indicate where they feel deficiencies are in a sampling project before the project is executed. Providing this opportunity for comment may help avert additional testing at a later date because of statements of insufficient data by reviewing regulatory agencies. This practice provides regulatory agencies the opportunity to share relevant environmental data which may have been previously unknown to the USACE. Other advantages could include coordination of monitoring events and prevention of effort duplication.

To further facilitate the level of confidence which can be placed in a sampling and testing effort, the USACE should provide a preliminary Quality Assurance Project Plan (QAPP) along with the above mentioned preliminary plan and information. The QAPP generates a level of confidence which can be placed upon data resultant from testing by providing a description of quality control and quality assurance measures which will be taken to ensure that the sampling and testing effort is of the highest quality. A generic QAPP for the sampling and testing of sediments has been provided as Appendix F.

The above mentioned information should be provided to the regulatory agencies involved in the assessment procedure before any execution phase of the sampling and testing plan takes place. This includes the calling for bids on any new contracts associated with sediment collection, testing, or removal.

Specific historical project information is necessary for the design of any proposed sediment sampling and testing scheme. This same background information is important to the various regulatory agencies involved in the review process. Providing consistent historical and operational information facilitates a more rational and expedient assessment of any sampling and testing plan, and provides the information which is the basis for USACE justification of project design. It is recommended that the attached standard reporting format be adopted by the USACE for the reporting of historical information and the preliminary sediment sampling and testing design. The reporting format contains information relating to project history, preliminary sampling and testing design, as well as projected removal and disposal methods. Rationales for all requested information are given following the reporting forms.

SEDIMENT SAMPLING AND TESTING PLAN REPORTING FORMAT
MAINTENANCE DREDGING

PLAN STATUS (circle one) : (PRELIMINARY / FINAL)

1) Date:____________________

2) Project:____________________

3) Waterway:____________________

4) Location: City:______________ County:______________ State:__________

Historical

5) Last year sampled: ____________________

6) Last year dredged: ____________________

7) Total volume removed: ____________________

8) Removal method/equipment: ____________________

9) Disposal (write in volume, method and location of disposal, where applicable):

a. beneficial use: ____________________

b. open-water disposal:____________________

c. upland disposal:____________________

d. confined disposal:____________________

10) Attach sediment sampling results from last sampling event in 5)
- reporting should be site specific
a. attach map of project area showing previous sampling locations, clearly identifi
b. comments or notes outlining/discussing problems or unusual conditions.

Proposed Project

11) Attach map(s) of project area showing :

a. project limits

b. project depths

c. most recent bathymetric data, with contours, showing depositional areas to be removed

d. projected delineation boundaries of sediment Types

e. location/identification of municipal, industrial, and combined sewer overflow oufalls from information supplied by USEPA

f. location/identification of loading docks, marinas, agricultural areas, surface drainage outfalls, and other possible non-point source influences

g. proposed location of sampling sites, clearly identified

Project Name: ____________

Date: ____________

12) Total material volume: ____________________

13) Estimated type volumes:

Type I ____________ Type II ____________ Type III ____________

14) Attach method and calculations for volume determination(s)

*15) Total number of sampling sites: __________

Identify number of stations in each projected Type:

Type I ______ Type II ______ Type III ______

16) Describe any change in land or water use practices which may affect contaminant concentrations or distributions relative to the last previous sediment collection and testing effort:

____

____

____

____

Projected Dredging and Disposal Plan

17) Anticipated dredging method and equipment: ____________________

____

____

____

18) Anticipated disposal method and location: ____________________

____

____

____

19) Attach projected timetable for coordination, review, sampling, testing/analysis, data assimilation and reporting, disposal site preparation (if applicable), and actual removal/disposal operation. Indicate any operational time-window constraints (i.e., spawning runs) which could interfere with operations.

* also complete station-specific description forms, Attachment A

ATTACHMENT A
SAMPLING STATION INFORMATION

Station #:___________ Projected Sediment Type:___________

Location: ________________________________ Historical Site: YES / NO

Depth of deposition at station: _______________ Type of sample : core / grab

Purpose for testing: ____

Testing required: ___physical ___chemical ___biological ___elutriate

___settling ___pore water

Additional chemical analysis:____

Justification for location: ____

Station #:___________ Projected Sediment Type:___________

Location: ________________________________ Historical Site: YES / NO

Depth of deposition at station: _______________ Type of sample : core / grab

Purpose for testing: ____

Testing required: ___physical ___chemical ___biological ___elutriate

___settling ___pore water

Additional chemical analysis:____

Justification for location: ____

[Comments or notes indicating any problems or unusual conditions should be included for each station.]

Rationales for Requested Information

Item 1-4 - Identification of project

Item 5 - provides temporal sampling information

Item 6 - provides temporal dredging information

Item 7 - provides comparison to present proposed action

Item 8 - provides comparison to present proposed action

Item 9a-d - provides background as to potential suitability of material(s) from project for a given disposal option

Item 10 - necessary to assess previous sampling effort and results

Item 11a - shows boundaries of proposed action

Item 11b - shows depths of proposed action

Item 11c - shows depositional location and area within the project

Item 11d - provides initial delineation for design of sampling effort relevant to projected suitability

Item 11e - provides point-source information; identification of potential parameters of concern based on process; identification of locations where worse-case conditions may exist

Item 11f - provides spatial information related to other possible contaminant source(s)

Item 11g - provides information as to spatial relationship between loading sources and sample station location

Item 12 - provides information about project size; provides basis for (minimum) initial sample number; related to possible impact of disposal

Item 13 - provides a more detailed breakdown of Item 12; necessary for sample number considerations

Item 14 - necessary for confidence in assigning sample number based (partially) upon volume considerations

Item 15 - provides comparison of estimated Type volume versus sampling site number

Item 16 - gives indication as to the comparability of the last sampling and testing results versus the proposed sampling and testing plan

Item 17 - provides comparison basis with previous efforts

Item 18 - provides insight as to material's projected suitability for a given disposal option(s)

Item 19 - provides a basis for coordination among all agencies involved in the overall assessment effort

Attachment A - provides information concerning the selection of specific sampling locations; allows for review of sediment type, purpose, and testing integration

The preliminary design should be reviewed in conjunction with the historical project data. Regulatory agencies should be provided thirty days for review, and written comments concerning the preliminary design should be submitted to the USACE. Any suggested changes or modifications to the preliminary design should be justified in the written text. Regulatory personnel should consult Appendix D which outlines approximate costs for different sampling efforts, chemical analyses, and biological testing. Economic factors can influence what is actually achievable, and a knowledge of cost ranges may prove valuable during design modification negotiations.

This concludes the section on Final Design. The next section deals with the execution of the sediment sampling and testing plan.

6.0 Execution

This section provides guidance concerning procedures and protocols applicable to sediment sample collection, chemical analysis, and biological testing. Appendix E provides an overview of the various contract types available to the USACE for contracting professional services to execute the actual sampling and testing of materials.

6.1 Sediment Collecting Methods

Regardless of how well planned a sampling program may be, analyses will provide an inaccurate assessment if sediment samples are not properly collected, handled, and stored. Poor collection procedures can easily result in the collection of samples which are not truly representative of the material from the given sampling area. Testing of cross-contaminated samples will usually result in data indicating elevated levels of contamination or toxicity relative to actual conditions, creating a situation where materials might be improperly characterized, incurring higher costs for the removal and disposal of non-contaminated materials.

Procedures for sediment collection, handling, and storage are available in EPA/CE- 81-1 "Procedure for Handling and Analysis of Sediment and Water Samples." The information below is provided as a supplement to this guidance.

1) Piston-coring devices with plastic liners should not be used for collection of samples for analysis of organics;

2) Piston-coring devices with reusable liners should not be used;

3) All sampling equipment should be cleaned using a brush and pesticide-grade hexane between each sampling station. Each sampling event (project) should include at least one equipment blank to ensure good equipment-cleaning procedure. The blank should be taken by pouring high-grade distilled water (ASTM Type I distilled water for inorganic analysis; ASTM Type I-organic free distilled water for organic analysis) over equipment after cleaning, and the subsequent runoff collected and analyzed. This procedure should be followed for cleaning grab samplers, core samplers, and sample mixing equipment. Brushes for cleaning should be used for only one sampling effort;

4) Sample containers should be wide-mouth glass jars of 8, 16, or 32 ounce size. For collection of organics, the cap should be teflon lined, or hexane-rinsed aluminum foil should be placed over the mouth of the jar before securing the top. Containers should always be new; do not reuse old containers. Do not use aluminum foil with sediment samples for inorganic analysis;

5) Piston corer--retainer in the mouth of sampler should be made of plastic for the collection of samples for inorganic analysis, and of metal for

the collection of samples for organic analysis; if a choice must be made between the two, the metal retainer is more desirable. Always check the retainer to make certain all prongs (especially plastic) are intact after each sample has been collected. The retainer and cutting head should be cleaned after each sample.

6) All core samples should be cut into sections using a stainless-steel spatula. Samples should be composited in a stainless steel mixing bowl using a stainless-steel spoon. All equipment should be cleaned with pesticide-grade hexane and a brush after each station. Disposable aluminum-foil mixing or baking pans may be used in place of the stainless-steel bowl as a mixing container. This eliminates having to re-clean the bowl after each station. An equipment blank, similar to that described for the sampling equipment, should be collected and analyzed if mixing bowl is cleaned and reused.

7) Site-specific safety plans should be developed for field personnel, based upon known historical contaminants in a worst-case situation.

Considerations relating to various types of sampling equipment are available in EPA/CE-81-1.

2 Chemical Analysis

The standard chemical/physical parameters that should be routinely tested for include the following:

-Particle size
-Total Solids
-Volatile Solids
-Total Organic Carbon
-Chemical Oxygen Demand
-Percent Moisture
-Ammonia Nitrogen
-Cyanide
-Metals
 -Arsenic
 -Cadmium
 -Chromium
 -Copper
 -Lead
 -Mercury
 -Nickel
 -Selenium
 -Zinc
 -Manganese
-Chlorinated Hydrocarbons
 -alpha BHC
 -beta BHC
 -delta BHC
 -gamma BHC (Lindane)
 -Chlordane
 -DDD
 -DDE
 -DDT
 -Dieldrin
 -Endrin
 -Heptachlor
 -PCB's

Additional parameters should be added to the standard list in cases where evidence exists that other contaminants are present at the sampling site. Situations may also arise where parameters could be justifiably removed from the standard list, such as at harbors having no identifiable point or non-point source loadings. A proposed list of parameters to be tested for, as well as a written justification for substractions from the standard list, should be provided for appropriate regulatory review before sampling is commenced.

Methods for the analysis of chemical constituents are available in EPA/CE-81-1 "Procedure for Handling and Analysis of Sediment and Water Samples". Other methods may be used provided they meet detection limit specifications and regulatory approval.

Elutriate testing should be performed with site water.
Leachate testing should be performed with water simulating the characteristics of rainwater.

3 Biological Testing

Benthic Macroinvertebrate Survey

A benthic macroinvertebrate survey should be carried out for all Type I and II materials that are being considered for open-water disposal. Recommended methods for collecting and analyzing data are described below. If other methods are deemed preferable, they should be reviewed by USEPA prior to implementation. A number of these methods have been taken from an Ohio Environmental Protection Agency's methods manual for conducting macroinvertebrate surveys (Ohio EPA 1987). Ohio is presently the only state in Region V to utilize numerical instream biological criteria for benthic macroinvertebrate communities, with widely distributed field and laboratory methods.

-Data Collection

A Ponar-type grab sampler should be used in collecting the survey samples. The samples should be sieved in the field, first passing them through a U.S. standard testing sieve number 30 and then passing the resultant wash out through a number 40 sieve. The material retained in each sieve should then be preserved in ethanol, with the solution after the addition of the organisms equaling 70% ethanol. Replicates should be taken for each sample.

For each sampling station where subsampling is done, this should be clearly noted and follow procedures given in Ohio EPA (1987). Organisms should be identified down to the taxonomic level listed in Table 2, taken from Ohio EPA (1987). Justification should be provided for each survey where less rigorous taxonomic identification is performed. Taxonomic keys used in making identifications should be fully referenced. It is extremely important that a voucher collection be prepared for each benthic invertebrate survey. The collection should be sent to USEPA for review until such time that USEPA deems this no longer necessary. After USEPA has reviewed the voucher collection, it should be maintained at an easily accessible location, should the need arise to reexamine a specimen.

-Data Analysis

Data analysis should involve both structural and functional measures of the biological community.

The structural analysis should include the following:

1) Number of taxa
2) Number of individuals per taxon
3) Diversity index (Shannon 1948)
4) Equitability index (Weber 1973)
5) Community similarity index (Van Horn 1950)
6) Dominant taxa. What taxa are dominant and to what degree?
7) Indicator organisms and/or biotic index (Hilsenhoff 1987,1988)

The functional analysis should include the following for the organisms sampled:

1) Trophic relationships (Merritt and Cummins 1984)
2) Anomalies/deformities should be reported

In addition to structural and functional measures, the data analysis should include a habitat component. Habitat requirements should be provided for each organism sampled and a detailed habitat description should be given for each sample location.

In doing a benthic macroinvertebrate survey, it should be kept in mind that the area being surveyed might not be expected to support a typical benthic community. This cannot always be attributed to sediment contamination. Navigational channels and harbors are areas of high agitation from ship traffic. If is quite possible to get a "false" reading concerning environmental quality from biosurveys in these areas. If the channel is regularly dredged, those organisms which are rapid colonizers will likely dominate the community. Likewise, if the sediments are organically-enriched, community diversity will drop while individual numbers of tolerant or opportunistic species may dramatically increase. Theoretically, sediments which contain highly-elevated levels of contaminants may support little or no community at all. There is the possibility that surficial sediments might be clean and support a healthy community, while contaminated sediments are located beneath. This situation could arise from a decreased loading of the system and a natural silting-over of contaminated material.

Benthic community data should thus be used to complement sediment chemical analysis and bioassay data. As shown above, placing too much emphasis on community structure alone can be very compromising; in conjunction with other sediment analyses, however, the use of benthic surveys in assessing sediment quality can be most helpful.

References for benthic invertebrate survey:

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20(1): 31-39.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family-level biotic index. J.N. Am. Benthol. Soc. 7(1): 65-68.

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Bioassays

Bioassays must be included as an integral part of the testing of Type II materials being considered for open-water disposal. This should include both lethal and sublethal testing of sediments upon sensitive species indigenous to the Great Lakes, as well as a test of bioaccumulation if any of the contaminants identified as present merit such consideration. The following tests and methods are suggested to assess potential biological effects of dredged materials:

a) A Cladoceran (*Daphnia magna*, *D. pulex*) elutriate-phase lethal test following the procedure outlined in Nebeker *et al*.(1984). While either of the cladocerans listed are appropriate for this test design, tests using *D. magna* might be the most readily available on a commercial basis at this time.

b) A sublethal test utilizing benthic invertebrates and whole sediments. Three species appear to have the greatest utility here, either the midge *Chironomus tentans*, the amphipod *Hyallela azteca*, or the burrowing mayfly *Hexagenia*. Testing with *C. tentans* should follow the procedure outlined in Adams *et al*. (1985,1986), Mosher *et al*. (1986), and Ziegenfuss *et al*. (1986). Testing with *H. azteca* should follow the procedure outlined in Nelson *et al*. (1987). Testing with *Hexagenia* should follow the procedure outlined in Fremling *et al*. (1980).

c) A test determining bioaccumulation should utilize the fathead minnow *Pimephales promelas* following the methods outlined in ASTM no. E 1022-84. Methods should be modified for the use of whole sediments rather than water alone. Decisions concerning the utility of this test should be decided case-by-case, based on both historical contamination and the results of the chemical analysis.

Sediment bioassays are a rapidly developing and expanding field. It is recommended that a committee be formed among all interested State and Federal agencies to periodically (every 2 years) revise suggested biological testing as information concerning sensitive species and new methods become available.

References for bioassays:

Adams, W.J., Kimerle, R.A., and R.G. Mosher. 1985. In: Cardwell, Purdy, and Bahner (eds.). Aquatic toxicology and hazard evaluation: seventh symposium. ASTM STP 854. American Society for Testing and Materials. Philadelphia, PA. pp. 429-453.

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Table 2: Recommended level of taxonomy for macroinvertebrate identification

---

- Porifera: Species
- Coelenterata: Genus
- Platyhelminthes: Class
- Nematomorpha: Genus
- Bryozoa: Species
- Entoprocta: Species
- Annelida
  - Oligochaeta: Class
  - Hirudinea: Species
- Arthropoda
  - Crustacea
    - Isopoda: Genus
    - Amphipoda: Genus/Species
    - Decapoda: Species
  - Arachnoidea
    - Hydracarina: Class
  - Insecta
    - Ephemeroptera
      - Siphlonuridae: Genus
      - Baetidae: Genus
      - Oligoneuriidae: Genus
      - Heptageniidae: Genus/Species
      - Leptophlebiidae: Genus
      - Ephemerellidae: Species
      - Tricorythidae: Genus
      - Caenidae: Genus
      - Baetiscidae: Species
      - Potamanthidae: Genus
      - Ephemeridae: Genus
      - Polymitarcyidae: Species
    - Odonata
      - Zygoptera
        - Calopterygidae: Genus
        - Lestidae: Species
        - Coenagrionidae: Family/Genus
      - Anisoptera
        - Aeshnidae: Species
        - Gomphidae: Species
        - Cordulegastridae: Species
        - Macromiidae: Species
        - Corduliidae: Species
        - Libellulidae: Species
    - Plecoptera
      - Pteronarcyidae: Genus
      - Peltoperlidae: Genus
      - Taeniopterygidae: Genus
      - Nemouridae: Species
      - Leuctridae: Genus
      - Capniidae: Genus
      - Perlidae: Species
      - Perlodidae: Species
      - Chloroperlidae: Genus
    - Hemiptera
      - Belostomatidae: Genus
      - Nepidae: Genus
      - Pleidae: Genus
      - Naucoridae: Genus
      - Corixidae: Genus
      - Notonectidae: Genus
    - Megaloptera
      - Sialidae: Genus
      - Corydalidae: Species
    - Neuroptera: Genus
    - Trichoptera
      - Philopotamidae: Genus/Species
      - Psychomyiidae: Species
      - Polycentropodidae: Genus
      - Hydropsychidae: Genus/Species
      - Rhyacophilidae: Genus/Species
      - Glossosomatidae: Genus
      - Hydroptilidae: Genus/Species
      - Phryganeidae: Genus
      - Brachycentridae: Genus
      - Limnephilidae: Genus
      - Lepidostomatidae: Genus
      - Beraeidae: Genus
      - Sericostomatidae: Genus
      - Odontoceridae: Genus
      - Molannidae: Genus
      - Helicopsychidae: Species
      - Calamoceratidae: Genus
      - Leptoceridae: Genus/Species
    - Lepidoptera: Genus

Table 2. Continued.

Coleoptera	
Gyrinidae: Genus	
Haliplidae: Genus	
Dytiscidae: Genus	
Noteridae: Genus	
Hydrophilidae: Genus	
Hydraenidae: Genus	
Psephenidae: Species	
Dryopidae: Genus	
Scirtidae: Family	
Elmidae: Genus/Species	
Limnichidae: Genus	
Heteroceridae: Family	
Ptilodactylidae: Family	
Chrysomelidae: Family	
Curculionidae: Family	
Lampyridae: Family	
Diptera	
Tipulidae: Genus	
Psychodidae: Genus	
Ptychopteridae: Genus	
Dixidae: Genus	
Chaoboridae: Genus	
Culicidae: Genus	
Thaumaleidae: Genus	
Simuliidae: Genus	
Certopogonidae: Family/Genus/Species	
Chironomidae	
Tanypodinae: Genus/Species	
Diamesinae: Genus/Species	
Prodiamesinae: Genus/Species	
Orthocladinae: Genus/Species	
Chironominae	
Chironomini: Genus/Species	
Pseudochironomini: Genus/Species	
Tanytarsini: Genus/Species	
Tabanidae: Genus/Species	
Athericidae: Species	
Stratiomyidae: Genus	
Empididae: Family	
Dolichopodidae: Family	
Syrphidae: Family/Genus	
Sciomyzidae: Family/Genus	
Ephydridae: Family/Genus	
Muscidae: Species	
Mollusca	
Gastropoda: Family/Genus/Species	
Pelecypoda: Family/Genus/Species	

7.0 Reporting of Data

Once analysis and testing have been completed, the USACE is responsible for data reduction and validation. The procedure utilized for this process should be explained in Sections 10.1 and 10.2 of the project QAPP.

Once data have been validated, USACE shall report to the appropriate regulatory agencies the results of all physical, chemical, and biological testing in the formats outlined in the following pages. Other pertinent information, including field notes, drilling logs, etc., should be included with the data.

The data should be accompanied by a preliminary statement of discussion by the USACE, including comparisons and contrasts of the present effort with historical data and statistical comparisons with the proposed disposal site (if material is being considered for open-water disposal). The USACE should also state its assessment of project material suitability for specific removal and disposal options.

7.1 Physical Data

Physical data, specifically grain-size distributions, should be reported following the format below.

Sample #	% retained #8	% retained #16	% retained #30	% retained #50	% retained #100	% retained #200	% passed #200

7.2 Chemical Data

Chemical data should be reported in the format outlined in the following pages. Parameters listed but not analyzed should be left blank.

Data Reporting Format

Physical/Nutrients/Metals
All values reported in mg/kg dry weight unless otherwise noted

Parameter	Sample no.	Sample no.	Sample no.	*Detection Limit
Total solids (%)				
Volatile solids (%)				
Total kjeldahl nitrogen				
Ammonia				
Total Phosphorus				
Oil and Grease				
COD (mg/kg)				
Mercury				
Arsenic				
Silver				
Boron				
Barium				
Beryllium				
Cadmium				
Cobalt				
Chromium				
Copper				
Lithium				
Manganese				
Molybdenum				
Nickel				
Lead				
Tin				
Strontium				
Vanadium				
Yttrium				
Zinc				
Calcium (mg/g)				
Potassium (mg/g)				
Magnesium (mg/g)				
Sodium (mg/g)				
Aluminum (mg/g)				
Iron (mg/g)				

* where applicable

Data Reporting Format

Organochlorine Compounds
All values reported in ug/kg dry weight unless otherwise noted

Parameter	Sample No.	Sample No.	Sample No.	Detection Limit
TOC				
Total PCBs				
Aroclor 1242				
Aroclor 1248				
Aroclor 1254				
Aroclor 1260				
o,p-DDT				
p,p-DDT				
o,p-DDE				
p,p-DDE				
o,P-DDD				
p,p-DDD				
g-chlorodane				
Oxy-chlorodane				
Heptaclor				
Heptaclor epoxide				
Zytron				
b-BHC				
g-BHC				
Trifluralin				
Aldrin				
Methoxychlor				
Endrin				
DCPA				
Endosulfan I				
Endosulfan II				
Dieldrin				
1,2-Dichlorobenzene				
1,3-Dichlorobenzene				
1,4-Dichlorobenzene				
1,2,4-Trichlorobenzene				
Hexachlorobenzene				
2-Chloronaphthalene				
2-Chlorophenol				
2,4-Dichlorophenol				
2,4,6-Trichlorophenol				
Pentachlorophenol				
p-Chloro-m-cresol				
Hexachloroethane				
Hexachlorobutadiene				
2,3,7,8-TCDD				
2,3,7,8-TCDF				
2,3,7,8-TCDD TEQ				

Data Reporting Format

Polynuclear Aromatic Hydrocarbons and Miscellaneous Organic Compounds
All values reported in ug/kg dry weight unless otherwise noted.

Parameter	Sample No.	Sample No.	Sample No.	Detection Limit
TOC				
Acenaphthene				
Acenaphthylene				
Anthracene				
Benzo(a)anthracene				
Benzo(b)fluoranthene				
Benzo(k)fluoranthene				
Benzo(g,h,i)perylene				
Benzo(a)pyrene				
Chrysene				
Dibenz(a,h)anthracene				
Flouranthene				
Fluorene				
Indeno(1,2,3,-cd)pyrene				
Phenanthrene				
Pyrene				
Napthalene				
Dimethyl phthalate				
Diethyl phthalate				
Di-n-butyl phthalate				
Di-n-octyl phthalate				
Butylbenzyl phthalate				
bis(2-Ethylhexyl) phthalate				
Phenol				
2,4-dimethylphenol				
p-t-Butylphenol				
Nitrobenzene				
2-Nitrophenol				
4-Nitrophenol				
4,6-Dinitro-o-cresol				
2,4-Dinitrotoluene				
2,6-Dinitrotoluene				
N-Nitrosodipropylamine				
N-Nitrosodiphenylamine				
Isophorone				
1,2-Diphenylhydrazine				

Biological Data Reporting Format

All biological data should be reported in the format presently utilized by USACE Buffalo District. Information should be reported in tabular form for individual species. Synopsis of all species together should be presented in both tabular and graphic forms.

EXAMPLE FORMAT FOR INDIVIDUAL SPECIES

Mortality of (species name) used in (state test type; i.e., acute elutriate, sublethal, whole sediment, etc.) bioassay of (project name) sediments, location, date.

Site Number	Number Dead	$\bar{x}$	Percent Dead	$\bar{x}$
1A	2		10	
B	4	4	20	20
C	6		30	
2A	1		5	
B	2	2	10	10
C	3		15	

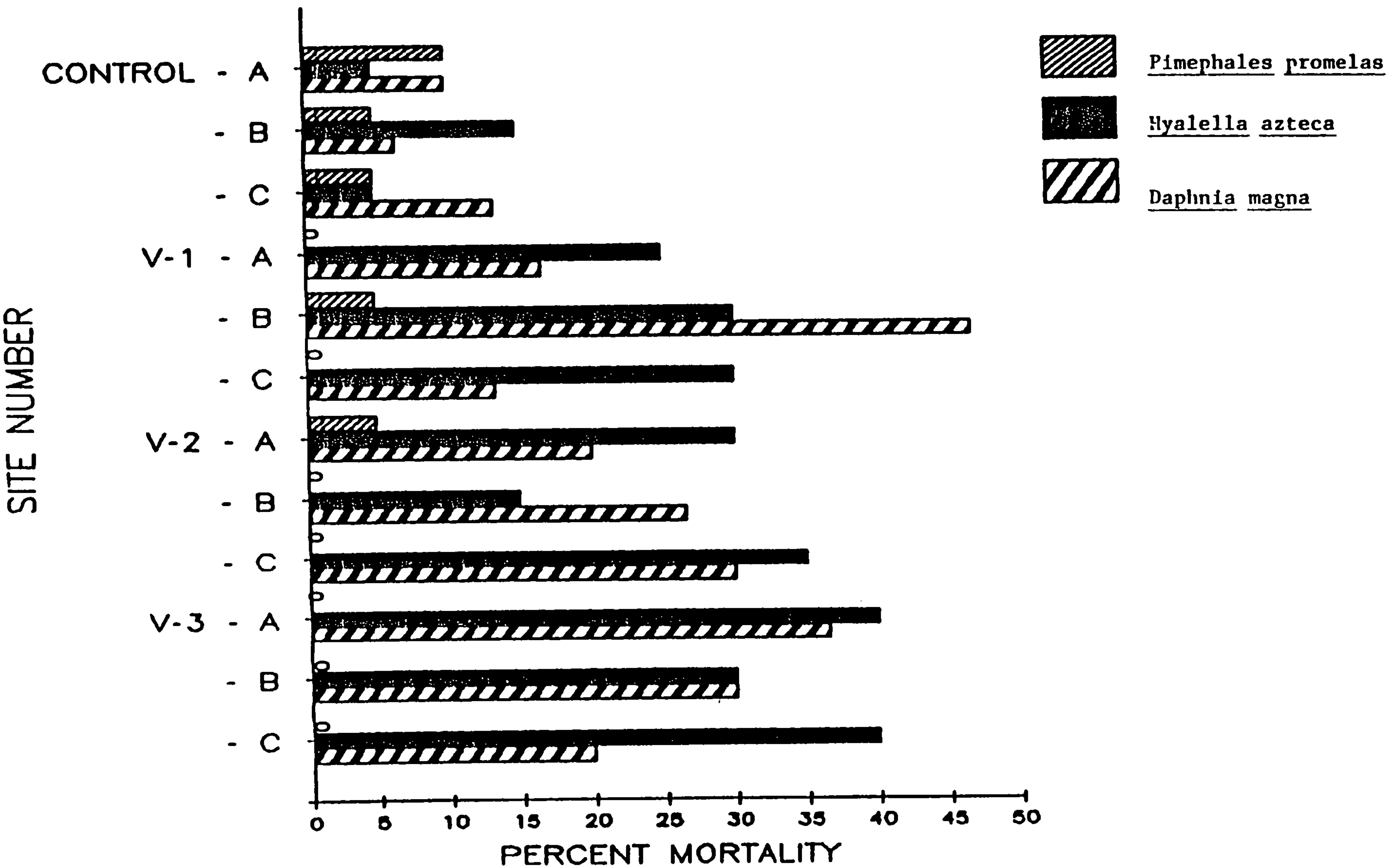
EXAMPLE FORMAT FOR TABULAR SUMMARY OF ALL SPECIES

Summary of Bioassay Results
% Average Mortality

Site Number	Species A	Species B	Species C
1	15	45	30
2	20	60	30
3	15	45	25

An example of bar graph synoptic format is included on the next page.

SEDIMENT BIOASSAY RESULTS
VERMILION HARBOR - OHIO



APPENDIX A

USACE Maintained Waterways in Region V

DEEP DRAFT COMMERCIAL CHANNELS & HARBORS

Alpena Harbor, MI
Ashland Harbor, WI
Ashtabula Harbor, OH
Black Rock Channel and Tonawanda Harbor, NY
Buffalo Harbor, NY
Burns Waterway Harbor, IN
Calumet Harbor & River, IL & IN
Channels in Lake St. Clair, MI
Channels in Straits of Mackinac
Charlevoix Harbor, MI
Cheboygan Harbor, MI
Chicago Harbor, IL
Chicago River, IL
Cleveland Harbor, OH
Conneaut Harbor, OH
Detroit River, MI
Duluth - Superior Harbor, MN & WI
Erie Harbor, PA
Fairport Harbor, OH
Frankfort Harbor, MI
Gladstone Harbor, Kipling, MI
Grand Haven Harbor, MI
Grays Reef Passage, MI
Green Bay Harbor, WI
Harbor Beach Harbor, MI
Holland Harbor, MI
Huron Harbor, OH
Indiana Harbor, IN
Kenosha Harbor, WI
Kewaunee Harbor, WI
Keweenaw Waterway, MI
Lorain Harbor, OH
Ludington Harbor, MI
Mackinac Island Harbor, MI
Manistee Harbor, MI
Manitowoc Harbor, WI
Marquette Harbor, MI
Menominee Harbor, MI & WI
Milwaukee Harbor, WI
Monroe Harbor, MI
Muskegon Harbor, MI
Ogdensburg Harbor, NY
Ontonagon Harbor, MI
Oswego Harbor, NY
Port Washington Harbor, WI
Presque Isle Harbor, MI
Rochester Harbor, NY

DEEP DRAFT COMMERCIAL CHANNELS AND HARBORS (cont.)

Rouge River, MI
Saginaw River, MI
Sandusky Harbor, OH
Sheboygan Harbor, WI
St. Clair River, MI
St. Joseph Harbor, MI
St. Marys River, MI
Sturgeon Bay and Lake Michigan Ship Canal, WI
Toledo Harbor, OH
Two Harbors, MN
Two Rivers Harbor, WI
Waukegan Harbor, IL

SHALLOW DRAFT COMMERCIAL & RECREATIONAL HARBORS

Bayfield Harbor, WI
Detroit Harbor, WI (Harbors at Washington Island)
Harrisville Harbor, MI
La Pointe Harbor, WI
Leland Harbor, MI
Petoskey Harbor, MI
Port Clinton Harbor, OH
Put-in-Bay Harbor, OH
Sackets Harbor, NY
St. James Harbor, MI (Beaver Island)

COMMERCIAL FISHING AND RECREATIONAL HARBORS

Algoma Harbor, WI
Barcelona Harbor, NY
Cape Vincent Harbor, NY
Cornucopia Harbor, WI
Detour Harbor, MI
Dunkirk Harbor, NY
Grand Marais Harbor, MI
Grand Marais Harbor, MN
Grand Traverse Bay Harbor, MI
Knife River Harbor, MN
Lac La Belle Harbor, MI
Manistique Harbor, MI
Michigan City Harbor, IN
Oconto Harbor, WI
Pensaukee Harbor, WI
Port Wing Harbor, WI
Vermilion Harbor, OH

RECREATIONAL HARBORS

Arcadia Harbor, MI
Au Sable Harbor, MI
Bay Port Harbor, MI
Belle River, MI
Big Bay Harbor, MI
Big Suamico River, WI
Black River Harbor, MI
Black River (Port Huron), MI
Bolles Harbor, MI
Caseville Harbor, MI
Chippewa Harbor, MI (Isle Royale)
Clinton River, MI
Eagle Harbor, MI
Great Sodus Bay Harbor, NY
Hammond Bay Harbor, MI
Inland Route, MI
Lexington Harbor, MI
Les Cheneaux Islands Channels
Little Lake Harbor, MI
Little River, NY
Little Sodus Bay Harbor, NY
Mackinaw City Harbor, MI
Morristown Harbor, NY
New Buffalo Harbor, MI
Niagara River, NY
Pentwater Harbor, MI
Pine River, MI
Point Lookout Harbor, MI
Portage Lake Harbor, MI
Port Austin Harbor, MI
Port Salinac Harbor, MI
Oak Orchard Harbor, NY
Olcott Harbor, NY
Rocky River Harbor, OH
Saugatuck Harbor, OH
Saxon Harbor, WI
Sebewaing River, MI
South Haven Harbor, MI
Tawas Bay Harbor, MI
Traverse City Harbor, MI
West Harbor, OH
Whitefish Pointe Harbor, MI
White Lake Harbor, MI
Wilson Harbor, NY

APPENDIX B - Comparison of Suggested Sampling Size to Historical Data

This section illustrates how suggested sediment volumes per one sample within different sediment Types compare to historical sampling efforts. Historical data were obtained from the Buffalo and Chicago Districts of the USACE. These data were broken out into Types based on the pollutional classification of the material and the method of material disposal. Material volume was then compared to the number of samples used to characterize the project. Final comparisons of suggested volumes versus historical volumes are given as percent increases or decreases.

APPENDIX B

Calculation of Volume versus Type
Type II

Name	Volume (yd^3)	Number of samples	1 sample every yd^3	project % of total volume considered
onneaut	104,000	16	6,500	9.5
rie	137,000	16	8,562	12.5
airport	172,000	17	10,117	15.8
uron	146,000	16	9,757	13.4
ak Orchard	28,000	7	4,000	2.5
ochester	184,000	14	13,142	16.9
ocky River	53,000	6	8,833	4.9
andusky	220,000	17	13,058	20.4
ermilion	28,000	12	2,333	2.5
ilson	16,000	6	2,666	1.5
TOTAL	1,090,000	127	Average = 8,583	99.9

1 sample per given volume calculation also derived by a % total volume basis, a weighted average.

Volume = (6,500)(.095) + (8,562)(.125) + (10,117)(.158) + (9,757)(.134) + (4,000)(.025)

+ (13,142)(.169) + (8,833)(.049) + (13,058)(.204) + (2,333)(.025) + (2,666)(.015)

= 617 + 1070 + 1598 + 1307 + 133 + 2220 + 432 + 2663 + 58 + 40

= 10,138 yd^3

APPENDIX B

Calculation of Volume versus Type
Type III

Name	Volume	Number of Samples	1 Sample every yd^3	Project % of total volume considered
Buffalo	230,000	39	5,900	20.0
Cleveland	526,000	29	18,137	45.6
Lorain	121,000	21	6,226	10.5
Calumet River	207,000	14	14,786	17.9
Main Stem-Chicago River	70,000	5	14,000	6.0
TOTAL	1,154,000	108	Average= 10,686	100.0

1 sample per given volume calculation also derived by a % total volume basis, a weighted average.

Volume = (5,900)(.20) + (18,137)(.456) + (6,226)(.105) + (14,786)(.179) + (14,000)(.06)

= 1180 + 8270 + 653 + 2646 + 840

= 13,589

Appendix B

Type II - remember two different sample sizes are proposed based on past historical data of Type II sediments (suitable versus non-suitable for open-water disposal)

A. One sample every 8,000 yd^3 to historical averages (material non-suitable)

Weighted average

$$\frac{10{,}138\ yd^3}{100\%} = \frac{8{,}000\ yd^3}{x} \qquad x = 78\%$$

Represents a 22% decrease in volume requiring one sample

Comparison of proposed sample size to the second (weighted) average is more representative of real situation.

B. One sample every 10,000 yd^3 to historical averages (history of open-water disposal)

Weighted average

$$\frac{10{,}138\ yd^3}{100\%} = \frac{10{,}000\ yd^3}{x} \qquad x = 98\%$$

Represents a 2% decrease in volume requiring one sample

Type III

A. One sample every 10,000 yd^3

Weighted average

$$\frac{13{,}589\ yd^3}{100\%} = \frac{10{,}000\ yd^3}{x} \qquad x = 74\%$$

Represents a 27% decrease in volume requiring one sample

B. One sample every 15,000 yd^3

Weighted average

$$\frac{13{,}589\ yd^3}{100\%} = \frac{15{,}000\ yd^3}{x} \qquad x = 110\%$$

Represents a 10% increase in volume requiring one sample

APPENDIX C

Significant Wastewater Parameters for Selected Industrial Classifications

	Aluminum	Automobile	Beet Sugar	Beverage	Fruits & Vegs.	Livestock Feeding	Dairy	Nitrogen Fertilizer	Phosphate Fertilizer	Flat Glass	Cement/Concrete	Grain Milling	Leather	Meat Products	Metal Finishing	Petroleum Refining	Plastics & Synthetics	Pulp & Paper	Steam Power	Steel	Textiles
Color			X	X	X		X						X	X		X		X			X
Suspended Solids	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oil and Grease	X	X	X	X									X	X	X	X	X	X		X	X
BOD_5		X	X	X	X	X	X			X		X	X	X		X	X	X	X		X
Ammonia Nitrogen		X	X			X	X	X	X				X	X		X				X	
Phosphorus	X	X		X	X	X	X		X	X	X			X		X	X				
Chromium		X						X		X	X		X		X	X		X	X	X	X
Cyanide		X													X	X	X			X	
Copper		X								X					X	X			X		
Nickel		X													X						
Iron		X							X	X					X	X			X	X	
Zinc		X						X		X	X				X	X	X		X	X	
Phenols	X	X														X	X	X		X	X
COD		X			X	X	X			X	X	X	X		X	X	X	X			X
Chlorides		X					X	X					X			X				X	
Nitrates								X		X							X				
Sulfate		X						X	X	X						X	X			X	
Tin		X								X										X	
Lead		X													X	X					
Cadmium		X													X						
Total Dissolved Solids	X	X	X	X	X	X		X			X	X	X	X	X	X	X	X	X		X
Alkalinity			X								X		X								X
Temperature			X	X	X		X				X	X	X			X			X	X	X
Toxic Organics			X	X									X				X				X
Free Chlorine	X																		X		
Fluoride	X																				
pH	X		X	X	X	X	X				X	X	X	X		X	X	X	X	X	X
Aluminum	X								X												
Total Coliforms			X	X	X	X									X			X			

(taken from Eckenfelder, W.W., Jr. 1980. Principles of Water Quality Management. CBI Publishing Co.; Boston, Massachusetts. 717 pp.)

Appendix D
Sampling Effort Costs and Considerations

Below are approximate costs for different types of sampling efforts ranging from simple grab samples to more difficult core samples. Included is a list of required equipment, approximate costs, and limitations and/or advantages of each type of sampling effort. Prices listed were taken from records of recent USACE sampling efforts. Again, the costs listed are not intended to be firm prices, but are included to give a feeling for the expense involved when considering a particular sampling program.

A. Simple Grab Sampling

1. Equipment and cost

	Cost
a. small (14-20') boat	$100/day
b. 2-3 man crew	$400/day
c. hand-held mini-ponar	$ 10/day
d. supplies (containers, solvents, etc.)	$50-100/day
TOTAL	$560-610/day + mobilization/ demobilization*

2.Limitations
 a. effort is restricted to protected waters, rivers, and very near-shore lake areas
 b. depth limitations (hand-held ponar)
 c. accuracy of position required (sighting by eye in this case)
 - if more accurate sighting required, add $25/hr + travel/per diem for two-man survey crew
 d. there is a limited quantity of sample obtainable by this method

B. Larger Boat doing Grabs

1. Equipment and cost

	Cost
a. 30-60' boat with more advanced equipment (radar, Loran C, power winch)	$300-400/day
b. 4-6 man total crew (boat and sampling)	$400-600/day
c. equipment	$100-200/day
TOTAL	$800-1200/day + mobilization/ demobilization

2. Limitations and/or advantages
 a. capability to self-fix position
 b. range includes anything required for this type of sampling effort

C. Simple Core Sampling

1. Equipment and cost — Cost **
   a. small (20-50') spud barge
   b. support boat
   c. tripod or Acker skid drill rig
   d. 3 man crew (driller, oiler, helper)
   e. sample handler
   f. split spoon and casing
   g. supplies

   TOTAL — $1500/day + mob/demob

2. Limitations and/or advantages
   a. effort is restricted to protected waterways
   b. restricted to shallow water depths owing to limited spud depth capability
   c. coring capability down to 40' from water surface
   d. requires survey crew to fix position

D. Advanced Core Sampling

1. Equipment and cost — Cost**
   a. large (80-150') spud barge
   b. support boat
   c. 5-6 man crew
   d. truck-mount drilling rig
   e. sampler (split spoon with casing; hollow stem auger; piston-tube sampler; etc.)
   f. supplies

   TOTAL — $3000-4000/day + mobilization/demobilization**

2. Limitations and/or advantages
   a. can work effectively in up to 30' water depth
   b. can tolerate small wave action
   c. difficult to assign exact location without survey crew (see A. Simple Grab)
   d. have capability to use crane to collect large demonstrative samples

* mobilization/demobilization cost vary dependent upon the type operation and the location of the project relative to the contractor's home base

** individual cost breakdowns not available for these operations

*** a recent 2-day effort collecting core samples at eight locations at Waukegan Harbor cost approximately $14,500

Appendix D
Chemical Analytical Costs

Listed below are analytical costs taken from USACE analysis contract records. They are included to give persons a feel for general analytical costs and are not to be considered firm prices. Analysis of TOC is not included in these figures, but can run between $30-40 per sample. Analysis of PAHs, chlorinated pesticides, and all other EPA priority pollutants by GC/MS will run around $1000 a sample. Costs will vary from vendor to vendor, and project size will obviously influence the price per sample (discounts may be available for a larger number of samples) and the contract type utilized for analysis, based on that projected cost. Below are costs per sample for analysis of the parameters listed in the 1977 Guidelines.

VENDOR	DATE	BULK CHEMISTRY 1-5	5-7	SIEVE ANALYSIS (with hydrometer)
Private I	July,1981	$185		*
Government I	April,1983	$371		$85
Private II	August,1984	$420	$443	$80
Private III	July,1985	$520	$468	*
Private IV	July,1987	$474	$450	$120

* sieve analysis price not stated in available list
- discount break and end points vary with vendor
- discount terms not stated in available list

Leachate costs run approximately $100 a sample.

Appendix D
Benthic Macroinvertebrate Survey Costs

Listed below are time estimates for components of a benthic macroinvertebrate survey. Also included is a cost estimate, based on a wage of $15/hour.

Survey Component	Hours/Sample	Cost/Sample
-Sampling and washing materials in sieves	1	$15
-Sorting of sample	1-4	$15-$60
-Sample preparation	1	$15
-Taxonomy	4-6	$60-$90
	Total hours/ sample = 7-12	Total costs/ sample = $105-$180

Bioassay Costs

Listed on the following page are ranges of costs associated with different toxicity testing efforts. There are a variety of bioassays available on the market today. The tests listed are those recommended as applicable to the Great Lakes Region in IJC (1987) "Guidance on Assessment and Remediation of Contaminated Sediment Problems in the Great Lakes". A more extensive discussion concerning bioassays and sediments of the Great Lakes may be found in the same aforementioned document. Again, these are approximate costs and will vary depending on the contracted laboratory and the number of samples run.

Test Organism	Test Type	Test Medium	Endpoint	Time Required (days)	Cost per Test
*Cladoceran	lethal	elutriate	death	4	$150 - $800
*Cladoceran	sublethal	sediment	fecundity	10	$500 - $1500
*Chironomus tentans	acute/sublethal	sediment	growth/emergence	23	$500 - $1500
*Hyallela azteca	sublethal/ partial life-cycle	sediment	growth/reproduction	28	$1000
*Pimephales promelas	accumulation	sediment	uptake	10	$1500

* includes Daphnia magna, D. pulex, and Ceriodaphnia ; D. magna testing is more readily available on a commercial scale

* these tests are applicable to bioaccumulation; add analytical costs of tissue analysis for parameters of concern

* additional cost associated with tissue analysis; will vary depending upon the constituent(s) of concern

Appendix E

USACE Contract Types for Sampling and Analysis

The USACE is responsible for the contracting of services for sediment collection and testing. There are four possible options regarding the contracting of services by the USACE. Three are termed service contracts (I,II,&III below) and the fourth type is a professional contract. It is important that regulators have at least a brief knowledge of these contract types, understanding the constraints and advantages of each. Each contract type and its conditions are listed below.

Option I: Internal (within the USACE)

- USACE "contracts" itself to do sampling and/or analysis
- USACE prepares the raw data into report form
- Sediment sampling method limited to grab samples only

"Contract" takes 1-2 weeks to arrange

Option II: Through other Federal Agencies

- includes USGS, USFWS, USEPA, etc.
- generally limited to grab samples

Contract takes 2-4 weeks to arrange

Option III: Through all other interested parties

- includes State agencies, universities, private laboratories, etc.
- breaks into two types dependent on the anticipated cost of services

a. less than $25,000
- requires estimates from three chosen contractors; lowest estimate is awarded the contract
- requires laboratory inspection for QA/QC
- takes 3-5* weeks to confirm contract

b. more than $25,000
- requires public announcement and open bids
- requires 2-3* months to confirm contract
- requires laboratory inspection for QA/QC

* labor rates must be anticipated 3-4 months in advance
- requires knowledge of what personnel are required to complete the task (i.e. chemist, lab technician, etc.)
- Labor Dept. is consulted for updated wage determination

Appendix E
USACE Contract Types

Option IV: Open-end contract

- a company/individual is retained by open-end contract
- this entity is on line to do any work for a specified period of time
- these contracts can be obtained only through anticipated need of specific services for a given period of time; cost-efficiency must be demonstrated
- requires 6-12 months lead time to obtain such a contract
- usually written as a one-year contract with an option to renew for a second year
- can obtain up to $500,000/yr worth of work; individual projects are limited to $75,000
- requires 4-5 weeks to confirm individual project contracts

Appendix F
Quality Assurance Project Plan (QAPP)

The following section is a generic Quality Assurance Project Plan geared for the collection and analysis of sediments from navigational maintenance dredging projects.

A preliminary QAPP should be submitted with the Preliminary Sampling and Testing Plan. This should include completed Sections 1, 2, 3, 4, 5, 6, 7, 9, 10.1, 10.2, 14, and 15.

Once the analytical laboratory doing the sediment analysis has been contracted, internal quality control information covered in Sections 8, 11, 12, and 13 should be submitted.

Sections 10.3, and 16 should be submitted when reporting of data occurs. Any Section which required revision owing to a change in methods or sampling strategy should also be submitted in its revised form at this time.

DRAFT

QUALITY ASSURANCE PROJECT PLAN
For
Sampling and Testing of Sediments
at
(Project Name)
(Project Location)

Prepared by

United States Army Corps of Engineers
(Your District)
(Your Location)

Approved for
U.S. Environmental Protection Agency

____________________________ Date ______

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3.0 PROJECT DESCRIPTION

3.1 Background

Provide a synopsis of project background.

The information necessary to complete this section is sufficiently covered by narratively describing items 1-16 of the Preliminary Project Design reporting format provided in the USEPA Region V Sediment Sampling and Testing Guidance (from here referred to as "Sediment Sampling and Testing Guidance").

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED BEFORE THE FINAL QAPP.

3.2 Plan Overview

Provide a description of the proposed plan, including number and location of sampling stations. The level and type(s) of testing required is directly related to the proposed method of material removal and disposal, as stated in Items 15 and 16 of the Preliminary Project Design format. The required information can be summarized from Item 11(g) and Supplement A of the Preliminary Project Design reporting format (see 3.1).

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED BEFORE THE FINAL OAPP.

3.3 Monitoring Parameters

List all parameters of analysis and testing.
Parameters should be segregated into physical, chemical, and biological testing.

List any other testing being performed (i.e., elutriate, leachate, etc.)

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED BEFORE THE FINAL QAPP.

It is the responsibility of the USACE to provide the testing data in addition to the completed QAPP, to all Regulatory Agenices involved in the review of navigational maintenance dredging projects through the 401 certification process, 404(b)(1) guidelines, or the NEPA process. The physical, chemical, and biological testing data shall be submitted following the format specified in the Sediment Sampling and Testing Guidance.

THIS SECTION SHALL BE INCLUDED, AS WRITTEN, IN BOTH THE PRELIMINARY AND FINAL QAPP.

4.0 ORGANIZATION AND RESPONSIBILITY

The USACE is responsible for the design of a preliminary sediment sampling and testing plan (hence referred to as "Preliminary Sampling Plan"), based on project-specific information and considerations. It is the responsibility of the USEPA to provide the USACE with project-specific contaminant point-source information of both industrial and municipal dischargers.

Project design should follow, at a minimum, the guidance set forth in EPA/CE-81-1 "Procedure for Handling and Chemical Analysis of Sediment and Water Samples" and the USEPA Region V "Guidance for the Design and Execution of Sediment Sampling and Testing Efforts" (from here referred to as "Sediment Sampling and Testing Guidance").

It is the responsibility of the USACE to submit the Preliminary Sampling Plan to the following Regulatory Agencies for a thirty day review and comment period:
- USEPA
- U.S. Fish and Wildlife Service
- State Regulatory Agency(ies) involved in the process from the respective State in which the project is located

The Preliminary Sampling Plan shall be submitted in the format outlined in the Sediment Sampling and Testing Guidance. The Preliminary Sampling Plan shall be accompanied by a Preliminary Quality Assurance Project Plan (QAPP). Only the sections indicated herein must be completed for the Preliminary QAPP.

All reviewing Agencies shall submit to the USACE, in writing, comments, approval, and/or revisions to the Preliminary Sampling Plan. Any proposed changes in sampling site location(s), number of sampling sites, methods of sampling, or parameters of analysis and testing shall be justified within these written comments. Final Project Design (the actual sampling and testing plan to be executed) shall be based upon those parameters of concern identified in the Preliminary Sampling Plan, along with the additional parameters identified and justified by Regulatory review. Final Project Design shall be submitted by the USACE to all Regulatory Agencies identified above before the sampling and testing plan is executed.

It is the responsibility of the USACE to contract services for the collection, analysis, and testing of project sediments, following the strategy outlined in the approved Final Project Design. USACE shall supply all contractors with the minimum QA/QC requirements for sediment sampling, analysis, and testing outlined in the revised QAPP associated with the Final Project Design. Once an IFB has been advertised and subsequent bids are received, USACE shall supply to Regulatory Agencies information concerning contractor Internal Quality Control required under Sections 8, 11, 12, and 13 of the QAPP.

5.0 QUALITY ASSURANCE OBJECTIVES

State the QA objectives set forth for all sampling and testing contractors.

Chemical analysis (at minimum):
1) should include ± 10% replicability for inorganic analysis of sample replicates
2) should include ± 30% replicability for duplicate analysis of matrix samples spiked with selected organics.

For biological testing:
1) test results with >10% mortality of controls will be unacceptable

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

6.0 SAMPLING PROCEDURES

This section of the QAPP should be covered by submitting the Preliminary Sampling Plan for the Final Project Plan, depending upon the stage of the project.

The Sampling Plan should follow, at a minimum, the guidelines set forth in EPA/CE-81-1 "Procedure for Handling and Chemical Analysis of Sediment and Water Samples" and the USEPA Region V Sediment Sampling and Testing Guidance.

This section should include the number and location of sampling sites, as well as the type of samples being taken.

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

7.0 SAMPLE CUSTODY

USACE should identify the exact procedures followed in tracking sample chain of custody.

The suggested format is that outlined on pp. 20-24 of "Methods Manual for Bottom Sediment Sample Collection" (EPA 905/4-85-004).

THIS SECTION MUST BE INCLUDED IN BOTH THE PRELIMINARY AND FINAL QAPP.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

This section should include the calibration procedure and frequency practiced by the specific analytical laboratory contracted for sediment chemical analysis. It should include information concerning all major equipment to be utilized during the sediment analysis.

THIS SECTION WILL NOT BE COMPLETED DURING THE PRELIMINARY QAPP, SINCE ANALYTICAL CONTRACT LABORATORY IS NOT KNOWN AT THIS TIME.

THIS SECTION SHOULD BE COMPLETED AND SUBMITTED BEFORE SEDIMENT ANALYSIS OCCURS. THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.

9.0 ANALYTICAL AND TESTING PROCEDURES

9.1 Chemical Analysis

List all parameters for chemical analysis and the proposed analytical method to be followed. Approved methodology is outlined in EPA/CE-81-1 "Procedure for Handling and Chemical Analysis of Sediment and Water Samples." All other proposed methods for analysis are subject to detection limit criteria and regulatory approval. Parameters and methods should be reported in the following format:

PARAMETER	METHOD	DETECTION LIMIT

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

9.2 Biological Testing

If project contains materials being considered for open-water disposal, identify the species of organisms being used to assess contaminant bioavailability. Also identify the protocols followed for the specific testing procedures. Suggested biological tests are listed in the Sediment Sampling and Testing Guidance.

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 Data Reduction

This section should include identification of the data reduction scheme planned for collected data, including all equations used to calculate the concentration or value of the measured parameter and reporting units.

THIS SECTION MUST BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

10.2 Data Validation

This section should include the principal criteria that will be used to validate data integrity during the collection and reporting of data.

THIS SECTION SHOULD BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MAY BE REVISED FOR THE FINAL QAPP.

10.3 Data Reporting.

Data should be reported to all Regulatory Agencies in the following formats outlined in the Sediment Sampling and Testing Guidance. Formats are provided for physical and chemical analysis, as well as biological testing.

THIS SECTION WILL NOT BE INCLUDED IN THE PRELIMINARY QAPP.
THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.

11.0 INTERNAL QUALITY CONTROL

This section should contain information concerning contractor laboratory internal Quality Control. Laboratory written QC manual should be provided as an attachment.

It is recommended that duplicates/replicates and matrix spike duplicates be run on a ratio of one per eight samples analyzed.

THIS SECTION CAN NOT BE COMPLETED DURING THE PRELIMINARY QAPP.

THIS SECTION SHOULD BE COMPLETED BEFORE ANALYSIS OCCURS.
THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.

12.0 PERFORMANCE AND SYSTEMS AUDIT

This section should include USACE results of contractor laboratory certification, as well as USACE data validation conclusions.

THIS SECTION CAN NOT BE COMPLETED DURING THE PRELIMINARY QAPP.
THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.

13.0 PREVENTIVE MAINTENANCE

This section should include preventive maintenance records from the contracted analytical laboratory responsible for sediment chemical analysis.

THIS SECTION CAN NOT BE COMPLETED DURING THE PRELIMINARY QAPP.

THIS SECTION SHOULD BE COMPLETED BEFORE ANALYSIS OCCURS.
THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

This section should show specific routine procedures used to assess data precision, accuracy and completeness. This includes equations used to assess these parameters, along with an explanation of the methods used to gather data for the precision and accuracy calculations.

THIS SECTION SHOULD BE COMPLETED DURING THE PRELIMINARY QAPP.
THIS SECTION MAY REQUIRE REVISION PRIOR TO THE FINAL QAPP.

15.0 CORRECTIVE ACTION

This section should explain what form of corrective action will be taken if the Data Quality Objectives (defined in Section 5.0) are not met during the process of Data Validation explained in Section 10.2.

THIS SECTION MUST BE INCLUDED IN BOTH THE PRELIMINARY AND FINAL QAPPs

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

This section should include any QA reports the contractor laboratory(ies) supply to the USACE.

THIS SECTION CAN NOT BE COMPLETED DURING THE PRELIMINARY QAPP.
THIS SECTION MUST BE INCLUDED IN THE FINAL QAPP.